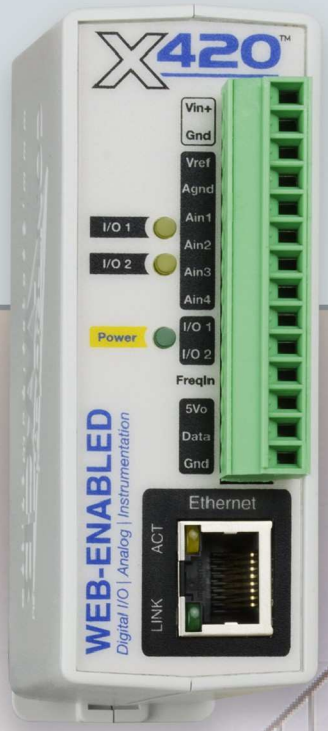


X420 Web-Enabled

Digital I/O | Analog | Instrumentation

DIREKTRONIK

USERS MANUAL

Rev 1.0

X-420 Features

Four analog inputs (16-bit):
±1.25V, ±2.5V, ±5.0V, ±10V, 4-20mA
Two configurable digital inputs/outputs
Two pulse counters
Frequency input
Up to 16 1-Wire sensors
9 to 28V DC and POE power options
Built-in web server (HTTPS supported)
Control I/O on other ControlByWeb devices
Control/Logic Task Builder
Log local and remote I/O
Real-time clock with manual or NTP time sync
Email alerts (up to 8 addresses)
Modbus/TCP, SNMP V1, V2 & V3, and Remote Services
Supports BASIC scripts
Simple and easy to use
5-year warranty

CONTROL by WEB™
www.ControlByWeb.com

a division of Xytronix Research & Design, Inc. Nibley, Utah, USA

X-420 User Manual Revisions	
Revision	**Description**
1.0	Initial release

Table of Contents

Section 1: Introduction

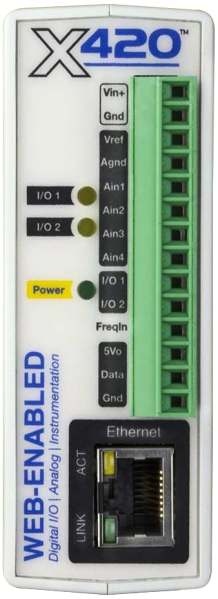
The X-420™ is a multifunction web-enabled industrial control and instrumentation module. The X-420 has four multi-function analog inputs, two digital I/O with programmable pull resistors, two pulse counters, one frequency input, 16 general purpose timers, 16 general purpose registers, and a 1-Wire® bus. The 1-Wire bus supports up to 16 sensors for monitoring temperature, humidity and more. It can be controlled and/or monitored over any TCP/IP network including private networks, IP-based industrial control networks, and the Internet. Users can operate the X-420 using a web browser, the CBW Mobile app, or custom applications written for a computer, PLC, or other automation controller.

The X-420's built-in interface allows you to create custom "Tasks" for simple and advanced control logic. Easily create tasks based on time, input or outputs' status, or device responsiveness. The X-420 also has a built-in BASIC interpreter for custom applications not achievable through the Task Builder system.

The module is powered by an external wall transformer (9-28 VDC), solar panel, or other DC power source. The model X-420-E is powered over the twisted pair Ethernet cable.

Other features are also included such as, email notification, event scheduling, and logging. The X-420 can control and monitor up to 32 remote devices, graph logged data, FTP logged data, email logged data, send encrypted emails, and monitor its power supply voltage. The X-420 supports a number of Ethernet protocols including HTTP/HTTPS, Modbus/TCP, SNMP V1,V2 & V3, NTP, SMTP(Encrypted), and FTP/FTPS. The status of the device can be retrieved in human readable formats XML and JSON.

The X-420 supports TLS V1.2 encryption as well as cloud integration(not required) for easier configuration and access. Specifically the X-420 supports HTTPS connections, can send encrypted emails, can communicate with remote devices using TLS, and send logged data to FTP servers over an encrypted connection. In addition, the X-420 can be configured to automatically connect to ControlByWeb.cloud, ControlByWeb's cloud service. This feature is not required, but does simplify the configuration process and internet access to an X-420 installed behind a network router by eliminating manual configuration of the device and port forwarding setup on routers.



1.1 Features

- Built-in web server for configuration and remote monitoring (HTTPS supported).
- Four channel, programmable, 16-bit, analog data acquisition system.
- Two 5V digital input/outputs with programmable pull resistors. Use as inputs to monitor wind speed or rainfall etc. Use as outputs to control relays or other devices.
- Two pulse counters.
- Millivolt AC frequency input for use with magnetic or optical wind speed sensors
- 1-Wire port for connecting up to 16 digital sensors for measuring temperature, humidity and more.
  - 1-Wire temperature sensors are available in various packaging and accuracy. A list of compatible 1-Wire sensors can be found in the *Optional Accessories* table.
- Sensor/Input status can control I/O on other ControlByWeb devices.
- Control/Logic Task Builder for custom control with no scripting necessary.
- Configurable logging of all I/O, both local and remote.
- Real-time clock with manual or NTP time sync.
- Send email alerts (up to 8 email addresses) based on any sensor or input conditions.
- Send encrypted emails.
- Auxiliary protocols including: *Modbus/TCP, SNMP V1,V2 & V3,* and *Remote Services.*
- Custom scripts using the built-in BASIC interpreter provide additional flexibility.
- Ethernet auto-negotiation automatically selects speed, duplex mode and works with straight or crossover cables.
- Simple and easy to use.
- Powered from a 9 to 28VDC power adapter. The power supply voltage is monitored internally and can be monitored and logged. The model X-420-E is an Ethernet powered device (PD).
- 5-year warranty.

Analog Inputs (4)
The X-420 features a four-channel, 16-bit, analog data acquisition system. Each channel is configurable for single-ended, differential or 4-20mA input operation. Programmable voltage ranges include; ±1.28V, ±2.56V, ±5.12V and ±10.24V. The 4-20mA mode enables a precision internal shunt resistor and configures the A/D for ±5V operation. This feature allows direct connection to 0-20mA current loop transducers. Use with industrial sensors, wind direction sensors, pyranometers, pressure transducers, and much more.

For applications where more than two digital inputs are needed, the analog inputs can be configured as pseudo digital inputs with a boolean (true/false) state. The input voltage is compared to a fixed threshold to determine a true/false state. The input is considered “true” when the voltage rises above 3.5V and “false” when it falls below 1.5V. A digital pulse counter or frequency measurement can be enabled for analog inputs that are configured as digital inputs.

Digital I/O (2)
Programmable as 5V logic outputs or inputs.
Programmable pull-up or pull-down resistors on inputs.
Pulse counter.
Pulse rate, 200 Hz max

Frequency Input
AC coupled frequency input. Suitable for use with magnetic and optical wind speed sensors. Use with an AC transformer to monitor AC line or generator frequency.

1-Wire Sensor Bus (16)
The X-420 has a 1-Wire port for connecting up to 16 digital sensors for measuring temperature, humidity and more. The sensors are available in several configurations, are interchangeable and require no calibration. The sensors require three connections for communications and power (+5V, Gnd, Data). Control a digital I/O or trigger email messages based upon these values.

Remote Devices (32)
Control and monitor up to 100 I/O points, including local and remote I/O. Up to 32 other ControlByWeb products can be added to the X-420. Once a remote device has been added to the X-420 and the desired I/O on that device has been configured, the remote I/O function the same as the local I/O on the X-420.

Power Supply
The X-420 employs a modern switch-mode power supply which works from 9 to 28VDC. With this type of power supply, the current draw decreases as the voltage increases. The model X-420-E is an Ethernet powered device (PD) and receives power along with data on the twisted pair Ethernet cable. The X-420-E can also accept power on the Vin+ and Gnd terminals. The power supply voltage (Vin+) is monitored internally and can be displayed, logged, used to control a digital I/O and configured to send email notifications.

Real-time Clock
Manual or NTP capability.

Control/Logic Task Builder
Easily program up to 50 scheduled task, 50 conditional tasks, and 20 Override Schedules.

Logging
Configurable logging of analog input voltages, 1-Wire sensor data, Vin and Register values, both local and remote. System logging of device operating parameters and events, such as power reset and NTP requests.

Graphing
Logged data can be graphed directly by any HTML 5 compatible web browser.

Email Notification
Send email alerts based on any sensor or input conditions, such as temperature, time, digital inputs, power supply levels, and more. Send text messages to a cell phone through a wireless carrier's email bridge. The X-420 supports encrypted emails using either implicit or explicit TLS (STARTTLS).

BASIC Script
The X-420 has a built-in BASIC interpreter for custom applications/logic not available in the built-in Task Builder.

Web Server and Protocols
All built-in services and protocols are configurable through the built-in, password protected, TLS enabled web server (HTTP/HTTPS). Other supported protocols include Modbus/TCP, and SNMP V1,V2 & V3. The X-420 IP address configuration can be either static or set through DHCP.

1.2 Applications

The X-420 was designed to meet a broad range of industrial applications. It works well as a stand-alone device that can be controlled using a web browser, or as a convenient way to add I/O to a computer or existing system. It can easily be configured using its menus and drop-down lists, or it can run a simple BASIC script. Many of its features such as scheduling, logging, input state monitoring, and the ability to control both local and remote I/O make the X-420 a powerful, yet simple controller.

Use the X-420 to monitor sensors, switches, fluid level, battery voltage, temperature, humidity, and much more. A few example applications include:

- I/O Extender
- POE powered weather station
- Monitor wind speed, wind direction, temperature and humidity
- Process Controller
- Monitor fluid level from your office
- Monitor fluid level in a tank and control a remote relay to operate a pump when needed.
- Monitor temperature and water level with your smart phone

The X-420 can be operated using a web browser through its built-in, customizable control page, or by sending Modbus/TCP requests and/or SNMP requests. Custom applications can also be written to communicate with the device using and of the aforementioned protocols (HTTP, MODBUS, SNMP).

The X-420 can control up to 100 local and remote I/O. The local I/O count towards the 100 I/O total. Some local I/O cannot be added/removed such as the analog and digital I/O. For example, you could configure the device to monitor 91 remote I/O and 9 of the non-configurable local I/O. Or along with the 9 non-configurable local I/O, you could add 16 local 1-Wire sensors, 16 local registers, and 16 local timers and have 43 remote I/O.

1.3 Part Numbers and Accessories

The X-420 is currently available in two different models:

Part Number	Power Supply Requirements
X-420-I	9-28VDC
X-420-E	Power Over Ethernet and/or 9-28VDC

1.3.1 Optional Accessories

Accessory	Description	Part Number
Power Supply	Regulated, DIN-rail / wall mount 24V DC, 1.75Amp, 100-240V AC Input	2868648
Power Supply	Regulated, plug in 12V DC, 1.5Amp,100-240V AC Input	PS12VW1.5-B
Temperature/Humidity Sensor Probe 	Digital temperature and humidity sensor probe -40°C to +80°C ±0.4°C, 0-99%RH ±2%	X-DTHS-P
Thermocouple to 1-Wire Adapter 	Thermocouple to 1-Wire interface, Type K -200°C to +1250°C, ±.5°C	X-TC1W-K
Temperature Sensor	Digital temperature sensor with 12 inch wire leads. Note: Leads may be extended -55°C to +125°C (±0.5°C from -10°C to +85°C)	X-DTS-U
Temperature Sensor	Digital temperature sensor with 3 foot wire leads (housed in a water resistant stainless steel probe) -55°C to +125°C (±0.5°C from -10°C to +85°C)	X-DTS-S3C
Temperature Sensor	Digital temperature sensor with 32 foot wire leads (housed in a water resistant stainless steel probe) -55°C to +125°C (±0.5°C from -10°C to +85°C)	X-DTS-S32C
Spare Connector	14-Pin Connector Plug	X-TERM14A

1.4 Security Notes

The X-420 is a dedicated device and does not employ a general purpose computer operating system (i.e. Windows, Linux etc.) It does not have features such as telnet, SSH, nor uncontrolled open ports. This means it is extremely difficult, if not impossible, for someone to 'break in' to the X-420 and access other devices on your local network. The simplicity of the X-420 makes it an inherently secure device. Nevertheless, as with any device installed on a network, appropriate security precautions should be observed. Where security is concerned, access to the device should be limited to using encrypted connections to the web server server using HTTPS. Unencrypted access can be disabled in the Network setup page.

It is recommended that passwords be enabled for the *Administrators*, *Managers* and perhaps *Users*. Passwords should be at least 8 characters in length and use a combination of upper and lower case letters and numbers. For additional security, the X-420 includes an IP filter and can be used in conjunction with an external firewall to further limit access to selected IP addresses.

The firmware in the X-420 can be upgraded, but not over the internet. By design, a firmware upgrade requires physical access to the *Restore Defaults* button on the module. See Appendix B: Installing New Firmware.

1.5 Connectors & Indicators

I/O Connector

The X-420 has a 14-position removable screw terminal connector for making connections to the power source, analog inputs, digital inputs, and temperature/humidity sensors.

Pin	Description
Vin+	Power Supply VDC+ (9-28 VDC) DO NOT EXCEED MAXIMUM POWER SUPPLY VOLTAGE.
Gnd	Ground (Vin-) power supply input.
Vref	+5.0 Reference output
Agnd	Analog ground for analog inputs 1-4
Ain1	Analog Input 1+ (single-ended mode) or Analog input 1+ (differential mode) ±1.28V, ±2.56V, ±5.12V, ±10.24V and 0-20mA
Ain2	Analog Input 2+ (single-ended mode) or Analog Input 1- (differential mode) ±1.28V, ±2.56V, ±5.12V, ±10.24V and 0-20mA
Ain3	Analog Input 3+ (single-ended mode) or Analog Input 3+ (differential mode) ±1.28V, ±2.56V, ±5.12V, ±10.24V and 0-20mA
Ain4	Analog Input 4+ (single-ended mode) or Analog Input 3- (differential mode) ±1.28V, ±2.56V, ±5.12V, ±10.24V and 0-20mA
I/O 1	Digital input/output. Configurable as a 0-5V logic input or output. Programmable pull resistors for input mode.
I/O 2	Digital input/output. Configurable as a 0-5V logic input or output. Programmable pull resistors for input mode.
FreqIn	Frequency input, AC coupled.
5Vo	This output voltage is used to provide power for the digital sensor(s) on the 1-Wire bus. It can also be used as an excitation voltage for the digital inputs.
Data	Data connection for digital sensor(s) on the 1-Wire bus.
Gnd	Ground connection for 5VDC output, digital inputs and the 1-Wire sensor(s)

Network Connector

The Ethernet connector is a standard, 8-position modular receptacle for RJ-45 connectors. The Ethernet port supports auto-negotiation and automatically selects the speed, duplex mode and works with straight or crossover cables.

Power Indicator

The green Power LED indicator is illuminated whenever the module is powered.

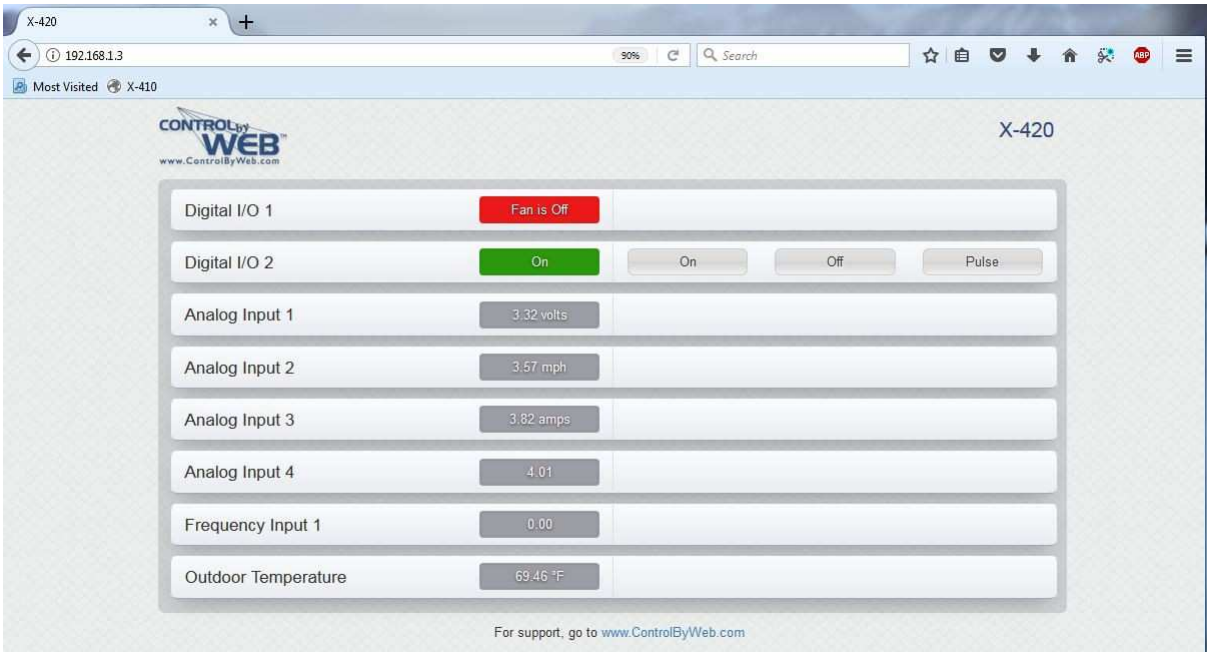
Digital I/O Indicators
Two yellow LEDs illuminate when the corresponding digital I/O is ON. The digital I/O is considered ON when the voltage is greater than 3.5V.

Ethernet Indicators
The LINK LED is illuminated green when the module is properly connected to an Ethernet network and is ready to communicate. Network communications will only occur if this LED is illuminated. The ACT LED flashes yellow when activity is detected on the network.

1.6 Accessing the X-420 Using a Web Browser

The X-420 has a built-in web server that provides simple web pages that can be accessed directly using a standard web browser. This allows users to access the unit with NO SPECIAL SOFTWARE installed on their computer. This is ideal for applications that require a quick and simple solution that does not need to be accessible to more than a few people. This configuration is simple to setup, simple to use, and can be accessed from just about any computer or smart phone.

Note: Network routers may need to be configured to allow access from computers outside of the local network (see Appendix C: Accessing the X-420 Over the Internet.)



Section 2: Installation and Connections

Installation consists of mounting the X-420 and connecting it to an Ethernet network, providing power, connecting the analog inputs and digital I/O, and 1-Wire sensors. The installation is completed by configuring the module using a web browser.

2.1 Installation Guidelines

- This unit must be installed by qualified personnel.
- This unit must not be installed in unprotected outdoor locations.
- This unit must not be used for medical, life saving purposes, or for any purpose where its failure could cause serious injury or the loss of life.
- This unit must not be used in any way where its function or failure could cause significant loss or property damage.
- Do not use to directly control motors or other actuators not equipped with limit switches or other safeguards to protect from equipment or wiring failures.
- The X-420 should be located in a clean, dry location where it is protected from the elements. Ventilation is recommended for installations where ambient air temperatures are expected to be high. See Appendix I: Mechanical Dimensions for additional mechanical details.
- If the X-420 is used in a manner not specified by Xytronix, the protection provided by the equipment may be impaired.

Wall Mounting

Mount the X-420 to a wall by using two #8 screws. Attach the screws to the wall vertically spaced exactly 2.5 inches apart. The head of the screw should be about 1/10 inch away from the wall.

DIN-Rail Mounting

The X-420 can be mounted to a standard (35mm by 7.55mm) DIN-Rail. Attach the X-420 to the DIN-Rail by hooking the top hook on the back of the enclosure to the DIN-Rail and then snap the bottom hook into place. To remove the X-420 from the DIN-Rail, use a flat-head screwdriver. Insert the screw driver into the notch in the release tab and pry against the enclosure to release the bottom hook.

2.2 Making Connections

CAUTION: Make sure the power is shut off before making connections

CAUTION: This unit should be installed by a qualified technician.

CAUTION: Miswiring or misconfiguration could cause permanent damage to the X-420, the equipment to which it is connected, or both.

A removable terminal connector is provided for making the power connections. To help protect the X-420 from mechanical stress, remove the terminal connector before making the connections.

1. Make sure power is turned off.
2. Remove the terminal connector from the X-420 and make wiring connections to the terminals. This technique avoids stressing the internal components while torquing the screws.
3. Reconnect the terminal connector.
4. Apply power.

It is recommended to not connect any load (device to be controlled) to the X-420 until after the X-420 has been configured and tested. By doing this, wiring and configuration mistakes will not cause the load device to turn on unexpectedly. Make certain the wires are properly inserted into to the terminals and that the screws are tight.

See Appendix D: Specifications for wire size, temperature rating and torque requirements for making connections to the terminal blocks.

Power Supply Connections

The X-420 requires power for its internal logic circuits. Connect a 9-28 VDC power supply to the +Vin and Gnd terminals. A regulated power supply is recommended, such as a wall-mount AC-DC adapter. Verify that the adapter is rated for the operating current of the X-420 (See *Appendix D: Specifications* for the current requirements.)

Multiple X-420 units may be connected to a single power supply by connecting the power supply input terminals in parallel. The power supply must have an ample current rating to power all units connected.

The model X-420-E is normally powered from a Power Sourcing Equipment (PSE) device which passes DC power along with data on the twisted pair Ethernet cabling. This allows a single cable to provide both the data connection and DC power. With the X-420-E no connections are needed to the Vin+ and Gnd terminals. The Vin+ and Gnd terminals however, can be used as a backup power source. The X-420-E has an internal “diode or” circuit between the Vin+ terminal and the internal Powered Device (PD) circuits. If a power supply is connected to the Vin+ terminal, the X-420-E will draw power from the PSE if the input voltage is less than 12.0V, and from the Vin+ terminal if the input voltage is greater than 12.0V. If the PSE power fails, the X-420-E will draw all power from the Vin+ terminal.

2.3 Analog Input Connections

The X-420 features a high performance, 4-channel, 16-bit analog data acquisition system. The inputs are high impedance (>500 Meg ohms.) Each channel is configurable for single-ended, differential or 0-20mA input operation. Programmable voltage ranges include; ±1.28V, ±2.56V, ±5.12V, ±10.24V and ±20.48V (differential). The input mode and voltage range is configured in the web-based setup pages. The analog inputs work with industrial sensors, wind direction sensors, pyranometers, pressure transducers, and much more. The input impedance is very high and if an input is left unconnected, the voltage measurement will float and drift. The analog inputs can be configured to send an email, log, or control a remote relay (over the network).

2.3.1 Single-Ended Mode

The analog data acquisition system can accept up to 4-bipolar input signals. Single-ended signals are referenced to the Agnd terminals. Each channel can be independently programmed with a ±1.28V, ±2.56V, ±5.12V, ±10.24V voltage range. Do not share the sensor ground connection with the power supply input terminal. Consider how the sensor(s) are powered, arrange the sensor connections so no current flows in the ground reference connections between the X-420 and your sensor(s).

2.3.2 Differential Mode

Differential sensors have two outputs that reference each other instead of ground. The differential mode uses two analog inputs instead of one. If Channel 1 is selected for differential operation, the differential signals are connected to Channel 1 and 2. If Channel 3 is selected for differential operation, the differential signals are connected to Channel 3 and 4. The differential mode supports input ranges of up to ±20.48V. However, the absolute input voltages must be less than ±10V. For example, if Input 1 is configured for differential operation and Input1 = +10V and Input2 = -10V, the measurement will read +20V. On the other hand, if Input1 = -10V and Input2 = +10V, the measurement will read -20V. With differential connections, a ground connection is still required between the X-420 and your sensor to maintain the two input voltages within the common mode voltage range (-10V < Vin < +10V) of the X-420.

2.3.3 4-20mA Mode

Some industrial sensors output a current instead of voltage levels. Normally, a shunt resistor is needed to measure the current; however, with the X-420, the 4-20mA mode enables an internal precision 200-ohm shunt resistor (0.1%, 25ppm) and automatically configures the A/D for ±5V operation. This feature allows direct connection to 0-20mA current loop transducers. At 20mA, the maximum loop voltage across the X-420 is 4.0 Volts (.020 x 200 = 4.0). With this setting, the voltage to current calculation ((Vin/200)*1000) is automatically made so the measurement is in units of mA.

2.3.4 Pseudo Digital Inputs

For applications where digital inputs are needed, specific analog inputs can be configured as a pseudo digital input with a boolean (true/false) state. The input voltage is compared to a fixed threshold to determine a true/false state. The input is considered “true” when the voltage rises above 3.5V and “false” when it falls below 1.5V.

When an analog input is configured as a digital input, the input can be configured to send an email, control a remote relay (over the network) or monitor the state of a discrete device.

2.4 Digital I/O connections

The Digital I/O's can be individually programmed to function as either inputs or outputs. The digital I/Os employ 5V logic, are not isolated and share a common ground with the power connection.

2.4.1 Digital Inputs

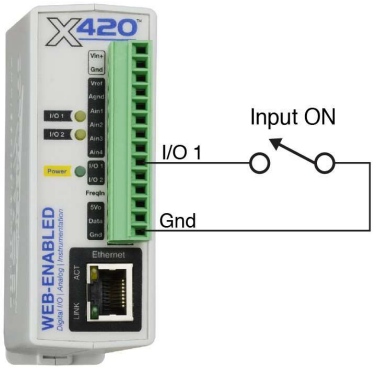
When a Digital I/O is configured as an input, the input can be configured to send an email, control a remote relay (over the network), monitor the state of a discrete device, or one input can control the other output. The digital inputs work with sensors with switch-closure outputs including push buttons, magnetic door alarm switches, micro-switches, or any device which has a relay, switch-closure or open-collector output. The X-420 can be configured for the alarm to be active when the switch is either open or closed.

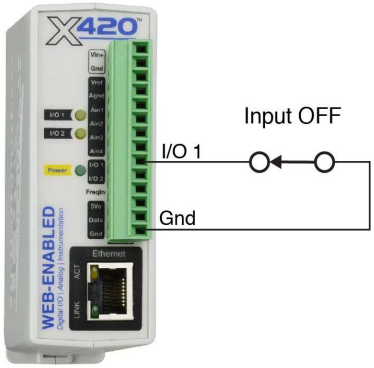
The illustrations below show an example of using the X-420 to monitor the status of a gate or door over an IP network. The status of the device is detected with a switch.

Pull Resistor

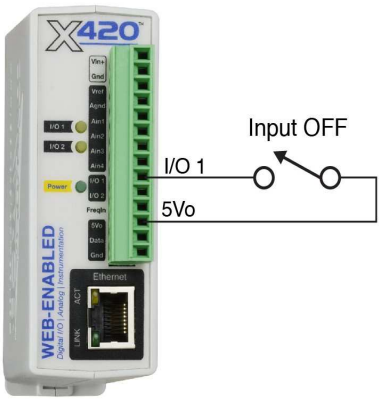
When configured as an input, a pull-up or pull-down resistor can be selected. If no connections are made to the input, the pull-up resistor will pull the input high (on), and the pull-down resistor will pull the input low (off). The illustrations below show how the pull resistors work with simple single pole switches connected to the digital inputs.

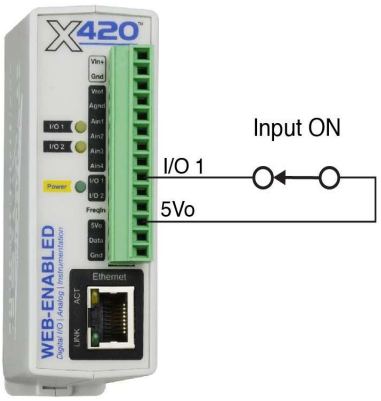
For a low-side switch, one side of the switch is connected to ground and the other to I/O 1 or I/O 2. Select the pull-up resistor. When the switch is open, the pull-up resistor pulls the input high (On).





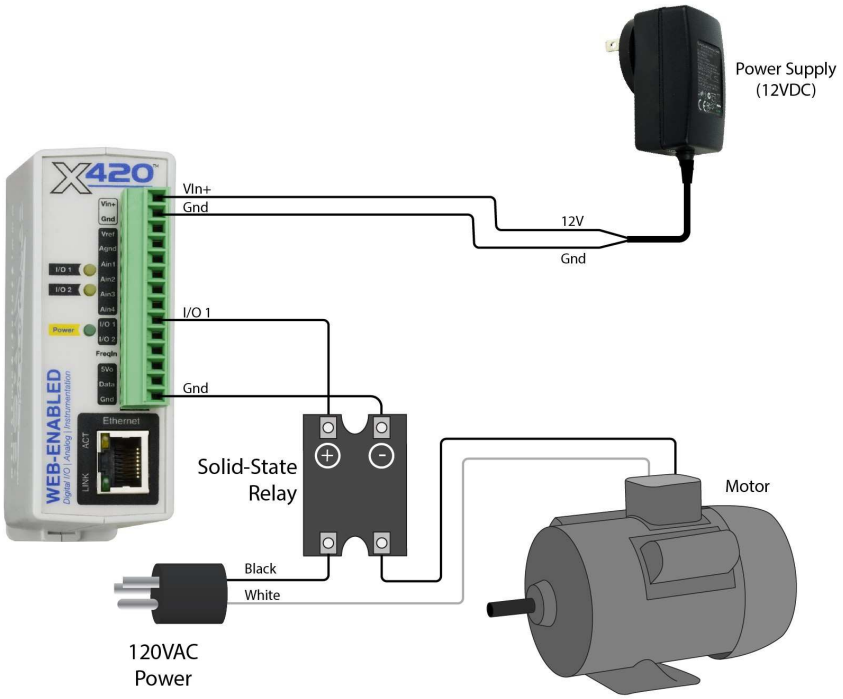
For a high-side switch, one side of the switch is connected to the +5V output and the other to I/O 1 or I/O 2. Select the pull-down resistor. When the switch is open, the pull-down resistor pulls the input low (Off).





2.4.2 Digital Outputs

When a Digital I/O is configured as an output, it can be used to supply a voltage to an external relay or device. The example below illustrates how the output can be used to actuate an external solid state relay.



2.5 Frequency Input

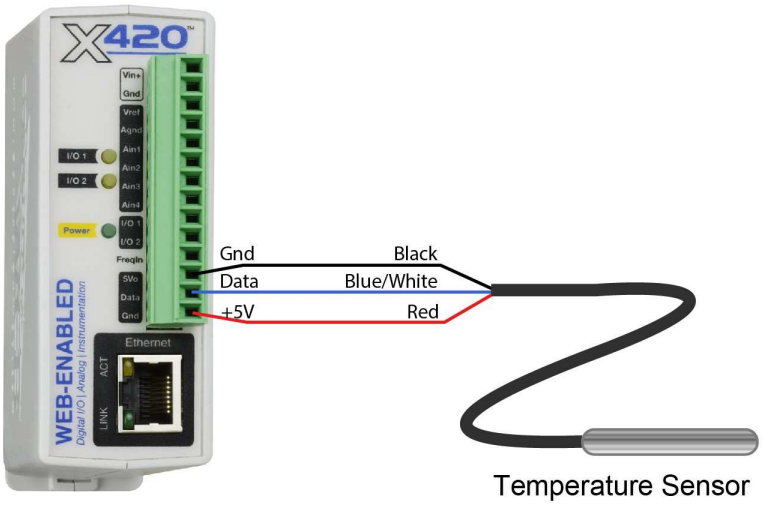
Sensors that output pulses can be connected to the Frequency Input. The input is AC coupled and is designed for direct connection to a magnetic wind speed sensor. Magnetic wind speed sensors output a low voltage sine wave at low wind speed, as the wind speed increases both the voltage and frequency increase.

The frequency input works with other sensors compatible with an AC input. For example, a 6VAC or 12VAC transformer can be used to measure the AC line frequency or the output frequency of a generator.

2.6 1-Wire Sensor Connections

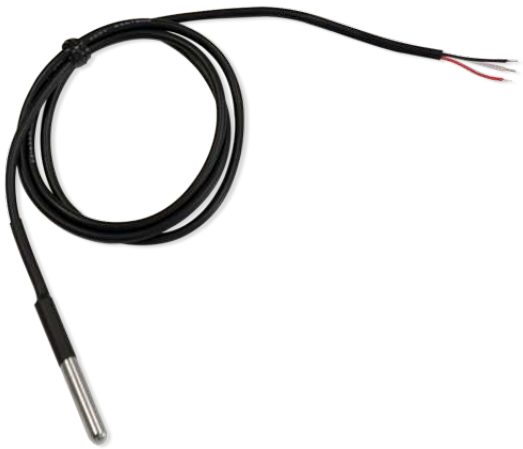
The X-420 has a 1-Wire port which supports up to 16 digital sensors for measuring temperature, humidity, and more.

The sensors share the same three connections for communications and power (+5V, Ground, Data). Every sensor on the bus is assigned a unique serial number when it is manufactured. That number is used to address the sensor during communication.



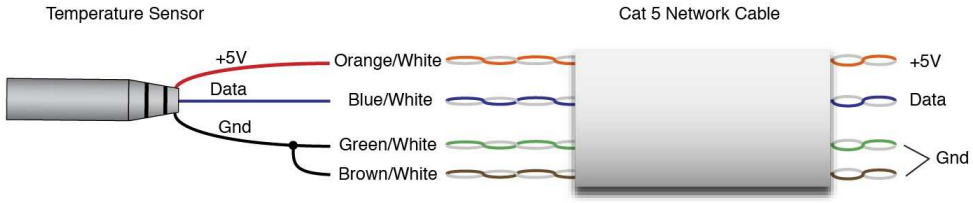
The digital temperature sensors are interchangeable and require no calibration. See *Optional Accessories* for a list of compatible 1-Wire sensors. The X-DTS-U and X-DTS-S3C temperature probes shown below have a measurement range of -67°F to +257°F (-55°C to +125°C) and an accuracy of +/- 0.5°C (-10°C to +85°C). The X-DTS-S3C has a stainless steel probe and can be used in unprotected outdoor locations; however, the probe is not suitable for immersion or use in pressure vessels. For immersion and other demanding applications use a thermowell to protect the sensor. The X-DTS-U sensor is used in protected locations. The temperature sensors have three wires as shown below.

Sensor Wire Color	Connection
Red	+5V
Black	Gnd
Blue, White, Yellow	Data



Multiple sensors can be connected in two ways: directly connected (star topology) or “daisy-chained” (linear topology). Many factors can determine the maximum length of the cable, including the sensor network topology, the type of cable used, the number of sensors and ambient electromagnetic noise. Combined cable lengths to all sensors of 600 ft using Cat 5e cable have been successful. However, due to the uniqueness of installation environments, results may vary. Please test in the desired environment before making a permanent installation.

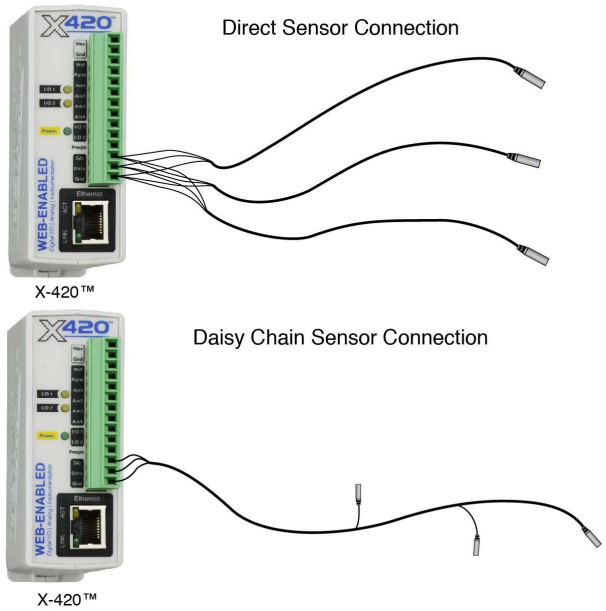
The following are general recommendations that will maximize sensor runs and minimize problems. Cat 5 and Cat 5e network cables have proven to be an effective and low-cost solution for long runs. Other cable types can be used, but cable capacitance generally limits the length. The illustration shows the recommended connection using a Cat 5 network cable. Connect all unused conductors to ground.



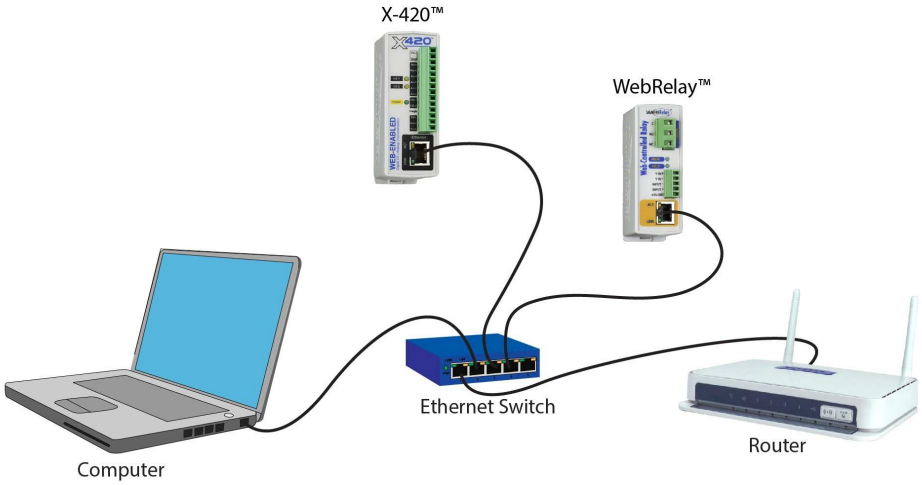
Recommended connections using Cat5 cable

A linear (daisy chain) topology will minimize signal reflections, providing a more reliable connection and will allow a longer cable length than a star topology.

