X-300

User's Manual

Revision 1.5

daq data acquisition series 3

Web Enabled
Thermostat
Thermometer
Alarm/Logger

CONTROL by WEB™

www.ControlByWeb.com

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

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    Xytronix Research & Design, Inc.

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This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- 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. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause interference to radio communications. There is no guarantee, however, 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.

Xytronix Research & Design, Inc.

Installation Guidelines (Read Before Installing)

- This unit must be installed by qualified personnel.
- This unit must not be installed directly outdoors.
- 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.

Security Notes

X-300™ does not employ a general purpose computer operating system and does not have features, such as telnet, FTP, SSH, nor uncontrolled open ports. This means it is unlikely for someone to 'break in' to X-300™ and access other devices on your local network. The simplicity of X-300™ makes it a inherently secure device. Nevertheless, as with any device installed on a network, appropriate security precautions should be observed.

If X-300™ is installed on the Internet, it is recommended that passwords be enabled for the **Control Page**. Passwords should be at least 8 characters in length and use a combination of upper and lower case letters and numbers. For additional security, a firewall may be used to limit access to selected IP addresses. Another option may be to set up a Virtual Private Network (VPN) between the network where X-300™ resides and the client machine (web browser, another, ControlByWeb™ product, etc.).

Final Installation Notes

This ControlByWeb™ product supports connection to *10 Mbps* and *100 Mbps* networks. Although *100 Mbps* networks are faster, the amount of data transferred to and from this device is very minimal and little, if any, performance increase will be gained by setting it to *100 Mbps*. There are advantages, however, to operate this device at *10 Mbps*. At *10 Mbps*, less power is required, the unit runs cooler, and the lifetime of the product will be extended.

Any changes to the Ethernet settings will require removing and re-applying power to X-300™.

Section 1: Introduction

X-300™ is a powerful web-based instrument for remote temperature measurement, equipment control, and logging. The device communicates directly through an Ethernet connection to any web browser, no additional software, drivers, or servers are needed.

X-300™ has two operating modes (instructions to change modes found on p. 43). In the Temperature Monitor mode, up to eight temperature or humidity sensors can be connected. Output relay states may be configured to turn on or off, based on temperature set points from any one of the sensors. Email messages can also be triggered by temperature events.

Applications may include irrigation control, HVAC operation, process monitoring and control.

Web Thermostat

In addition, X-300™ can be field configured as a full-featured, single stage thermostat. The web browser control page changes to emulates the look and feel of an electronic thermostat.

In Thermostat mode, two temperature and one humidity sensor can be used to measure indoor and out door conditions. A 7-day schedule can be customized to optimize HVAC operation.
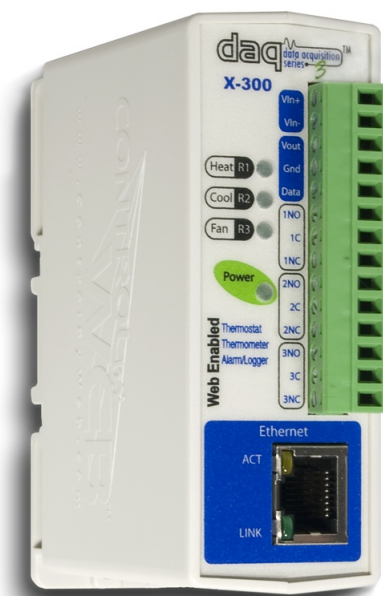
Figure 1.1a - X-300

1.1 X-300™ Features

Operating Modes

Select between general purpose Temperature Monitor Mode or Thermostat Mode.
Thermostat mode is an web-accessible, programmable thermostat.

Relay Outputs

Automatic/manual control of 28VAC/24VDC, 5A loads with on-board relays such as HVAC systems.

Temperature and Humidity Sensor

Monitor any combination of up to 8 temperature or humidity sensors in Temperature Monitor mode.
Thermostat Mode supports 1 indoor temp, 1 outdoor temp, and 1 humidity sensors.
Run sensors up to 600 ft away.

User Interface

Web-browser user interface; no software required.
Configure with simple drop-down list, radio buttons, and text boxes.

Network

Manually configured static IP address or with DHCP.
Supports Simple Network Management Protocol (SNMP).
Supports Modbus/TCP as slave device.
Remote Services options allows X-300™ to initiate connection to external servers.

Real-Time Clock

Built-In Real Time Clock for logging and scheduled temperature changes.
Capacitor backup power keeps time for days during power failure.

Scheduling

Full 7-day programmable schedule in Thermostat Mode.

Logging

Configurable event and time-based logging of temperature and relay status.

BASIC Script

BASIC script support for advanced automation and control.