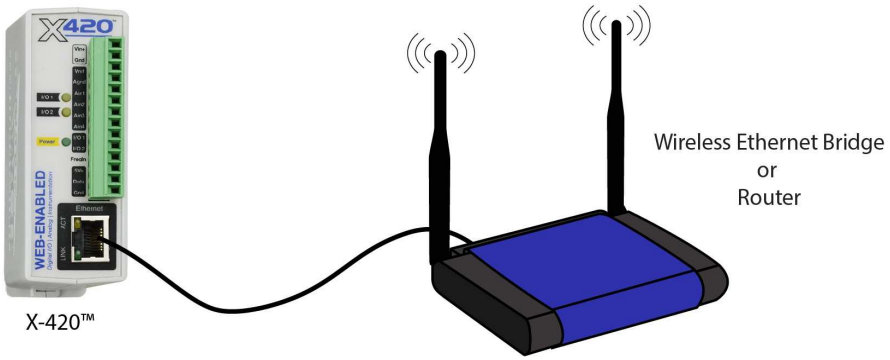
The 1-Wire bus is "single-ended" and has no intrinsic noise protection. It is susceptible to interference if the cable is routed near power lines, fluorescent fixtures, motors or other noise sources. Keep the cable wiring short and avoid routing it near other electrical equipment.



2.6.1 Network Connection



Connect the Ethernet port to a standard 10/100/1000 Base-T Ethernet connection. The X-420 typically connects to an Ethernet switch, or router. For configuration, X-420 may be connected directly to the Ethernet port on a computer or through a switch or router. The X-420 supports auto negotiation and will work with either crossover or straight-thru cables. The X-420 can be used on a wireless network by connecting through an Ethernet bridge or a wireless router.



Note: *The wireless Ethernet bridge or router must be properly configured for the wireless network. Refer to the installation instructions for the wireless device.*

2.7 Establishing Communications for Setup

In order to configure the X-420 with the web browser interface, the X-420 must be connected to an Ethernet network. This can be done by one of two methods:

Method 1– Temporarily change the IP address of a connected computer to be compatible (same subnet) with the default IP address used by the X-420.

-or-

Method 2 – Assign a temporary IP address to the X-420 to work on an existing network.

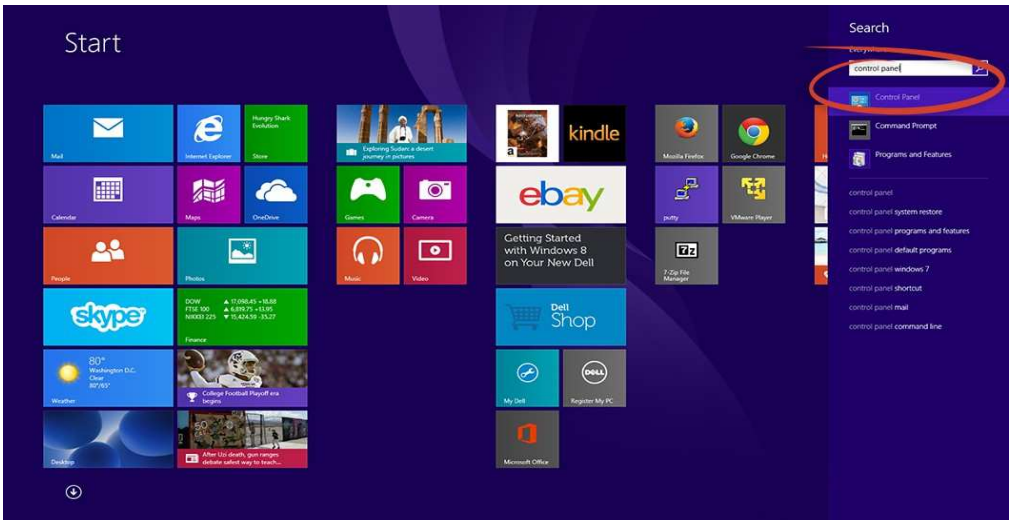
Note: If multiple ControlByWeb™ products are used on the same network, install one at a time and set the IP address of each unit before connecting the next unit to the network. This avoids having multiple devices being installed on the network with the same factory default IP address at the same time. If this approach is used, be sure to clear the arp cache after disconnecting each unit (run '`arp -d`' from an administrative command prompt).

2.7.1 Method 1: Assign a Temporary IP Address to the Configuration Computer

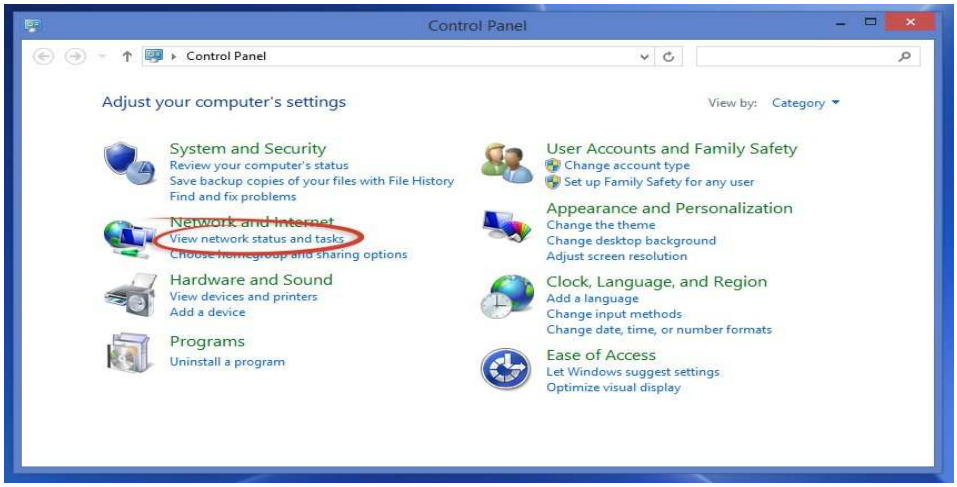
By default, the X-420 comes from the factory with an IP address of 192.168.1.2. Communication with the X-420 may be established by assigning an IP address to the configuration computer so that it is on the same network as the X-420 (for example, the configuration computer could be assigned to 192.168.1.50)

The following example is for those running the Windows-8 operating system:

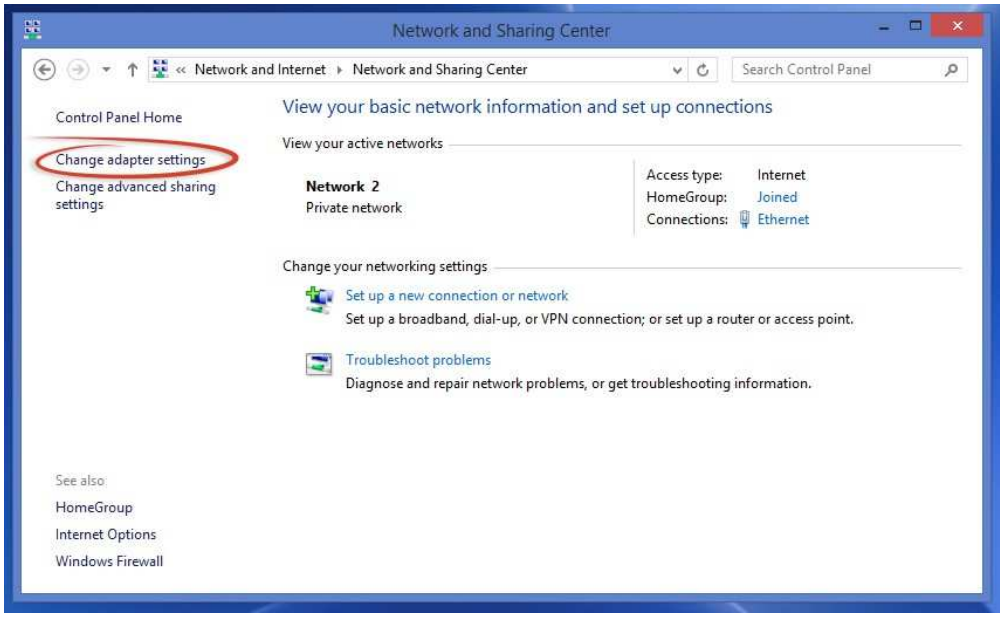
1. Apply Power, wait 15 seconds for the X-420 to become operational, and then connect the Ethernet cable.
2. Open the Windows 8 start screen.
3. Type *"Control Panel"* and press enter (the search box opens automatically when you begin typing).



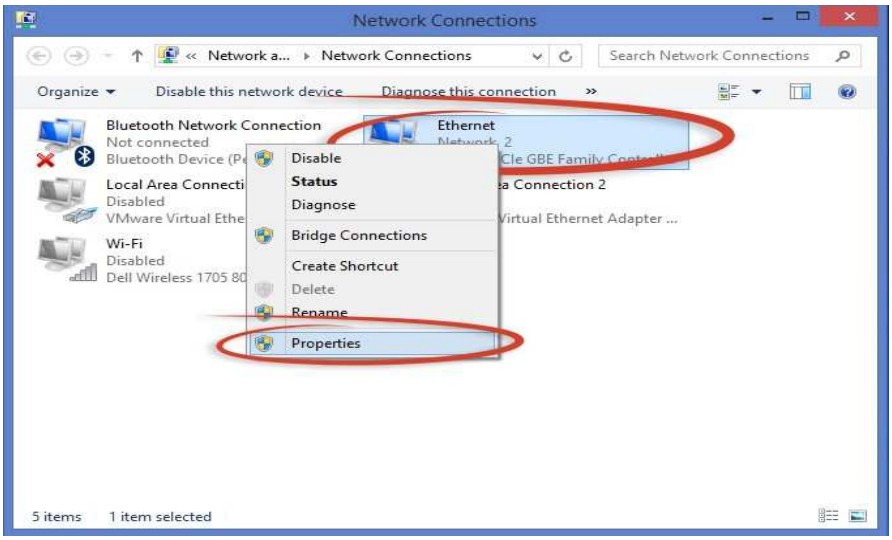
4. Select *View network status and tasks.*



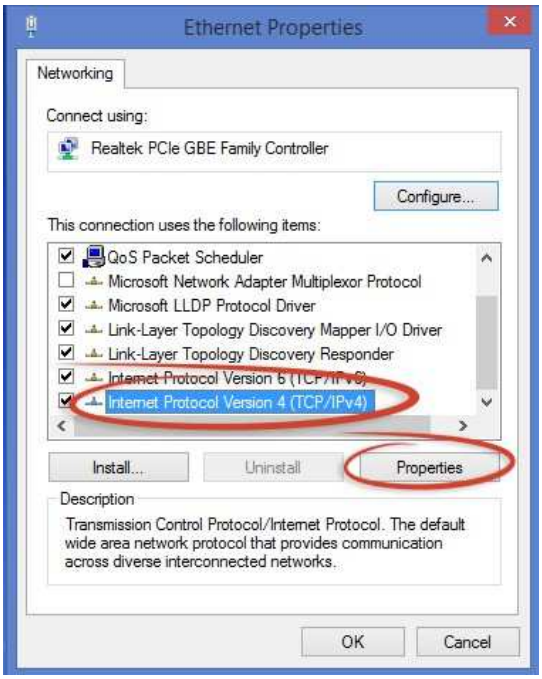
5. Select *Change adapter settings*



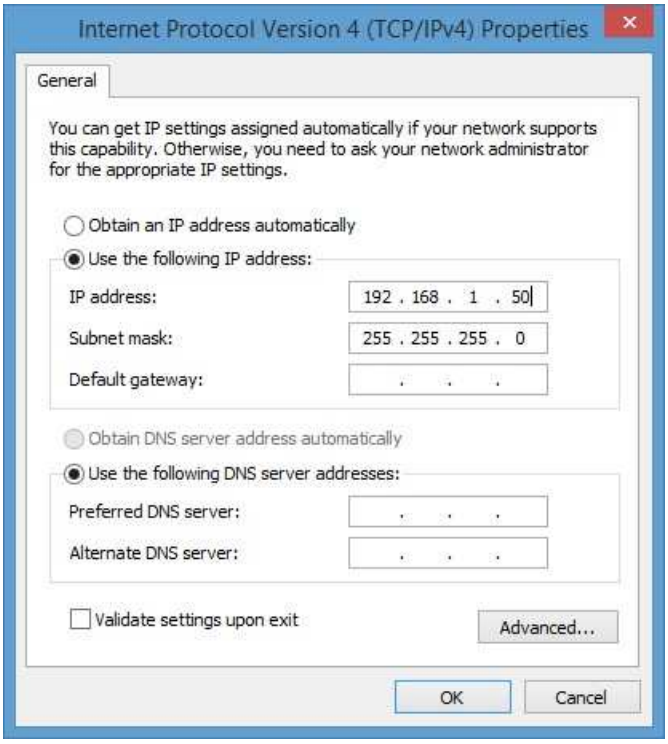
6. Your machine may have more than one Internet connection shown. Right-click on the adapter for your connection to the Internet. A drop-down box will appear, choose *Properties* to view/edit the settings for this internet connection.



7. Select *Internet Protocol Version 4 (TCP/IPV4)* and then click the *Properties* button.



8. If “Use the following IP address” is already selected, the computer has been setup with a static IP address. Record these values so that the current IP address of the computer can be restored once the IP address of the X-420 has been successfully changed.



Select the radio button labeled *"Use the following IP address"* and type in the IP address:

```
192.168.1.50
```

Type in the subnet mask:

```
255.255.255.0
```

No need to change the default gateway field. Click *OK* to accept the new settings.

9. Open the setup pages by entering the following URL in the address bar of a web browser:

   ```
   http://{ipaddress}/setup.html
   ```

   (For example: http://192.168.1.2/setup.html)

   If the setup pages are not accessible, verify that the X-420 is powered on and that the LINK light is illuminated. Check all network connections and settings.

   Another way to check communications is to ping the X-420 from the command prompt by typing:

   `ping [ipaddress]` (e.g. `ping 192.168.1.2`)

2.7.2 Method 2: Assign a Temporary IP address to the X-420

This option (arping) is used to TEMPORARILY assign an IP address to the X-420 without the need to change the IP address of the configuration computer. The X-420 will use this IP address as long as power is maintained. Once power is lost, the X-420 will use the IP address assigned in the setup page and not the temporary address assigned here. Make sure that the X-420 and the configuration computer are connected to the same network. Since ARP is non-routable, this will not work through routers or gateways.

Microsoft Windows Instructions

1. Open a Command Prompt (select START, then RUN, then type “cmd”).

   Note: For Vista, 7, 8, and 8.1, the Command Prompt should be run as administrator (select Start, then type “cmd” and right click on “cmd” and select “Run as administrator”).
2. Type:

   ```
   arp -s {new IP address} {serial number of the X-420 }
   ```

   Note: IP address format is xxx.xxx.xxx.xxx. The serial number can be found on a label on the module board. The format is ss-ss-ss-ss-ss-ss.
   For example, to set the X-420 (with serial number 00-0C-C8-01-00-01) to 10.10.10.40 the following command would be used:

   ```
   arp -s 10.10.10.40 00-0c-c8-01-00-01
   ```
3. Next, type:

   ```
   ping -l 102 {new IP address}
   ```

   For example, if the new IP address is 10.10.10.40, the following command would be used:

   ```
   ping -l 102 10.10.10.40
   ```
4. Proceed with the X-420 setup in *Section 3*.

   Once setup is complete, it may be necessary to clear the 'arp' cache to configure additional devices. This is necessary because each unit has the same default IP address, but a different unit serial number (MAC address). Clearing the arp table can be done by typing `arp -d` in the command prompt window.

Linux/Unix Instructions

1. Open a terminal and change to root user (su -, then enter root password).
2. Type:

   ```
   arp -s {new IP address} {serial number of the X-420 }
   ```

   Note: IP address format is xxx.xxx.xxx.xxx. The serial number can be found on a label on the module board. The format is ss:ss:ss:ss:ss:ss.
   For example, to set the X-420 (with serial number 00-0C-C8-01-00-01) to 10.10.10.40 the following command would be used:

   ```
   arp -s 10.10.10.40 00:0c:c8:01:00:01
   ```
3. Next, type:

   ```
   ping -s 102 {new IP address}
   ```

   For example, if the new IP address is 10.10.10.40, the following command would be used:

   ```
   ping -s 102 10.10.10.40
   ```

4. Proceed with the X-420 setup in *Section 3*.

   Once setup is complete, it may be necessary to clear the 'arp' cache to configure additional devices. This is necessary because each unit has the same default IP address, but a different unit serial number (MAC address). Clearing the arp table can be done by typing `sudo arp -d -a` in the command prompt window.

Mac OS X Instructions

1. Open a terminal.

   Note: The terminal is in the "Utilities" directory, which is in the "Applications" directory.
2. Type:

   ```
   sudo arp -s {new IP address} {serial number of the X-420 }
   ```

   Administrator password may be required.

   Note: IP address format is xxx.xxx.xxx.xxx. The serial number can be found on the label on the module board. The format is ss:ss:ss:ss:ss:ss.
   For example, to set the X-420 (with serial number 00-0C-C8-01-00-01) to 10.10.10.40 the following command would be used:

   ```
   sudo arp -s 10.10.10.40 00:0c:c8:01:00:01
   ```

3. Next, type:

   ```
   ping -s 102 {new IP address}
   ```

   For example, if the new IP address is 10.10.10.40, the following command would be used:

   ```
   ping -s 102 10.10.10.40
   ```

4. Proceed with the X-420 setup in *Section 3*.

   Once setup is complete, it may be necessary to clear the 'arp' cache to configure additional devices. This is necessary because each unit has the same default IP address, but a different unit serial number (MAC address). Clearing the arp table can be done by typing `sudo arp -d -a` in the command prompt window.

Section 3: Web Server and Setup Pages

The internal web server presents two classes of web pages; *Setup* pages and *Control* pages. *Setup* pages are used by an installer to provision and configure the X-420. The *Control* page allows the digital I/O to be controlled and displays analog input voltages, temperature and digital input status information.

To access the *setup* pages, enter the following URL in the address bar of a web browser:

`http://{ipaddress}/setup.html`

For example, using the default IP address, enter:

http://192.168.1.2/setup.html

To access the *control* page, enter the following URL in the address bar of a web browser:

`http://192.168.1.2`

To access any web pages over an encrypted connection replace http with https. For example:

https://192.168.1.2/setup.html

https://192.168.1.2

Before accessing any setup page, the browser will request a username and password. The X-420 supports various levels of user authentication with different permissions to the setup pages. For a description of *Administrators*, *Managers* and *Users* see *Section* General Settings Tab > PASSWORDS.The *Administrator* username is `admin` and the default password is `webrelay` (password is case sensitive).

The setup pages are divided into six sections. Sections with a ▼ symbol can be expanded to reveal other related settings. When using the setup pages, you must click the *Submit* button at the bottom of a page if you have made changes to a setting on the page.

3.1 Setup Strategy

To configure the X-420, first update the Network tab settings to make the X-420 accessible on your network and configure the Gateway and DNS Server IP Addresses. (The module must be power-cycled for these settings to take effect.) Setup any email addresses that will be needed for alarms and messages.

Next, name and define the resources under the I/O Setup menu (analog and digital inputs, 1-Wire sensors, registers and timers.) For example, change the name of “Analog Input 1” to something descriptive such as: “Battery Voltage”. Once the resources are named, define any control logic (tasks) or Basic scripts under the Control/Logic menu. Finally, setup and configure the Control Page under Monitor & Control to show the information and control buttons needed for your specific application.

Finish by viewing and testing the Control Page, monitor your analog inputs and sensor display and experiment with any buttons or controls. Test for proper operation of email messages and alarms.

3.2 General Settings Tab

The General Settings tab is a collection of menus for configuring the X-420 and its services. The IP network settings, email server settings and device configuration backup and restore features are grouped under this menu.

3.2.1 General Settings Tab > GENERAL INFORMATION

This is the initial page that is displayed when setup.html is entered into the address bar of the browser. It displays the part number, firmware revision, and serial number of the unit. The optional latitude and longitude settings are used for calculating sunrise and sunset times for Scheduled Tasks. A global setting selects the temperature units.

Part Number

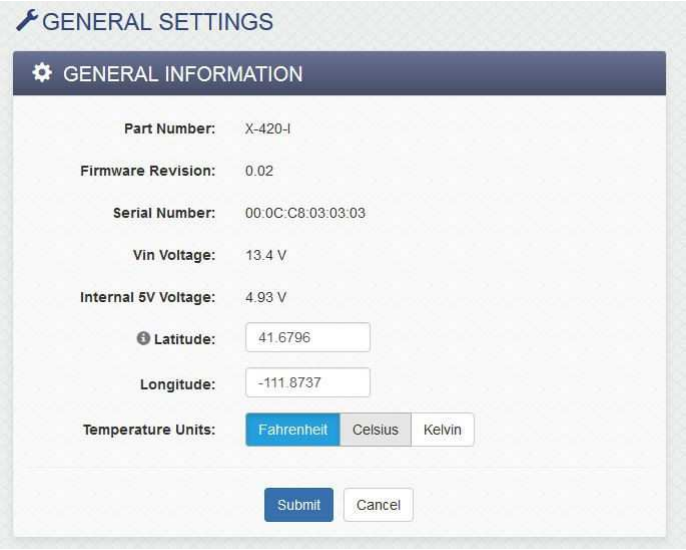
This displays the full model number of the module.

Firmware Revision

This is the current product revision of the unit's firmware.

Serial Number

This is the serial number of this unit. The serial number is also the MAC address of the unit.



Vin Voltage

This is the voltage on the +Vin power input terminal. If the module is powered from a battery/solar panel, this value will show the voltage. With the X-420-E the power is provided over the Ethernet cable and the Vin+ monitor will show POE unless a voltage of 9-28VDC is supplied on Vin+.

Internal 5V Voltage

This diagnostic displays the voltage of the internal 5V power rail. It should be 5.0V ±.25V. If it is low, check for overload conditions on the 1-Wire bus.

Latitude & Longitude

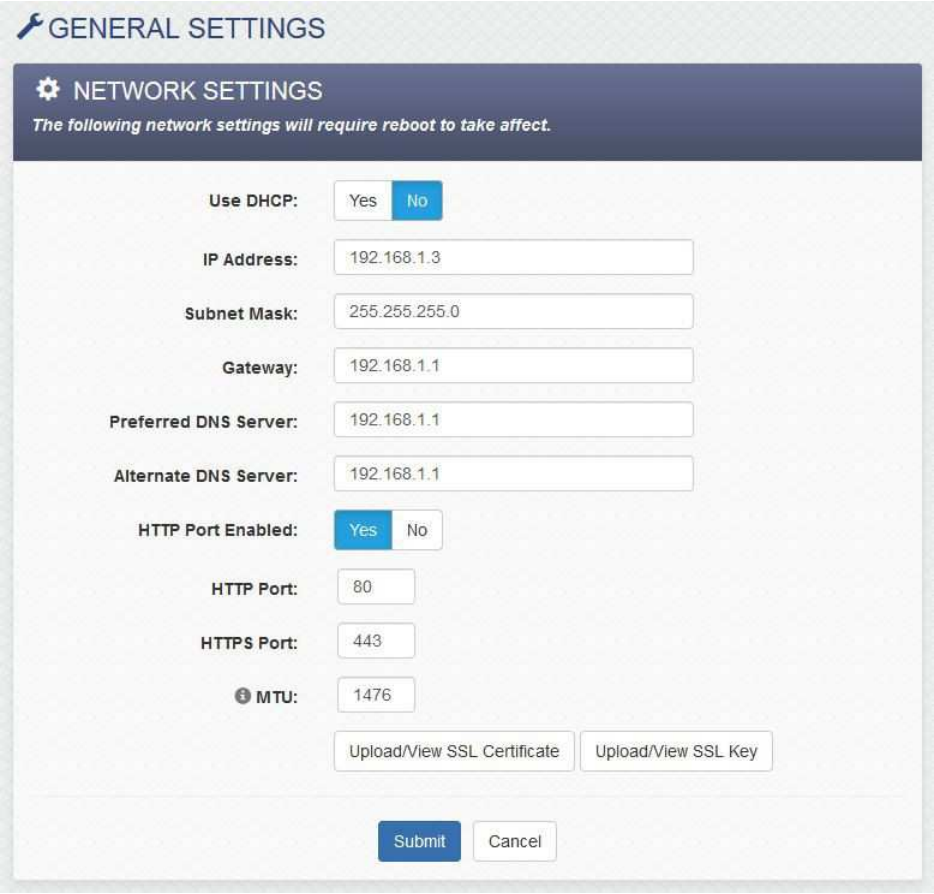
The optional latitude and longitude settings are used for calculating sunrise and sunset times which are used in *Scheduled Tasks*.

Temperature Units

This global setting sets the temperature units of *Fahrenheit, Celsius,* or *Kelvin* for all temperature sensors, both local and remote.

3.2.2 General Settings Tab > NETWORK SETTINGS

The network parameters are set on this page. Configure the network settings to make the X-420 accessible on your network. **The X-420 must be power-cycled (power disconnected, then reconnected) before new network settings take effect.**



Use DHCP

This option allows DHCP to be enabled or disabled. If this option is set to *Yes,* the X-420 will request an IP address from the DHCP server each time it is powered on. The default setting is *No* (this is recommended for most installations). If DHCP is set to *Yes*, the Network page must be submitted and the X-420 must be rebooted before an IP address will be assigned. Once the X-420 is assigned an IP address by the DHCP server, the new IP address can be found through the list of clients kept by the DHCP server (for most instances, the DHCP server is in the local gateway or router).

Brief Notes About DHCP: All devices on an IP network require an IP address. This is a unique address that identifies each device on the network. DHCP (Dynamic Host Control Protocol) is a mechanism that automatically assigns an IP address to a computer (or other device) when it is connected to a network. This eliminates the need to manually enter the IP address. When a computer is connected to the network, another device on the network called a DHCP server detects the presence of the computer or device and dynamically assigns an IP address. On many small networks, the DHCP server is built into the router.

DHCP works well for "client" devices such as computers, but is not ideal for servers. This is because servers usually don't initiate communications with other devices, but rather they wait for a request from "clients." To make this request, the client must know the IP address of the server. If a server gets its IP address dynamically, the IP address may not always be the same so client devices may not be able to find the server. For this reason, servers usually use an IP address that is fixed and does not change. The X-420 is a server and manual IP address assignment is usually recommended.

IP Address

Enter the IP address for the X-420 in this field. The IP address is specific to the network where the X-420 will be installed, and must be obtained from the network administrator. For more information on IP addresses and remotely accessing the X-420 over the Internet, see *Appendix C: Accessing the X-420 Over the Internet.* The default setting for this field is 192.168.1.2.

Subnet Mask

The subnet mask defines the size of the local network. This can be obtained from the network administrator. For additional information about sub-netting and IP networking, many tutorials are available on the Internet. The default setting for this field is 255.255.255.0.

Gateway

This specifies the IP address of the gateway router. This can be obtained from the network administrator. The default setting for this field is 192.168.1.1.

Preferred DNS Server:

The IP address of the Primary DNS server is specified here. When DNS services are required, this is the address that will be used. The default setting for this field is 192.168.1.1. This field is only required when the following options are used:

Remote Services	When server is specified by name and not IP address.
Sync time clock with remote NTP server	When server name is specified by name and not IP address.
Email Server	When server name is specified by name and not IP address.
SNMP Manager	When the server for receiving traps and notifications is specified by name and not an IP address.
Remote Devices	When remote device (such as for use as a remote relay) is specified by name and not IP address.

Alternate DNS Server

This field is used to specify the IP address of a Secondary DNS server. This is used when the X-420 requires DNS services and the preferred DNS server is not available. The default setting for this field is 192.168.1.1.

HTTP Port Enabled

This option enables or disables access to the web server without encryption. For high security applications the HTTP port should be disabled to limit access to only encrypted connections on the HTTPS port.

HTTP Port

The TCP port used for unencrypted HTTP communications with the X-420 is specified here. The default setting for this field is 80, which is the standard HTTP port. It is recommended that the port be left unchanged unless the user has an understanding of TCP/IP and ports. For more information on TCP ports and IP addressing see *Appendix C: Accessing the X-420 Over the Internet*.

HTTPS Port

The TCP port used for encrypted HTTPS communications. It is recommended not to change this port. When requesting a web page using https://192.168.1.2/setup.html, the web browser will automatically use port 443. If this port is changed to 9000 for example, the HTTPS port will have to be specified in the request https://192.168.1.2:9000/setup.html.

MTU

MTU is the Maximum Transmission Unit network parameter. This defines the max size, in bytes, of the TCP packets sent out from the device. The valid range is 256 to 1476 bytes. This normally can be left alone, but there are some circumstances where it might be beneficial to change it. One of these circumstances is when the device is to be used over a VPN (virtual private network). VPN's add extra information to TCP packets, if the new packets are too big to physically travel across the network (greater than about 1500 bytes) then the packets will be split up. This causes problems for some firewalls and those firewalls will discard the packets. To fix this, the MTU can be adjusted until the TCP packets do not get split up.

Upload/View SSL Certificate

By default, the X-420 comes with a previously generated SSL Certificate that is used for encrypted HTTP communications. The default SSL Certificate can be replaced by clicking on this link, choosing the new Certificate file (PEM format), and uploading the file. SSL Certificates are preserved through resetting defaults and updating firmware.

Upload/View SSL Key File

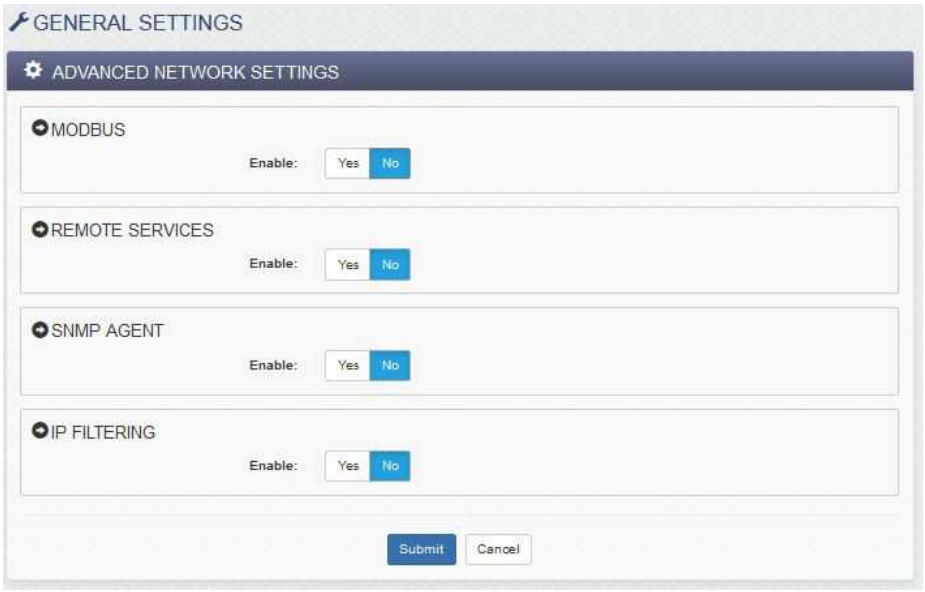
By default, the X-420 comes with a previously generated SSL Key that is used for encrypted HTTP communications. The default SSL Key can be replaced by clicking on this link, choosing the new Key file (PEM format), and uploading the file. The SSL Certificates are preserved if the firmware is updated or the module is reset to its default settings.

3.2.2.1 Hidden Network Setting

Remote Reboot

To cause the device to reboot, the following command can be entered into the address bar of the browser http://192.168.1.2/network.srv?spc0_rbt=1 The username and password will be requested before the reboot will occur so only administrators of the device can cause the reboot. This feature is useful for rebooting the device after changing the network settings if the device is located remotely. Changing the network settings and then rebooting the device can cause the device to become inaccessible if the network settings aren't correct. Make sure the network settings are correct before doing a remote reboot.

3.2.3 General Settings Tab > ADVANCED NETWORK SETTINGS



MODBUS

MODBUS/TCP Service can be enabled or disabled. Modbus is a messaging structure protocol used in industrial manufacturing control and automation. It is an open protocol and offers interoperability with software and devices from other manufacturers. This is enabled by selecting *Yes* in this field. The default setting for this field is *No*. (See *Section* Modbus/TCP for more information on using the X-420 on a Modbus network.)

Note: Modbus communications are disabled whenever the User password is enabled because Modbus/TCP does not provide a mechanism for password protection.

The X-420 functions as a Modbus slave. Host devices, such as PLCs, open a connection with the X-420 on port 502 and then send requests to read or set digital I/O states, or sensor values. When the X-420 receives a command, it performs the desired function and returns a response.

Modbus Port

This specifies the port used for Modbus/TCP communications with the X-420. By default this is set to port 502 which is the standard Modbus port. It can be set within the range of 1 to 65535.

Endianness

32-bit data is treated as two individual 16-bit words using IEEE 754 floating point format. Floating point format is used for the sensors, pulse counters and for setting the output pulse duration.
If *Big* is selected, the X-420 will use big-endian architecture, and the most significant 16-bit word (big end) is sent first. If *Little* is selected, then the X-420 will use little-endian architecture, and the least significant 16-bit word (little end) is sent first. The default setting is *Little* (little-endian).
For example, in little-endian format, a 32-bit floating point number represented by '1234 ABCD' is sent as 'ABCD 1234'.

Modbus Address Table

The X-420 has a default Modbus address table with addresses for the digital I/O, Vin and other fixed resources. As dynamic resources such as 1-Wire sensors, Registers, and remote I/O are added, additional Modbus addresses are automatically created. Use this table to view the current Modbus

address assignments. The addresses are assigned when the I/O is added and cannot be customized except by deleting the I/O and changing the order in which they are added.

To interpret the Modbus Address Table, find the I/O resource in the left-most column. Then follow the line across to the column of interest. All I/O resources have a corresponding holding register pair for reading the values. This holding register address is listed in the *IO* column of the table and is interpreted as a IEEE-754 floating point value. The number in the cell is the Modbus address for the given data type (or starting address in the case of floating point numbers). On the X-420, all holding registers are read and written as pairs. This is because Modbus registers are 16-bits wide and the data types for reading the registers are floating point and require 32-bits. The number listed in the table is the starting address and the corresponding register immediately follows it.

This example table shows the Modbus addresses of the X-420's resources and a configured 1-Wire sensors.

Modbus Address Table

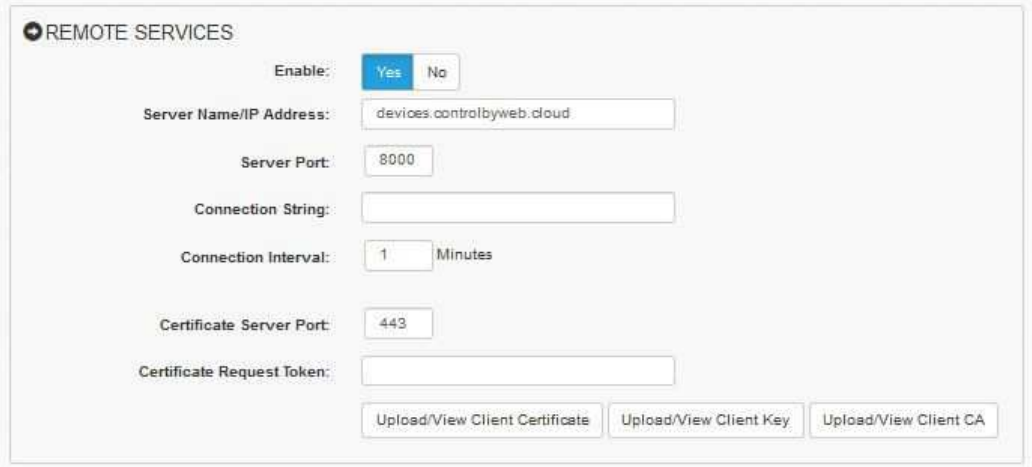
	Register Addr					Coil Addr	Input Addr
IO Name	IO	Pulse Timer	Counter	On Timer	Total On Timer	IO	IO
Digital I/O 1	0	--	1024	1536	2048	--	0
Digital I/O 2	2	514	--	--	--	1	--
Analog Input 1	4	--	--	--	--	--	--
Analog Input 2	6	--	--	--	--	--	--
Analog Input 3	8	--	--	--	--	--	--
Analog Input 4	10	--	--	--	--	--	--
Frequency Input 1	12	--	--	--	--	--	--
Vin	14	--	--	--	--	--	--
Register 1	16	--	--	--	--	--	--
Outdoor Temperature	18	--	--	--	--	--	--

Done

Remote Services

Remote Services allows internet access to an X-420 which is installed behind a network router, without the need to setup port forwarding in the router. It also allows for a streamlined installation without the need to directly access the device and configure its network settings.

Remote Services can be enabled or disabled. If *Yes* is selected, Remote Services will be enabled as soon as the Submit button is pressed and the X-420 will immediately attempt to make a connection with the remote server (power-cycle not required). Once a connection is established, the connection will remain until it is disconnected by the remote server. By default, Remote Services is configured to connect to the ControlByWeb.cloud service. The default setting for this field is *No*.



Server Name/IP Address

Specify the name or IP address of the Remote Services server here. If the IP address is specified, enter it in this format aaa.bbb.ccc.ddd. For numbers that are less than 100, preceding zeros should not be included (for example, enter 80 rather than 080). This field can be up to 40 characters long, the default setting is: *devices.controlbyweb.cloud*

Server Port

Enter the TCP port used for the Remote Services server. This can be set within the range of 1-65535. The default setting for this field is 8000.

Connection String

This text is sent to the Remote Services server when the connection is established. This string should include any information required by the server for connection. For example, it may include an ID number, customer number, password, etc. The format is entirely dependent upon the server requirements. This field can be up to 80 characters long. By default this field is left blank, as the ControlByWeb cloud service does not use it.

Connection Interval

This field specifies the periodic interval in which the X-420 attempts to connect to the remote server, or if the X-420 is already connected, it is the interval in which it sends the connection string followed by the current state of the device. This field can be set within the range of 1 to 60 minutes. The default setting for this field is 1 minute.

Certificate Server Port

The certificate server is a server that has been configured to deliver the Client Certificate, Key, and CA when requested by the X-420. These certificates and key are required for the X-420 to connect to the remote service.

Certificate Request Token

When the X-420 has a valid Certificate Request Token entered, it will automatically attempt to request and download its Client Certificate, Key, and CA. Once successful, the token will be erased and the X-420 will stop its requests. (See *Remote Services* at the end of this section for more information.) It will then be able to authenticate and connect to the cloud service securely.

Upload/View Client Certificate

Uploads a client certificate that will be used for authenticating the X-420 to the cloud service.

Upload/View Client Key

Uploads a client key that will be used for encrypting the X-420 communications with the cloud service.

Upload/View Client CA

Uploads a CA that has been used to generate the client certificate and key. The X-420 will use this certificate to verify that the server it has connected to is the server that it expects to connect to.

Remote Services Notes: Remote Services initiates an outgoing connection to a server at a remote location. This can be used in an environment where a web server on the Internet provides a custom web page to X-420 and other ControlByWeb products. Users access the X-420 through the remote services web server rather than communicating directly with it. This method is sometimes referred to as “web services” and allows programmers to create powerful, custom web pages to multiple devices using the web programming languages of their choice.

The X-420 initiates the connection to the external web server (rather than the web server initiating communications to X-420). This has two main benefits. First, the web server does not need to know the IP address of X-420. This means that X-420 can get its IP address dynamically from a DHCP server, simplifying the installation. Second, since the connection from X-420 is outgoing, rather than incoming, the local router on the network where X-420 resides does not need to be configured to forward ports. This simplifies the installation. Since the router configuration is not modified, the risk of compromising security on the local network is eliminated. For more information about the Remote Services see *Section Using an External Web Server.*

SNMP AGENT

The X-420 Supports SNMP V1, V2c & V3. The SNMP agent is the server running on the X-420 responsible for receiving SNMP requests and returning SNMP responses. SNMP Managers are remote servers that the X-420 can send SNMP Trap and Notification messages to. The Agent is always enabled when SNMP is enabled. The SNMP Managers can be enabled/disabled separately. When using SNMP V3, the X-420 supports the User-based Security Model (USM).

SNMP Enabled

SNMP (Simple Network Management Protocol) can be enabled or disabled. The default setting for this option is *No*. (See *SNMP* at the end of this section for more information.)

SNMP Version

The X-420 supports versions 1, 2c, and 3. This option allows choosing what version of SNMP will be used, and will determine what SNMP options are presented. The X-420 will only respond to SNMP requests that use the selected SNMP version.

Agent Settings:

Agent Port

When SNMP is used, this field is used to specify the SNMP port that the X-420 SNMP Agent listens on. The default setting for this field is 161.

Agent Read Community

The read community string is used for SNMP V1 and V2c requests. It is required to read I/O on the device using SNMP V1 or V2c.

Agent Write Community

The write community string is used for SNMP V1 and V2c requests. It is required to write I/O on the device using SNMP V1 or V2c.

Notification Retries

When sending notifications, this field defines how many attempts the X-420 will make to send the notification to the SNMP Managers. Notifications differ from Traps in that a response is expected back from the SNMP Manager.

Notification Timeout

When sending notifications, this field defines how many seconds the X-420 waits for a response to a previously sent notification before attempting to send the notification again.

Manager Settings:

Manager Enable

An SNMP Manager is the server intended to receive traps and notifications from the X-420. The X-420 supports sending traps and notifications to two different SNMP managers. The default setting is *No*.

Manager Hostname/IP

This field is used to specify the hostname or IP address of the SNMP manager. The default setting for this field is 192.168.1.15.

Manager Port

This field is used to specify the SNMP Trap or Notification port of the SNMP Manager. The default setting for this field is 162.

Manager 1 Community

This field is used to defined the Trap/Notification community string used by the SNMP Manager for SNMP V1 and V2c. The SNMP Manager will not accept the Trap/Notification without a correct community string.

The X-420 MIB File:

MIB File

This button generates the Management Information Base (MIB) used for managing the entities in a communication network associated with the SNMP protocol. The file will be automatically generated and downloaded. This file will change as the I/O configured on the device changes.

SNMP V3 Security Settings:

The following settings appear when the SNMP version is set to Version 3. These settings configure the authentication and privacy protocols used by SNMP V3 User-based Security Model (USM). The Agent, and Both SNMP Managers each have their own set of USM settings. When SNMP V3 is selected, the community string settings disappear and are not used. They are replaced by the following settings:

Username

This field is defines the security username.

Auth Protocol

This field defines the authentication protocol used: None, MD5, SHA, SHA224, SHA256.

Auth Password

This field defines the authentication password.

Priv Protocol

This field defines the privacy protocol used: None, DES, AES128, AES192, AES256.

Priv Password

This field defines the privacy password used.

SNMP Notes: Simple Network Management Protocol (SNMP) is used to manage and administer network devices. X-420 supports SNMP V1, V2c, and V3 and can be configured here. Using SNMP, the I/O states of X-420 can be read as well as some basic information about the device. See *Section SNMP Requests, Objects and Community Strings* for information about how to request information from the X-420 using an SNMP manager.

IP Filtering

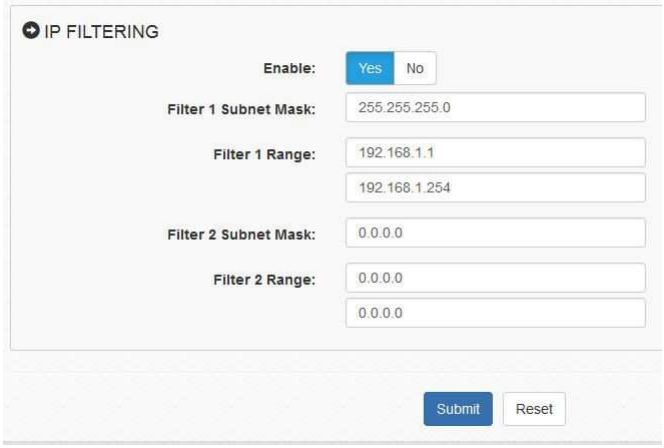
IP filtering can be enabled or disabled. IP filtering is used to restrict incoming network connections to only specific IP addresses. If a connection comes in to the X-420 that is not in the range of allowable IP addresses, the connection is terminated. IP filter only applies to incoming connections and not to outbound connections such as those to DNS servers. The X-420 allows for two different ranges to be defined. If one of the ranges is not needed, the IP address in each of the three fields for a given filter must be 0.0.0.0. IP filter settings only take effect after the X-420 is power-cycled.

Filter Subnet Mask

This is the subnet mask that is applied first. If the IP address does not fit within this subnet, the connection will be terminated. This subnet mask is applied to the Filter 1 Range's first IP address (the start address).

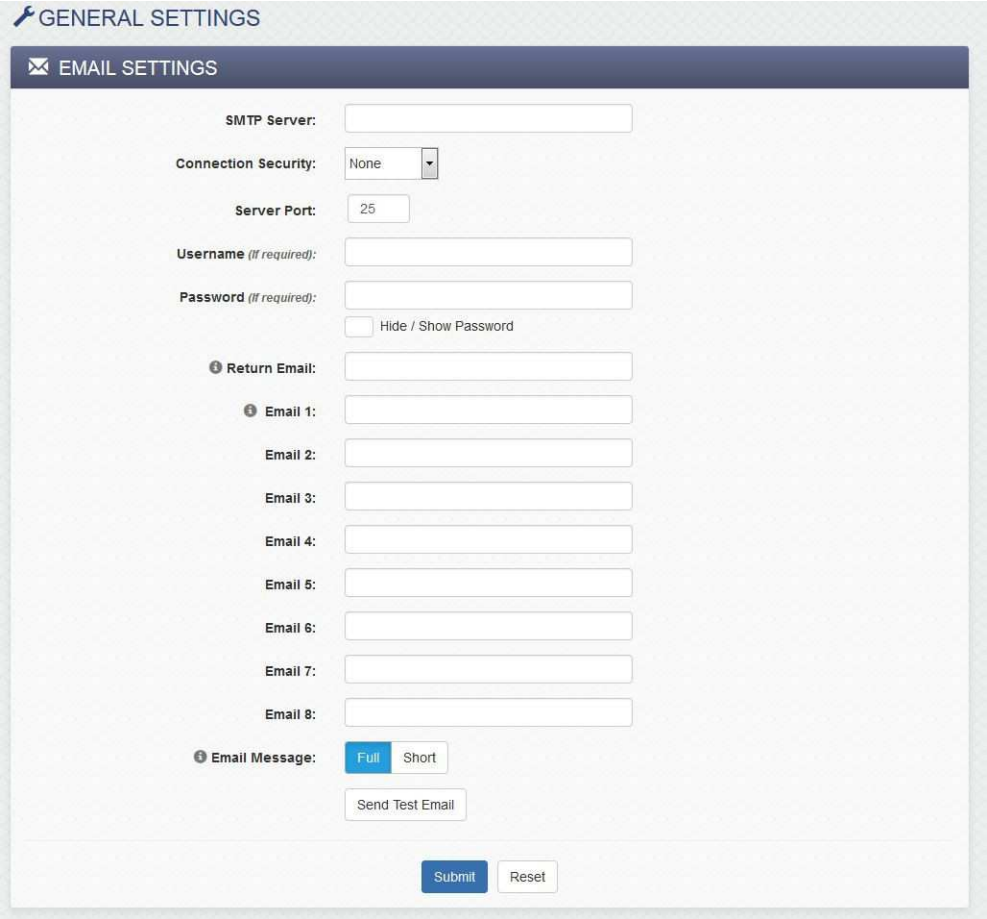
Filter Range

The range of IP addresses within the defined subnet mask that are allowed to communicate with the X-420. The first field is the start address, the second field is the end address.



3.2.4 General Settings Tab > EMAIL SETTINGS

The Email parameters are set on this page.



SMTP Server

The name of the SMTP (Simple Mail Transfer Protocol) mail server (i.e., mail.example.com) or the IP address of the mail server (i.e., 192.10.10.10) should be entered in this field. There is no default setting for this field.

Note: If the server name is entered and not the IP address, the address of a DNS server will be required in the DNS field in the Network settings.

Connection Security

Select the security method used for sending the email. There are two methods used to securely transmit email messages. STARTTLS and TLS/SSL. When STARTTLS is chosen, encryption will begin after the X-420 makes an unsecured connection to the SMTP server and negotiates TLS. When TLS/SSL is chosen, the connection to the server will be securely negotiated with the SMTP server from the beginning. Both methods are secure. STARTTLS generally requires the use of port 587 and TLS/SSL generally requires the use of port 465. No security method is also an option, and still supported by some SMTP servers. This method generally uses port 25.

Email Server Port

This field is used to specify the SMTP Mail Server Port. The default setting is 25, which is the standard SMTP port. This port will generally be different if a connection security method is chosen.

User Name (If Required)

If the SMTP mail server requires authentication, the user name must be entered here. There is no default setting for this field.

Password (If Required)

If the SMTP mail server requires authentication, the password must be entered here. There is no default setting for this field.

Return Email

The X-420 will not receive email messages, but when the X-420 sends email messages, it must include a return email address. This field is used to specify the return email address. Note that although the X-420 will send email messages with any email address specified in this field, some email filters (spam filters) will not allow messages through that include an invalid email address. There is no default setting for this field.

Email 1 to Email 8

Enter the email addresses of up to eight recipients. Email messages will not be sent to all of these addresses, but only those chosen when configuring email notifications. When creating Tasks, different recipients can be chosen to receive different email notifications.

Email Message

Choose either “Full” or “Short” email formats. *Full* sends an email with all visible fields on the control page. *Short* sends and email only showing what triggered the email.

Send Test Email

This button sends a test email to the first email address in the email list using the currently configured network and email settings. After the settings are automatically submitted, a progress window will pop-up and display the result of the test email:

- Success
- Failed DNS Lookup
- No Response from DNS server. Check DNS addresses, Power Cycle Device, etc.
- Failed
- Bad Username/Password
- Missing recipient email address(es)
- Server Address/Hostname does not exist or is misspelled
- Server Address/Hostname is blank
- No Response from SMTP server. Check server address and security/port combination

Email Notification Description

The X-420 can be configured to send messages to up to eight email addresses when certain events occur. Events that can trigger email messages include digital I/O state changes, Vin changes, temperature/humidity changes, and commands sent from a BASIC script.

When an email message is sent, it looks similar to this:

```
X-420

Trigger: Digital IO 1 ON

Digital IO 1: ON
Digital IO 2: OFF
Analog Input 1: 4.2 V
Analog Input 2: 2.5 VDC
Analog Input 3: 1.00 VAC
Analog Input 4: 0.001 Amps
Vin: 12.00 V
Sensor 1: 76.2° F
Sensor 2: 73.7° F
Sensor 3: 32.0° F
Sensor 4: 84.5° F
Digital IO 1 Count: 5.00
Digital IO 2 Count: 0.00
Time: 09/27/2017 15:30:00
```

Note: Digital I/O, Count, and Sensor names as well as ON and OFF status text may be customized by the user (installer) in the setup pages. The same field names are used on the Control Page.

Subject Line

The top line (that reads “X-420”), appears in the subject line of the email message. This is the same text that appears as the header on the *Control Page*. It is set in the *Main Header Text* field under the *Monitor & Control Tab* > *CONTROL PAGE SETUP* tab.

Trigger

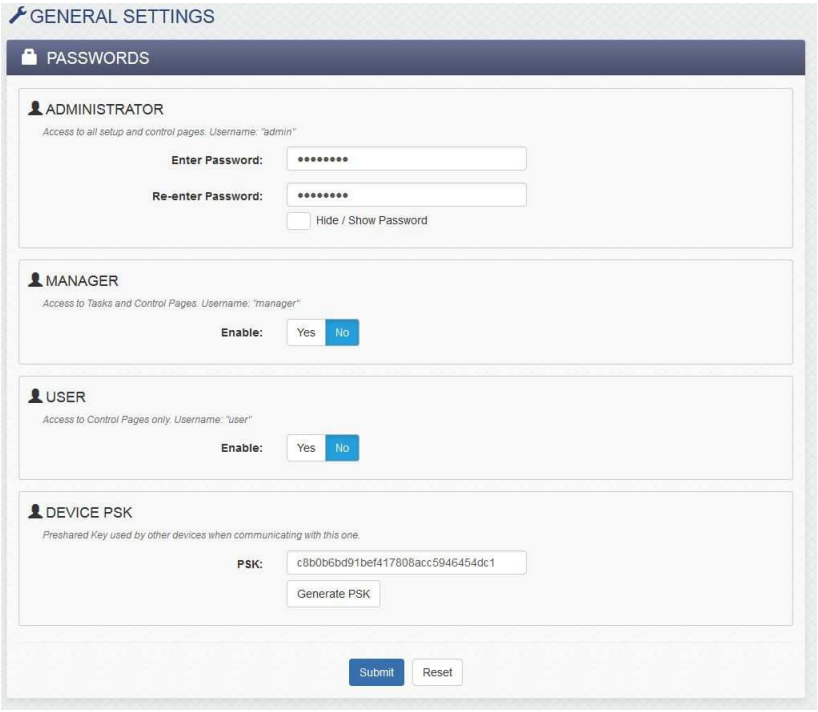
The first line displayed in the body of the message shows the event that triggered the message. The text “Trigger” will always appear and cannot be changed. The remaining text includes the trigger name, and what caused the trigger. The text that describes the trigger and its current state are configured in the setup pages as described below.

Current Status of the Analog Inputs, Digital I/O, Vin, and Sensors

The remainder of the email message will display the same information shown on the *Control Page*. Fields not displayed in the *Control Page* will not be included in the email message. Displayed fields may be configured in the *Monitor & Control Tab* > *CONTROL PAGE SETUP* page. Alternatively, the email message can be set from Full to Short on the *Email* tab of the setup pages. Setting the Email Message to Short will only include the trigger and the I/O that caused it to show in the email body.

3.2.5 General Settings Tab > PASSWORDS

The X-420 requires passwords to access specific resources. The passwords can be changed on this page. Passwords must be 8 to 18 characters, both alphabetic and numeric characters are recommended. A hide/show check-box selects if the password will be shown. When a password is changed, it must be entered twice for verification. If the password is not entered identically in both fields, the password will not be changed.



Administrator

Administrators have access to all setup, task and Control Page. This access privilege is normally used by a system integrator or installer to setup the I/O, control logic and user interface. The *Administrator* username is `admin` (all lower case). The default password is `webrelay` (all lower case).

Manager

Managers have access to tasks and Control Page. This access privilege can be used for example, to allow a door access schedule to be changed for a holiday. A *Manager* cannot change the network settings, I/O, or control logic. The *Manager* username is `manager` (all lower case). The default *Manager* password is `webrelay` (all lower case). The password access for *Managers* can be enabled or disabled. When a manager logs into the setup pages, they will receive a subset of the menu options allowing them to edit Scheduled Tasks and view the Control Page.

User

Users have access privilege to the Control Page only. This access privilege is for users and operators to monitor sensors or control outputs that are on the Control Page. The password access for *Users* can be enabled or disabled. When this field is set to *Yes,* a password will be required to view the *Control Page*. The default setting for this field is *No*. The *User's* username is `user` (all lower case). The default *User* password is `webrelay` (all lower case).

Note: Since Modbus has no provision for passing passwords, Modbus will be disabled if the Control Page password is enabled.

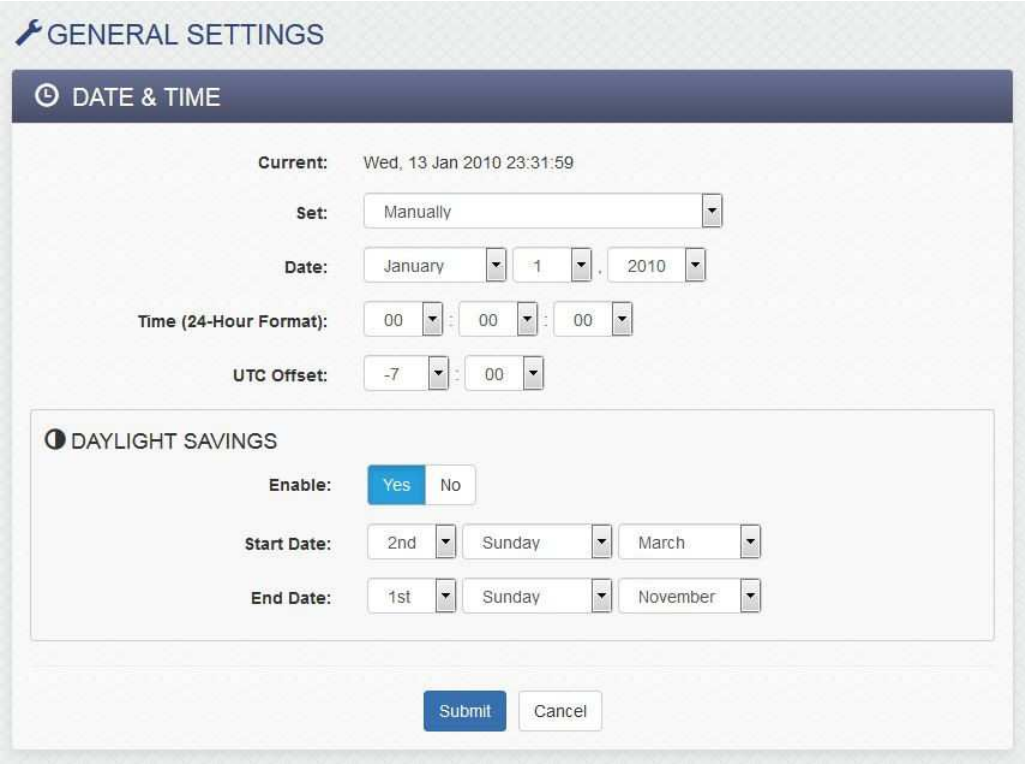
Device PSK

The Device PSK is a pre-shared key used by other devices when communicating with this device securely. When adding a device as a remote device, that device's pre-shared key is asked for during the configuration. This is where that PSK is defined.

The PSK is a 32-byte hexadecimal key with valid characters being a-f and 0-9. Anything can be used as the devices PSK as long as it is 32 bytes long and contain only valid characters. The Generate PSK button can be used to request that the X-420 generate a secure, random PSK. This is the preferred way to generate the PSK. Once generated, a new PSK does not need to be generated unless the old one has been compromised. A new PSK is generated when the device is reset to factory defaults.

3.2.6 General Settings Tab > DATE & TIME

The X-420 uses the time of day for scheduled events, such as turning the Digital I/O on or off at scheduled times and for logging (a time stamp is included with each logged event). The time is stored and displayed in 24-hour time format. The X-420 has a capacitor-backed, real-time-clock circuit that will sustain the time for several days in the event of a power failure.



Current

This is the current date and time maintained in X-420. The time is stored and displayed in 24-hour format.

Set Time:

This drop-down list offers two options for setting the time: *Manually* or *Sync with NTP server*.

The options that follow this field will change based upon how this option is set:

Manually	Requires the user to enter the time and date.
Sync with NTP server	Allows the user to set the clock automatically by using an NTP (Network Time Protocol) server.

Manual Time Configuration

Date

The current date is entered by selecting the month, day, and year using the drop-down boxes.

Time (24 Hour Format)

Enter the time as HH:MM:SS. (HH represents hours in 24-hour format [00-23], MM represents minutes [00-59], SS represents seconds [00-59].)

UTC Offset

Time servers return the current time in Universal Time (GMT). It is common for many servers and data loggers to use GMT as their official time, even when they are not located within the GMT time zone. The default value for this field is -7 (Mountain Standard Time). For convenience, the time can be converted to local standard time by entering the offset here. This manual cannot include the UTC Offset for all parts of the world, but the offset for GMT time and the four major US Time zones are listed here.

GMT Time: 0
Eastern Standard Time: -5:00
Central Standard Time: -6:00
Mountain Standard Time: -7:00
Pacific Standard Time: -8:00

SYNC With NTP Server

NTP Host Name

This field is used to specify the name or IP address of the NTP server. If a name is specified, a working DNS server address must be entered into the Network settings. If the IP address is specified, it should be entered in the following format aaa.bbb.ccc.ddd where each of the letters represents a number between 0 and 255. This field can be up to 40 characters. There is no default value for this field.

Many NTP Internet servers are available. In addition, many desktop computers will function as an NTP server (both Mac and PC). If a desktop computer is used, firewall settings may need to be adjusted to allow for NTP communications on UDP port 123.

Public NTP servers can be found at www.pool.ntp.org. Some of these are listed below.

US Servers (http://www.pool.ntp.org/zone/us):
0.us.pool.ntp.org
1.us.pool.ntp.org
2.us.pool.ntp.org
3.us.pool.ntp.org

North America (http://www.pool.ntp.org/zone/north-america):
0.north-america.pool.ntp.org
1.north-america.pool.ntp.org
2.north-america.pool.ntp.org
3.north-america.pool.ntp.org

Europe (http://www.pool.ntp.org/zone/europe):

0.europe.pool.ntp.org
1.europe.pool.ntp.org
2.europe.pool.ntp.org
3.europe.pool.ntp.org

Australia (http://www.pool.ntp.org/zone/au):
0.au.pool.ntp.org
1.au.pool.ntp.org
2.au.pool.ntp.org
3.au.pool.ntp.org

South America (http://www.pool.ntp.org/zone/south-america):
0.south-america.pool.ntp.org
1.south-america.pool.ntp.org
2.south-america.pool.ntp.org
3.south-america.pool.ntp.org

Africa (http://www.pool.ntp.org/zone/africa):
1.africa.pool.ntp.org
1.pool.ntp.org
3.pool.ntp.org

NTP Sync Interval

This option allows the user to specify how often the time on the X-420 will be synchronized with the time server. When the Submit button on this page is pressed, the X-420 will immediately synchronize with the time server. If Daily, Weekly, or Monthly options are selected, the X-420 will thereafter re-synchronize with the time server at the period interval specified starting at 12:00 AM (00:00).

To prevent multiple X-420s from overwhelming the NTP server at power on, the exact time the NTP Request occurs is 12:00 AM (00:00) plus the minute equivalent of the last two digits in the model's serial number. For example, if the last two digits in the model's serial number were -09, the NTP Request will occur 9 minutes after 12:00 AM. The default value of this setting is Once (the unit will immediately sync with the NTP server, but will not automatically sync again).

Sync on Power Up

When this option is set to *Yes*, the X-420 will be synchronized with the time server each time it is powered.

Note: If the X-420 will lose power on a frequent basis, it may be beneficial to set this option to No. Some servers are configured to dis-allow access from client devices that excessively request their services. The default value of this setting is No.

Daylight Savings

Enable

Daylight Savings can be enabled or disabled. The default setting is *Yes.*

In many parts of the United States and in some other countries, the time is shifted forward by one hour during the summer months. This is an effort to conserve energy by making the daylight last longer into the evening hours. If this option is set to *Yes,* the time on the X-420 will automatically be shifted forward by one hour between the hours of 12:00 AM – 5:00 PM on the Daylight Savings Start date set below, and it will shift back to standard time between the hours of 12:00 AM – 5:00 PM on

the Daylight Savings End date set below. The time change is made at a random time within the previously mentioned, five-hour time frame, in order to prevent multiple devices from simultaneously requesting a time and overwhelming the NTP server.

Note: Enabling the daylight savings time adjustment, scheduled events will be adjusted for the new time. Logged data includes a time stamp based upon the current time in the device followed by DST when the device is in daylight savings and STD when it is not. To avoid confusion, many servers and data loggers are set to remain on GMT time and do not shift for daylight savings.

Daylight Savings Start Date/Time

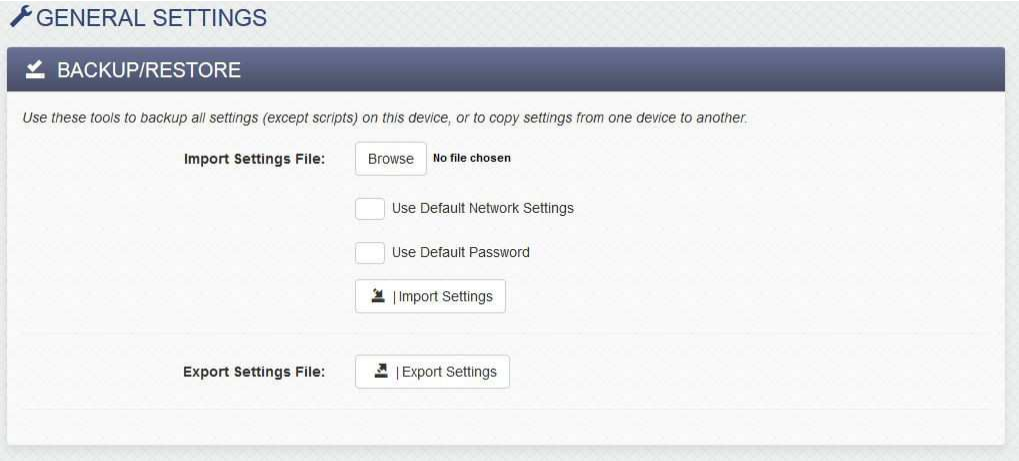
This is the date and time that daylight savings will start. Note that on this date, between the hours of 12:00 AM – 5:00 PM, the current time will be shifted forward by one hour (i.e. the time will jump from 12:02 AM [00:02] to 1:02 AM [01:02]). By default this is set to the 2nd Sunday in March which is the date used in the United States.

Daylight Savings End Date/Time

This is the date and time that daylight savings will end. On this date, between the hours of 12:00 AM – 5:00 PM, the current time will be shifted backward by one hour (i.e. time will jump from 12:02 AM [00:02] to 11:02 PM [23:02] the day before). By default this is set to the 1st Sunday in November which is the date used in the U.S.

3.2.7 General Settings Tab > BACKUP/RESTORE

Use these tools to backup the settings (excluding scripts and SSL Certificates) on this device, or to copy settings from one device to another. This is useful for “cloning” or copying devices, or to maintain a backup copy of the settings.



Import Settings File

To import settings from an external file, first click the *Browse* button and select the desired *settings.txt* file on your computer. If *Use Default Network Settings* is checked, any network settings in the file are ignored and the network settings are forced to the default state. If *Use Default Password* is checked, the Administrator password in the file is ignored and the Administrator password is forced to the default state. Click the *Import Settings* button to import (load) the settings from the selected file.

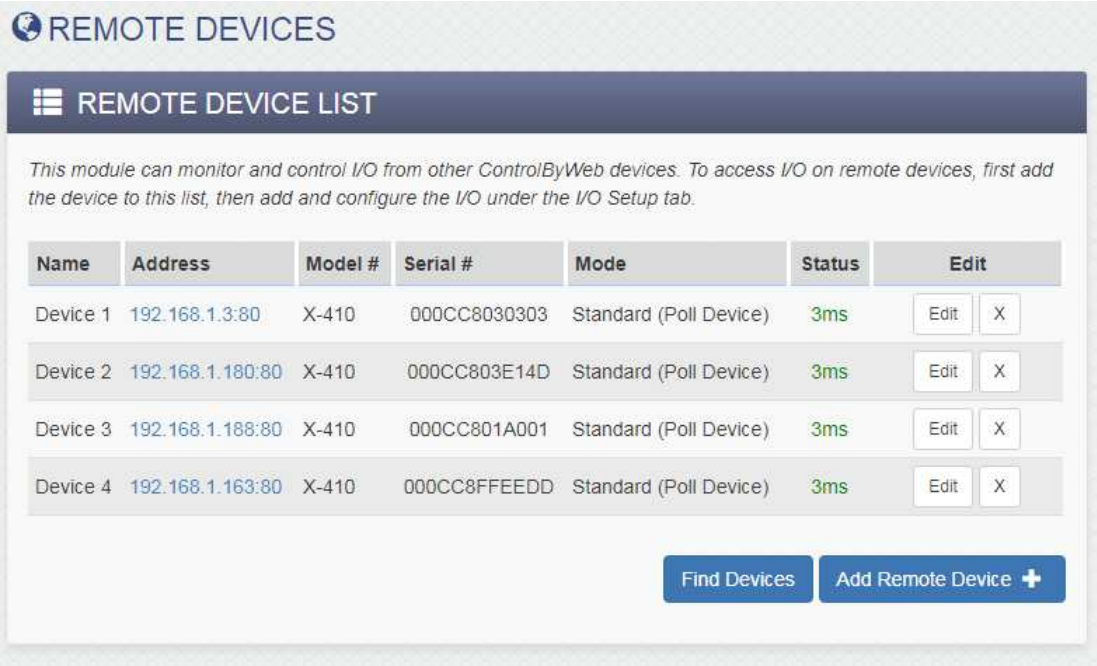
Export Settings File

Click the *Export Settings* button to export all of the current settings to a “settings.txt” file. If desired, the file can be opened and examined with a text editor. Note that BASIC scripts and SSL Certificates are not included in this settings file and should be saved separately.

3.3 Remote Devices Tab

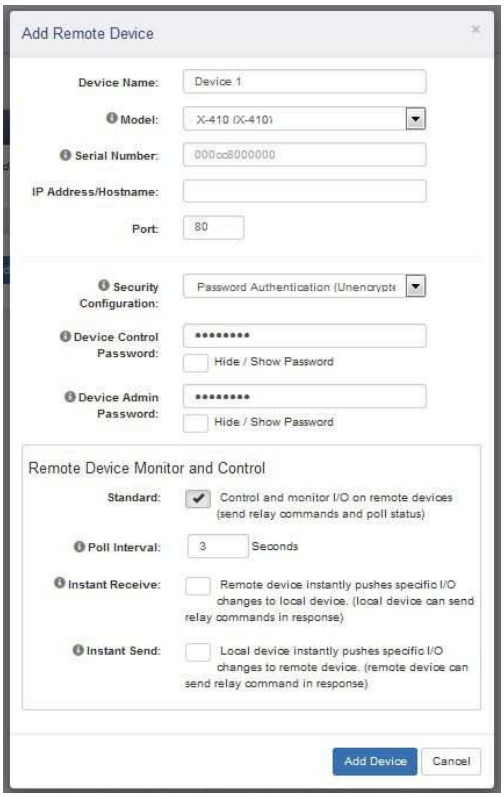
The X-420 can monitor and control up to 100 I/O points on up to 32 other ControlByWeb devices. This feature can be used to implement a distributed control system. With distributed control, intelligent control devices such as the X-420 are placed in close proximity to the sensors, relays, motors and valves that are to be monitored and controlled. The control devices are connected together into a control system with Ethernet communication. No central control cabinet is needed with long wire runs to the sensors, relays, motors and valves in your facility. With Ethernet communication, the control system can accommodate applications with long distances between the devices being monitored and controlled. Each device on the bus implements a portion of the control application.

To access I/O on remote devices, first add the remote device to this device list, then add and configure the I/O under the *I/O Setup* tab. Remote devices appear in the table on the remote devices tab and can be created, edited or deleted as needed.



To add a remote device, click *Add Remote Device*. Depending on the *Model* selected in the pull down ▼ list, the available settings will change to accommodate the capability's of the remote device. For example, only certain devices can support encrypted communications.

Device Name
This text field allows you type a descriptive device name that will be referenced throughout the setup pages. Up to 24 characters may be entered in this field. The default text is “Device 1”. Set the name to a descriptive value such as “Warehouse Lights”.



Model
Click the ▼ symbol and choose from the list of supported remote devices. When changing the device type of a previously configured device, only I/O compatible device types will be enabled.

Serial Number
The MAC address of the remote device is entered here. The serial number is only required for 400 series devices. The default value is 000CC8000000

IP Address/Hostname
The IP address or hostname of the remote device. Up to 61 characters may be entered in this field.

Port
The TCP port number of the remote device. This must match the TCP port (HTTP port) set in the remote device. The valid range is 1 to 65535. The default port number is 80. If *TLS PSK Encryption* is selected (see below), the default port number is 443.

Security Configuration
Select either *Unencrypted* or *TLS PSK Encryption*. When both devices are on the same local network unencrypted communication is usually acceptable. When devices communicate across the Internet, encrypted communication is recommended. Performance with encrypted communication will be slightly slower.

Device Control Password
This setting is shown if the security configuration is set to *Unencrypted*. Enter the password required to access the I/O on the remote device. This password will be the same as the ‘User’ password on the remote device.

Device PSK
This setting is shown if the security configuration is set to TLS PSK E*ncryption*. This is the pre-shared key required to access the I/O on the remote device using encryption. The pre-shared key can be found on the Passwords tab on the remote device's setup page.

Device Admin Password
Enter the admin password to be used to access the remote device's I/O setup page. This setting is only shown if the remote device supports this feature. This feature will only work if the remote device is connected to the Ethernet and both the Serial Number and IP address are set (above). The X-420 will automatically add itself to the remote device's device list.

Remote Device Monitor and Control:

X-400 series devices can be remotely controlled with *Instant Send* or *Instant Receive* communication architectures. If the remote device selected from the pull-down list does not support *Instant Send* or *Instant Receive,* these settings will not be shown and only the polling interval can be configured.

Standard
If the check-box ☑ is enabled, the remote device is controlled and monitored by sending relay commands when needed and periodically polling its status.

Poll Interval
If polled communication is selected (see above), the local (this) device will request the state of the remote device at this polling interval.

Instant Receive
If the check-box ☑ is enabled, the remote device instantly pushes specific I/O changes to the local (this) device. The local device can send relay commands in the response. The remote device will push I/O state to the local device periodically and/or when triggers are set up on the remote device to do this.

Instant Send
If the check-box ☑ enabled, the local (this) device instantly pushes specific I/O changes to the remote device. The remote device can send relay commands in response. The local device will push the state of all local I/O to the remote device periodically and/or when triggers are set up with an Action (see Control/Logic Tab > TASK/FUNCTIONS.

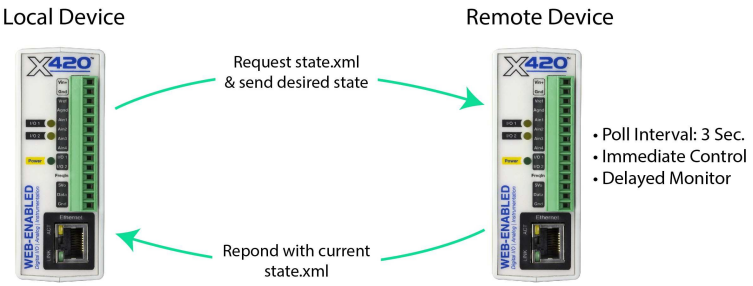
Poll Interval
If *Instant Send* is selected (see above), the local (this) device will request the state of the remote device at this polling interval.

Notes for Remote Devices

Communication with remote ControlByweb™ devices is done using both event-driven and polled communication models. Relay and output I/O changes sent to the remote device are event driven. Digital inputs and input I/O of the remote device are sampled at a periodic rate set by the polling interval. The latency of the system is determined by the polling interval. ControlByWeb's X-400 series devices however, allow event-driven communication in both directions where I/O changes are “pushed” to other devices. This has the advantage of avoiding the latencies of the polling interval, and since the information is “pushed”, the communication can occur through a router or firewall without the need to configure port forwarding.

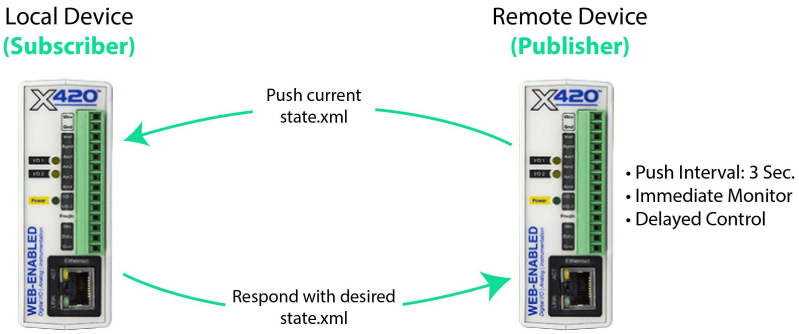
Communication with non X-400 series devices is done with *Polled* communications only.

Polled
The state of the remote device is periodically polled by requesting state.xml. The remote device responds with its current state.xml. Changing remote relays is event driven (immediate.) Choose this setting for non X-400-series devices and for monitoring the outputs of the remote device where the state is slowly changing (temperature, humidity etc.)

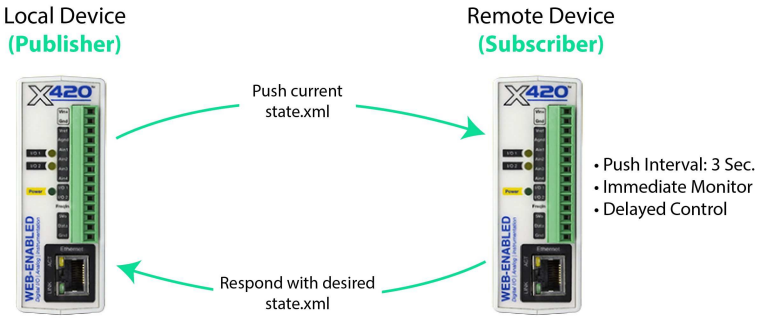


Communication with ControlByWeb's X-400 series devices can be done with the *Publisher*/*Subscriber* communication model as well.