Email Notification

Web-Based Temperature Monitoring with Email Alerts and Alarms.

System

Wide operating temperature range.
Internal temperature and voltage monitoring for diagnostics.
Removable terminal connector for convenient wiring.
Compact, DIN-Rail or wall mountable enclosure.
Field upgradable firmware.

1.2 Applications

This section briefly describes some of the applications for the X-300™, illustrates connections for those applications, and provides key configuration settings.

Before installing the X-300™, please read **Section 2: Installation and Setup.**

Note: Some examples require that the temperature sensors be mounted in harsh environments, such as outdoors or in water. For those applications, the submersible X-DTS-S12 or sensors that are properly protected should be used.

1.2.1 Temperature Monitoring, Logging, and Alarming

The X-300™ can be used as a simple web-enabled thermometer for conveniently viewing temperatures on a computer or web-enabled mobile telephone. This is useful for viewing the temperatures of living spaces, outdoors, refrigeration systems, tanks, or pipes.

Temperatures can be configured to log data to internal memory on a scheduled or event-driven trigger. Email alerts (or indirectly, text messages) can be sent directly by X-300™ when programmable temperature thresholds are crossed.

X-300™ can communicate directly with a custom computer application which can read the temperature data from the X-300™ for process control or other functionality.

Temperature Monitoring

Applications

- Single or multi-point thermometer
- Temperature monitoring of living spaces, outdoors, refrigeration systems, or process control with email alerts and public alarms.
- Ethernet based data acquisition systems

Connection Requirements (Figure 1.2a)

- DC power, network, and temperature sensors. See **Section 2.2.2** for notes about connecting multiple sensors.

Software Configuration

- Mode:**Temperature Monitor**
- Settings: Connect first temperature sensor (Under Sensors tab).
    • Set *Sensor* to *Sensor 1*
    • Set *Sensor Address* to address of connected temperature sensor
- Connect additional sensors one an a time, selecting the next sensor number and associating it with the new address in the list.
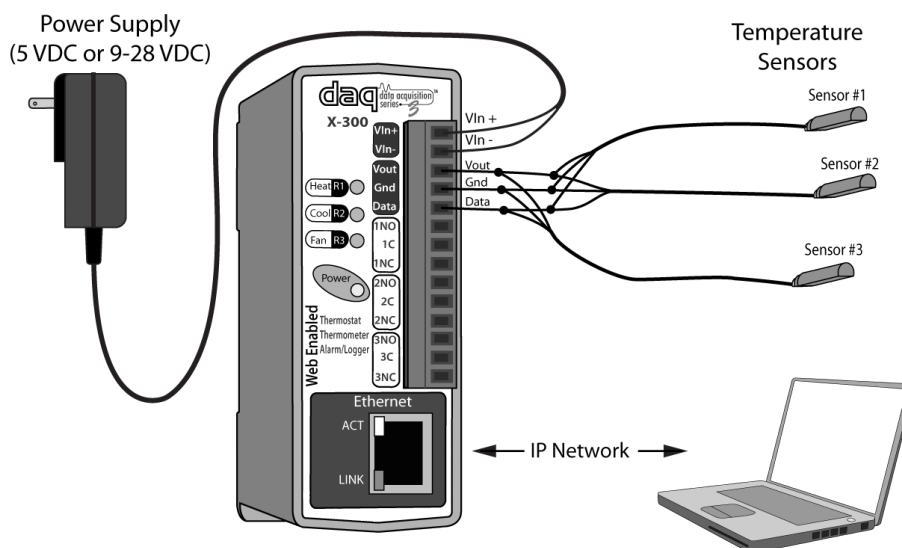
Figure 1.2a - Temperature Monitoring with Multiple Sensors

Temperature Monitoring with Alarm

This example illustrates how the X-300™ can be used to monitor temperatures, plus provide an alarm for extreme temperatures. The alarm illustrated is a bell, however this could be any audio device, a light in a control panel or flashing alert lamp, or a functional device such as a fan, heater, or valve.

Applications

- Refrigeration system high temperature alarm
- Freezing pipe alarm
- HVAC system failure alarm

Connection Requirements (Figure 1.2b)

- DC power, network connection, and temperature sensor.
- Connect alarm (bell, light, etc) to relay contacts.