Publisher
The remote device is event driven and pushes (publishes) its state changes to the local device. The local device can send control messages in the response. The update of remote relay states is delayed. Choose this setting for applications where the local device must immediately know the I/O state changes of the remote device.



Subscriber
The local device is event driven and pushes (publishes) its state changes to the remote device. The remote device can send relay commands in response. Choose this setting for applications where the remote device must immediately know the state of changes to the local device inputs.



3.4 I/O Setup Tab

The X-420 supports a total of up to 100 Input/Output (I/O) resources. These can be a mix of analog inputs, digital I/O, 1-Wire sensors, registers, counters, timers and Vin. These can also include I/O found on up to 32 remote devices. Fixed I/O such as the analog inputs and digital I/O of the X-420 are automatically predefined in the I/O resource list.

As I/O resources are added, they appear in rows in the respective setup sections and can be created, edited or deleted as needed. If an I/O resource is deleted, any dependent *Scheduled Task*, *Conditional Task* or Control Page widget which reference the I/O resource being deleted is automatically deleted.

If logging is enabled for the I/O resource being deleted, the I/O resource is automatically removed from the logging list and the log file is reset (a warning is given that the log file will be deleted.) The log file is deleted since the log file format is dependent on the I/O being logged. If a remote device is deleted, any dependent I/O resources, control tasks, Control Page widgets and logging are also automatically deleted.

3.4.1 I/O Setup Tab > 1-Wire SENSORS

This tab is used to configure local and remote temperature, humidity, and/or other 1-Wire sensors. Up to 16 1-Wire sensors can be connected to the X-420. The X-420 will automatically detect the type of sensor connected. Once added to the X-420, 1-Wire sensors appear in the table on the 1-Wire Sensors tab and can be created, edited or deleted as needed.

Every 1-Wire sensor comes from the factory with a unique, non-changeable address. Once the sensor is connected to the X-420, the X-420 must associate a sensor name with the sensor address. You must define a sensor name and associate an address for each 1-Wire sensor. For remote 1-Wire sensors, only the device and sensor number (not address) are needed (the 1-Wire address should be configured locally on the remote device).

For example, a list of named, associated 1-Wire sensors is shown:

To add a new local 1-Wire sensor, click *Add 1-Wire Sensor* in the local 1-Wire Sensors table.

Enter a descriptive name for the sensor in the *Sensor Name* box such as “Outdoor Temperature”. The text in this field appears to the left of the corresponding temperature/humidity reading on the Control Page. This text also appears in the email status message when email notifications are enabled. When later defining the control logic, logging and other settings, this label appears in the pull-down lists of sensor resources. This field can be up to 27 characters in length.

Click ▼ to see a list of the connected 1-Wire sensors. The addresses of the non-associated sensors on the bus are shown in the drop-down list together with the sensor type of each sensor. Click the button to make a fresh scan of the bus for sensors. For each sensor being added, select the appropriate address from the sensor address drop-down list. As 1-Wire sensors are added to the X-420, the addresses are removed from the pull-down ▼list of available addresses. The X-DTHS-P temperature/humidity probe is a composite device and has a single 1-Wire address. The drop-down list will show both a temperature and a humidity ID with the same sensor address. Select appropriate ID (temperature or humidity) and the sensor address that matches the sensor address printed on the housing of the X-DTHS-P.

Alternatively, connect the sensors to the bus one at a time. The procedure is to start with one sensor and add it with the appropriate sensor name by selecting the sensor address within the drop-down list. Press *Submit*, connect a second sensor, and press the Refresh List button. Associate the second sensor to the appropriate sensor name. Continue this procedure until all sensors are set up.

The G*eneral Setting*s page has a setting to select the display for *Fahrenheit*, *Centigrade* or *Kelvin* units. 1-Wire addresses that have already been associated will not show in the list of available 1-Wire sensors.

1-Wire Options

Decimal Places

The number of digits to the right of the decimal point. This setting does not affect the accuracy of the underlying value. It is applied whenever the 1-Wire value is displayed in the Log files, Control Pages, Emails, Etc.

Local 1-Wire Options

Offset

If desired, an offset can be added to the 1-Wire sensor's measurement. By default, the offset is 0.0

FinalValue = Sensor's Measured Value + Offset

Remote 1-Wire Options

Device

For remote 1-Wire sensors, this settings specifies the device to which the remote 1-Wire sensor is connected.

Device's Sensor #

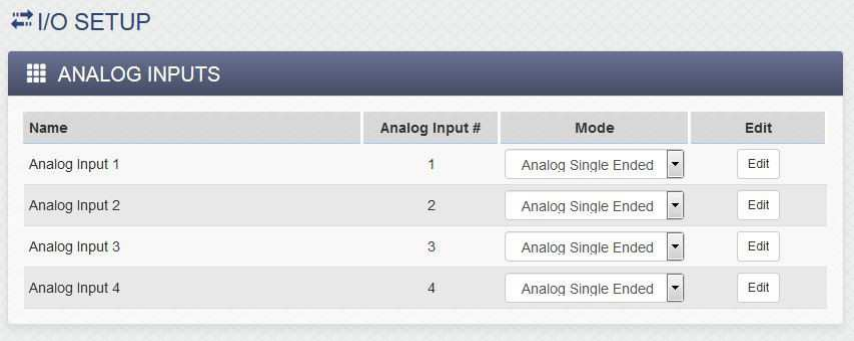
For remote 1-Wire Sensors, this settings specifies the 1-Wire number on the remote device. (Not the address of the 1-Wire sensor.)

Sensor Type

The X-420 can determine the type of 1-Wire sensor if it is connected directly to the device. For remote 1-Wire sensors, the sensor type must be configured for the X-420 to know which type of sensor it is.

3.4.2 I/O Setup Tab > Analog Inputs

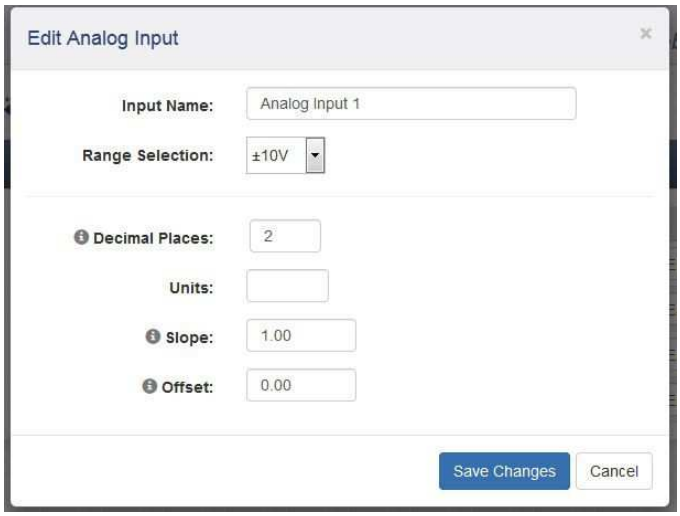
This page allows configuration of both local and remote analog inputs if remote devices have been configured. There are two tables, one for local analog inputs and one for remote. The analog inputs can be sampled and logged up to 25Hz for short durations. A scheduled or conditional task “action” can be used to start and stop logging.



The X-420 features a high performance, 4-channel, 16-bit analog data acquisition system. Each analog input can be configured separately:

Single Ended	Single ended signals are referenced to the Gnd terminals. Each channel can be independently programmed with a ±1.28V, ±2.56V, ±5.12V, ±10.24V voltage range.
Differential	Differential sensors have two outputs that reference each other instead of ground. The differential mode uses two analog inputs instead of one. If Channel 1 is selected for differential operation, the differential signals are connected to Channel 1 and 2. If Channel 3 is selected for differential operation, the differential signals are connected to Channel 3 and 4. The differential mode supports input ranges of up to ±20.48V. However, the absolute input voltages must be les than ±10V. For example, if Input1 is configured for differential operation and Input1 = +10V and Input2 = -10V, the measurement will read +20V. On the other hand, if Input1 = -10V and Input2 = +10V, the measurement will read -20V.
4-20mA	Some industrial sensors output a current instead of voltage levels. Normally, a shunt resistor is needed to measure the current. With the X-420, the 4-20mA mode enables an internal precision 200-ohm shunt resistor (0.1%, 25ppm) and automatically configures the A/D for ±5V operation. This feature allows direct connection to 0-20mA current loop transducers. At 20mA the maximum loop voltage across the X-420 is 4.0 Volts (.020 x 200 = 4.0). With this setting, the voltage to current calculation ((Vin/200)*1000) is automatically made so the measurement is in units of mA.
Digital Input	For applications where more than two digital inputs are needed, each analog input can be configured as a pseudo digital input with boolean (true/false) states. The input voltage is compared to fixed thresholds to determine a true/false state. The input is considered “true” when the voltage rises above 3.5V and “false” when it falls below 1.5V. If an analog input is configured as a “digital input”, the analog input widget on the control page will be similar to and have the same setup options as a digital input.

Click the respective *Edit* button to configure each analog input. Local analog inputs have some settings that remote analog inputs don't have and vice versa.



Edit Analog Input Options

Input Name

This text field describes the function of the selected analog input. The label text appears to the left of the corresponding analog input on the *Control Page* and in the email message when email alerts are enabled. When later defining the control logic, logging and other settings, this label appears in the pull-down lists of analog input resources. Up to 27 characters may be entered in this field. The default text is "Analog Input #". Set the name to a descriptive value such as "Wind Direction".

Range Selection

The analog to digital converter has a programmable gain amplifier (PGA). This setting specifies the full scale range of the analog input. Settings include; ±1.28V, ±2.56V, ±5.12V, ±10.24V.

Decimal Places

The number of digits displayed to the right of the decimal point. This does not affect the accuracy of the underlying value.

Units

Text entered here will be displayed on the right of the value when shown on the Control Page. This text does not affect the underlying value. Set the units to Volts, mA, mph etc.

Slope (Multiplier)

The analog value can be scaled into engineering units. The X-420 reads the raw value (volts) from the analog-to-digital converter and calculates a new value in engineering units. This scaled value is calculated using the following y=mX+b formula..

Scaled Value = Slope * RawValue + Offset

The calculated scaled value is used for logs, email messages, control pages, XML pages, and is returned when Modbus values are read.

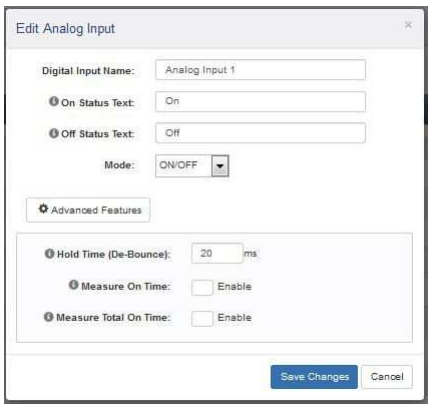
The "slope" in the formula above is provided by the user and is entered in this field. When both the slope and offset are set to their default values (m=1 and y=0) the scaled value equals the input voltage.

Offset

The "offset" in the formula above is provided by the user and is entered in this field. The default value for this field is 0.

Pseudo Digital Input Options

If an analog input is configured as a pseudo digital input, the following options are available.



Digital Input Name

This text field describes the function of the selected digital input. The label text appears to the left of the corresponding digital input status on the *Control Page* and in the email message when email alerts are enabled. When later defining the control logic, logging and other settings, this label appears in the digital input pull-down list.
Up to 27 characters may be entered in this field. The default text is “Digital I/O #”. Set the name to a descriptive value such as “Warehouse Door”.

On Status Text

The text in this field specifies the text that will be displayed in the *Control Page* and in email messages when the digital input is On. The digital input is considered “on” when sufficient voltage is applied to the input. Up to 16 characters may be entered in this field. The default text is “On”. Set the status text to a descriptive value such as “Door Open”.

Off Status Text

The text in this field specifies the text that will be displayed in the *Control Page* and in email messages when the digital input is Off. Up to 16 characters may be entered in this field. The default text is “Off”. Set the status text to a descriptive value such as “Door Closed”.

Mode:

The digital input can be configured for several operating modes:

On/Off	A single I/O resource with the name “name” is created, where name is the digital input name defined above. The resource has binary (true/false) values.
Counter	The digital input is configured as a digital counter which counts the number of pulses on the respective digital input. Two I/O resources are created: name and name.counter. The counter value can be scaled into engineering units and is accessible to conditional tasks, BASIC scripts, Modbus and control page widgets. The counters associated with digital inputs 1 and 2 are stored in battery-backed memory and will retain their count through a power loss; however, the counters will not continue to increment while the X-420 power is off.
Frequency	The frequency of the respective digital input is measured by counting the number of pulses that occur during a period of 1-second. The value is updated once each second. A single I/O resource is created in the form name.frequency. The frequency value can be scaled into engineering units and is accessible to Conditional Tasks, BASIC scripts, Modbus and Control Page widgets.

Each of the digital inputs can be configured for use with a 24-bit digital counter which counts the number of pulses on the respective digital input. The counters can count up to 20Hz and can be used traffic sensors and other sensors which output pulses. The counters can be named and work similar to *Registers* where the counter value is accessible to Conditional Tasks, BASIC scripts and control page widgets. The counters associated with digital inputs 1 and 2 are stored in battery-

backed memory and will retain their count through a power loss; however, the counters will not continue to increment while the X-420 power is off.

Counter:
When *Counter* is selected, the following options are available:

Reset Count At

The counters automatically “roll over” to zero when the count reaches the value of this setting (modulo n). This setting is an integer for the raw count, before any slope multiplier or offset is applied. When *name.counter. is* accessed *by* Conditional Tasks, BASIC scripts and Control page widgets, the slope multiplier and offset are applied, and the value is a single precision floating point value.

Reset Counter

This button manually resets the counter to zero.

Units

Text entered here will be displayed on the right of the value when shown on the control page. This text does not affect the underlying value. Set the units to GPM, ea., mph etc.

Decimal Places

The number of digits displayed to the right of the decimal point. This does not affect the accuracy of the underlying value.

Slope (Multiplier)

The counter value can be scaled into engineering units. The X-418 reads the raw value from the counter and calculates a new value in engineering units. This scaled value is calculated using the following y=mX+b formula..

Scaled Value = Slope * Count + Offset

The calculated scaled value is used for logs, email messages, control pages, XML pages, and is returned when Modbus values are read.

The “slope” in the formula above is provided by the user and is entered in this field. When both the slope and offset are set to their default values (m=1 and y=0) the scaled value equals the actual count.

Offset

The “offset” in the formula above is provided by the user and is entered in this field. The default value for this field is 0.

Local Digital Input Options

Digital Input Count Mode

Increment when ON	Count on the rising edge of the pulse
Increment when OFF	Count on the falling edge of the pulse
Increment when input changes	Count on both rising and falling edges of the pulse

Advanced Features

The digital inputs can be configured for several additional operating modes:

Hold Time (de-bounce): The input must remain *On* for this amount of time before the logic considers this input to be *On*. For switches and other noisy sensors, this eliminates problems with falsely detecting multiple *On* states before the input becomes stable. The default setting is 20ms and can be set from 0-250ms. The digital input is processed by this setting before it is applied to the on/off, counter and frequency logic. This setting directly limits the maximum input frequency that can be measured.

Measure On-Time: When this feature is enabled, the time that the input is on is measured. This value will be cleared when the input changes from “off” to “on”. When the input changes from “on” to “off” the value will be frozen and can be accessed as long as the input remains “off”. The *On-Time* only starts counting once the debounce time has expired and continues after the input goes off until the debounce timer expires again. An I/O resource is created in the form *name.onTime*

Measure Total On-Time: When this feature is selected, the accumulated time that the input is on is measured. When the input is off the timer stops. When the input goes on again, the timer resumes. This feature is useful for example, to measure the total run time of a machine to determine when maintenance is needed. The Total On-Time only starts counting once the debounce time has expired and continues after the input goes off until the debounce timer expires again. An I/O resource is created in the form *name.totalOnTime*

Remote Digital I/O Options

Remote Digital I/O have the same options as the local Digital I/O which depends on if the remote Digital I/O is configured as an input or an output. Remote Digital I/O have two more options that identify the device and Digital I/O number of the remote Digital I/O.

Device

For remote digital I/O, this settings specifies the device that the remote digital I/O is found on.

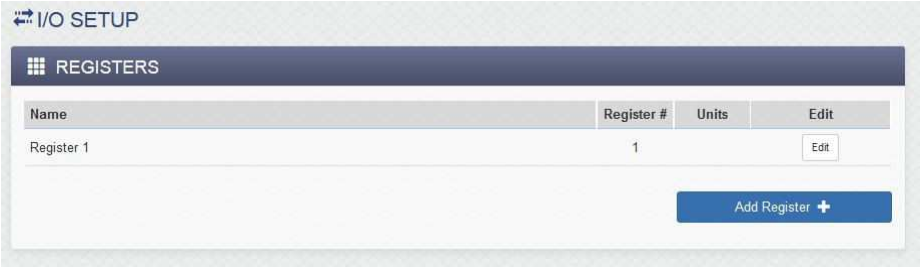
Device’s Output/Digital Input #

For remote digital inputs, this settings specifies the digital input number on the remote device. For remote digital outputs this specifies the digital output number on the remote device.

Note: For remote counters, frequency, etc., the values are read from the remote device and not calculated locally.

3.4.3 I/O Setup Tab > REGISTERS

Registers are working variables that can be changed externally through the *Control Page, XML requests,* or the BASIC script. Registers can allow a BASIC script to react to user input. These variables are considered to be floating point numbers, just like other variables in the BASIC script. Registers can also hold boolean information where "1"=true and "0"=false. This tab has settings for each of the configured Registers. By default, one register (*register1)* is pre-defined and is battery backed such that its value is retained across power loss. Registers appear in tables on the Registers tab and can be created, edited or deleted as needed. Up to 16 Local Registers can be created. The X-420 can also access remote registers found on other devices.



Register Options

Register Name
Text entered here will be displayed in the left column of the Control Page. Up to 27 characters may be entered here. The default text is "Register 1". This is also the resource name used in a BASIC script. When later defining the control logic, logging and other settings, this label appears in the pull-down lists of Register resources.

Decimal Places
The number of digits displayed to the right of the decimal point. This does not affect the accuracy of the underlying value.

Units
Text entered here will be displayed on the right of the value when shown on the control page. This text does not affect the underlying value. Set the units to °F, ft, mph etc.

Minimum Value
If this register can be changed externally through the *Control Page, XML requests,* or the BASIC script it is may be useful to restrict the range of the register value. For example, a thermostat set-point register can be restricted to a minimum value.

Maximum Value
If this register can be changed externally through the *Control Page, XML requests,* or the BASIC script it is may be useful to restrict the range of the register value. For example, a thermostat set-point register can be restricted to a maximum value.

Local Register Options

Power Up State

At power-up the register is set to either an *Initial Value* (set below) or the *Scheduled State*. The Scheduled State will cause the register value to be defined by any scheduled tasks as if the power was always on.

Remote Register Options

Device

The device where the remote register is found.

Device's Sensor #

The register number on the remote device.

3.4.4 I/O Setup Tab > Vin

Vin reflects the voltage of the power source applied to the device and is measured internally. This page configures the name for the Vin voltage.

Note: With the X-420-E the power is provided over the Ethernet cable and the Vin+ monitor will show 0-volts. The X-420 can also monitor the power supply voltage of remote devices.

To edit the Vin name click *Edit*.

Vin Options

Vin Name

This text field is used to describe the power supply voltage value. By default it is set to “Vin.” The text appears to the left of the Vin status on the *Control Page.* This text will also appear in email messages when email alerts are enabled. This field may be up to 27 characters long. Set the name to a descriptive value such as “Power Supply” or “Battery Voltage”.

Remote Vin Options

Device

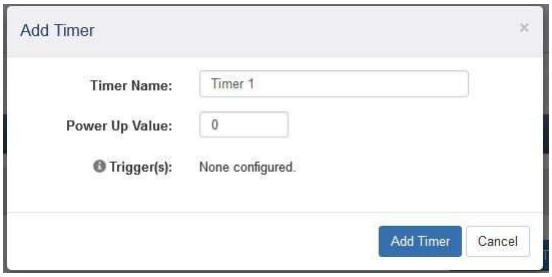
The device where the remote Vin is found.

3.4.5 I/O Setup Tab > TIMERS

Timers are I/O resources for measuring the time between events or generating controlled delays. The timers are essentially 24-bit, down counters with a one-second resolution. Timers appear in a table on the Timers tab and can be created, edited or deleted as needed. Up to 16 Timers can be created. The timer's value is accessible to Schedule and Conditional Tasks, BASIC scripts, Modbus and Control Page widgets. There are no remote timers.

A timer is started when an *Action* sets it to a non-zero value. The timer counts downwards and stops when it reaches zero. When the timer reaches zero, it generates a “timer expires” event. The *Timer Expires* event appears in the pull-down list ▼ of available *Triggers* for Scheduled and Conditional Tasks.

To add a timer click *Add Timer*.



Timer Name

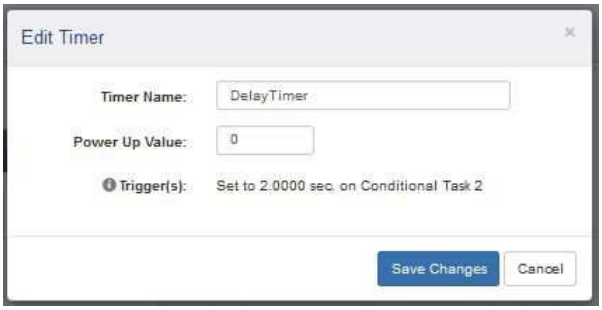
This text field is used to describe the timer. By default it is set to “Timer #”. The text appears to the left of the timer status on the *Control Page.* When later defining the control logic, logging and other settings, this label appears in the pull-down lists of Timer resources. This field may be up to 27 characters long. Set the name to a descriptive value such as “Warmup Delay”.

Power Up Value

At power-up the timer is set to this value. If the power-up value is something other than 0, then the timer will begin to count down.

Trigger(s)

Scheduled and Conditional Tasks can start or clear a Timer. Once a timer is added and named in this tab, it will appear in the pull-down list ▼ of available *Actions* for Scheduled and Conditional Tasks. The Action can be specified to either reset the counter (clear) or to set it to a fixed value (start). Actions which affect the timer are shown in the Trigger(s) field as shown in the example to the right for reference.



3.4.6 I/O Setup Tab > DIGITAL I/O

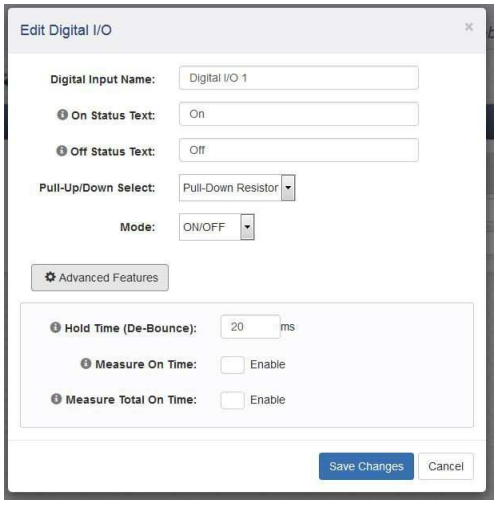
This page has settings for each of the X-420's two local digital I/O as well as any remote digital I/O that have been added. The digital I/O resources can be named and have binary (true/false) values. Digital I/O appear in tables on the digital I/O tab and can be created, edited or deleted as needed.

Each digital I/O can be configured for several operating modes:

Digital Input	The digital I/O terminal is configured as a logic input
Digital Output	The digital I/ terminal is configured as a logic output

Click the respective *Edit* button to configure each digital I/O.

Digital I/O Options



Digital Input Name

This text field describes the function of the selected digital input. The label text appears to the left of the corresponding digital input status on the *Control Page* and in the email message when email alerts are enabled. When later defining the control logic, logging and other settings, this label appears in the digital input pull-down list.
Up to 27 characters may be entered in this field. The default text is “Digital I/O #”. Set the name to a descriptive value such as “Warehouse Door”.

On Status Text

The text in this field specifies the text that will be displayed in the *Control Page* and in email messages when the digital input is On. The digital input is considered “on” when sufficient voltage is applied to the input. Up to 16 characters may be entered in this field. The default text is “On”. Set the status text to a descriptive value such as “Door Open”.

Off Status Text

The text in this field specifies the text that will be displayed in the *Control Page* and in email messages when the digital input is Off. Up to 16 characters may be entered in this field. The default

text is “Off”. Set the status text to a descriptive value such as “Door Closed”.

Pull-up/Pull-down resistor

When configured as an input, a pull-up or pull-down resistor can be selected. If no connections are made to the input, the pull-up resistor will pull the input high (on), and the pull-down resistor will pull the input low (off).

Mode:

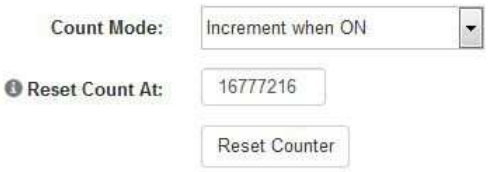
The digital input can be configured for several operating modes:

On/Off	A single I/O resource with the name “name” is created, where name is the digital input name defined above. The resource has binary (true/false) values.
Counter	The digital input is configured as a digital counter which counts the number of pulses on the respective digital input. Two I/O resources are created: name and name.counter. The counter value can be scaled into engineering units and is accessible to conditional tasks, BASIC scripts, Modbus and control page widgets. The counters associated with digital inputs 1 and 2 are stored in battery-backed memory and will retain their count through a power loss; however, the counters will not continue to increment while the X-420's power is off.
Frequency	The frequency of the respective digital input is measured by counting the number of pulses that occur during a period of one second. The value is updated once each second. A single I/O resource is created in the form name.frequency. The frequency value can be scaled into engineering units and is accessible to Conditional Tasks, BASIC scripts, Modbus and Control Page widgets.

Each of the digital inputs can be configured for use with a 24-bit digital counter which counts the number of pulses on the respective digital input. The counters can count up to 200Hz and can be used with paddle wheel flow-meters, traffic sensors and other sensors which output pulses. The counters can be named and work similar to *Registers* where the counter value is accessible to Conditional Tasks, BASIC scripts and Control Page widgets. The counters associated with digital inputs 1 and 2 are stored in battery-backed memory and will retain their count through a power loss; however, the counters will not continue to increment while the X-420 power is off.

Counter:

When *Counter* is selected, the following options are available:



Reset Count At

The counters automatically “roll over” to zero when the count reaches the value of this setting (modulo n). This setting is an integer for the raw count, before any slope multiplier or offset is applied. When *name.counter. is* accessed *by* Conditional Tasks, BASIC scripts and Control Page widgets, the slope multiplier and offset are applied, and the value is a single precision floating point value.

Reset Counter

This button manually resets the counter to zero.

Units

Text entered here will be displayed on the right of the value when shown on the control page. This text does not affect the underlying value. Set the units to GPM, ea., mph etc.

Decimal Places

The number of digits displayed to the right of the decimal point. This does not affect the accuracy of the underlying value.

Slope (Multiplier)

The counter value can be scaled into engineering units. The X-420 reads the raw value from the counter and calculates a new value in engineering units. This scaled value is calculated using the following y=mX+b formula..

Scaled Value = Slope * Count + Offset

The calculated scaled value is used for logs, email messages, control pages, XML pages, and is returned when Modbus values are read.

The “slope” in the formula above is provided by the user and is entered in this field. When both the slope and offset are set to their default values (m=1 and y=0) the scaled value equals the actual count.

Offset

The “offset” in the formula above is provided by the user and is entered in this field. The default value for this field is 0.

Local Digital Input Options

Digital Input Count Mode

Increment when ON	Count on the rising edge of the pulse
Increment when OFF	Count on the falling edge of the pulse
Increment when input changes	Count on both rising and falling edges of the pulse

Advanced Features

The digital inputs can be configured for several additional operating modes:

Hold Time (de-bounce): The input must remain *On* for this amount of time before the logic considers this input to be *On*. For switches and other noisy sensors, this eliminates problems with falsely detecting multiple *On* states before the input becomes stable. The default setting is 20ms and can be set from 0-250ms. The digital input is processed by this setting before it is applied to the on/off, counter and frequency logic. This setting directly limits the maximum input frequency that can be measured.

Measure On-Time: When this feature is enabled, the time that the input is on is measured. This value will be cleared when the input changes from “off” to “on”. When the input changes from “on” to “off,” the value will be frozen and can be accessed as long as the input remains “off”. The *On-Time* only starts counting once the debounce time has expired and continues after the input goes off until the debounce timer expires again. An I/O resource is created in the form: *name.onTime*

Measure Total On-Time: When this feature is selected, the accumulated time that the input is

on is measured. When the input is off, the timer stops. When the input goes on again, the timer resumes. This feature is useful for example, to measure the total run time of a machine to determine when maintenance is needed. The Total On-Time only starts counting once the debounce time has expired and continues after the input goes off until the debounce timer expires again. An I/O resource is created in the form: *name.totalOnTime*

Remote Digital I/O Options

Remote Digital I/O have the same options as the local Digital I/O which depends on if the remote Digital I/O is configured as an input or an output. Remote Digital I/O have two more options that identify the device and Digital I/O number of the remote Digital I/O.

Device

For remote digital I/O, this settings specifies the device that the remote digital I/O is found on.

Device's Output/Digital Input #

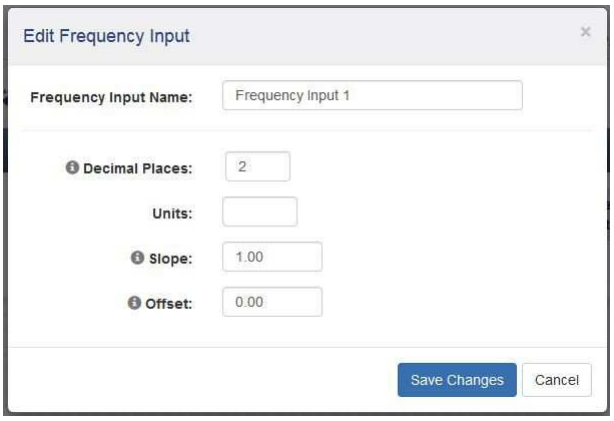
For remote digital inputs, this settings specifies the digital input number on the remote device. For remote digital outputs this specifies the digital output number on the remote device.

Note: For remote counters, frequency, etc., the values are read from the remote device and not calculated locally.

3.4.7 I/O Setup Tab > Frequency Input

This page configures the name and settings for the AC coupled frequency input.

To edit the frequency input settings click *Edit*.



Frequency Input Name

This text field is used to describe the frequency input value. By default it is set to "Frequency Input 1." The text appears to the left of the Vin status on the *Control Page.* This text will also appear in email messages when email alerts are enabled. This field may be up to 27 characters long. Set the name to a descriptive value such as "Wind Speed".

Decimal Places

The number of digits displayed to the right of the decimal point. This does not affect the accuracy of the underlying value.

Units

Text entered here will be displayed on the right of the value when shown on the Control Page. This text does not affect the underlying value. Set the units to kpm, mph, etc.

Slope (Multiplier)

The frequency value can be scaled into engineering units. The X-420 reads the raw value (Hz) and calculates a new value in engineering units. This scaled value is calculated using the following y=mX+b formula:

Scaled Value = Slope * Count + Offset

The calculated scaled value is used for logs, email messages, Control Page, XML page, and is returned when Modbus values are read.

The "slope" in the formula above is provided by the user and is entered in this field. When both the

slope and offset are set to their default values (m=1 and y=0), the scaled value equals the actual frequency.

Offset

The “offset” in the formula above is provided by the user and is entered in this field. The default value for this field is 0.

3.5 Control/Logic Tab

The sub-menus under the Control/Logic tab define the control and monitoring logic of the X-420. Conditional and Scheduled tasks together with BASIC scripts are defined under this tab group.

3.5.1 Control/Logic Tab > TASK/FUNCTIONS

"Tasks" are logic functions that do specific things, such as turn a digital I/O on or off under certain conditions or at certain times. Tasks are assigned a name, configured for the desired function, and saved. They appear in tables on the Tasks/Functions tab and can be created, edited or deleted as needed. Up to 50 Scheduled Tasks and 50 Conditional Tasks Tasks can be created. Tasks can run one time, periodically or continually depending on its settings.

Tasks are defined using settings and pull-down menus to define the logic function without the need to learn boolean or other programming syntax. For more complex logic functions or logic functions not supported by this tab see *Section* Control Logic Tab > BASIC SCRIPT.

***Scheduled* tasks** run at specific times or specific times and days of the week.

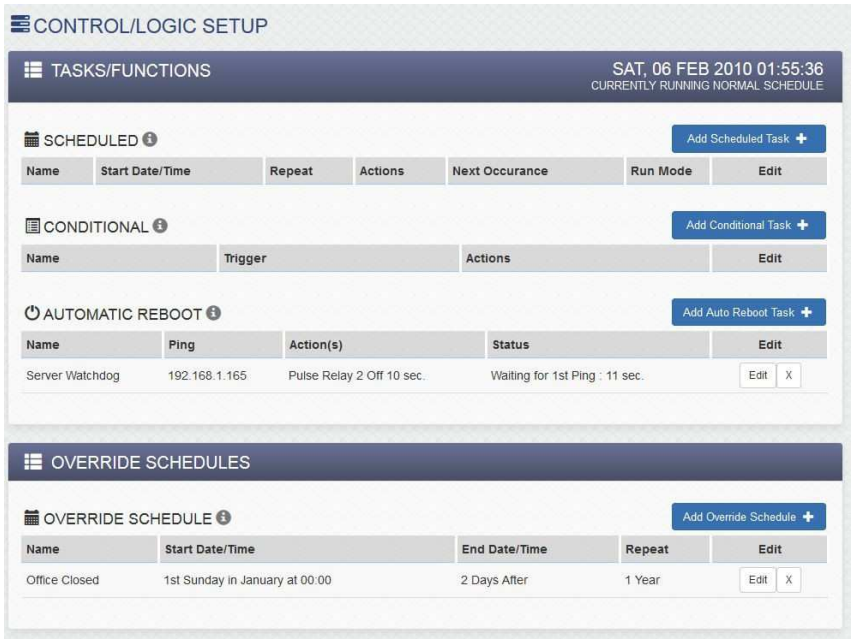
***Conditional* (boolean) tasks** run only if specified logic conditions are met (i.e., If an input or sensor is "on" then perform an action).

The Tasks/Functions tab has a status display which shows the current time of day and whether the *Normal* or *Override* schedule is running. An Override Schedule can temporarily cause certain Scheduled tasks to stop operating, such as for a holiday, and resume Normal schedule tasks after the Override Schedule expires. Up to 20 Override Schedules can be defined.

From this single page you can observe all of the tasks, their start times, run modes, triggers and actions.

For debug and testing, open the *Control Page* in another browser window (or another browser) and together with this page you can monitor what tasks are running and what they are doing in response to user input.

See Control Logic Examples Using Tasks/Functions for examples of using *Tasks* for control logic.

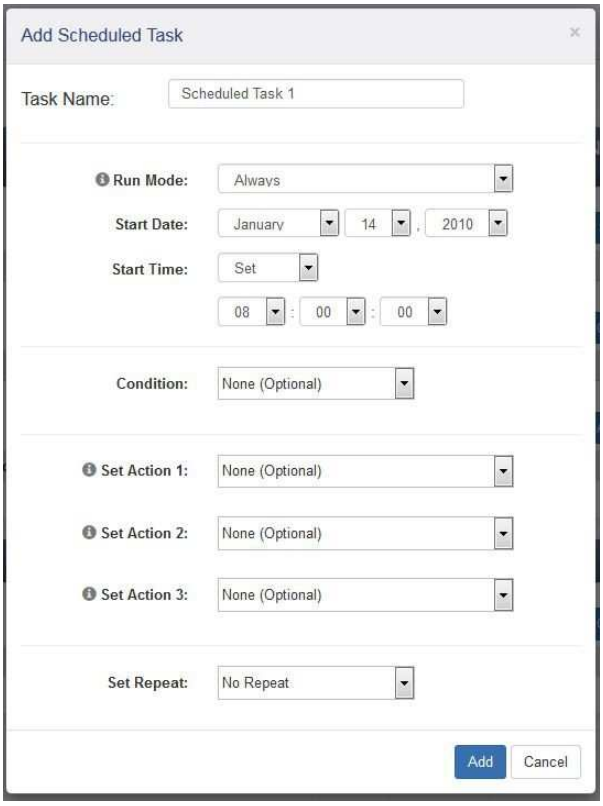


3.5.1.1 Scheduled Tasks

Scheduled tasks run at a specific time and on specific days of the week (e.g. turn a light on at 08:00, Monday through Friday). *Scheduled tasks* can be configured to be conditional with specified resources. Each *Scheduled task* can initiate up to three *Actions*. Actions are control outputs that "do" something, such as turn a digital I/O on or off, send an email, send a SNMP trap or make a data log.

Scheduled Tasks appear in a table on the Control/Logic Setup tab and can be created, edited or deleted as needed. Up to 50 Scheduled Tasks can be created.

To add a Scheduled task, click *Add Scheduled Task*.



Task Name:

This text field is used to describe the task. By default it is set to "Scheduled Task 1". This field may be up to 24 characters long. Set the name to a descriptive value such as "Unlock Front Door".

Run Mode:

The Run Mode defines when the scheduled task is active.

Always	Always active
Normal Schedule	Active, unless overridden by an override schedule.
Override Schedule	Active only during an override schedule.
Off	Never active (disabled).

Start Date*:*

Using the drop-down boxes, select the month, day and year when the scheduled task is set to begin.

Start Time*:*

- ***Set:*** Select the time of day when the scheduled task will begin.
- ***Sunrise:*** Enter the offset (HH:MM) from sunrise. Choose *Before* or *After* sunrise.
- ***Sunset:*** Enter the offset (HH:MM) from sunset. Choose *Before* or *After* sunset.

Note: The sunrise and sunset times are automatically calculated based on the latitude and longitude settings made in the General Settings Tab > GENERAL INFORMATION tab.

Scheduled Task Condition (Optional):

Scheduled tasks can optionally be controlled (enabled) based on an I/O state. In order for I/O to appear in the condition pull-down menu ▼, the I/O must be first added and named in the I/O setup tab. The scheduled task only runs if the conditional I/O state evaluates as “true”.

If ***None*** is selected, no conditional logic will be evaluated.

If a ***Digital I/O*** resource is selected, the following conditions are available:

ON	The scheduled task runs if the input is On
OFF	The scheduled task runs if the input is Off

If an **Analog Input** resource is selected, the following conditions are available:

Value ≥ X.X	If the analog input value is greater than or equal to the setting, the compare is true.
Value <X.X	If the analog input value is less than the setting, the compare is true.
Deadband	Hysteresis for the compare

If a **Digital I/O Counter** resource is selected, the following conditions are available:

Value = X.X	If the Counter value is equal to the setting, the compare is true.
Value >X.X	If the Counter value is greater than the setting, the compare is true.
Value < X.X	If the Counter value is less than the setting, the compare is true.

If a **1-Wire Sensor** resource is selected, the following conditions are available:

Value ≥ X.X	If the sensor value is greater than or equal to the setting, the compare is true.
Value <X.X	If the sensor value is less than the setting, the compare is true.
Deadband	Hysteresis for the compare

If a **Register** resource is selected, the following conditions are available:

Value = X.X	If the Register value is equal to the setting, the compare is true.
Value >X.X	If the Register value is greater than the setting, the compare is true.
Value < X.X	If the Register value is less than the setting, the compare is true.
Deadband	Hysteresis for the compare

If a **Vin** resource is selected, the following conditions are available:

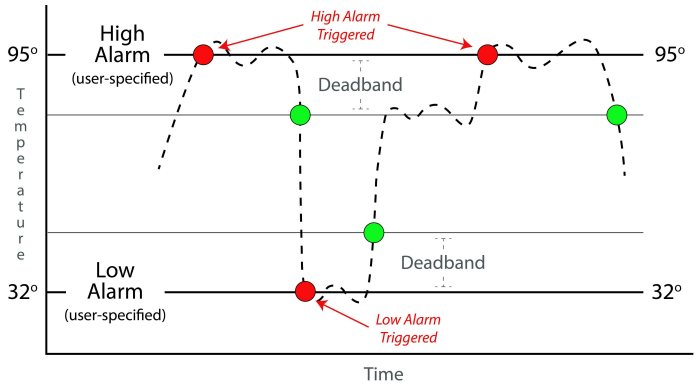
Value ≥ X.X	If the Vin value is greater than or equal to the setting, the compare is true.
Value <X.X	If the Vin value is less than the setting, the compare is true.
Deadband	Hysteresis for the compare

If a **Frequency Input** resource is selected, the following conditions are available:

Value ≥ X.X	If the frequency input value is greater than or equal to the setting, the compare is true.
Value <X.X	If the frequency input value is less than the setting, the compare is true.
Deadband	Hysteresis for the compare

If a **Timer** resource is selected, the trigger is true when the timer expires (reaches 0).

The *Deadband* settings prevent alarms from triggering excessively when an analog value vacillates around the trigger point. With high alarms, the value must fall below the high alarm point, minus the *Deadband*, before the high alarm will be triggered again. Likewise the *Deadband* on the low alarm requires the value to rise above the low alarm point, plus the *Deadband*, before the low alarm will be triggered again.



For example, if the *Deadband* is set to 1 degree, and a high alarm is occurs at 95 degrees, the *Deadband* ensures that once the high alarm is triggered, it won't trigger again until the temperature first drops below 94 degrees (95 – 1).

Scheduled Task Actions

Up to three actions can be specified for each Scheduled Task. Tasks can change the state of digital I/O, counters, registers and other resources. To be available in the task setup pull-down menus ▼ for an *Action,* the resource must be first added and named in the I/O setup tab.

If ***None*** is selected, nothing is done when the task runs.

If a ***Digital I/O*** Action is selected, the following actions are available:

On	The digital I/O is turned on
Off	The digital I/O is turned off
Pulse On	The digital I/O is pulsed on (then off)
Toggle On/Off	The digital I/O changes state
Condition-1 I/O Value	The digital I/O is set to the state of condition 1 I/O
Opposite of Condition-1 I/O Value	The digital I/O is set to the opposite state of condition 1 I/O
Pulse On (heartbeat mode)	The digital I/O is pulsed continually over and over while the trigger is true. When the trigger changes to false, the digital I/O will go off. This is useful for remote digital I/O and detecting network drop-outs, etc.

If a **Digital Input Counter** Action is selected, the following actions are available:

Log	The counter value is logged
Reset	The counter is reset to 0
Log & Reset	The counter value is logged, then reset to 0

If a ***Register*** Action is selected, the following actions are available:

Set-To	Set the value of the register to a specific value
Increment By	Increment the register by the specified value
Decrement By	Decrement the register by the specified value

If a ***Timer*** Action is selected, the following actions are available:

Start Timer	Set the timer to the specified value
Clear (stop) Timer	Reset the timer to 0

If a ***Log*** Action is selected, the following actions are available:

Log	A data log is made of selected resources: Logging Tab > LOG I/O
Reset Log	Clear (Erase) the log file

Pause Logging	Temporarily pause all logging to the log file.
Resume Logging	Resume logging after previously pausing it.

If an ***Email*** Action is selected, an email is sent when the task runs.

Send Email To	With the drop-down box, select which Email address(es) to use. The address list is configured in the General Settings Tab > EMAIL SETTINGS tab.

If ***SNMP TRAP*** Action is selected, the following actions are available:

Send SNMP Trap for Cond 1 I/O value	Send SNMP trap to configured SNMP Managers for I/O in Condition 1
Send SNMP Trap for Cond 2 I/O value	Send SNMP trap to configured SNMP Managers for I/O in Condition 2
Send SNMP Trap for Cond 1 and 2 I/O value	Send SNMP trap to configured SNMP Managers for I/O in Condition 1 and 2.

If ***SNMP NOTIFICATION*** Action is selected, the following actions are available:

Send SNMP Notification for Cond 1 I/O value	Send SNMP notification to configured SNMP Managers for I/O in Condition 1
Send SNMP Notification for Cond 2 I/O value	Send SNMP notification to configured SNMP Managers for I/O in Condition 2
Send SNMP Notification for Cond 1 and 2 I/O value	Send SNMP notification to configured SNMP Managers for I/O in Condition 1 and 2.

If ***Remote Services Notification*** Action is selected:

Send Device State to Remote Service	The local device state is sent to the remote service's server, if configured.

If **Push I/O State to Remote Receiver Devices Action** is selected:

Push I/O State to Remote Receiver Devices Action	The state of the X-420 is sent to all remote devices configured to receive such messages.

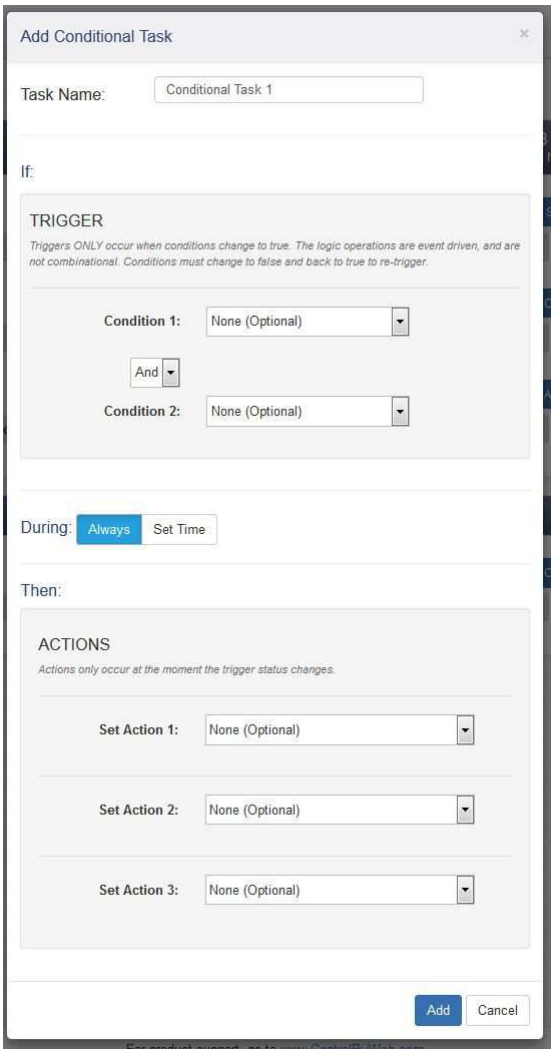
If **Set I/O Color** Action is selected, an I/O can be chosen and its status color in the Control Page can be changed.

Repeat

The *Scheduled Task* is repeated:

No Repeat	Runs only once
Seconds	Repeats once every X seconds
Minutes	Repeats once every X minutes
Hourly	Repeats once every X hours
Daily	Repeats once every X days
Weekly	Repeats weekly on the selected days of the week
Monthly	Repeats monthly either on selected days of the month, or the 1st Sunday, etc.
Yearly	Repeats yearly on the 1st, 2nd, 4th Day of the Start Date Month, or the 1st, 2nd, 4th Day of the Start Date Every month that year.

3.5.1.2 Conditional Tasks



Conditional Tasks occur (run) if certain conditions are met. *Conditional Tasks* are made by comparing specified resources using simple and/or (boolean) logic. For example, if a digital input is on or off, turn a digital I/O on or off. *Conditional Tasks* can be configured to be active continually or only during specific time periods each day/week. Each *Conditional Task* can initiate up to three *Actions*. Actions are control outputs that "do" something such as turn a digital I/O on or off, send an email, send an SNMP trap or make a data log. *Conditional Tasks* are event driven and do not evaluate asynchronously. Their triggers are only evaluated when the conditions of the trigger change state. Conditional Tasks appear in a table on the Control/Logic Setup tab and can be created, edited or deleted as needed. Up to 50 *Conditional Tasks* can be created.

To add a Conditional Task, click *Add Conditional Task*.

Task Name

This text field is used to describe the task. By default it is set to "Conditional Task 1". This field may be up to 24 characters long. Set the name to a descriptive value such as "High Temp Shutdown".

Conditional Task Triggers

The "Trigger" section is a boolean logic comparison of two I/O. Triggers ONLY occur when the conditions change to true. The logic operations are event driven, and are not combinational. Conditions must change from false and back to true to re-trigger. The I/O must be first added and named in the I/O setup tab to appear in the task pull-down menus ▼ as a trigger.

The two conditions (arguments) can be evaluated with "AND" or "OR" boolean logic. If both triggers are set to *None*, the Conditional Task is never evaluated. If one trigger is set to *None*, only one condition is evaluated for a True or False state.

If an **Analog Input** selected, the following conditions are available:

Value ≥ X.X	If the analog input value is greater than or equal to the setting, the compare is true.
Value <X.X	If the analog input value is less than the setting, the compare is true
Deadband	Hysteresis for the compare

If a ***Digital I/O*** is selected the following logic states are available:

On	The trigger is true if the digital input is on
Off	The trigger is true if the digital input is off

Changes	The trigger is true if the digital input changes state

If a **Digital I/O Counter** is selected, the following conditions are available:

Value =X.X	If the Counter value is equal to the setting, the compare is true
Value >X.X	If the Counter value is greater than the setting, the compare is true
Value < X.X	If the Counter value is less than the setting, the compare is true.

If a **1-Wire Sensor** selected, the following conditions are available:

Value ≥ X.X	If the sensor value is greater than or equal to the setting, the compare is true.
Value <X.X	If the sensor value is less than the setting, the compare is true
Deadband	Hysteresis for the compare

If a **Register** is selected, the following conditions are available:

Value =X.X	If the Register value is equal to the setting, the compare is true
Value >X.X	If the Register value is greater than the setting, the compare is true.
Value < X.X	If the Register value is less than the setting, the compare is true.

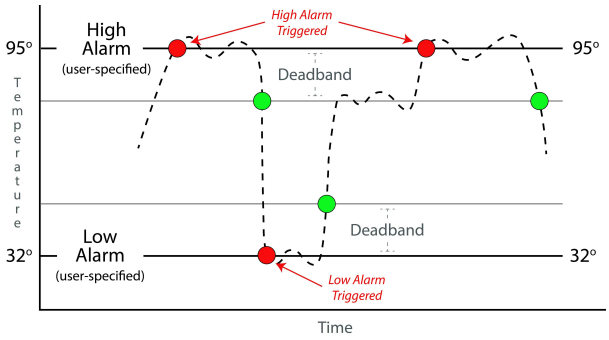
If a **Vin** selected, the following conditions are available:

Value ≥ X.X	If the Vin value is greater than or equal to the setting, the compare is true.
Value <X.X	If the Vin value is less than the setting, the compare is true.
Deadband	Hysteresis for the compare

If a **Frequency Input** selected, the following conditions are available:

Value ≥ X.X	If the frequency input value is greater than or equal to the setting, the compare is true.
Value <X.X	If the frequency input value is less than the setting, the compare is true.
Deadband	Hysteresis for the compare

If a **Timer** selected, the trigger is true when the timer expires (reaches 0).



The *Deadband* settings prevent alarms from triggering excessively when an analog value vacillates around the trigger point. With high alarms, the value must fall below the high alarm point, minus the *Deadband*, before the high alarm will be triggered again. Likewise the *Deadband* on the low alarm requires the value to rise above the low alarm point, plus the *Deadband*, before the low alarm will be triggered again.

For example, if the *Deadband* is set to 1 degree, and a high alarm is occurs at 95 degrees, the *Deadband* ensures that once the high alarm is triggered, it won't trigger again until the temperature first drops below 94 degrees (95 – 1).

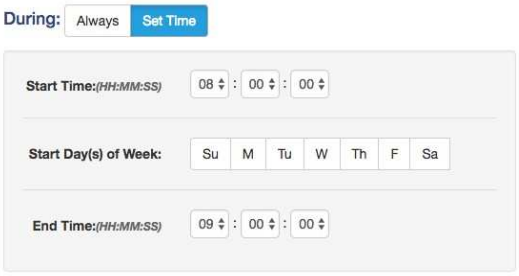
Conditional During Time

Conditional tasks can be configured to run continually or during specific days each week.

Always
Runs continually.

Set Time
Specify the time interval and day(s), when this task will evaluate.

Note: If the Start Time begins after the end time (i.e., Start Time: 8:00pm, End Time: 6:00am), then the time interval will start and continue through the end time of the next day.



Conditional Task Actions

Up to three actions can be specified for each Conditional Task. Tasks can change the state of digital I/O, counters, registers and other I/O. To be available in the task setup pull-down menus ▼ for an *Action* the resource must be first added and named in the I/O setup tab.

If a ***None*** Action is selected, nothing is done when the task runs

If a ***Digital Output*** Action is selected the following actions are available:

On	The digital output is turned on
Off	The digital output is turned off
Pulse On	The digital output is pulsed on (then off)
Toggle On/Off	The digital output changes state
Condition-1 I/O Value	The digital output is set to the state of condition 1 I/O
Opposite of Condition-1 I/O Value	The digital output is set to the opposite state of condition 1 I/O
Pulse On (heartbeat mode)	The digital output is pulsed continually over and over while the trigger is true. When the trigger changes to false, the digital output will go off. This is useful for remote digital I/O and detecting network drop-outs, etc.

If a **Digital Input Counter** Action is selected, the following actions are available:

Log	The counter value is logged
Reset	The counter is reset to 0
Log & Reset	The counter value is logged, then reset to 0

If a Register Action is selected, the following actions are available:

Set-To	Set the value of the register to a specific value
Increment By	Increment the register by the specified value
Decrement By	Decrement the register by the specified value

If a ***Timer*** Action is selected the following actions are available:

Start Timer	Set the timer to the specified value
Clear Timer	Resets the timer to 0

If a ***Log*** Action is selected the following actions are available:

Log	A data log is made of the resources enabled in Logging Tab > LOG I/O
Reset Log	Clear (Erase) the log file
Pause Logging	Temporarily pause all logging to the log file
Resume Logging	Resume logging after previously pausing it

If an ***Email*** Action is selected, an email is sent when the task runs.

Send Email To	With the drop down box, select the Email address to use. The address list is configured in the General Settings Tab > EMAIL SETTINGS tab.

If ***SNMP TRAP*** *Action* is selected the following actions are available:

Send SNMP Trap for Cond 1 I/O value	Send SNMP Trap to configured SNMP Managers for I/O in Condition 1
Send SNMP Trap for Cond 2 I/O value	Send SNMP Trap to configured SNMP Managers for I/O in Condition 2
Send SNMP Trap for Cond 1 and 2 I/O value	Send SNMP Trap to configured SNMP Managers for I/O in Condition 1 and 2

If ***SNMP NOTIFICATION*** *Action* is selected the following actions are available:

Send SNMP Notification for Cond 1 I/O value	Send SNMP Notification to configured SNMP Managers for I/O in Condition 1
Send SNMP Notification for Cond 2 I/O value	Send SNMP Notification to configured SNMP Managers for I/O in Condition 2
Send SNMP Notification for Cond 1 and 2 I/O value	Send SNMP Notification to configured SNMP Managers for I/O in Condition 1 and 2.

If ***Remote Services Notification*** Action is selected:

Send Device State to Remote Service	The local device state is sent to the remote services server if configured.

If **Push I/O State to Remote Receiver Devices** Action is selected:

Push I/O State to Remote Receiver Devices Action	The state of the X-420 is sent to all remote devices configured to receive such messages.

If **Set I/O Color** Action is selected, an I/O's status color in the Control Page can be changed.

3.5.1.3 Override Schedules

Override Schedules temporarily disable Scheduled Tasks that are configured for *Normal Schedule* in the Run Mode column, and enables any Scheduled Tasks that are set to *Override Schedule*. Tasks that are set to *Always* will not be effected by this schedule. Override schedules are especially helpful for creating holiday schedules. Override Schedules appear in a table on the Control/Logic Setup tab and can be created, edited or deleted as needed. The X-420 can support up to 20 different override schedules.

A task running on a Normal Schedule is setup by an Administrator (with *Administrato*r credentials) and can be used for example, to open door locks during office hours. Override schedules allow the normal schedule to be temporarily disabled without disturbing the underlying schedule. For example, an employee (with *Manager* credentials) can temporarily change the schedule to accommodate a special holiday without the need to change or adjust the Normal schedule.

An example of this would be the 1st of January. An override schedule could be created that starts 00:00 on January 1st and ends at 23:59 on January 1st. This override schedule would stop normally scheduled tasks from running every year on the 1st of January.

Override schedules are repeated annually, meaning the event will happen at the configured time every year.

To add an Override Schedule, click *Add Override Schedule*. Click to edit an override schedule, click to delete an override schedule.

Name:

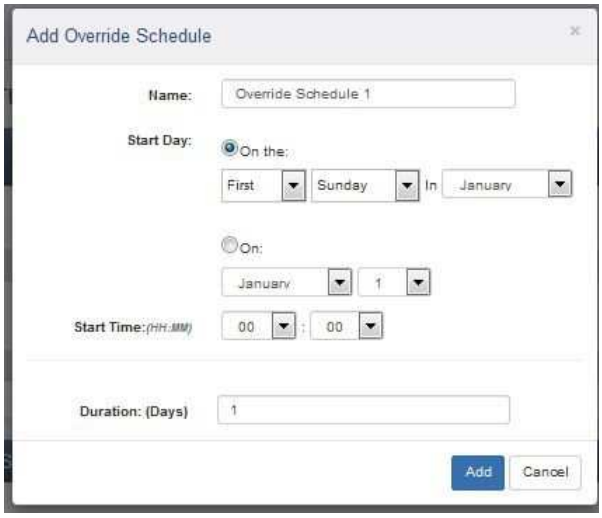
This text field is used to describe the override schedule. By default it is set to "Override Schedule 1". This field may be up to 24 characters long. Set the name to a descriptive value such as "Office Closed".

Start Day/Time:

Different options will appear depending on the option you choose:

▪ Choose "On the" to enter a start day of the month, start time, and duration (days) for the override schedule.

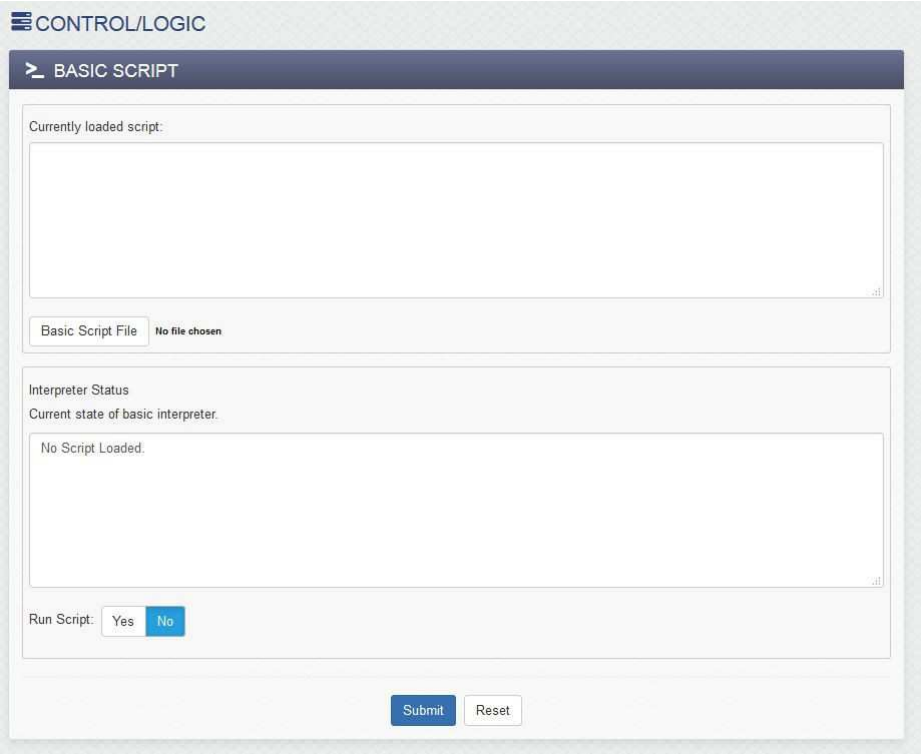
▪ Choose "On" to enter a specific start date and time, and a specific end date and time.



3.5.2 Control Logic Tab > BASIC SCRIPT

The X-420 can run simple custom programs written in a modified version of BASIC. This page is used to load and execute these programs. Before it can be loaded to the X-420, a script must first be prepared as a text (.txt) file. The file must then be uploaded to the X-420 via the *Basic Script* tab.

The maximum size of script that can be uploaded to the device is 4K bytes. Information on writing a basic program for the X-420 can be found in *Section Basic Scripts*. See Control logic examples using BASIC Scripts for examples of BASIC scripts.



Note: An ASCII standard text file format should be used, such as Windows Notepad, Programmer's Notepad, vi, or other text editor that output the file as a .txt. Rich Text Format (.rtf) used by Microsoft WordPad is NOT compatible.

Currently Loaded Script

This field displays the .txt file that is uploaded to the X-420. The script (text) displayed in this screen cannot be edited. In order to edit any script, it must be edited in the .txt file and uploaded to the unit again.

Basic Script File

To upload a BASIC script file to the device, click *Basic Script File*. A file upload dialog box opens which allows you to choose the file to upload. To upload the script, click *Open*.

Interpreter Status

This field displays whether the program is continuing to run, has stopped or finished, or if there are errors contained in the script. If there are errors in the script, the line on which the error occurred is displayed. Clicking the Refresh Status button will update this field.

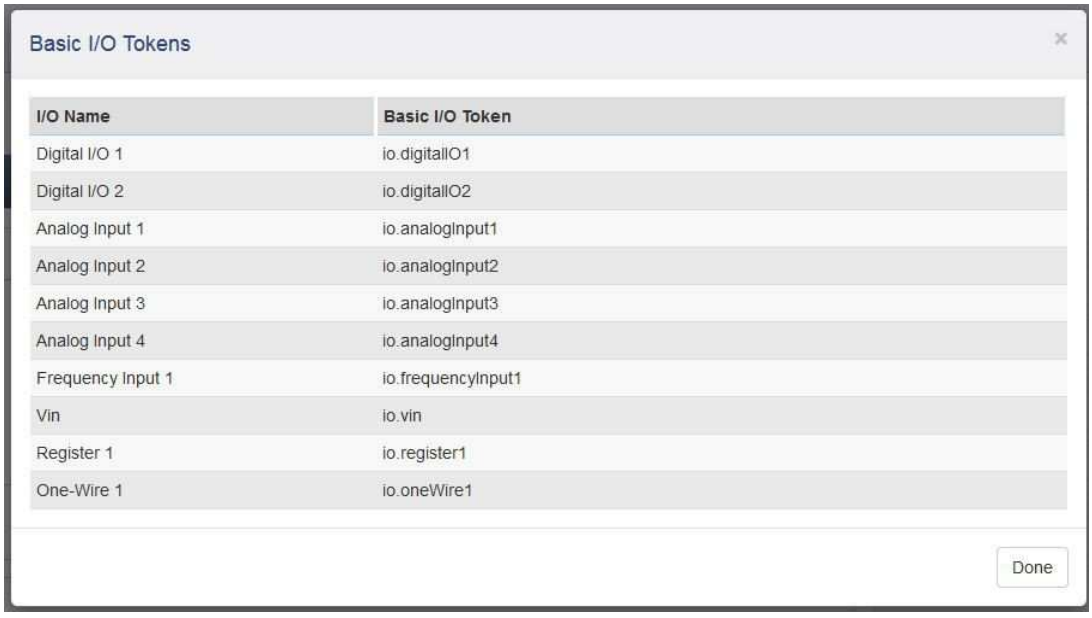
Run Script

This option selects whether or not the selected script will be run after it has been uploaded. The Submit button must be clicked to run the script.

BASIC I/O Tokens

The X-420's I/O resources are not fixed. After 1-Wire sensors, registers, counters, and other I/O are added and named, they can be controlled and monitored within BASIC scripts. BASIC scripts must reference I/O resources such as digital and analog inputs in the form of “io.name” where “name” is the resource name defined when the resource was added in the I/O Setup Tab. If the resource name has embedded spaces, they must be removed in the io.name statement. The first character must be lower case. For example, if a digital IO is named “Warehouse Fan”, the fan can be turned on with the BASIC statement “LET io.warehouseFan = 1”. If a resource name is changed during development and testing, the resource name in the BASIC scrip must be renamed to match.

The View Basic I/O Tokens button displays a list of all of the I/O resources currently available together with the equivalent token to be used in BASIC scripts to reference the respective I/O resource.



3.6 Logging Tab

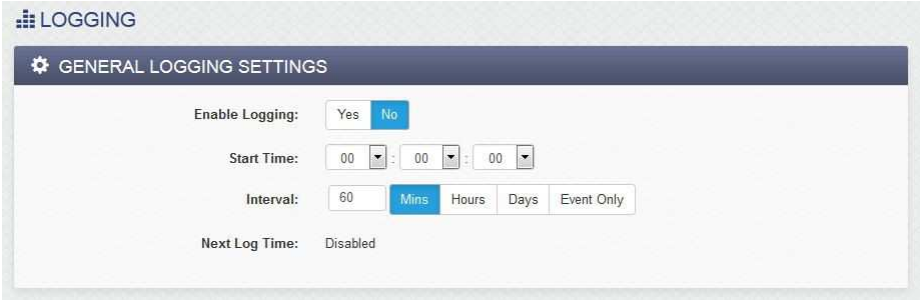
Record data such as changes in I/O state, sensor data, and events. Both periodic and event-based logging are supported. The logged data is stored in internal nonvolatile memory and can be retrieved by entering the command http://{X-420 IP address}/log.txt. For more information on logging, see *Section* Log Files.

The X-420 can make up to 25 logs per second with event-driven logging. Each log entry has a time stamp with millisecond resolution. Two Conditional Task actions are available to pause and resume logging.

The log is stored in non-volatile, flash memory using a circular buffer (old data is over written). 3072 KB of memory space is reserved for logging. Log entries are composed of the following components, 30-byte header, 16-bytes for relays/digital outputs, 16-bytes for inputs/digital inputs, and 4 bytes for each analog value being logged (counters, 1-Wire sensors, vin, registers, etc). The space allocated for digital I/O does not change depending on whether any digital I/O are being logged.

Note: Changing the log settings will erase the current log file.

3.6.1 Logging Tab > GENERAL LOGGING SETTINGS



Enable Logging

When this option is set to *Yes*, the X-420 will record data as configured on this page. The default setting for this option is *No*.
Note: This option controls data logging, but not system logging. System logging is always enabled.

Start Time

If a logging interval is specified (periodic logging rather than event logging), logging will occur relative to this start time. For example, if the start time is 01:00 and the Interval is 6 hours, logging will occur at 01:00, 07:00, 13:00, and 19:00. Start time is specified in 24-hour time format.

Interval

This field is used to specify the time period of logging. A numerical value is entered into the text field, and the unit of time is selected using the adjacent radio buttons. The range of values in this field is 1-60. Time units are *Minutes, Hours*, and *Days*. Select *Event Only* to disable periodic logging.

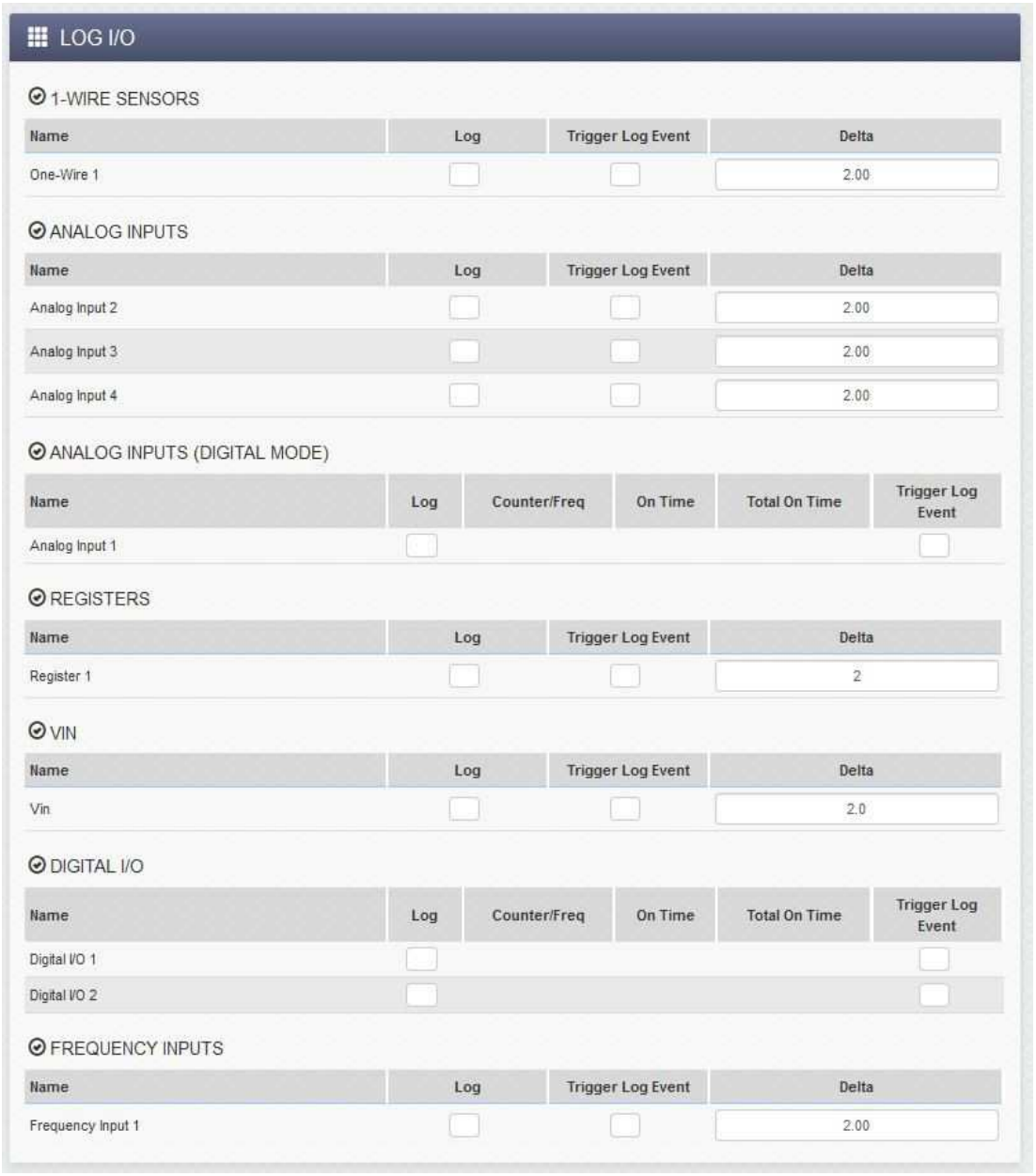
Next Log Time

This field shows when the next periodic log event is scheduled to occur. If logging is disabled, the next log time will indicate "Disabled." If logging is enabled, but periodic logging is disabled (by selecting *Event Only*) the next log time will indicate "Event Logging Only."
Note: This information is updated only when the page is refreshed.

3.6.1.1 Logging Tab > LOG I/O

This setup page is used to select which resources are periodically logged on a fixed schedule and/or which resources asynchronously trigger logging. The resources are grouped into five sections.

When a periodic log occurs, each resource which has its *Log* check-box ☑ enabled will be included in the periodic log. If a resource has its *Trigger Log Event* check-box ☑ enabled, a log will asynchronously occur when the resource changes its state or value.



Asynchronous Log Events

Analog Inputs	Logging will occur whenever the voltage changes by the trigger delta
Digital I/O	Logging will occur whenever the state changes
Counter Inputs	Logging will occur whenever the counter changes
1-Wire Sensors	Logging will occur whenever the sensor changes by the trigger delta
Registers	Logging will occur whenever the Register changes by the trigger delta
Vin	Logging will occur whenever the Vin voltage changes by the trigger delta

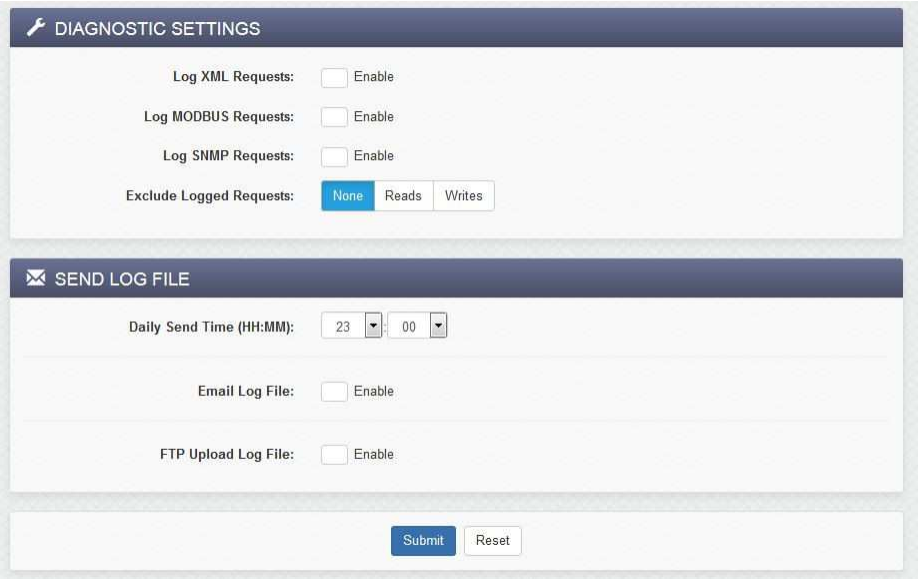
Trigger and Delta

Analog resources log data when the value changes by the amount specified in the *Delta* fields. The default setting for these fields is shown below.

Sensor	Trigger Delta
Analog Inputs	2.0 V
Counters	1
Vin	2.0 V
Temperature	2º
Humidity	2%

3.6.1.2 Diagnostic Settings

XML, MODBUS and SNMP requests received by the X-420 can generate a log entry. Each communication protocol has a check-box ☑ to enable logging for that protocol.



Exclude Logged Requests

When logging is enabled for XML requests, Modbus requests, or SNMP requests, you can filter out *Reads* (such as reading the Digital I/O states via an XML request) or *Writes* (such as changing the output state via an XML command).

On the *Control Page* setup tab, you can specify the refresh rate of the Control Page. Each time the page is refreshed, an XML request is sent and logged as a *Read*. Since the default refresh rate is 3 seconds, the log file can get cluttered by many XML request logs. By filtering out *Reads,* refresh requests will not be logged. Likewise, by selecting *Writes,* write requests will not be logged. The default selection is *None.*

3.6.1.3 Send Log File

The X-420 can be configured to send its log file to a remote server at a specific time once per day. The file can be emailed and/or uploaded to an FTP server. Only new log entries since the last successful upload are sent, the log file is not deleted.

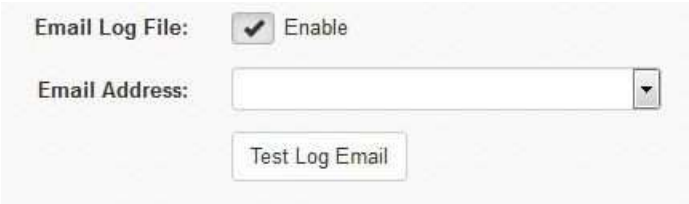
Daily Send Time

Select the time each day (24-hour format) the log file is to be sent.

Email Log File

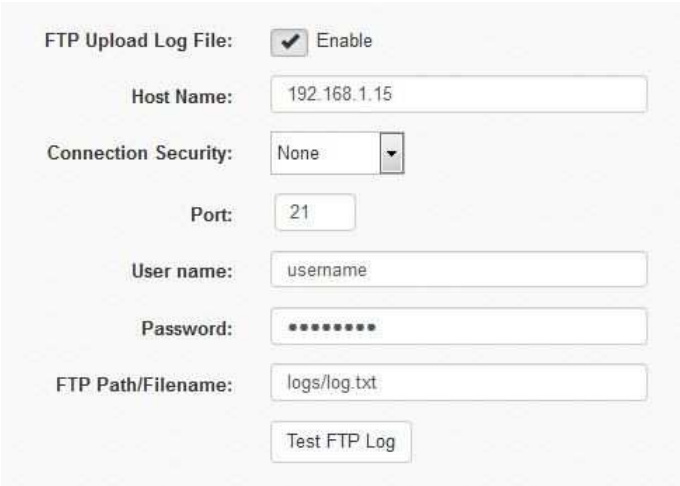
If this check-box ☑ is enabled, the log file is sent in an email once each day. With the drop-down box, select the email address to send the daily log. The address list is configured in *General Settings Tab > EMAIL SETTINGS*.