Basic Configuration

- Mode: *Temperature Monitor*
- Settings: See **Section 2.2.2** for connecting temperature sensors.
- Under the **Sensors** tab, set *Alarm 1* to desired temperature where relay should turn on.
  • Specify *High* or *Low* value for Alarm 1.
  • Set *Deadband* to appropriate value.
  • Set *Relay 1 Action* to *Turn On* when *Alarm 1*.
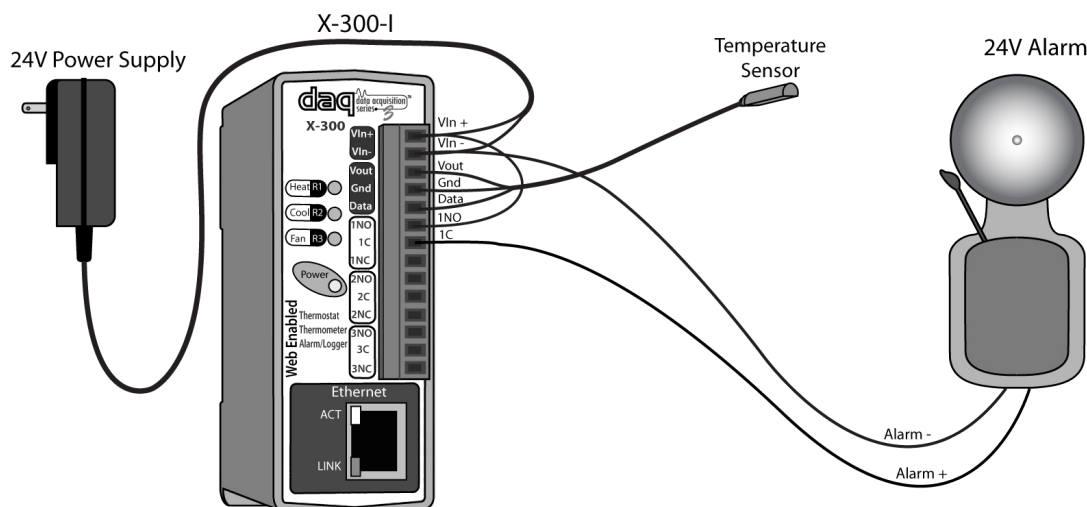
Figure 1.2b - Temperature Monitoring with Alarm

Temperature Monitoring with Remote Alarm

This example illustrates how the X-300™ can be used to monitor temperatures, plus provide an alarm for extreme temperatures. This is similar to the example described in the previous section, but differs in that the alarm indicator (bell, light, etc.) is located at another location.

Applications

- Refrigeration system high temperature alarm
- Freezing pipe alarm
- HVAC system failure alarm

Connection Requirements (Figure 1.2c)

- DC power, network and temperature sensor.
- Another WebRelay™ setup at a remote location.
- Connect alarm (bell, light, etc) to relay contacts of the remote WebRelay™.

Software Configuration

- Mode: *Temperature Monitor*
- Settings under **Sensors** tab in the X-300™ setup pages:
    • Set *Alarm 1* to desired temperature where alarm should turn on.
    • Specify *High* or *Low* value for *Alarm 1*.
    • Set *Deadband* to appropriate value.
    • Set *Remote Relay 1 Action* to *Turn On* when *Alarm 1*.
- Under **Relays** tab in the X-300™ setup pages:
    • Set *Relay* field to *Remote Relay 1*.
    • Set *IP Address*, *TCP Port*, *Password*, *Relay #*, and *Periodic State Interval* corresponding to the Remote Device.
    • Configure remote device settings as required.
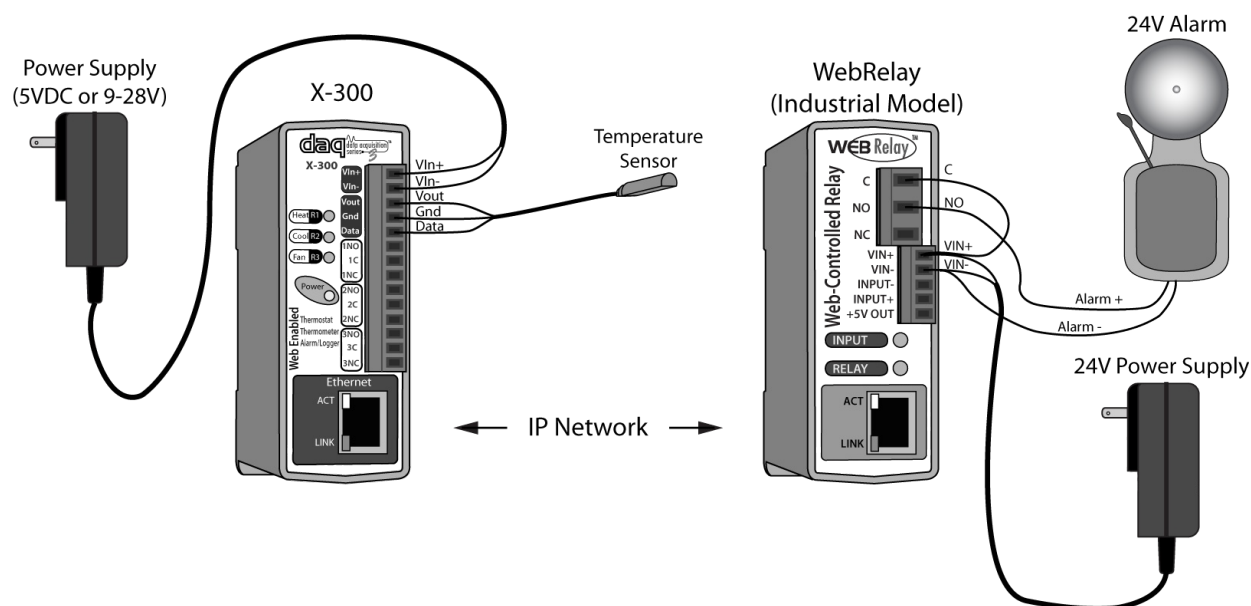
Figure 1.2c - Temperature Monitoring with Remote Alarm