The *Test Log Email* button causes the log file to be emailed immediately, without waiting until the daily send time.



FTP Upload Log File

If this check-box ☑ is enabled, the log file is sent to an FTP server once each day.



Host Name

The IP address or hostname of the remote FTP server is entered here. The default value is `192.168.1.15`

Connection Security

Choose *None*, *Implicit TLS* or *Explicit TLS*. The security and port number must be configured to match the FTP server. *None* uses no encryption on the connection. *Implicit TLS* uses SSL to encrypt the channel before any FTP commands are sent or received. *Explicit TLS* allows the connection to start unencrypted and then upgrades the connection to encrypted through FTP commands.

Port

The TCP port number of the FTP server. This must match the TCP port set in the FTP server. The valid range is 1 to 65535. The default port number is 21.

User name

The username for connecting to the FTP server.

Password

If the FTP server requires a password, the password is entered here.

FTP Path/Filename

When uploading the log file to an FTP server, the FTP server will have a default location where it will place the log file. Here is where the name of the log file is defined. If there is a subdirectory where the log file should go, that should be defined here as well. For example, if the FTP server by default places all files uploaded to it in the directory /uploads and we wanted the X-420 to upload its log files to a subdirectory called /logs, then we would enter “logs/log.txt”.

The actual filename used for saving the file on the FTP server will be the specified filename with the date and time appended to it. For example log.txt would be log_YYYYMMDDHHMMSS.txt where YYYY is the year, MM is the month, DD is the day of the month, HH is the hour, MM is the minutes, and SS is the seconds. This date and time comes from the X-420, and it’s the time that the X-420 uploaded the file.

Test FTP Log

The *Test FTP Email* button causes the log file to be sent immediately, without waiting until the daily send time. If nothing is in the log file, no file will be sent. Once tested, the log information sent in the test file will not be sent in the following file as it’s already been sent.

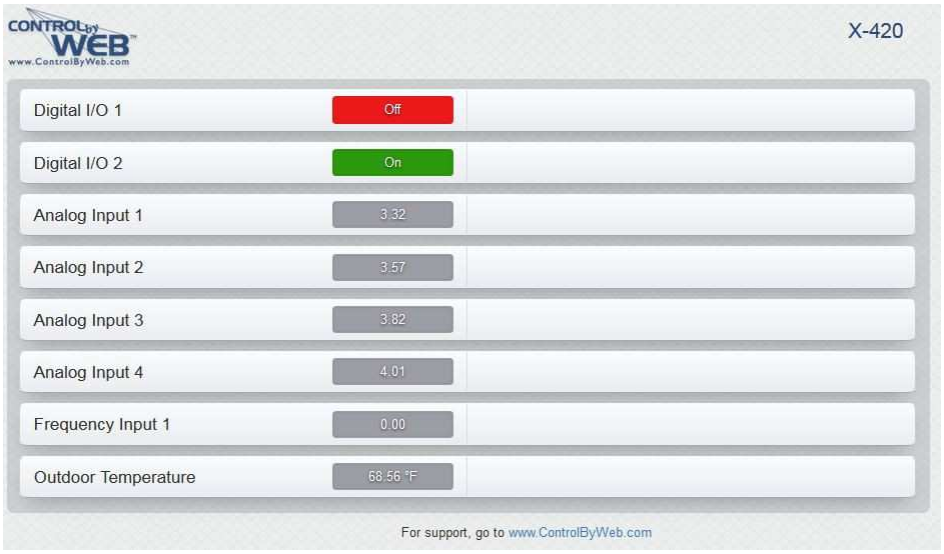
3.7 Monitor & Control Tab

This tab has settings for viewing and customizing the Control Page as well as graphing the log file.

3.7.1 Monitor & Control Tab > CONTROL PAGE

This tab displays the current Control Page. The Control Page is what users will see after typing the IP address of the X-420 directly into the web browser address bar. The Control Page is highly configurable for your specific needs. The Control Page Setup tab determines what resources are shown on the Control Page and how they are presented and displayed.

An example of a Control Page with one 1-Wire temperature sensor:



An example of a Control Page with customized resources:

If a sensor is disconnected or fails, the data value will be shown as X.X .

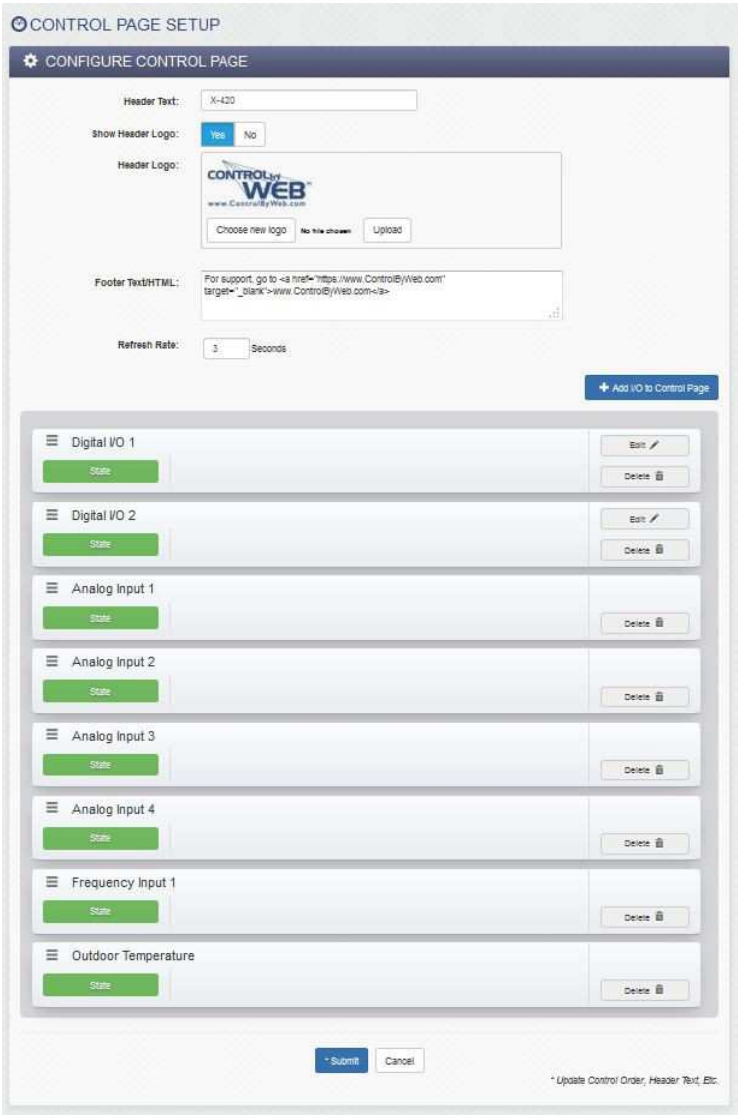
3.7.2 Monitor & Control Tab > CONTROL PAGE SETUP

The content, format and presentation of the Control Page is made by the settings on this tab. For example, the settings below illustrate Control Page with a temperature sensor shown in the previous section.

After making changes, you must click the *Submit* button for the changes to take effect.

Note: Any browsers currently viewing the Control Page while making changes will need to be refreshed before seeing the new changes. Do this by clicking the Refresh button on your browser.

It is easy to explore and experiment with the “look and feel” of the Control Page. Make a change, submit the changes, refresh your browser - and see how it looks. The Control Page is what users will see and use.



Header Text

The text entered here appears at the top of the *Control Page*. It also appears in the header of the email text when the email notification is used. This field can be up to 30 characters in length. The default text is `X-420`.

Show Header Logo

A graphic logo can be displayed in the upper left-hand corner of the Control Page. This setting determines if the logo is shown or not.

Header Logo

The *ControlByWeb* logo is shown by default. To upload a new logo, click *Choose New Logo*. A file upload dialog box opens allowing you to browse for the file on your computer. The file must be a *.png format. Click the Upload button to initiate the file upload. The logo file size must be less than 16 kb. Once a logo has been uploaded, the default ControlByWeb logo will be overwritten. The ControlByWeb logo will not be restored if the module is reset to factory defaults (there is only room for one logo.)

Footer Text/HTML

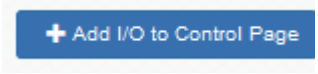
The bottom of the Control Page has a configurable "footer" field. The text entered in this setup box appears as a footer on the Control Page. The text can include HTML hypertext links as shown in the example.

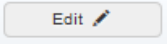
Refresh Rate

The Control Page continually updates its contents by setting a timer in the web page that causes it to be reloaded at a specified time interval. The web page content will be refreshed at the time interval specified in this setting. It can be set from 1 to 60 seconds. The default Refresh Rate is `3` seconds.

Control Page Widgets

A list of I/O resources that can be added to the Control Page appear next. The "widgets" appear on the Control Page in the same order as the setup list. Resources such as analog inputs and digital I/O automatically appear in this list and can be removed from the Control Page, if desired. For all other I/O (counters, registers, 1-Wire sensors, timers, etc.), you must have previously added them in the I/O Setup tab before adding them to the Control Page.

To add one or more widgets, click 

To edit a widget, click 

To remove a widget, click

To re-arrange the order of the widgets, click the widget handle  and drag the widget to a different row.

When finished, click to save your edits.

To change the name of the resources (analog inputs, digital I/O, 1-Wire sensors, registers and Vin) on the Control Page, edit the respective settings in the *I/O Setup Tab* and change the resource name. While naming each resource, it is good practice to edit the associated status text. For example, for a digital input perhaps name the input "Warehouse Door", set the *On Status Text* to "Door is Open" and the *Off Status Text* to "Door is Closed".

Some widgets have more setup options than others. Widgets for the analog inputs, Vin, 1-Wire sensors and timers can be added, but have no options to edit.

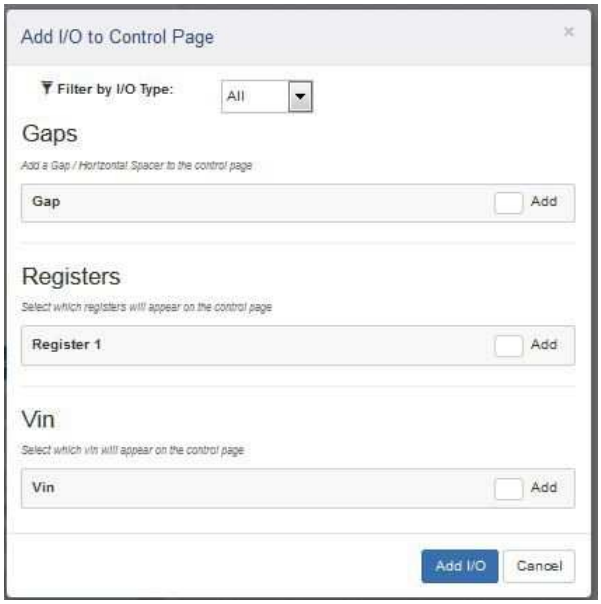
Once the I/O has been added, rearrange the I/O by clicking on the icon and dragging to the desired position.

Click *Submit* once you have the finished making changes to the page.

Add I/O to the Control Page

To add one or more widgets, click + Add I/O to Control Page. From the list of available resources, check one or more *Add* boxes to add the selected resources.

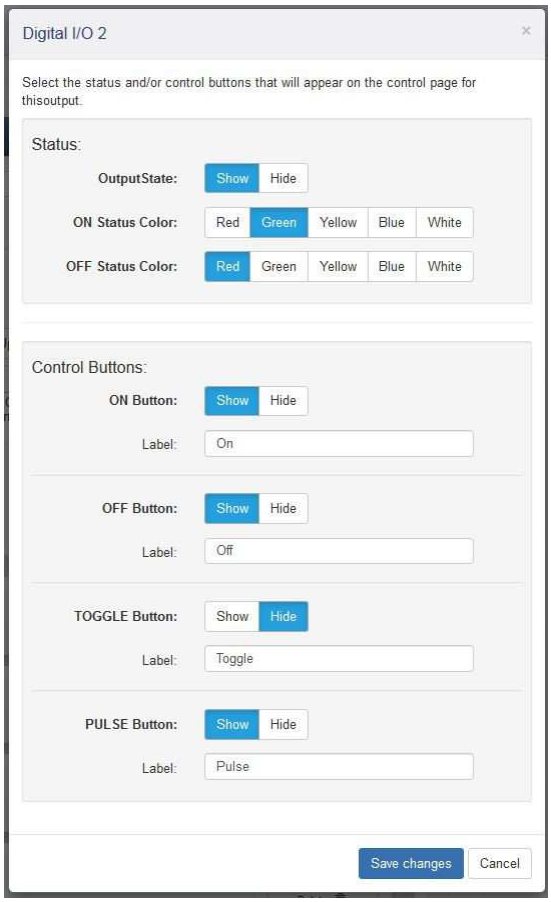
After adding the desired widgets to the Control Page, edit the widgets one by one, as needed for the desired appearance and function. The visual presentation of the labels, buttons and colors can be highly configured. The display options available for the widgets depend on the specific resource. The next sections have a description of each widget editor.



Gap Widgets

Gap widgets are cosmetic widgets that allow sections of the Control Page to be separated by a small space. This is useful when grouping similar controls together.

Digital Output Widget Editor



State
Show or Hide the digital output state.

On Status Color
This setting specifies the color that will be displayed on the Control Page when the digital output is On. Options are Red, Green, Yellow, Blue and White. The default color is Green.

Off Status Color
This setting specifies the color that will be displayed on the Control Page when the digital output Off. Options are Red, Green, Yellow, Blue and White. The default color is Red.

ON Button
Show or Hide the On button.

ON Button Label
The text in this field specifies the text that will be displayed on the ON Button on the Control Page to turn on the digital output. Up to 16 characters may be entered in this field. The default text is “On”.

Off Button
Show or Hide the Off button.

OFF Button Label
The text in this field specifies the text that will be displayed on the OFF Button in the Control Page to turn off the digital output. Up to 16 characters may be entered in this field. The default text is “Off”.

Toggle Button
Show or Hide the Toggle button.

Toggle Button Label
The text entered in this field appears in the 'Toggle' button. Up to 16 characters may be entered in this field. The default text is “Toggle”.

Pulse Button
Show or Hide the Pulse button.

Pulse Button Label
The text entered in this field appears in the 'Pulse' button. Up to 16 characters may be entered in this field. The default text is “Pulse”.

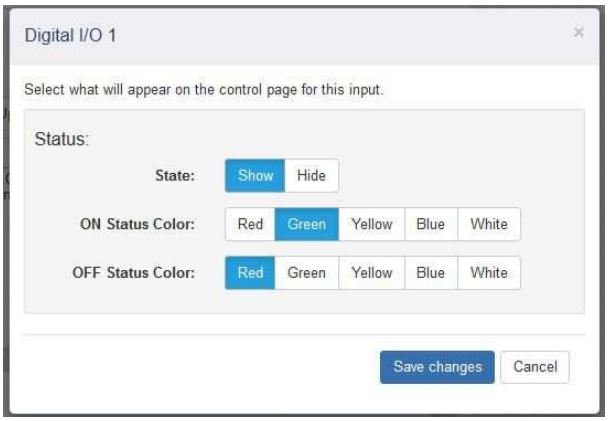
Digital Input Widget Editor

Note: If an analog input is configured as a “digital input”, the analog input widget can be edited and will have settings similar to a digital input shown below.

State
Show or Hide the state (value).

On Status Color
This setting specifies the color that will be displayed on the Control Page when the input is considered On. Options are Red, Green, Yellow, Blue and White. The default color is Green.

Off Status Color
This setting specifies the color that will be displayed on the Control Page when the input is considered Off. Options are Red, Green, Yellow, Blue and White. The default color is Red.



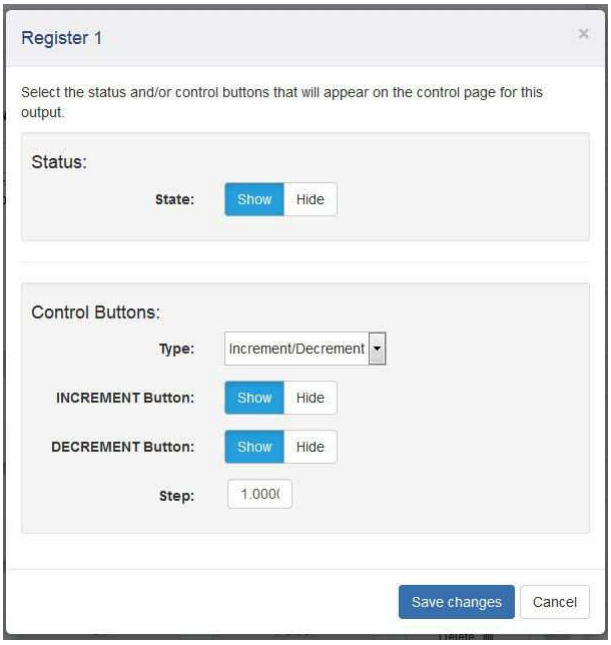
Input Counter Widget Editor

Count/Frequency
Show or Hide the counter/frequency value.

Allow reset in control page
When enabled, the count value on the Control Page may be clicked to reset the counter's value back to 0 after confirmation.

Register Widget Editor

Registers can be changed externally through the Control Page, XML requests, ModBus, or the BASIC script. This allows a BASIC script to react to user input. These variables are considered to be floating point numbers, just like other variables in the BASIC script.



Status:

State
Show or Hide the state (value).

Control Buttons:

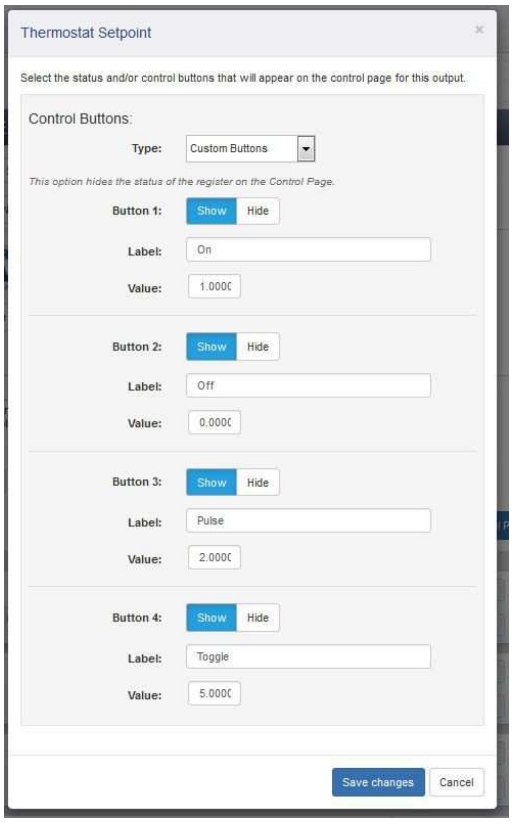
There are four different types of control buttons for a register widget, each types has its own set of options:

1. Type = Increment/Decrement

Increment Button
Show or hide the button

Decrement Button
Show or hide the button

Step
This setting is the amount the Register will be incremented or decremented when the respective increment/decrement button is clicked. The value can be an integer or floating point number.



2. Type = Custom Buttons

This setting provides up to 4-buttons with custom labels and set-values. Use one or more of these buttons to force a Register to specified fixed values.

Use these buttons for example, to provide a fan speed control with buttons labeled *High*, *Medium* and *Low* and perhaps with 100%, 50% and 20% for the button set-values.

Button (1-4)
Show or Hide the button.

Label (1-4)
The text in this field specifies the text that will be displayed in the button. Up to 16 characters may be entered in this field.

Value (1-4)
When the user clicks the button, the Register defined in the Widget being edited will be set (forced) to the specified fixed value. The setting can be any integer or floating point value.

3. Control Button Type = Text Box

Use this setting to allow the user to manually change the value of a Register. The input can be an integer or floating point value. The input value can be restricted between minimum and maximum values defined by settings for the Register itself. See *Section* I/O Setup Tab > REGISTERS.

Use this input field for example, to enter a thermostat set-point value.

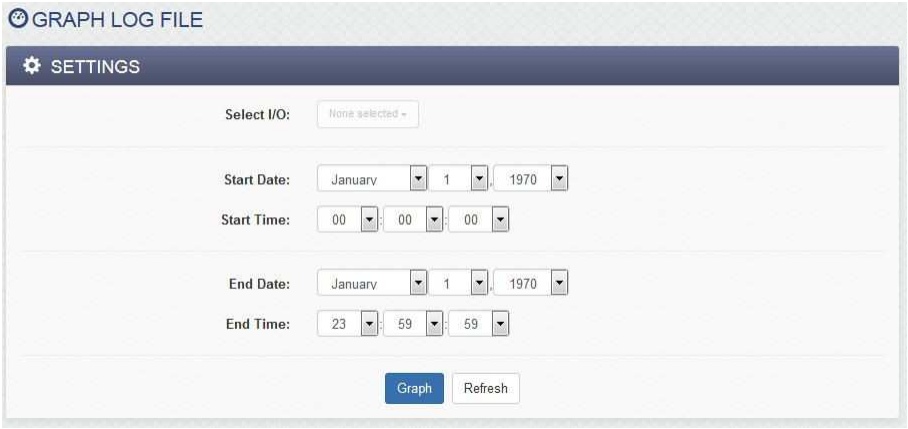
4. Analog I/O Status Colors

The status colors of analog I/O can be changed by creating Tasks under Control/Logic which set the I/O status colors.

3.7.3 Monitor & Control Tab > GRAPH LOG FILE

The data in the log file can be displayed in a graphical format. Use the fields in this tab to control and view the graph. With the *Start* and *End* settings you can "zoom in" to display the data over a specific time interval.

3.7.3.1 Settings



Select I/O

Select which I/O from the log file is to be graphed. Up to 10 I/O can be graphed at a time.

Start Date & Time

This is the start time for the graph. Select the month, day, year and time of day using the drop-down boxes.

End Date & Time

This is the stop time for the graph. Select the month, day, year and time of day using the drop-down boxes.

3.7.3.2 Settings

The graph includes a legend describing the colors and I/O in the top right corner of the graph. The graph is interactive in that if you hover over specific data-points, the exact values can be read. To zoom in on a specific region of the graph, click and drag to highlight the area of interest. To return to a normal zoom, click the Graph button.

Section 4: Control Page

The X-420 can be operated using a web browser, by sending HTTP requests from a custom application, by sending Modbus/TCP requests and/or SNMP requests. The X-420 digital I/O (and remote digital I/O) can be controlled from the Control Page if the page has a widget for the specific I/O.

Administrators, *Managers* and *Users* have separate access privilege to the Control Page. See General Settings Tab > PASSWORDS for a description of each access privilege.

4.1 Browser Operation

There are two ways users can access the Control Page by using a web browser:

1. Control Page

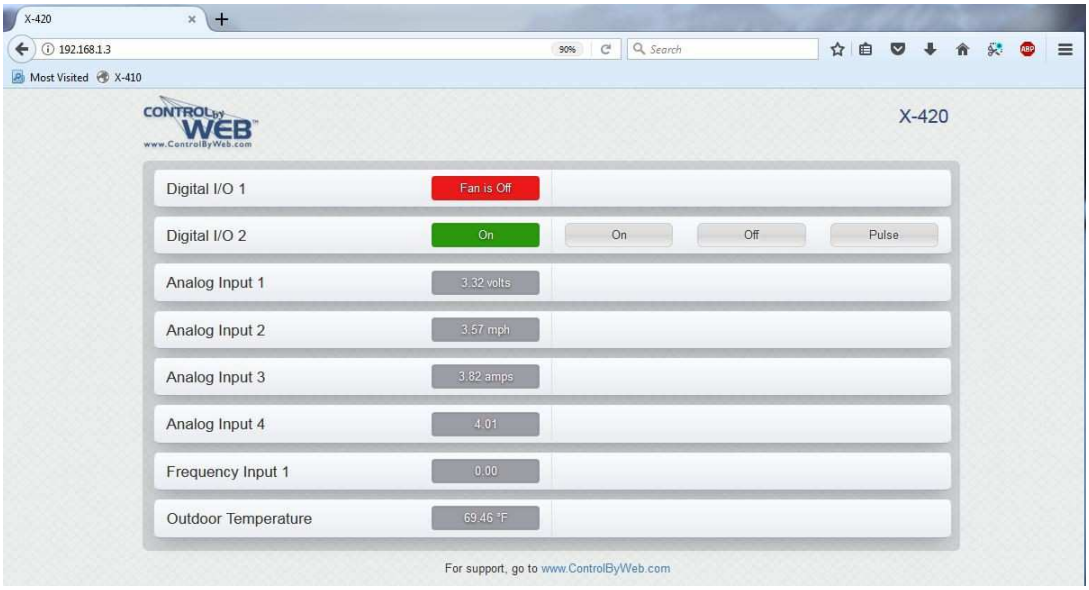
The first is by typing the IP address of the X-420 directly into the web browser address bar. For example, using the default IP address, the user would enter http://192.168.1.2 (If the IP address was changed from the default, the user must use the new IP address.)

Note that if any port is used other than the default port 80, the port must also be included in the request. For example, accessing the unit at port 8000 would be as follows: http://192.168.1.2:8000

To access the X-420 over HTTPS, the user would enter: https://192.168.1.2

If any port is used other than the default HTTPS port 443, the port must also be included in the request. Additionally, you will get a warning when accessing the X-420 over HTTPS, this is because the X-420 is using a default, self-signed SSL certificate.

The I/O on the Control Page updates every 3 seconds.



The Control Page is normally what users see and use and it can be highly configured to fit your needs. The Monitor & Control Tab > CONTROL PAGE SETUP tab has settings that determine what resources are displayed and how they are formatted.

2. Control Page via Setup Tabs

The second method of accessing the Control Page is through the Setup pages (http://192.168.1.2/setup.html). Choose Monitor & Control Tab > CONTROL PAGE.

This displays the same Control Page as before, but has the setup menu on the left side.

Section 5: Example Control Scenarios

This section presents various control examples using *Scheduled Tasks*, *Conditional Tasks,* and BASIC scripts to solve example applications.

5.1 Control Logic Examples Using Tasks/Functions

The following examples illustrate tasks or functions that can be performed by the X-420. These examples may be used as a tutorial to illustrate how to perform certain functions and can be a good starting point for more advanced logic.

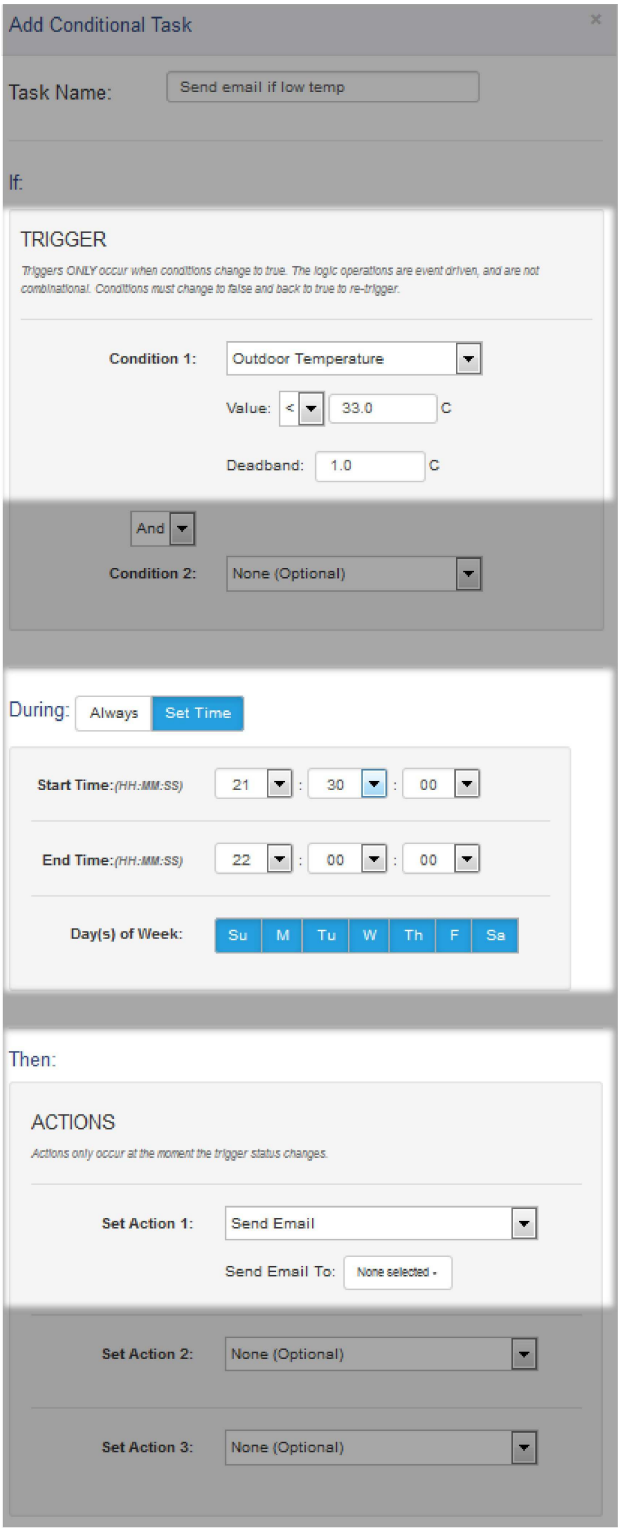
Important: *When creating tasks that perform actions when something is triggered, the action will not automatically reverse when the trigger goes away. For example, if a trigger turns a digital output on when temperature rises above 50 degrees, you must create a second task to turn the digital output off when the temperature falls below 50 degrees.*

5.1.1 Send an email if the temperature is less than 33°C between 9:30PM and 10PM each day

In this example the Deadband of 1 degree was used to prevent multiple email messages being sent due to "chatter".

Another email message won't be sent until the temperature rises above 34 degrees (33 plus 1 degree deadband) and then back below 33 degrees.

The "During" section of the task limits the time when the triggers are effective to 9:30 P.M. and 10:00 P.M. every day of the week. Outside this time frame, emails will not be sent when the temperature drops below 33 degrees.



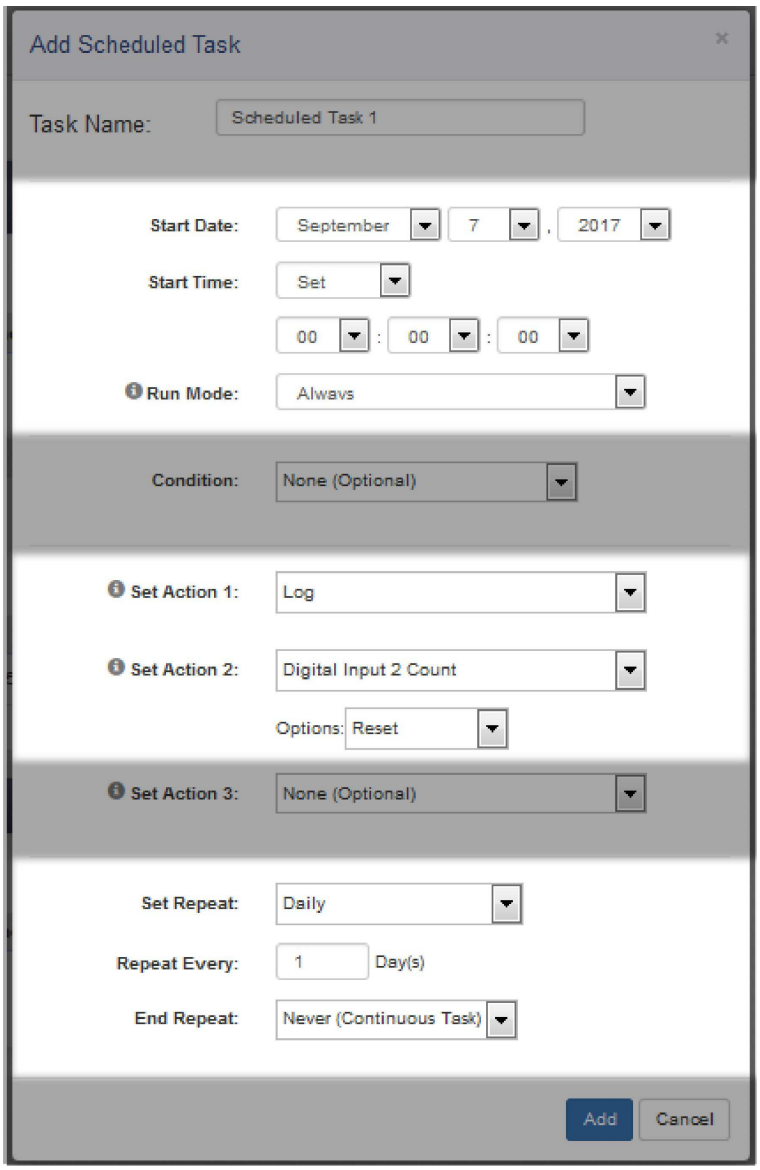
5.1.2 Log a counter value at midnight and reset the counter to 0 to begin the next day.

A counter is configured in the *I/O Setup* tab to count the number of cars which activate a road-tube sensor. Use this task to log the number of cars passing each day.

At 00:00:00 the daily task initiates two actions.

Action1 makes the data log.

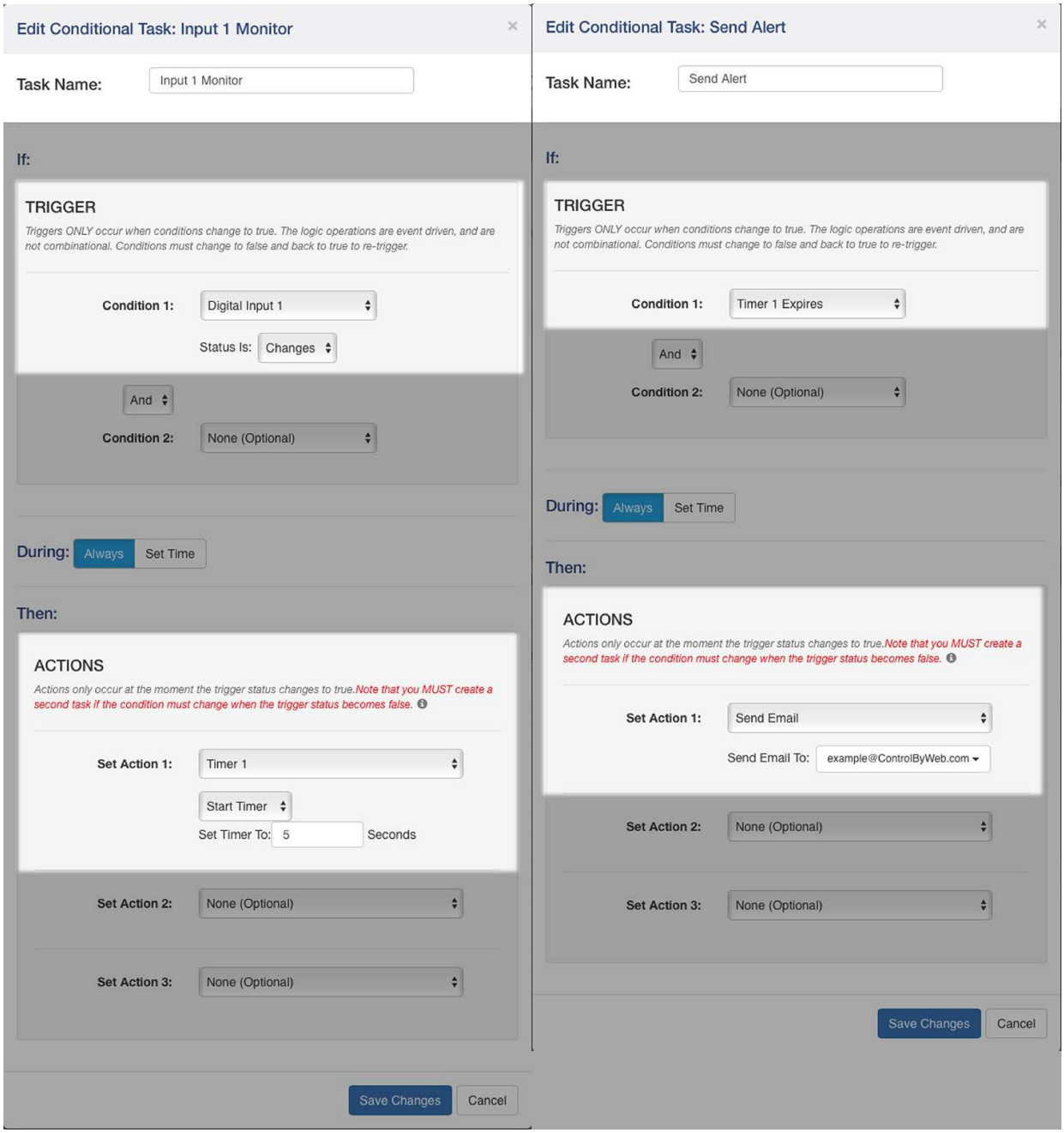
Action2 resets the counter to 0 to begin the next day.