1.2.2 Stand-Alone Web Thermostat

X-300™ has two operating modes that can be configured in the field, Temperature Monitor and Thermostat modes. **Sections 1.2.2** and **1.2.3** describe applications for the web-enabled thermostat mode.

X-300™ can be used as a thermostat to control HVAC (Heating, Ventilation, and Air Conditioning) systems. The web browser interface allows users to access the thermostat from anywhere in the building or over the Internet. This is also limits access to only authorized users.

The thermostat **Control Page** (web page) looks like a professional grade thermostat and includes: indoor temperature, set temperature, outdoor temperature (if connected), high and low outdoor temperatures for current and previous days (if connected), current humidity (if connected), and other basic information. The user can adjust the set temperature from the **Control Page**.

X-300™ also offers a seven day schedule and logging. Logging enables users to track the run time of the HVAC system at a given set temperature. Indoor and outdoor temperatures can also be included. With this information, users can make adjustments to scheduled set temperatures for energy savings.

Heat-Only System, Stand-Alone Thermostat

Applications

- Thermostat for single-stage heating systems.

Connection Requirements (1.2d)

- Power, network, and indoor temperature sensor. Outdoor temperature sensor is optional.
- Connect heating signal (W) to the normally open terminal of Relay 1 and power (R) to the common contact of Relay 1. Whenever the thermostat calls for heat, Relay 1 is turned on.
- If a separate fan connection is required, connect Relay 3 common to power (R) and the normally open terminal to the fan control (W).

Software Configuration

- Mode: *Thermostat*
- Settings under *Thermostat Setup* tab:
  - Set *Indoor Air Sensor* to corresponding temperature sensor.
  - Set *Outdoor Sensor* to corresponding sensor (as needed).
  - Set *Humidity Sensor* to corresponding sensor (as needed).
  - Set *Fan On with Heat* as required. See **Section 2.4.7** for more information.
- On Thermostat View Page:
  - Set **Heat Mode** to **Heat**.
  - Set **Fan Mode** to **Auto**.
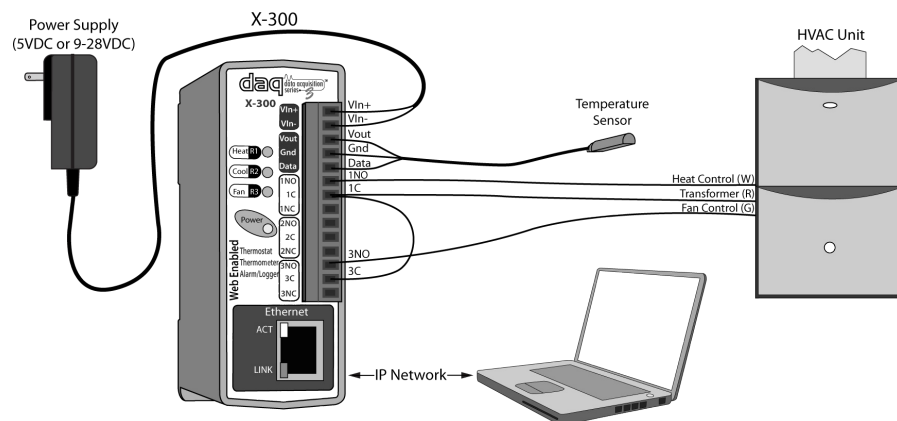
Figure 1.2d - Stand-Alone Thermostat for Heat-Only Systems

Cool-Only System, Stand-alone Thermostat

Applications

- Thermostat for single-stage cooling systems.

Connection Requirements (Figure 1.2e)

- Power, network and indoor temperature sensor. Outdoor temperature sensor is optional.
- The cooling system power (RC) should connect to Relay 2 common and the cooling signal (Y) to normally open contacts of Relay 2
- The fan control power (RC) is connected to the common of Relay 3 and the fan signal (G) to normally open contacts of Relay 3. Relays 2 and 3 are turned on when the thermostat calls for cool and fan.

Software Configurations

- Mode: *Thermostat*
- Settings under **Thermostat Setup** tab:
  - Set *Indoor Air Sensor* to corresponding temperature sensor.
  - Set *Outdoor Sensor* (optional) to corresponding sensor.
  - Set *Humidity Sensor* (optional) to corresponding sensor.
- On Thermostat View Page:
  - Set *Heat Mode* to *Cool*.
  - Set *Fan Mode* to *Auto*.
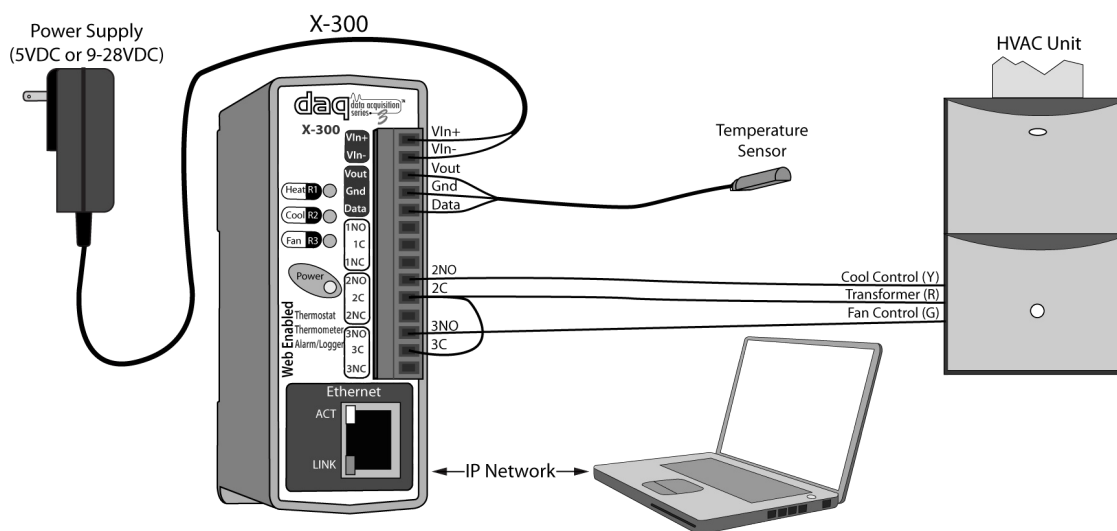
Figure 1.2e- Stand-Alone Thermostat for Cool-Only System

Heat and Cool System, Stand-Alone Thermostat

Applications

- Thermostat for single-stage heating and cooling systems.

Connection Requirements (Figure 1.2f)

Note: The following is for HVAC systems that share a common power supply for both heating and cooling applications; RC and RH are tied together either at the thermostat or in the HVAC equipment.

- DC Power, network, indoor temperature sensor, outdoor temperature sensor (optional).

- Connect heating signal (W) to the normally open terminal of Relay 1 and power (RH/RC) to the common contact of Relay 1. Whenever the thermostat calls for heat, Relay 1 is turned on.

- If a separate fan connection is required, connect Relay 3 common to power (RH/RC) and the normally open terminal to the fan control (W).

- Connect the cooling system power (RH/RC) to Relay 2 common and the cooling signal (Y) to normally open contacts of Relay 2

- The fan control power, (RH/RC) is connected to the common or Relay 3 and the fan signal (G) to normally open contacts of Relay 3. Relays 2 and 3 are turned on when the thermostat calls for cool and fan.