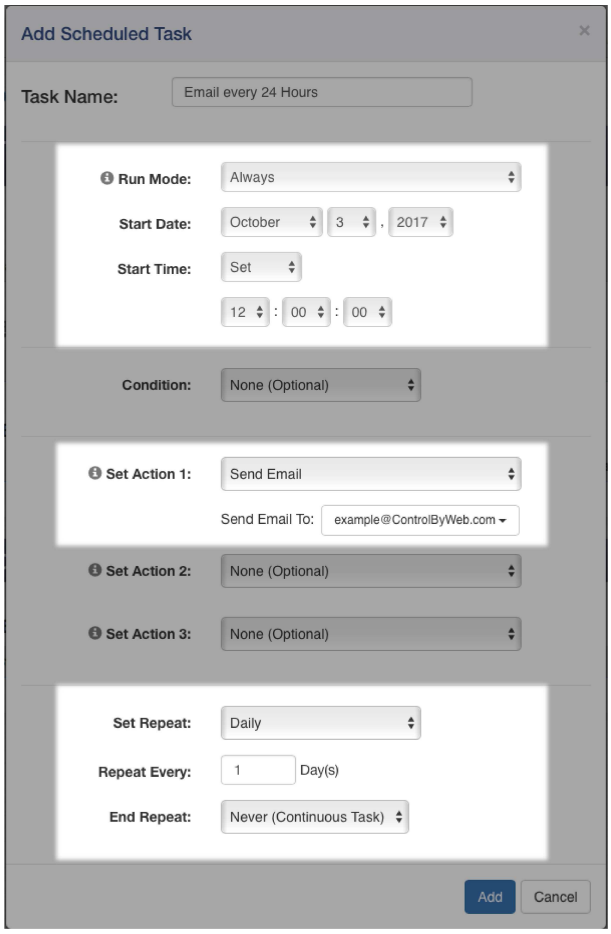
5.1.3 Send Email if Input stops toggling

Monitor Digital Input 1 for state changes. If Input 1 doesn't change state every 5 seconds or faster, an email message will be sent.

For this example, there are two tasks. Task 1 starts (or re-starts) a timer each time the input changes. Task 2 sends the alert if the timer ever expires.

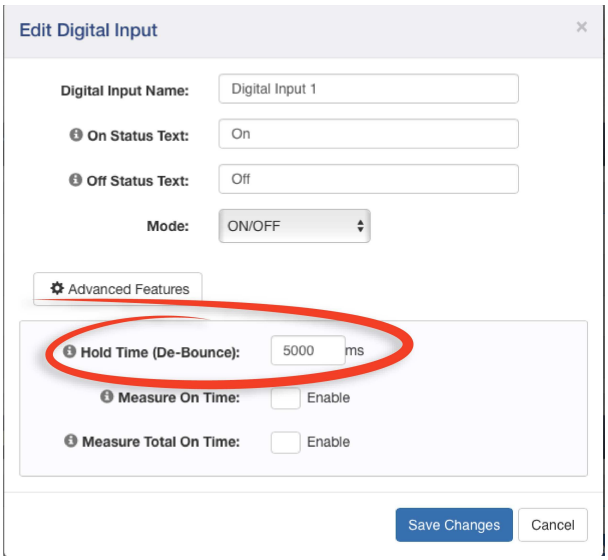


5.1.4 Send an email message every 24 hours



5.1.5 Require input to stay on for 5 seconds before triggering

This can be done in the digital input setup. By default the digital inputs must stay "on" for 20mS which is used to de-bounce the digital inputs. This can be changed to other values by accessing the digital input setup pages (I/O Setup -> Digital Inputs -> Edit). Under the digital input settings there is an option for "Advanced Features". Change the *Hold Time (De-Bounce)* to your desired delay time (in milliseconds).



5.1.6 Network Monitor between an X-420 and an X-410 (Advanced)

In this example we will configure an X-420 and an X-410 to share a register. In the example we are using this as a network monitor, but this example illustrates how to share register or I/O states between modules.

One X-420 will be configured to share a register with an X-410. The X-420 will change that register value once every 10 seconds. The X-410 will monitor that register value. If the X-410 detects no changes to the register for more than 12 seconds, it will send an email alert.

Setup the X-420 communications with the X-410:

1. Connect both devices to the network and assign IP address to each of them.
2. Open the setup page for the X-420 and select "Remote Devices" tab. Click the "Find Devices" button. The X-410 should appear in the list. If multiple X-420 units are installed on the network you may need to identify it by serial number. Select that X-420 device so the "Add Remote Device" window appears. Within that window...
    - Name the device "X-410"
    - Select model X-410 (should already be selected)
    - Serial number should be filled in with correct serial number.
    - IP address should have correct IP address for the X-410 and port should be correct.
    - Set up the security options and enter passwords for the X-410
    - In the bottom portion of the window, select "Instant Send"
    - Click "Add Device"

Wait a minute and then you should see the X-410 in the Remote Device List and the status should indicate a response time (in milliseconds) from the remote unit (the smaller the response time the better).

Now the X-420 is set up to push its I/O state to the remote device. By default it will push the state every 3 seconds (PUSH interval) but we want it to push its state instantly when the register changes, so we will set that up in the Conditional Tasks.

Setup of the X-420 to toggle register and share it with the X-410 (add two Conditional Tasks):

1. Open setup page for the X-420 (should already be there from above setup)
2. Set up a timer (called Timer 1) with a Power Up value of 8 seconds. This timer will be used to change the register and the Power Up value will cause it to start automatically.
3. Set up a task and call it "Toggle Register to 1". Set the trigger to "Timer 1 Expires AND Register 1 = 0". Set the Actions to "Set Register 1 to 1" and "Start Timer 1 for 10 Seconds" and "Push I/O State To Remote Receiver Device"
4. Set up a task and call it "Toggle Register to 0". Set the trigger to "Timer 1 Expires AND Register 1 = 1". Set the Actions to "Set Register 1 to 0" and "Start Timer 1 for 10 Seconds" and "Push I/O State To Remote Receiver Device"

Setup of the X-410 to monitor the register from the X-420 and sent alert if the register doesn't change within 12 seconds:

1. Open setup page for the X-410 and select Remote Devices tab. You should see the X-420 in the

list of devices but the name will show as the serial number rather than the name the X-420. You can click edit and change the name to the X-420. If the X-420 device doesn't appear in the list you will need to add it to the list manually.

2. Once the X-420 device appears as one of the Remote Devices you will need to add its register to the local I/O. Click on I/O Setup, then Registers. At the bottom of the table, click on the button called "Add Remote Register". Add the register "X-420 Register 1" to the list. You should now see this new register listed under "Remote Register".
3. We need a timer to go to I/O Setup and create a timer called "Timer 1". Give it a power up value of 30 seconds to make sure both the X-420 and the X-410 have plenty of time to boot before sending error messages.
4. Now add the logic. Click on "Control/Logic" and create a new Conditional Task. Call this task "Set Timer When 1". Set trigger Condition 1 to "X-420 Register 1 = 1". Set Action 1 to "Start Timer" with a time of 12 Seconds.
5. Add a second Conditional Task. Call this task "Set Timer When 0". Set trigger Condition 1 to "X-420 Register 1 = 0". Set Action 1 to "Start Timer" with a timer of 12 Seconds.
6. Add a third Conditional Task. Call this task "Send Alarm". Set trigger Condition 1 to "Timer 1 Expires". Set Action 1 to "Send Email" and specify the email address where the message should go (if no email addresses appear you will need to set them up first).

5.2 Control logic examples using BASIC Scripts

Most advanced logic can be accomplished using the X-420's Task Builder; however, the X-420 has a BASIC interpreter that can also be used for advanced logic.

With the X-420, the I/O resources are not fixed. After 1-Wire sensors, registers and other I/O are added, they can be controlled and monitored within BASIC scripts. BASIC scripts must reference I/O resources such as digital I/O in the form of io.name where “name” is the resource name defined when the resource was added in the I/O Setup Tab.

If the resource name has embedded spaces, they must be removed in the io.name statement. The first character must be lower case. For example, if a digital I/O is named “Warehouse Fan”, the fan can be turned on with the BASIC statement “LET io.warehouseFan = 1”. If a resource name is changed during development and testing, the resource name in the BASIC script must be renamed to match.

5.2.1 If a temperature is in an alarm state, send an email every hour.

```
DO

'If 55 < sensor1 < 185 then send an email every 1 hour

IF io.temp1 < 185 THEN
    IF io.temp1 > 55 THEN
        IF t0 = 0 THEN
            EMAIL
            LET t0 = 36000          '3600 seconds
        END IF
    END IF
END IF

LOOP
END
```

5.2.2 Monitor 4 doors, send an Email if a door is open more than 5-minutes

Send an email if a door has been open for more than 5 minutes, repeat the email every 5 minutes thereafter while the door is open.

```
'Send an email alert after a door has been open for more
than 5 minutes.
'Continuously set a timer for 5 minutes if the door is
closed

'Setting initial timer values
'Using variables a-d allow simple changes to alarm times
LET a = 3000            'Input1 300.0 seconds
LET b = 3000            'Input2 300.0 seconds
LET c = 3000            'Input3 300.0 seconds
LET d = 3000            'Input4 300.0 seconds

LET t1 = a
LET t2 = b
LET t3 = c
LET t4 = d

'Begin main program, sequentially service each door.
DO

'If door1 is closed, then set timer for 5 minutes.
'If door1 is open, then send an email and reset timer
after timer expires

'Door 1
IF io.input1 = 1 THEN
    LET t1 = a
ELSE                                'Else if door is open
    IF t1 = 0 THEN
            EMAIL io.input1
            LET t1 = a
    END IF
END IF
```

```
'Door2
IF io.input2 = 1 THEN
    LET t2 = b
ELSE                                'Else if door is open
    IF t2 = 0 THEN
            EMAIL io.input2
            LET b
    END IF
END IF

'Door3
IF io.input3 = 1 THEN
    LET t3 = c
ELSE                                'Else if door is open
    IF t3 = 0 THEN
            EMAIL io.input3
            LET t3 = c
    END IF
END IF

'Door4
IF io.input4 = 1 THEN
    LET t4 = d
ELSE                                'Else if door is open
    IF t4 = 0 THEN
            EMAIL io.input4
            LET t4 = d
    END IF
END IF

LOOP
END
```

5.2.3 Measure the running average frequency of a digital input

Increment a counter whenever input1 turns on. Every 10 seconds, set register1 to the average counts per second.

```
LET a = 0   'edge flag
LET b = 0   'accumulator

DO

'Count up whenever input1 turns on
IF io.input1 = 1 THEN
    IF a = 0 THEN
            b = b + 1
            LET a = 1
    END IF
ELSE
    LET a = 0
END IF

'Every 10 seconds, readjust the average counts / second
IF t1 = 0 THEN
    LET io.register1 = b / 10
    LET b = 0
    LET t1 = 100    '10.0 seconds
END IF

LOOP
END
```

5.2.4 Send an email if the AC power fails

Send an email if the AC power (via input1) has been off for 60 seconds. Send a followup email when the power is restored. Send the power restored email only if a 'power off' email was previously sent.

Note: A simple AC to 12VDC wall transformer connected to the digital input can be used to detect the loss of AC power.

```
'Script will send an email after power has been off for a specific amount of time.
'Will also send an email when power is on only if a 'power off' email has been sent.

LET a = 0   'Power on email sent if true
LET b = 0   'Power off email sent if true

DO

IF io.input1 = 1 THEN                          'If power is on
    LET t1 = 600
    IF a = 0 THEN                   'If no 'power on' email has been sent
        IF b = 1 THEN               'If 'power off' email has been sent
            EMAIL io.input1
            LET a = 1               'Set power on email sent flag
        END IF
    END IF
    LET b = 0
END IF

                                    'Once power has been off a specific time
IF t1 = 0 THEN
    IF b = 0 THEN
        EMAIL io.input1
        LET b = 1                   'Set power off email sent flag
    END IF
END IF

LOOP
END
```

5.2.5 Monitor a generator. Send an email if it runs for more than 10 seconds.

Send an email if a generator ever turns on for more than 10 seconds, and every 30 minutes afterward. Send an email when the generator turns off if a 'generator on' email was sent.

```
'Input1 is used as the source for the generator status
'Input1 = 1 : Generator off
'Input1 = 0 : Generator on

LET a = 0                   'Generator on email sent flag
LET t1 = 100                '10.0 seconds

DO

'Generator off
IF io.input1 = 1 THEN
    LET t1 = 100                    '10.0 seconds
    IF a = 1 THEN                   'If generator on already email sent
        EMAIL io.input1             'Email everything okay
        LET a = 0                   'Set generator on flag back to false
    END IF
END IF

'Generator on and timer expires
IF t1 = 0 THEN              'If timer has expired
    EMAIL io.input1         'Email generator on
    LET t1 = 18000          '30 minutes until another email
    LET a = 1               'generator on email flag
END IF


LOOP
END
```

Section 6: Auxiliary Operations

6.1 XML

Custom computer applications may be created to monitor and control the X-420. This method does not use a web browser. There are two XML pages that can be used to monitor and control the X-420, state.xml and customState.xml. All requests to the XML files must be in the form of HTTP GET requests, see *Section HTTP GET Requests (for custom applications)* for details.

See *Section External Server and Remote Services* for more information on network configurations when using XML.

6.1.1 state.xml

The state.xml page only shows the local I/O on the X-420. The XML tag names on this page are hard-coded and cannot be modified. They represent the io type and io number on the device. Some values may or may not show depending on the I/O configuration.

Reading state.xml

XML Monitor All Functions

The state of the Digital I/O, Analog Inputs, Counters, Sensors, and Vin can be monitored by sending a request to port 80 (or port specified in setup). This can be demonstrated by entering the following URL into the address bar of a web browser (substituting the IP address as necessary):

```
http://192.168.1.2/state.xml
```

The following state.xml page is returned:

```
<datavalues>
      <digitalIO1>0</digitalIO1>
      <digitalIO2>0</digitalIO2>
      <analogInput1>4.96</analogInput1>
      <analogInput2>4.96</analogInput2>
      <analogInput3>4.97</analogInput3>
      <analogInput4>4.97</analogInput4>
      <frequencyInput1>0.00</frequencyInput1>
      <vin>12.2</vin>
      <register1>0</register1>
      <utcTime>1262394580</utcTime>
      <timezoneOffset>-25200</timezoneOffset>
      <serialNumber>00:0C:C8:00:00:00</serialNumber>
</datavalues>
```

The numbers enclosed by the tags, `<tag>`, indicate the current state or value monitored by the X-420. Values for each tag are described in the table below.

Custom computer applications can open a TCP/IP connection with the X-420 and send a `GET` request for the state.xml file to obtain the current state of the X-420. Parameters can be passed with the GET request to control digital I/O on the X-420. (See *Section* HTTP GET Requests (for custom applications) for instructions on using GET requests to monitor and control the X-420.)

XML Tags*	Monitor Values
`<digitalIO1>`	0=off (voltage not applied to input one) 1=on (voltage applied to input one)

XML Tags*	Monitor Values
<digitalIO2>	0=off (voltage not applied to input one) 1=on (voltage applied to input one)
<analogInput1>	Value of analog input 1
<analogInput2>	Value of analog input 2
<analogInput3>	Value of analog input 3
<analogInput4>	Value of analog input 4
<frequencyInput>	Value of frequency input
<vin>	Scaled internal Vin measurement
<register1>	Value of the register 1
<utcTime>	Current UTC time expressed in seconds since January 1st, 1970
<timezoneOffset>	Value to offset utcTime for local time
<serialNumber>	00:00:00:00:00:00, serial number of X-420.

Controlling with state.xml

Commands can be sent to the X-420 to control the digital output, counters, and registers. The parameters used differ depending on if state.xml is used or customState.xml is used. State.xml uses the io type names and io numbers when controlling the I/O. CustomState.xml uses the camelcase version of the user configurable name when controlling the I/O.

Digital Output Control

Commands are sent using the parameter composed of the io type and digital I/O number digitalIOX (X is replaced by 1 for digital IO 1, or 2 for digital IO 2, etc). A few examples of using digitalIOX are given here.

Command	Description
state.xml?digitalIO1=0	Turn Digital I/O 1 *OFF*
state.xml?digitalIO1=1	Turn Digital I/O 1 *ON*
state.xml?digitalIO2=0	Turn Digital I/O 2 *OFF*
state.xml?digitalIO2=1	Turn Digital I/O 2 *ON*

Pulse Digital Output

When the pulse command is sent, the output will turn *ON* for the Pulse Duration specified in the Digital I/O *setup page*. It is also possible to send a pulse time command that is different than the configured Pulse Duration. This is done by sending a pulseTime variable. The pulseTime variable does not change the Pulse Duration in the setup page and it is not stored or recorded. The pulseTime variable only changes the duration for the single pulse initiated by that command. In other words, you must issue the pulseTime command for each pulse command that differs from the preset value. For example, if the X-420 is configured for a pulse duration of 1.5 seconds. To issue one 1.5 second pulse, three 5 second pulses, and another 1.5 second pulse to digital I/O 1, you would issue the following commands:

Command	Description
state.xml?digitalIO1=2	Pulse Digital I/O 1 for the preset time (1.5 seconds).
state.xml?pulseTime1=5&digitalIO1=2	Pulse Digital I/O 1 for 5 seconds.
state.xml?pulseTime1=5&digitalIO1=2	Pulse Digital I/O 1 for 5 seconds.
state.xml?pulseTime1=5&digitalIO1=2	Pulse Digital I/O 1 for 5 seconds.
state.xml?digitalIO1=2	Pulse Digital I/O 1 for the preset time (1.5 seconds).

NOTE: The pulseTime argument MUST come before the digitalIO1=2 command.

XML Set On Time Counters

The on time counter and total on time counter values can be set using the `onTimex` and `totalOnTimex` commands respectively:

Command	Description
state.xml?onTime1=0	Reset the onTime1 counter to 0
state.xml?onTime1=5	Reset the onTime1 counter to 5
state.xml?totalOnTime1=0	Reset the totalOnTime1 counter to 0
state.xml?totalOnTime1=5	Reset the totalOnTime1 counter to 5

XML Set Counter

The counter values can be set using the `countx` command:

Command	Description
state.xml?count1=200	Set counter1 to 200.

XML Set Register Values

The register values can be set using the `registerx` command:

Command	Description
state.xml?register1=10.5	Set register1 to 10.5.

6.1.2 customState.xml

The customState.xml works very similarly to the state.xml page in that current control data is presented and made available to control. The difference is in the customState.xml, the XML tag names are set to a name very similar to the name of the I/O it is associated with. For example, if you were to set the name of 'Digital IO 1' to 'My Digital IO 1' the digital I/O would show in the customState.xml in the tags 'myDigitalIO1'. Using these names allows applications interfacing with the X-420 to use more appropriate names when reading and writing I/O values.

Controlling I/O with the customState.xml is the same as with the state.xml except you may now use the names shown in the XML tags. For example, if you wanted to turn on a relay named 'My Digital IO 1', you would use the following command:
`http://192.168.1.2/customState.xml?myDigitalIO1=1`

You will need to reference the customState.xml for the exact names to use for each of the configured I/O.

6.2 JSON

The X-420 can also allow reading the current state of the devices I/O through JavaScript Object Notation (JSON). The JSON format may be preferred for some custom applications as some languages provide native methods for processing data in JSON form.

There are two primary files that can be requested from the X-420 in JSON form. The state.json and the customState.json. Each of these files provide the same information as their XML counterparts, but will be formatted with JSON. Additionally, the methods of controlling the I/O will be the same as with the XML pages. Note that all requests to the JSON files must be HTTP GET requests, see *Section HTTP GET Requests (for custom applications)*

6.3 HTTP GET Requests (for custom applications)

The X-420 has a built-in web server that responds to HTTP GET requests. These GET requests are sent from web browsers when a web page is requested. They are fairly similar to the actual addresses seen in the browser's address bar. The following section describes the HTTP protocol and how it can be used to control and monitor the X-420. All examples below show the state.xml, but will be the same for customState.xml and the JSON files. It is also assumed that a TCP/IP connection has already been established from the custom application to the device. The following are the messages that should be sent over the TCP/IP connection to control and monitor the device.

6.3.1 Using GET for Control and Monitoring

No Password

GET requests to the device for XML files.

Example request state.xml:

```
GET /state.xml HTTP/1.1\r\n\r\n
```

Example turn Digital I/O On:

```
GET /state.xml?digitalIO1=1 HTTP/1.1 \r\n\r\n
```

Password Enabled

If the *User* account is enabled on the X-420 and the state.xml page is requested through a browser, the user will be prompted for a password. If the request is sent from custom application, the HTTP request will need to contain the password encoded as Base64.

The following is an HTML request header without the password:

```
GET /state.xml?digitalIO1=1 HTTP/1.1 (Terminated with two \r\n.)
```

The following example adds the password:

```
GET /state.xml?digitalIO1=1 HTTP/1.1 (Terminated with one \r\n.)
Authorization: Basic bm9uZTp3ZWJyZWxheQ== (Terminated with two \r\n.)
```

`bm9uZTp3ZWJyZWxheQ==` is the Base64 encoded version of the user “name:password,” `none:webrelay.`

6.4 SNMP Requests, Objects and Community Strings

All configured I/O, and some simple network parameters can be retrieved using Simple Network Management Protocol (SNMP). For most cases, using SNMP is as simple as locating the appropriate Management Information Bases (MIB) files and loading them into the SNMP manager software. The X-420 will generate an MIB file based on its I/O configuration for use with the SNMP manager software. If the I/O are configured (added/deleted), a new MIB will need to be generated.

SNMP is configured under the *Advanced Network* setup tab. See *Section* General Settings Tab > ADVANCED NETWORK SETTINGS for more information.

The X-420 supports the following Packet Data Units (PDU):

- GetRequest
- GetNextRequest
- GetBulkRequest
- SetRequest
- Trap
- Notification

6.4.1 Standard Objects

The X-420 supports several standard RFC1213 objects that usually come with SNMP management software. If not, an Internet search for RFC1213-MIB will turn up multiple links.

RFC1213 Object	Response
`system.sysDescr`	X-420
`system.sysObjectID`	X420
`system.sysUpTime`	Time in hundredths of seconds since X-420 was last powered.
`system.sysName`	X-420*

*The sysName is customizable under the **Control Page** setup tab. It's the Control Page header.

6.4.2 X-420 Objects

All configured I/O on the X-420 can be monitored and controlled through SNMP. The MIB file can be generated for the X-420 by going to General Settings Tab > ADVANCED NETWORK SETTINGS

and pressing the button Generate and Download MIB File. This file should be regenerated whenever there are changes made to the I/O.

6.4.3 TRAPS

The X-420 can send SNMP traps when a digital I/O changes state, when a particular sensor value is reached, or when the supply voltage is out of the desired range. Traps are configured as actions in Conditional and Scheduled Tasks. As more I/O are added to the X-420, more I/O will appear in the MIB file.

6.4.4 Notifications

The X-420 also supports sending of SNMP Notifications when the SNMP version is 2c or 3. Notifications

are similar to traps accept they require a response to be sent back from the SNMP manager. Retries will occur if the SNMP manager does not return a response. This makes notifications more reliable than Traps. Notifications are configured as actions in Conditional and Scheduled Tasks.

6.4.5 Community Strings

The X-420 allows customization of both the read and write community strings. The proper community string will be needed for all read and write requests. By default both read and write community strings are `webrelay`. Community strings are only used by SNMP versions 1 and 2c. SNMP version 3 uses a different security mechanism.

6.4.6 SNMP V3 User-Based Security Model

The X-420 supports the SNMP V3 User-Based Security Model (USM). This replaces the community strings “security” of SNMP V1 and 2C. The details of USM can be complicated, but the main thing is that both the X-420’s security settings and the SNMP Manager’s security settings need to match for it to work.

There are two protocols used for USM. The first authentication protocol, allows the SNMP manager to authenticate the X-420 and vice versa. The second privacy protocol, allows the SNMP communication to be encrypted. Each protocol has an “algorithm” and a password associated with it. There is also a security username that is shared by both protocols.

6.5 External Server and Remote Services

Note: The following methods are supported by the X-420; however, Xytronix Research & Design, Inc. does not provide or support custom third-party applications, or external web servers.

6.5.1 Accessing the X-420 with custom software or third party applications

Custom applications can send commands to the X-420 for monitoring and control functions using HTTP requests for XML or JSON files. (See S*ection XML* and *JSON* for more information) The application interface can be used to provide a custom user interface, access to multiple units in a single screen, and allow for automation, logging, and other application-specific features.

6.5.2 Using an External Web Server

Rather than accessing the X-420 directly from a computer, an external web server can be used. The term “external” web server is used here to mean a separate web server (such as Apache, IIS, or NGINX) that is not the web server built into the X-420. In this scenario, users access custom web pages that reside on the external web server and the external web server communicates with the X-420.

An external web server can integrate multiple ControlByWeb products into a single control page. In other words, the user may not be aware that he/she is using multiple ControlByWeb™ devices, but rather the user sees an integrated control page for the entire system. In addition, the use of an external web server allows programmers to create custom user interfaces that take advantage of the additional resources typically available on larger web servers, including more memory and various web programming languages.

There are two approaches that an external server can use to communicate with the X-420 and other ControlByWeb™ devices, *Direct Server Control* and *Remote Services*.

Direct Server Control

The first approach is for the external server to create a TCP connection whenever it needs to access the X-420. In this case, the external server opens the connection, sends commands and/or reads the device, and closes the connection.

This method is ideal when the web server and all of the X-420 devices are on the same network (without routers between them). In this case, the server can communicate with the X-420 devices directly and securely since data never has to leave the local network.

When the server and the X-420 are on different networks, routers must be configured to allow appropriate access. If a public network is used, such as the Internet, security precautions should be considered.

Remote Services

The second approach is for the X-420 to initiate a connection using *Remote Services*. The settings under the *Advanced Network* tab in the setup pages will enable the X-420 to open a TCP connection with an external server. Once the connection is open, the external server can send commands and/or read the device. The external server can leave the connection open (so that it never closes) or close the connection.

Remote Services is ideal for installations where the server and the X-420 are installed on different networks. This is especially useful when each X-420 is installed on a separate private network. For example, if the user doesn't control the network connections where the X-420 is installed, *Remote Services* would initiate a TCP connection over the Internet with the control computer. Since the X-420

initiates the connection, the control computer doesn't have to know the IP address of the X-420. This means that the X-420 can be installed using DHCP. In addition, no special router configuration is required. This makes the network installation of the X-420 very simple, and since no incoming ports need to be opened in the router, security is not compromised. See S*ection General Settings Tab > ADVANCED NETWORK SETTINGS* for more information.

The X-420 can be configured to establish a connection when triggered by an event, such as an I/O state changing. This is done by setting a conditional task with the action being *Send Device State to Remote Service.*

When an event occurs and a connection is open, the state.xml file is sent.

If a connection is not open and *Remote Services* is enabled, a connection will be established by sending the connection string.

Connection String

With *Remote Services* enabled, a connection attempt will be made periodically according to the Connection Interval setting in the *Advanced Network* setup tab. The Connection String consists of static information about the device, a user-defined character string configured in the *Advanced Network* tab and ends with sending the state.xml.

The connection string is also sent at the same interval once the connection is open. The external server is responsible for closing the connection when it is done.

A three-character “ACK” response is expected in return to every connection string. If the “ACK” is not received within 10 seconds, the X-420 will close the connection.

6.6 Log Files

The X-420 logs information to two different log files; log.txt and syslog.txt. Both log files are text files and are stored in nonvolatile memory; this data will not be lost due to power failure and the syslog.txt is not cleared when restoring factory defaults. The log files are stored in circular buffers which write from the beginning of the allocated memory space to the end and then repeat from the beginning (over-writing the original data). The nonvolatile memory is divided into 4K byte sectors. Each time data gets erased to make room for new data, a full sector (4K bytes) is erased at one time.

Data Log File – log.txt

This log file is user-configurable under the *Logging* tab, and stores real-world data such as temperatures and events such as digital I/O state changes (see *Section* Logging Tab > GENERAL LOGGING SETTINGS for more information). It can be up to 3072K bytes long and is displayed using a comma-separated value formatting scheme.

Inputs, Digital I/O, Counters, Vin, and Sensors will only be displayed if they are selected in the *Logging* setup tab. The file is read by requesting the log.txt file from the X-420. For example, using the default IP address the following command would be used to request the log file:

```
http://192.168.1.2/log.txt
```

Example File Format:

```
MM/DD/YYYY HH:MM:SS.mmm DDD, Digital I/O 1-2, Analog Inputs 1-4, Frequency
Input, Vin, Sensors 1-16, Trigger: Source
```

Date and Time Format:

MM – Month (1-12)
DD – Day (1-31)
YYYY – Year (1970 - 2106)
HH – Hour in 24 hour time (0 -23)
MM – Minutes (0-59)
SS – Seconds (0-59)
mmm – Milliseconds
DDD – DST when in daylight savings; STD when not in daylight savings time

Sample File:

```
Date Time,Relay 1,Relay 2,Relay 3,Relay 4,Digital Input 1,Digital Input
2,Digital Input 3,Digital Input 4,Vin(V),Register 1,Trigger
09/07/2017 13:56:18 DST,0,1,1,0,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,0,0,1,1,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,1,0,0,1,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,1,1,0,0,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,0,1,1,0,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,0,0,1,1,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,1,0,0,1,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,1,1,0,0,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,0,1,1,0,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,0,0,1,1,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,1,0,0,1,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,1,1,0,0,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,0,1,1,0,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,0,0,1,1,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,1,0,0,1,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,1,1,0,0,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,0,1,1,0,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,0,0,1,1,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,1,0,0,1,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,1,1,0,0,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,0,1,1,0,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,0,0,1,1,0,0,0,0,24.74,0.00,I/O:(Relay 1)
09/07/2017 13:56:18 DST,1,0,0,1,0,0,0,0,24.74,0.00,I/O:(Relay 2)
09/07/2017 13:56:18 DST,1,1,0,0,0,0,0,0,24.74,0.00,I/O:(Relay 1)
```

The file can then be saved using the 'Save As...' option under the 'File' menu of the web browser. If the TCP port has been changed (not port 80), the port will be required to read the file. For example, using the default IP address, and port 8000, the log file would be read as follows:

```
http://192.168.1.2:8000/log.txt
```

The log.txt file may be erased with the following command:

```
http://192.168.1.2/log.txt?erase=1
```

Note: If the User account is enabled in the setup pages, the password will be required to access the log file.

System Log File – syslog.txt

The syslog file records various system events, which can be used for diagnostics and troubleshooting purposes.

File Format:

```
MM/DD/YYYY HH:MM:SS, (category to which message applies): (message)
```

Sample File:

```
01/02/2010 04:08:13 DEVICE: Power Up.
01/01/2010 00:41:05 DEVICE: Reset factory defaults.
```

Listed below is a description of messages that a user may see:

Category	Message	Description
DEVICE	Power Up	Device has been properly powered.
	Initialize	Device is ready.
	Reset Factory Defaults	Device has been reset to factory defaults.
EMAIL	Failed DNS Lookup	Unable to lookup mail server due to an incorrect DNS setting.
	Bad Username	Email was not sent due to an incorrect user name.
	Bad Password	Email was not sent due to an incorrect password.
	Authentication Required	A user name and password are required by the mail server.
	No Response	No response from SMTP server.
CLOCK	RTC Reset	Real Time Clock has been reset.
NTP SERVER	Request Attempt	Device attempting to connect to NTP Server.
	Failed DNS Lookup	Unable to lookup NTP server name due to an incorrect DNS setting.
	Success	Device successfully connected to NTP Server.
REMOTE SERVER	Failed DNS Lookup	Unable to lookup Remote Server due to an incorrect DNS setting.
	Connection Attempt Started	Connection port with Remote Server has been opened.
	Connection Closed	Connection port with the Remote Server has been closed.
DHCP	Address Acquired	IP address request successful, and IP address assigned.
	Lease Renewal	IP address assigned to device was renewed.
MAIN_MCU	New Firmware Loaded	New firmware has been loaded to the device.

This file is read by requesting the syslog.txt file. For example, using the default IP address the following command would be used:

```
http://192.168.1.2/syslog.txt
```

Note: The setup user name and password are required to access this file.

If the TCP port has been changed (not port 80), the port will be required to read the file. For example, using the default IP address, and port 8000, the log file would be read as follows:

```
http://192.168.1.2:8000/syslog.txt
```

To erase the file, use: `http://192.168.1.2/syslog.txt?erase=1`

6.7 Modbus/TCP

The X-420 can be controlled and monitored using Modbus/TCP protocol. This provides a standard means of using the X-420 with devices and software from other manufacturers. This section is not a tutorial on Modbus and it is assumed that the reader is already familiar with Modbus. Detailed Modbus information can be found at http://www.modbus.org.

Note: Modbus communications are disabled whenever the User account is enabled. This is because Modbus/TCP does not provide a mechanism for password protection. Make sure the User account is disabled (default) and Modbus functionality is enabled on the Advanced Network.

The X-420 functions as a Modbus slave. Host devices, such as PLCs, open a connection with the X-420 on port 502 (configurable under *Advanced Network* tab) and then send requests to read or set digital I/O states, or sensor values. When the X-420 receives a command, it performs the desired function and returns a response.

The X-420 can have additional I/O added and removed that can cause changes to the Modbus address map. For an up-to-date map of I/O on the X-420 to the addresses for Modbus, please select the *View Modbus Address Table* button from the setup pages under the *Advanced Network* tab.

The following sections provide an overview and explanation of Modbus operation.

6.7.1 X-420 Function Code Summary

The X-420 supports the following function codes:

Code Name	Modbus Function	X-420 Feature
Read Coils	01	Digital I/O (Configured as outputs)
Read Discrete Inputs	02	Digital I/O (Configured as inputs)
Read Multiple Registers	03	Vin, Sensors, Registers, Counters, Analog Inputs (All I/O)
Write Single Coil	05	Digital I/O (Configured as outputs)
Write Multiple Coils	15	Digital I/O (Configured as outputs)
Write Multiple Registers	16	Digital I/O Pulse Counters, Registers, Counters (All writable I/O)

Multiple commands may be sent without closing and re-opening the connection, but if no data is transferred for 50 seconds, the connection will time out and close. To keep the connection open, a read request can be sent periodically.

The X-420 has two TCP sockets available for Modbus/TCP. This allows two connections to be open at one time. Requests for more than two open connections will be rejected.

When errors occur, an error code is returned. Most Modbus client software will interpret this code in a human readable form. The code is comprised of the original function code plus 0x80. For example, an error during the read coils function 0x01 would return 0x81. Each error has a qualifying exception number. The following are the possible exception codes and their meanings:

0x01 - Function code not supported (also when Modbus is disabled in the setup pages).
0x02 - Incorrect starting address/quantity of output combination.

6.7.2 Read Coils - Modbus Function Code 01 (0x01)

Read the state of the digital I/O configured as outputs.

Request

Start Address: 0x0000 (coil 1) to 0x0001 (coil 1)
Coil Quantity: 0x0001 (1 coil) to 0x0002 (2 coils)
Both Outputs may be read at the same time by specifying the correct starting address and quantity of coils to be read.

Response

The X-420 will respond to the request with a data field of one byte, each bit representing the coil status. A '1' indicates the Output is *ON*. A '0' indicates that the Output is *OFF*.

Bit zero of the return value will be the state of the coil corresponding to the start address. For example, if a start address of 0x0001 is used, bit zero will be the status of Digital I/O 2.

Coil State Byte							
Bit 7	**6**	**5**	**4**	**3**	**2**	**1**	**Bit 0**
X	X	X	X	X	X	Digital I/O 2	Digital I/O 1

Errors

The sum of the start address and coil count cannot exceed the maximum coil count or an error response will be returned.

The following are possible error responses:

Coil Read Error Function Code (1 byte):	0x81
Exception Codes (1 byte):	0x01 – Function code not supported. 0x02 – Incorrect combination of start address and quantity of Digital I/O

6.7.3 Read Discrete Inputs – Modbus Function Code 02 (0x02)

This function returns the state of the Digital I/O (when configured as inputs).

Request

Start Address: 0x0000 (Digital I/O 1) to 0x0001 (Digital I/O 2)
Input Quantity: 0x0001 to 0x0004

The sum of the starting address and the quantity of coils must not be greater than 0x0002. For example, if you want to read 0x0002, both inputs, then the start address must be 0x0000. To read the second input only the start address is 0x0001 with a quantity of 0x0001.

Response

The inputs states are indicated by bits one and two of the status byte. A `1` indicates that the input is switched *ON*. A `0` indicates that the input switched *OFF*. Bit zero of the return value will be the state of the coil corresponding to the start address. For example, if a start address of 0x0001 is used, bit zero will be the status of input 2.

When reading all 4 inputs, the following table shows the bit positions:

Discrete Input State Byte							
Bit 7	**6**	**5**	**4**	**3**	**2**	**1**	**Bit 0**
X	X	x	x	x	x	Digital I/O 2	Digital I/O 1

Errors

Input Read Error Function Code (1 Byte): 0x82

Exception Codes (1 byte):	0x01 – Function not supported. 0x02 – Incorrect combination of start address and input quantity.

6.7.4 Read Holding Registers – Modbus Function Code 03 (0x03)

The Read Holding Registers function is used mainly to read analog I/O such as the analog inputs, registers, counters, vin and 1-Wire sensors. All I/O can be read using this function code, including digital I/O. The holding register addresses can be found in the Modbus Address Table in the Advanced Network setup page under Modbus.

Request

32-bit sensor values are read from 16-bit register pairs. Consequently, senors addresses, analog input addresses, and registers must be even numbers.

Analog Input Start Addresses

Start Address: 0x0004 (Analog Input 1)
Input Quantity: 0x0002 – 0x0008 (Depending on number of analog inputs to read)

Vin Start Addresses

Start Address: 0x000E (Vin)
Input Quantity: 0x0002

Temperature and Humidity Sensor Start Addresses

Start Address: Refer to Modbus map in setup pages
Input Quantity: Varies and must be an even number

Counter Input Start Addresses

Start Address: Refer to Modbus map in setup pages
Input Quantity: Varies and must be an even number

Response

32-bit floating-point values are returned, either as little-endian or big-endian numbers, depending on the configuration in the *Advanced Network tab*.

With little-endian ordering, a temperature reading of sensor 1 would return 0x800042A2. The least significant word would be 8000 hex and the most significant word would be 42A2. This hexadecimal value converts to a temperature reading of 81.25 degrees.
If a temperature or humidity sensor is not installed, a value of 0xFFFFFFFF (NaN) is returned. Other inputs will show measured values of the open circuits.

Errors

Sensor Read Error Function Code (1 byte):	0x83
Exception Codes (1 byte):	0x01 – Function not supported. 0x02 – Incorrect combination of start address and input quantity.

6.7.5 Write Single Coil – Modbus Function Code 05 (0x05)

Digital I/O (configured as outputs) may be controlled one at a time.

Request

Start Address (2 bytes):	0x0000 (Digital I/O 1) – 0x0001 (Digital I/O 2)
Output Value (1 byte):	0x00 (OFF), 0xFF(ON)
Padding (1 byte):	0x00

Response

The response mirrors the requested state, 0x00 or 0xFF.