Software Configuration

- Mode: **Thermostat**
- Settings under **Thermostat Setup** tab:
    - Set **Indoor Air Sensor** to corresponding temperature sensor
    - Set **Outdoor Sensor** (optional) to corresponding sensor.
    - Set **Humidity Sensor** (optional) to corresponding sensor.
    - Set **Fan On with Heat** as required. See **Section 2.4.7** for more information.
- On Thermostat View Page:
    - Set **Heat Mode** to **Auto**.
   - Set **Fan Mode** to **Auto**.
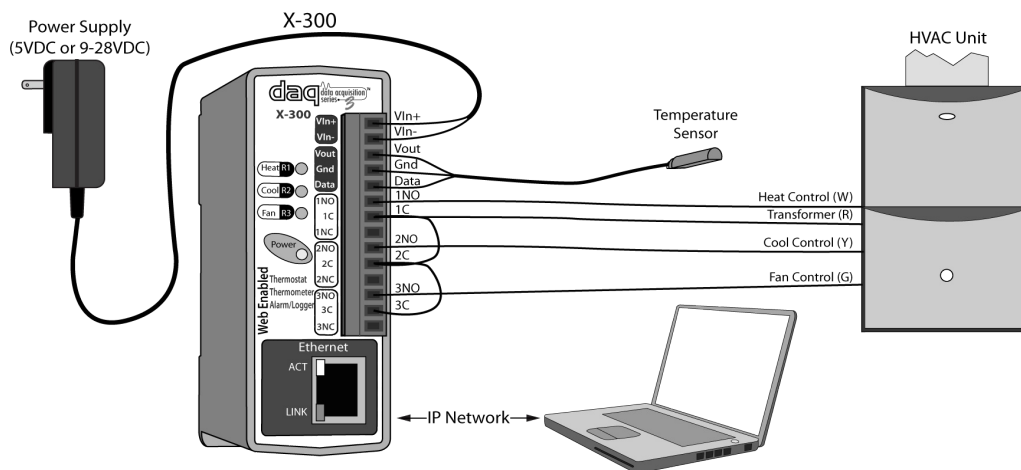
Figure 1.2g - Stand-Alone Thermostat for Heat/Cool System

Heat and Cool System with Separate Transformers, Stand-Alone Thermostat

Many HVAC systems use a single transformer for both heat and cool. In some cases, however, the heating system and cooling system are isolated and use separate transformers for each system. The X-300™ relay contacts are internally isolated so connection to separate systems is safe.

Applications

- Thermostat for single-stage heating and cooling systems.

Connection Requirements (Figure 1.2f)

- Power, network and indoor temperature sensor. Outdoor temperature sensor is optional.

- Connect heating system to the common and normally open contacts of Relay 1.

- Connect cooling system to the common and normally open contacts of Relay 2 and the fan to the common and normally open contacts of Relay 3.

Note: If a separate red wire is used for the heating system and the cooling system. The fan is typically tied to the transformer of the cooling system, but this should be verified with the HVAC equipment instruction manual.

Software Configuration

- Mode: *Thermostat*
- Settings under **Thermostat Setup** tab:
    • Set *Indoor Air Sensor* to corresponding temperature sensor.
    • Set *Outdoor Sensor* (optional) to corresponding sensor.
    • Set *Fan On With Heat* as required. See **Section 2.4.7** for more information.
- On **Thermostat View** page:
   • Set *Heat Mode* to *Auto*.
    • Set *Fan Mode* to *Auto*.
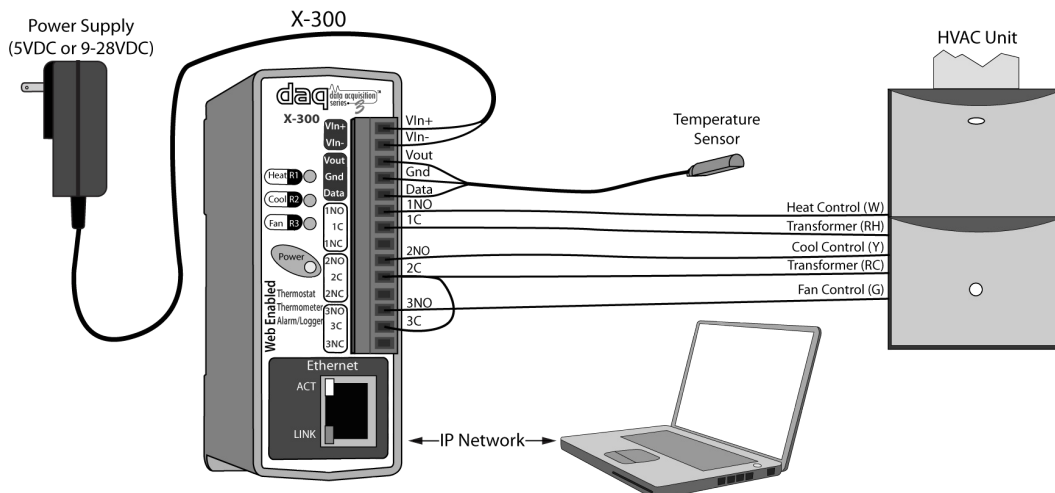
Figure 1.2f - Stand-Alone Thermostat for Heat/Cool System with Separate Transformers

1.2.3 X-300™ as Second Thermostat

Although the applications below are for a thermostat, the X-300™ is used in **Temperature Monitor** mode in order to take advantage of additional functionality in this mode.

In situations where local control of the thermostat is desired, X-300™ can be used in conjunction with a conventional wall-mount thermostat. X-300™ may be configured to over-ride local control or add functionality for remote control. Some typical applications are described in the following sub-sections.

X-300™ Holds Minimum Temperature and Override

X-300™ can be used to take control of the temperature when a building is unoccupied. Users can remotely disable the local thermostat and enable the X-300™. In this case, the X-300™ is configured to maintain a lower temperature. This saves energy and prevents pipes from freezing.

Applications

- Vacation Homes and spaces that are often unoccupied.

Connection Requirements (Figure 1.2g)

- Power, network, and indoor temperature sensor.

- The white wire (heat) of the HVAC system is connected to the Common contact of Relay 3.

- The NC of relay 3 is connected to the local thermostat (white wire connection).

- The normally open of Relay 3 is connected to the normally open contact of relay 1.

- The Common contact of Relay 1 is connected to the red wire. Relay 3 is used to select which thermostat has control of the heat. When the X-300TM has control of the heat, Relay 1 is used to control the temperature.

Software Configuration

- Mode: **Temperature Monitor**
- Settings under the **Sensors** tab:
    - Connect and setup temperature sensors.
    - Enter temperature set point into **Alarm 1** field. This will be the low temperature setting when unoccupied.
    - Specify **Alarm 1** to a **Low** alarm.
    - Set **Relay 1 Action** to **Turn On** when **Alarm 1**.
- Under **Relays** tab:
    - Set **Relay** to **Relay 1**.
    - Label **On Status Text** as `HEAT ON` and **Off Status Text** as `HEAT OFF`.
    - Set **Relay** to **Relay 3**.
    - Label **On Button Label** as `X-300` and **Off Button Label** as `Local`.
    - Label **On Status Text** as `X-300` and **Off Status Text** as `Local`.
- Under **Control Page Setup** tab:
    - Check the following for **Display Configuration**: **Sensor1**, **Relay1**, **Relay3**, and uncheck all others.
    - Check **Relay3** for **Display On/Off Buttons**. Uncheck all others boxes.
    - Uncheck everything under **Display Pulse Button**.
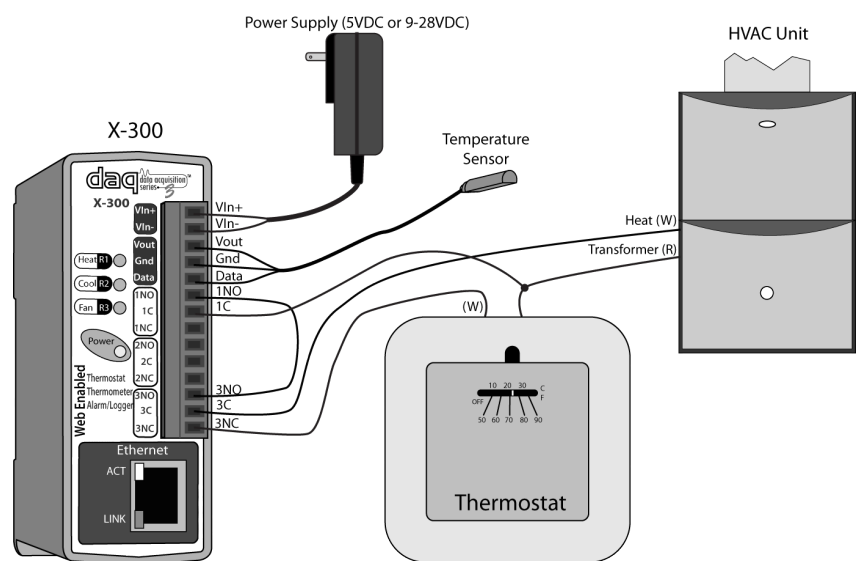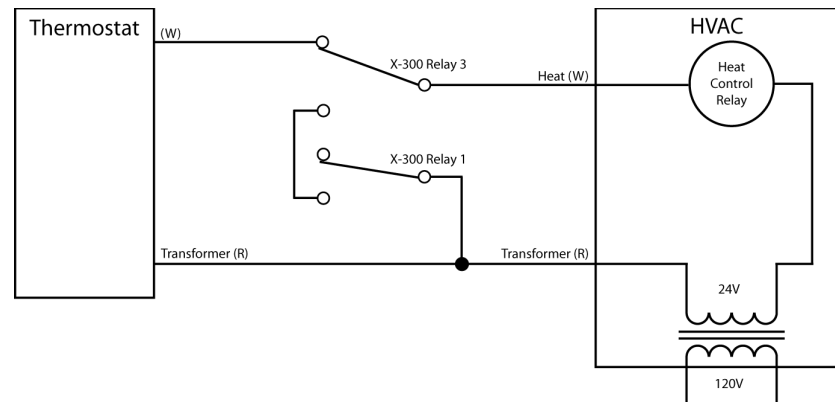
Figure 1.2g - X-300™ Holds Minimum Temperature plus Thermostat Override (Wiring View)

X-300™ Controls Min. and Max. with Local Thermostat Control

The X-300™ can be used to limit minimum and maximum temperatures within a living space. This provides a way for landlords to monitor temperatures within a rented space and limit settings within reason.