Errors

Single Coil Write Error Function Code (1 Byte):	0x85

Exception codes (1 Byte):	0x01 – Function not supported. 0x02 – Address out of range. 0x03 – Padding value.

6.7.6 Write Multiple Coils - Modbus Function Code 15 (0x0F)

One byte can be written to set the state of all digital I/O (configured as outputs), each bit representing one digital I/O.

Request

Digital I/O states are controlled by specifying the start address of the first digital I/O to be controlled, the count of the digital I/O to be affected, and the digital I/O state byte.

A digital I/O value of 0xFFFF would be used to turn *ON* all of the digital I/O in the range or 0x0000 to turn them *OFF*. In the example below, the digital I/O value 0xFF would turn digital I/O 1-2 *ON*.

Start Address (2 bytes): 0x0000 (Digital I/O 1) – (Digital I/O 2)
Output Quantity (1 bytes): 0x0001
Byte Count (1 byte): 0x01
Digital I/O Value (1 byte): 0x00 – 0x0F

Digital I/O State Byte							
Bit 7	**6**	**5**	**4**	**3**	**2**	**1**	**Bit 0**
X	X	X	X	X	X	Digital I/O 2	Digital I/O 1

Response

The quantity value is returned.

Errors

Multiple Coil Write Error Function Code (1 Byte):	0x8F

Exception codes (1 Byte):	0x01 – Function not supported 0x02 – Incorrect combination of start address and Digital I/O quantity 0x03 – Byte count out of range

6.7.7 Write Multiple Registers – Modbus Function Code 16 (0x10)

The Modbus Write Multiple Registers function can be used to set a counter to a specific value or pulse the digital I/O (configured as outputs).

Request

Set Counters, Registers and other analog values

The counter value is specified using a 32-bit integer (not a floating point number).

Start Address (2 bytes):	Refer to Modbus map in setup pages
Register Quantity (2 bytes):	Varies and must be an even number
Byte Count (1 byte):	Varies and must be a multiple of four
Counter Quantity (4 bytes/Counter):	0x00000000 – 0xFFFFFFFF

Pulse Digital I/O

The Modbus Write Multiple Registers function is used to pulse the digital I/O(s) for a specified time. When the X-420 receives this command, it immediately turns the appropriate digital I/O *ON* (if not already on) and starts the pulse timer. The digital I/O are selected by writing the pulse time in seconds to the register(s) associated with the desired digital I/O.

The pulse time is specified using floating point format in the register value field and can range from 0.1 seconds to 86400 seconds (1 day). When the pulse time expires, the digital I/O will be turned *OFF*. If a pulse time command is sent with a value greater than 86400, the pulse timer will be set to 86400. If a pulse time command is sent with a value less than 0.1, the pulse timer will be set to 0.1.

If any commands are sent to the X-420 (Modbus, XML, SNMP, or HTML) before the pulse timer has expired, the pulse timer will be canceled immediately and the new command will be executed.

IEEE 754 floating point format is used for the pulse time. The X-420 may be configured for little-endian or big-endian transmission. The endian-ness is configured in the *Advanced Network* tab. (See MODBUS for more information.)

Start Address (2 bytes):	0x0200 (Digital I/O 1) – 0x0202 (Digital I/O 2)
Register Quantity (2 bytes):	0x0002 – 0x0004 (2 registers for each digital I/O, even number)
Byte Count (1 byte):	0x04 – 0x08 (Multiples of 4)
Pulse Duration (4 bytes/digital I/O):	0x3DCCCCCC – 0x47A8C000 (big-endian) 0xCCCC3DCC – 0xC00047A8 (little-endian)

Response

The request is acknowledged by responding with the register quantity that was requested.

Errors

Pulse Function code Error (1 Byte):	0x90
Exception codes (1 Byte):	0x01 – Feature not supported. 0x02 – Address quantity not an even number. Incorrect combination of start address and digital I/O count.

6.8 Basic Scripts

BASIC (Beginners All-purpose Symbolic Instruction Code) is a computer programming language that has been in use for many years. The X-420 has an integrated BASIC interpreter for a simple BASIC script. This provides a great deal of flexibility by allowing users to customize basic functions of the unit. The interpreter only supports a small subset of the BASIC commands that are available for larger computers. Some non-standard commands have been added, and some commands may function differently on the X-420 BASIC interpreter than on other platforms. The following is a short tutorial on the supported BASIC functions.

Example scripts are available at https://www.controlbyweb.com/support/tutorials/basic-script-tutorial.html. Contact customer support if further assistance is required.

6.8.1 Structure

A BASIC script is written as a .txt file, which is then uploaded to the device using the *Script* setup tab. The maximum script size is 4-Kbytes. Each line within the script contains a single statement. Line numbers are not used.

Statements are not case sensitive; however, variables are.

IF THEN, FOR loops, and DO loops can only be nested up to 5 times per command. For those not familiar with nesting, the following is an example of nested FOR loops:

```
FOR a = 0 to 100
  FOR b = 0 to 100
  NEXT b
NEXT a
```

Every program must end with an END statement. Subroutines would then follow after the END statement, if required. The last line of the script should be left blank.

6.8.2 Line Format

Every line follows the same format. The basic format is:

statement (variable) (=, <, >, <=, >=, <>) (expression) (THEN)

The fields in parentheses are optional depending on the statement. One space must be used between all statements, numbers, variables, operators, expressions, etc. Multiple spaces are invalid.

Comments may be inserted, but must begin with an apostrophe. All text on a line after the apostrophe is ignored. For example:

```
LET a=1            'this will return an error because of insufficient spacing
LET a = 1          'this is valid
LET a  =  1        'this will return an error because of too many spaces
```

Only a single variable or literal is allowed on the left side of any operator. The following example is incorrect and will return an error. The error occurs because there is more than a single value to the left of the comparison operator (a + b is to the left of =).

```
IF a + b = 3 THEN  'this will return an error
```

To fix the above line, replace 'a + b'. One of the following options may be used:

```
Let c = a + b
IF c = 3 THEN
```

6.8.3 Supported Statements

The following are the statements supported by the ControlByWeb™ BASIC interpreter.

LET

The LET statement assigns a variable a value. The format is:

LET (variable) = (expression)

IF THEN, ELSE, END IF

The IF THEN statement tests the truth of a condition. The ELSE statement defines a second function if the condition is found false. In other words, if the condition is true, then a function is performed. If it is not true, a second function may be performed. The second function may or may not be necessary depending on the application. The IF THEN (ELSE) statement must always be followed with an END IF statement. The format is:

IF (variable) (=, <, >, <=, >=, <>) (expression) THEN
(Function 1)
ELSE
(Function 2)
END IF

A special Variable NAN is available to check if I/O values are valid before using them. To check if a 1-Wire temperature sensor value is valid before using it to send an email the following could be used:

```
IF NAN <> io.oneWireSensor1 Then
    ' send email
ELSE
    ' do something else
END IF
```

Note: In most BASIC interpreters, 'Function 1' (see above) may be placed after the THEN statement. This interpreter requires 'Function 1' to be put on the following line.

FOR TO, NEXT

The FOR TO statement loops a section of code a predefined number of times. The NEXT statement always follows the section of code to be looped. The format is:

FOR (variable) = (expression) TO (expression)
(code to be looped)
NEXT (variable)

DO WHILE, LOOP

The DO WHILE statement loops a section of code while a condition is found true. The LOOP statement always follows the section of code to be looped. Note that if the condition is omitted, the code will be looped without end. The format is:

DO WHILE (variable) (=, <, >, <=, >=, <>) (expression)
(code to be looped)
LOOP

If the loop is to continue indefinitely, the format would be:

DO
(code to be looped)
LOOP

Example:

```
let t0 = 100
do while t0 > 0
    ' wait
loop
```

LOG

The LOG statement causes the device to log data according to the settings specified under the *Logging setup tab*.

Note: In order to log, logging must be enabled in the Logging setup tab.

The format is: LOG

EMAIL

The EMAIL statement causes the device to send an email of the same format as that generated by other status change and alarm conditions. If an I/O variable is given as a parameter, then the subject line in the email will contain “Variable Name = Variable Value”. If no I/O variable is given, then the subject of the email will be “Basic Script”.

EMAIL (io.digitalIO1, etc)

Examples:

```
    EMAIL
...or...
    EMAIL io.digitalIO2
...or...
    EMAIL io.input1
...or...
    EMAIL io.temp2
```

END

The END statement ends the main body of code.

CALL

The CALL statement is found within the main body of code, but requires the interpreter to skip to a subroutine found at the end of the program. After the subroutine is finished, the interpreter returns to the line immediately following the CALL statement. The format is:

CALL (name of subroutine)

SUB, END SUB

The SUB statement defines the beginning and name of a subroutine. The END SUB statement defines the end of the respective subroutine. Subroutine names can be up to 20 characters long and are case sensitive. The SUB and END SUB statements always must follow the END statement. The format is:

```
END

'*** Subroutines Go Here ***
SUB (name of subroutine)
  (contents of subroutine)
END SUB
SUB (name of subroutine)
```

(contents of subroutine)
END SUB

REM or '

The REM or apostrophe (') statement designates remarks made by the programmer. The interpreter will disregard any characters on the line following these statements.

6.8.4 User-Defined Variables

Two types of variables are available for use in the ControlByWeb™ BASIC interpreter, user-defined variables, and predefined variables.

Up to 10 user variables may be initialized. These must be single character, lower case letters.

a, b, c, d, e, f, g, h, i, j
They are always global and stored internally as floating point numbers. Variables are defined using the LET statement.

Examples:

```
Let b = 5           'variable b will be set to 5
Let d = b + 2       'variable d will be set to 7
```

6.8.5 Predefined Variables

The following are useful predefined variables for the ControlByWeb™ BASIC interpreter. These are useful for accessing internal values and features states.

Timer Variables

Ten timers are available for use in BASIC scripts.

t0, t1, t2, t3, t4, t5, t6, t7, t8, t9
Timers can be set to any positive integer (or 0) by using the LET statement. As soon as a value is assigned to a timer, it will begin to count down immediately by decrementing one count every 100 ms until it reaches zero.

Examples:

```
Let t3 = 1500       'set timer 3 to 150 seconds
Let t1 = 0          'disable time 1
```

These timers are different than the Timer I/O that can be configured under the I/O setup tab. They are only accessible to the basic script, and their resolution is 100 ms. The Timer I/O can also be accessed from the BASIC script as io.timer1, etc. These timers have 1-second resolution.

Date and Time Variables

The variables 'time' and 'date' are predefined, read only variables that store the current date and time. They can be used to schedule events and activities, such as sending emails, reading temperature, or setting outputs. The date uses the mm/dd/yyyy format. Clock time is formatted as hh:mm:ss (24-hour clock).

Example:

```
If date = 01/01/2014 Then
  If time > 12:30:00 Then
    Let io.digitalIO1 = 1
    Let io.digitalIO2 = 0
  End If
End If
```

Note: Current date and time can only be set in the Date/Time tab.

Event Variables

Data and time variables can be used to execute script events.

Up to 10 date variables are available:

ed0 'event date variable 0
… 'ed1, ed2, ed3, ed4, ed5, ed6, ed7, ed8,
ed9 'event date variable 9

The value assigned to event variables should be in the format mm/dd/yyyy. The event-date variables store the number of days that have passed since January 1, 1970.

Event-time variables may be used in math expressions as well as comparison statements.

Time variables have a similar naming convention.

et0 'event time variable 0
... 'et1, et2, et3, et4, et5, et6, et7, et8
et9 'event time variable 9

Event-time variables are declared in the format hh:mm:ss in 24-hour time. The event-time variables store the number of seconds from the beginning of the day.

Event-date and event-time variables of the same number are linked. If the event-time variable is incremented more than the number of seconds in a day (86400 seconds), the variable is reset to 0 and the event-date variable is incremented by one. For example, if et3 rolls over to zero, ed3 will be incremented.

The following script example demonstrates defining the event variables and comparing it to the current date and time. Assume current time is April 10, 2010 at 1:30 AM and the event should occur in one hour and every hour thereafter.

Example:

```
Let a = 1
Let ed1 = 04/10/2010            'sets the event date to April 10,
                                '2010.
Let et1 = 02:30:00              'sets the event time to 2:30
Do While a <> 0
  If ed1 >= date Then           'Tests event date versus current date.
    If et1 >= time Then         'Tests event time versus current time.
      Let et1 = et1 + 3600      'Increments the event time by one hour
                                '(in seconds).
                                'Event to occur would go on this line
    End If
  End If
Loop
End
```

6.8.6 I/O Variables

The BASIC interpreter has full access to all configured I/O on the X-420. The I/O are treated as variables and can be read and written to the same as other variables. With the X-420 the I/O resources are not fixed. After 1-Wire sensors, registers and other I/O are added and defined they can be controlled and monitored within BASIC scripts. BASIC scripts must reference I/O resources such as digital inputs and relays in the form of io.name where “name” is the resource name defined when the resource was added in the I/O Setup Tab. If the resource name has embedded spaces, they must be removed in the io.name statement. For example, if a digital I/O is named “Warehouse Fan”, the fan can be turned on with the BASIC statement “LET io.warehouseFan = 1”. If a resource name is changed during development and testing, the resource name in the BASIC script must be renamed to match.

The View Basic I/O Tokens button on the BASIC setup page displays a list of all of the I/O resources currently available together with the equivalent token to be used in BASIC scripts to reference the respective I/O resource.

Digital I/O Variables

Digital I/O variables represent the state of the digital I/O and can be used to change the state of the digital I/O when they are configured as outputs. Remote digital I/O and local digital I/O are read and controlled the same. Below is an example on how to access the digital I/O provided they are at the default names.

```
io.digitalO1            'digital io 1
io.device1DigitalIO1    'remote digital io 1
```

Note: Commands can be sent to remote digital I/O, but the states of those digital I/O cannot be reliably read immediately. Consequently, remote digital I/O should not be used in safety or security-critical applications.

Digital I/O can be turned ON, turned OFF, pulsed, toggled, or read in BASIC scripts. The LET statement is used to set the output state. The state options available are:

0 – turn digital I/O off
1 – turn digital I/O on
2 – pulse digital I/O
5 – toggle digital I/O

The pulse time is specified in the Digital I/O setup tab.

Examples:

```
Let io.digitalO1     = 1   'turn on digital I/O 1
Let io.digitalO1     = 0   'turn off digital I/O 1
Let io.digitalO1     = 2   'pulse digital I/O 1
Let io.digitalO1     = 5   'toggle digital I/O 1
Let a = io.digitalIO2      'read the state of digital I/O 2, state will be 0 or 1
```

Registers

Registers are similar to general purpose variables and can be used in the same manner. The difference between general purpose variables and registers is that registers can be accessed by the user through a web browser and modified while the script is running. Scripts can use registers as a method of retrieving input from the user or through any of the scheduled or conditional tasks. Below is an example of how to access a register assuming it is at the default name.

io.register1

The following example demonstrates the BASIC script reacting to user input by creating a script that will turn ***ON*** a remote relay if *Register 1* equals 1 and turn ***OFF*** if a remote relay if *Register 1* equals 0.

Example:

```
Do
  If io.register1 = 1 Then
    Let io.device1Relay1 = 1
  Else
    Let io.device1Relay1 = 0
  End If
Loop
End
```

Registers can also be used to show numeric values, such as a count-down timer. The following code will show a count down from 10 seconds and automatically restart. The refresh rate must be configured in the *Control Page* setup in order to see each of the count down values.
Example:

```
let t0 = 10                     'Initialize variables and start timer
let io.register1 = 10

'Main Loop
Do
      if t0 = 0                 'when timer reaches 0 decrement counter
            let io.register1 = io.register1 - 1
            let t0 = 10
      end if

      if io.register1 < 0       'restart when counter reaches zero
            let io.register1 = 10
      end if
loop
end
```

Counter Variables

The input counter can be read in BASIC scripts. Below is an example assuming the name for input 1 is left at the default.

io.digitalIO1.count 'digital I/O 1 counter

Example:

```
If io.digitalIO1.count > 5000 Then     'If digital I/O counter 1 is greater
than 5000 then
      Let io.digitalIO2 = 1     'turn digital I/O 2 on
End If
```

Analog Variables

The analog input scaled values can be read in BASIC scripts. Below is an example assuming the name for analog input 1 is left at the default.

io.analogInput1 'analog input 1

Example:

```
If io.analogInput1 > 4 Then      'If Analog Input 1 is greater than 4 then
      Let io.digitalIO1 = 2            'Pulse output 1, otherwise
Else
      Let io.digitalIO1 = 0            'output1 will be off
End If
```

Temperature/Humidity Sensor Variables

Each temperature sensor or humidity sensor can be read in BASIC scripts. Below is an example assuming the name for the 1-Wire sensor is left at the default.

io.oneWire1 'temp or humidity sensor 1

Example:

```
If io.oneWire1 >= 80 Then        'If temperature sensor reads greater than 80
                                 ' degrees, then
  Let io.digitalIO2 = 1          'Turn on digital I/O 2
```

```
            End If
```

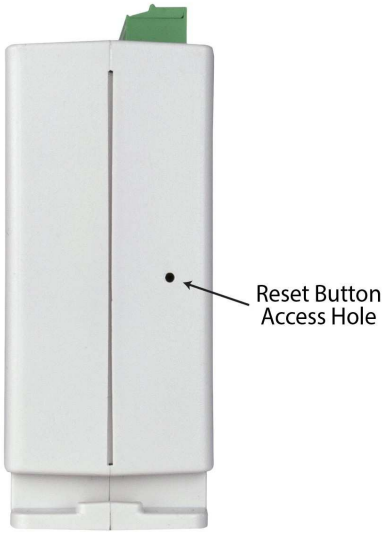
Appendix A: Restoring Factory Default Settings

In the event that the IP address or passwords are forgotten, the X-420 may be restored to its original factory default settings.

1. Remove the DC power from the unit.
2. Use a thin, non-conductive object (such as a toothpick) to press and hold the small button located on the bottom of the unit. When the object is inserted, a tactile feedback can be felt as the button is depressed.

   CAUTION: Do not use metal objects for this function

3. While depressing the button, apply power and wait for about 10 seconds before releasing the button. All settings will be back to the original factory defaults. log.txt and syslog.txt are retained.
4. Refer to *Section 2.6: Establishing Communications for Setup* to begin reconfiguration of the X-420.



Appendix B: Installing New Firmware

From time to time, updates are made to the X-420 firmware. Unlike many consumer products, firmware updates are recommended only on an as-needed basis. The firmware can be updated in the field. The procedure for updating the firmware is outlined below. Please note that it is important that this procedure is followed precisely.

Requirements

The firmware update software requires Windows 7/8/10 with the .Net framework installed. The .Net framework is generally installed automatically through Windows update. To install it manually, go to the following address:

http://www.microsoft.com/downloads/details.aspx?FamilyId=333325FD-AE52-4E35-B531-508D977D32A6&displaylang=en

Select the Download button. Once you've downloaded the installation file, double-click on the installation file to install the framework.

Setup

1. Contact technical support if a firmware update is needed and a download link will be provided. Only an X-420 image can be installed on the X-420 so make sure the correct image is being downloaded.
2. bootloader.exe will connect to the X-420 using default IP address 192.168.1.2, not the address currently assigned to the X-420. After the update, all settings will be lost and the device will return to its default IP address of 192.168.1.2.

   Configure the PC to the same subnet as the IP address 192.168.1.2, such as 192.168.1.10. For instructions on doing this, see *Section Establishing Communications for Setup*.

   Note: The IP address of the X-420 will automatically be set to the default 192.168.1.2 during the update process. Since the X-420 supports auto negotiation, a crossover cable is not necessary.

3. Open the bootloader.exe utility on the computer by double clicking on the downloaded file.
4. Within the ControlByWeb™ Programmer utility programmer, select File, then Open. Specify the firmware image downloaded from the ControlByWeb™ web site.

Device Upgrade Procedure

Carefully follow the following steps to put the X-420 into bootloader mode and perform the upgrade:

1. Remove DC power from the X-420.
2. Using a small, non-conductive tool, press and hold the reset button.
3. While holding the reset button, apply power to the X-420. The LINK and ACT lights will flash. Continue to hold the reset button for the next step.
4. While holding the reset button, press the Upload Firmware button at the bottom of the ControlByWeb™ Programmer window. After the programming process begins, the reset button can be released.
5. Programming will take approximately 60 seconds, the LINK LED will stop flashing and remain lit. The X-420 will be set to factory defaults with an IP address of 192.168.1.2.
6. Refer to S*ection Establishing Communications for Setup* to reconfigure the X-420. Verify the new version of firmware has been installed by viewing the default setup page with a web browser (http://192.168.1.2/setup.html).

Appendix C: Accessing the X-420 Over the Internet

The X-420 can be monitored and/or controlled from a remote location over the Internet. Once the X-420 can be accessed on the local network, almost all of the settings required to provide remote access are in the router and not in the X-420.

This guide is not meant to be a tutorial in router setup, but rather to provide a basic overview of remote access. For specific details, the user should refer to the instruction manual for the router on the local network. Users not familiar with basic IP networking should study one or more basic IP networking tutorials before proceeding (many tutorials are available on the Internet).

IP Addresses

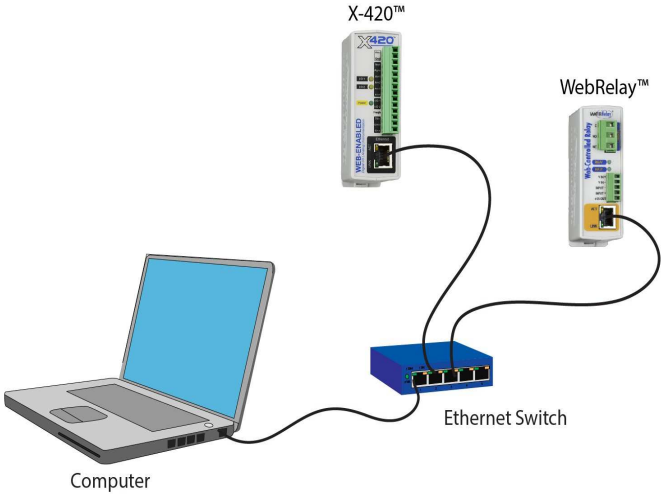
Every device on the Internet is identified by a unique address called an IP (Internet Protocol) address. IP addresses are somewhat similar to mailing addresses in that they identify the precise logical location of the device on the Internet. The IP address identifies the global region down to the network and then the specific device on that network. IP addresses are globally maintained and assigned by an entity called the Internet Assigned Numbers Authority (IANA). IP addresses consist of four sets of numbers that range from 0 to 255 and are separated by a decimal. For example, 192.168.200.167 is an IP address.

Every device that is “directly” connected to the Internet uses a “public” IP address. The X-420 can be assigned a public IP address for direct connection to the Internet. Typically, a public IP address would only be assigned to the X-420 when it is the only device on the local network. The IP address would be obtained from an Internet Service Provider (ISP).

Due to the limited number of public IP addresses, private networks can be set up with “private” IP addresses. These addresses are used within a local network and have no global designation, they are not routed on the Internet. The following address blocks are designated for private networks (where x represents decimal numbers from 0 to 255): 192.168.x.x, 10.x.x.x, and 172.16.x.x.

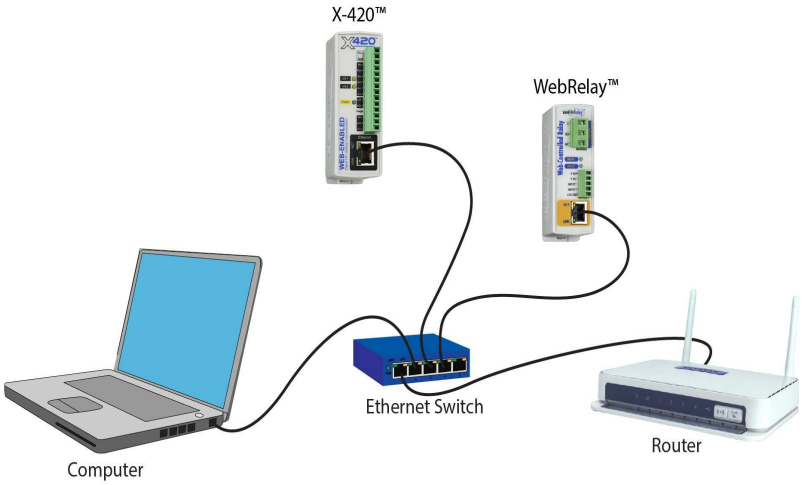
A Simple Local Area Network

A small Local Area Network (LAN), can be made up of two or more computers or other devices connected to an Ethernet switch. Each device on the network is assigned a unique private IP address. For example, consider a simple network that consists of a computer, an X-420, and a WebRelay™. In this example, the computer is assigned an IP address of 192.168.1.10, the X-420 has the IP address of 192.168.1.25 and a WebRelay™ has and IP address of 192.168.1.26. A person using the computer can access the X-420 by entering its IP address in the URL line in the browser, http://192.168.1.25. Similarly, the WebRelay™ can be accessed by entering its unique private IP address in the URL line in the browser, http://192.168.1.26.



A Simple LAN connected to the Internet

The LAN in the example above can be connected to the Internet by adding a router and an Internet connection. The router has two network connections. It has an Ethernet network connection to the LAN and another connection to the Internet. Often the Internet connection is called a Wide Area Network (WAN) connection. Each network connection on the router has an IP address. In our example, the IP address on the LAN side of the router has an address of 192.168.1.1. The IP address on the WAN side of the router has an IP address that has been assigned by the Internet Service Provider, such as 203.0.113.254.



In the example, when a user on the computer needs to access a server on the Internet, the computer sends the request to the router at 192.168.1.1. The router sends the request to the ISP server on the Internet. The ISP server does not send the response directly to the computer on the LAN, but to the router at the IP address of 203.0.113.254. The router then forwards the response to the computer. This way, all devices on the LAN share a single public IP address. This is called Network Address Translation (NAT).

Port Forwarding

The router can be configured to allow outside access to the X-420 and WebRelay™. All requests from the Internet to any device on the local network must use the public IP address (203.0.113.254). With only a single IP address, TCP ports are used to identify the intended device for the incoming message.

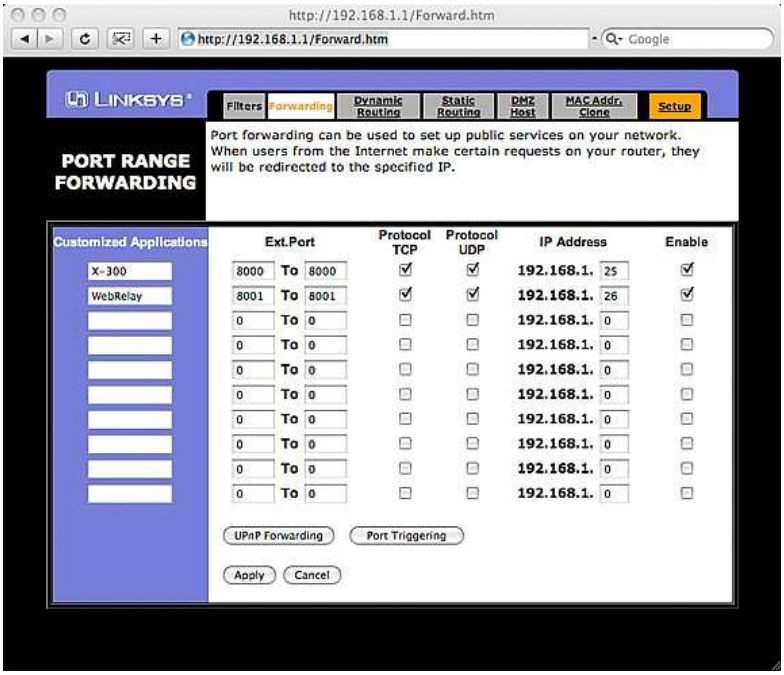
Using the mailing address analogy, the port is similar to a post office box. The IP address specifies the location, and the port specifies the specific recipient. Port numbers can be set to any number between 1 and 65535. However, many port numbers are reserved for specific applications and should be avoided. As a general rule, numbers above 8000 are safe to use. All of the ControlByWeb™ products come from the factory with the HTTP port set to 80, which is the standard port for HTTP. In this example, the X-420 HTTP port will be changed to port 8000 and WebRelay™ port will be changed to 8001. Once the ports are changed in the two ControlByWeb™ devices, the router must be set up for port forwarding.

Port forwarding associates the IP address of each local device with an assigned port. In this example, the address 192.168.1.25 for the X-420 would be associated with port 8000. The address 192.168.1.26 for WebRelay™ would be associated with port 8001. The X-420 would be accessed from the Internet by entering the public IP address of the router, plus the port number assigned to the X-420 in the URL window of the browser, http://203.0.113.254:8000. All Internet requests to the router for port 8000 would be forwarded to the X-420. Similarly, all request for port 8001 would be forwarded to WebRelay.

Note: When an HTTP request comes in to the router without the specific port specified (http://203.0.113.254), the router will handle this as a port 80 request (default HTTP port). In other words, http:// 203.0.113.254 is exactly the same as http://203.0.113.254:80.

Router configuration can vary widely. Some routers have the capability of translating the addresses and the ports, which would require no port configuration change on the WebRelay. For example, the router would be configured so that messages sent to http://203.0.113.254:8000 would be forwarded to http://203.0.113.254:80, which is the default HTTP port.

An example screen shot of a router configuration is given below. This setup allows the two ControlByWeb™ products in the above example to be accessed remotely from the Internet.



Example of Port Range Forwarding

Note: This screen shot is simply an example of a typical router setup page. Routers will vary.

Accessing Setup Pages

After changing ports, the setup pages are accessed on a local network as described below:

```
http://(Local IP Address):(Port Number)/setup.html
```

For example, to access the setup pages when the port is set to 8000, the following command would be used:

```
http://192.168.1.25:8000/setup.html
```

To access the ControlByWeb™ units from the Internet, enter the public IP address of the router plus the port number of the desired device in the following format:

```
http://(Public IP Address of Router):(Port Number of Device)/setup.html
```

Using the example above, the following line would be used to access the setup page of the X-420:

```
http://203.0.113.254:8000/setup.html
```

Appendix D: Specifications

Power Requirements

Input Voltage:

Model X-420-I:	9-28 VDC
Model X-420-E:	Power Over Ethernet and/or 9-28VDC. 48V injected into Ethernet Line as per 802.3af specification. POE Class 1 (0.44Watt to 3.84Watt range)

Input Current: See table below for typical values at 25°C, 2-Digital I/O=On, no 1-Wire sensors

Power Supply	Input Current
9 VDC	175 mA
12 VDC	135 mA
24 VDC	75 mA

I/O Connector

14-position, removable terminal strip, 3.81 mm spacing
(replacement part number, Phoenix Contact 1803691)

Analog Data Acquisition System:

Number of channels:	4
Type:	16-bit, SAR
Mode:	Single ended, differential, 4-20mA (0-20mA)
Input Range (programmable):	±1.28V, ±2.56V, ±5.12V, ±10.24V, ±20.48V (differential)
Max Input Voltage Range (Vin):	-12.5V < Vin < +12.5V
Input Impedance (Zin):	>500Meg Ohm
Channel Off Leakage:	±0.6nA (typ)
Input Common Mode Rejection:	>100dB
Total Unadjusted Error:	-9LSB (min), +9LSB (max)
Voltage Reference Drift:	±5 ppm/°C
Internal 4-20mA input shunt:	200.0-ohm, ±0.1%, 25ppm (uses ±5.12V range)
Logging Rate:	25 Hz

Digital Input/Output:

Number of Digital I/O:	2, each programmable as an input or output
Pull-up/Pull-down Resistor:	47K

Vih (high-level input voltage):	3.5V min
Vil (low-level input voltage):	1.5V max
Vout:	5V CMOS logic thru a 49.9-ohm resistor
Debounce:	Configurable, 0 to 250mS
Pulse Counters:	2ea, 24-bit
Max Counter Frequency Input:	200Hz

Frequency Input

Type:	AC coupled, sine or square wave (works with millivolt magnetic wind speed sensors)
Input Voltage:	20Vpp max
Hysteresis:	25mV
Frequency:	0-2500HZ
Vin @ 1 Hz	50mVpp min
Vin @ 10 Hz	50mVpp min
Vin @ 100 Hz	60mVpp min
Vin @ 1 kHz	80mVpp min
Vin @ 10 kHz	700mVpp min
Vin @ 20 kHz	1.7Vpp min

1-Wire Sensor Input

+5Vout Output:	5.0V, 100mA max
Maximum number of sensors:	16
Maximum cable length:	600 feet (180m) maximum combined cable length
Compatible with Maxim (Dallas) Semiconductor DS18B20 digital 1-Wire thermometer	
Compatible with X-DTHS-P (temperature/humidity), X-TC1W-K (thermocouple) and other supported digital 1-Wire sensors	
Sensors are interchangeable, no calibration needed	

Network

10 Base-T or 100 Base-T Ethernet IPv4 (10 Mbit/s or 100 Mbit/s)
Static IP address assignment or DHCP
HTTP port selectable
HTTPS port selectable
Standard 8-pin RJ-45 modular socket, with auto-negotiation
Supports Encrypted Web Browser (HTTP/HTTPS), Modbus/TCP, SNMP V1,2C,V3 protocols

LED Indicators (11)

Power	Green
Digital I/O (1-2)	Yellow
Network Linked	Green
Network Activity	Yellow

Email Alerts

Email Addresses:	Configurable, up to 8 addresses
Encrypted Email Alerts:	STARTTLS and TLSL/SSL
Status Alerts:	Inputs, temperatures, 1-Wire sensors, digital I/O, etc.
Other Alerts:	Alert logic is fully customizable

Real-Time Clock

Manual or NTP (Network Time Protocol) setup
NTP Sync configurable for once, daily, weekly, or on power-up
Automatic daylight savings adjustment
Battery (capacitor) backup: 2-weeks min, supports real-time clock and 1 register

Nonvolatile Memory

Flash Memory
All user settings are stored in nonvolatile memory. Settings will not be lost when power is disconnected.

Logging

Stored in Nonvolatile Flash
Circular Buffer
3072-Kbyte (up to 50688 log entries depending on configuration)
Unlimited data storage possible through sending the log through email or FTP services.

Password Settings

Password protection for *Administrators* (setup pages)
Optional password protection for *Managers*
Optional password protection for *Users* (control page)
Base 64 Password Encoding
Password Length: 18 character, case sensitive

Scripts

Implement special or custom features with a BASIC script
Max size : 4-Kbytes

Environmental

Operating Temperature:	-40ºC to 65.5ºC (-40ºF to 150ºF)
Storage Temperature:	-40ºC to 85ºC (-40ºF to 185ºF)
Altitude:	up to 2000m
Humidity:	5-95% non-condensing

Mechanical

Size: 1.41 x 3.88 x 3.1 in. (35.7 x 98.5 x 78 mm), not including connector
Weight: 5 oz (142 g)

Electromagnetic Compliance

IEC CISPR 22, CISPR 24
EU EN55024, EN55022
X-420-I: FCC 47CFR15 (Class B)
X-420-E: FCC 47CFR15 (Class A)

Product Safety Compliance

UL 61010-1 (Electrical Equipment for Measurement, Control, and Laboratory Use)

Appendix E: Trademark and Copyright Information

Appendix F: Warranty

This Xytronix Research & Design, Inc. product is warrantied against defects in material and workmanship for a period of five years from the date of shipment. During the warranty period, Xytronix Research & Design, Inc. will, at its option, either repair or replace products that prove to be defective. This warranty is extended to the original purchaser of the equipment only.

For warranty service or repair, customer must contact Xytronix Research & Design, Inc. technical support (support@ControlByWeb.com) and obtain a Return Authorization number (RA#). Before issuing an RA#, a support technician will work with customer to try to resolve the issue without returning the product. If technician determines that product must be returned for service an RA# will be issued. Next, the product must be properly packaged and returned to Xytronix Research & Design, Inc. with the RA# clearly marked on the package. The purchaser shall prepay all charges for shipping to Xytronix Research & Design, Inc. For warranty repairs of products less than one year old, Xytronix Research & Design, Inc. will pay the shipping charges to return the product to the purchaser as long as the product is shipped within the continental United States. If the product is shipped outside of the continental United States or the product was shipped more than one year earlier, the purchaser shall pay all shipping charges both ways.

Limitation

The foregoing warranty shall not apply to defects or damage resulting from improper use or misuse, unauthorized repair, tampering, modification, improper connection, or operation outside the electrical/environmental specifications for the product. Further, the warranty does not cover damage from Acts of God, such as lightning, fire, flood, hurricanes and tornadoes. This warranty does not cover damage to property, equipment, direct, indirect, consequential, or incidental damage (including damage for loss of business profit, business interruption, loss of data, and the like) arising out of the use or misuse of this product.

UNDER NO CIRCUMSTANCES WILL THE LIABILITY OF XYTRONIX RESEARCH & DESIGN, INC. TO THE PURCHASER OR ANY OTHER PARTY EXCEED THE ORIGINAL PURCHASE PRICE OF THE PRODUCT, REGARDLESS OF THE FORM OF THE CLAIM. No other warranty is expressed or implied. Xytronix Research & Design, Inc. specifically disclaims the implied warranties or merchantability and fitness for a particular purpose. Some jurisdictions may not allow the exclusion of limitation of liability for consequential or incidental damage.

Appendix G: FCC Statement

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.
2. This device must accept any interference received, including interference that may cause undesired operation.

Warning

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 in-stalled 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 a relay on a circuit different from where the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Notice

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

Appendix H: Licensing

The webpages on the X-420 use javascript libraries that contain permissive free software licenses such as MIT and BSD 3-Clause. The licenses and copyrights are included directly in the source for setup.html on the X-420.

The firmware included in this product also contains copyrighted software that is licensed under various permissive free software licenses.

mbedtls - Copyright (C) 2006-2015, ARM Limited, All Rights Reserved
License: Apache-2.0
http://www.apache.org/licenses/LICENSE-2.0

lwIP - Copyright (c) 2001-2004 Swedish Institute of Computer Science.
All rights reserved.

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3. The name of the author may not be used to endorse or promote products derived from this software without specific prior written permission.

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OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Appendix I: Mechanical Dimensions

A 3D-CAD model of the X-420 is also available at https://www.controlbyweb.com/x420/x-420_3d.stp