WARNING: Check your local laws for restrictions regarding the limiting of occupant temperature controls on rented spaces.

Note: This diagram assumes that the thermostat either is battery powered, or requires no power. If your thermostat requires power from the transformer, the following diagram may cause you to lose all programmed settings within the thermostat. To avoid this, the Heat and Cool would need to be controlled by separate relays within the X-300™.

Applications

- Rental apartments

Connection Requirements (Figure 1.2h, 1.2i)

- Power, network and indoor temperature sensor.

- The heat and cool relays are wired in series with the local thermostat.

Software Configuration

- Mode: ***Temperature Monitor***
- Settings under **Sensors** tab:
    - Enter upper limiting temperature into ***Alarm 1*** field.
    - Set ***Alarm 1*** to ***High*** alarm.
    - Enter lower limiting temperature into ***Alarm 2*** field.
    - Set ***Alarm 2*** to ***Low*** alarm.
    - Set ***Relay 1 Action*** to ***Turn On*** when ***Alarm 1***.
    - Set ***Relay 1 Action*** to ***Turn On*** when ***Alarm 2***.
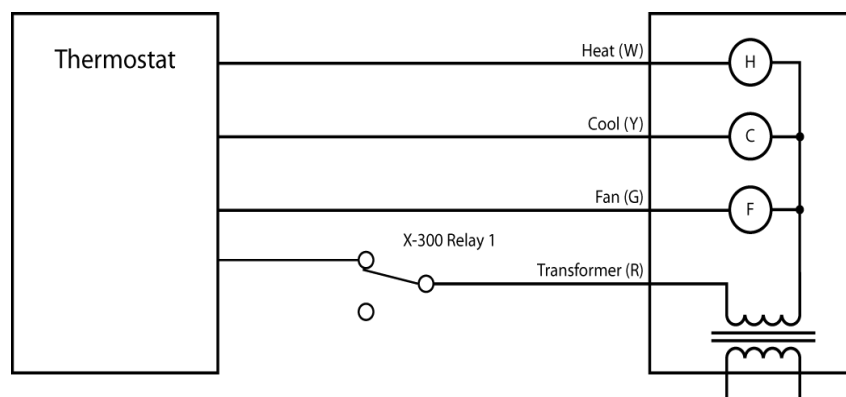
Figure 1.2h - X-300™ Control Minimum and Maximum Temperature, Local Thermostat can Adjust Temperature within Range (Schematic View)
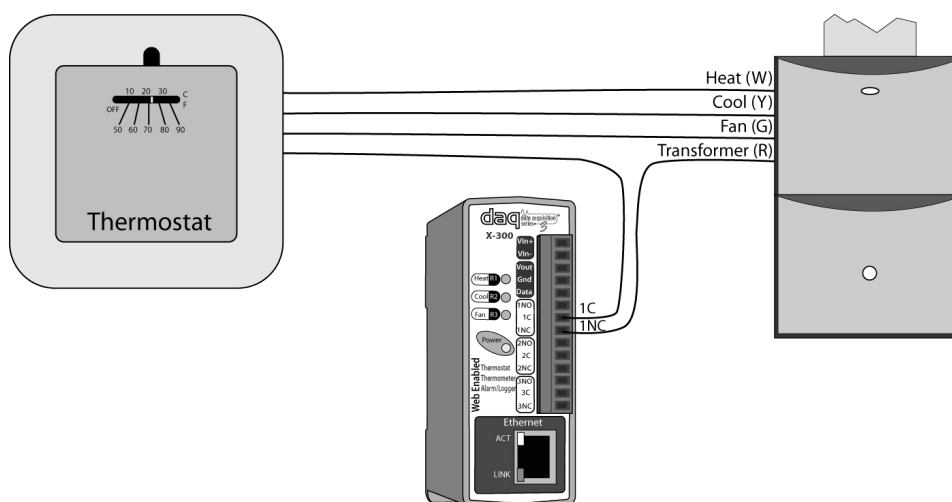
*Figure 1.2i - X-300™ Control Minimum and Maximum Temperature, Local Thermostat
can Adjust Temperature within Range (Wiring View)*

X-300™ Disables Cooling System when Unoccupied

The X-300™ can be used to enable and disable cooling systems when buildings are not occupied.

Applications

- Vacation homes that are not always occupied.

Connection (Figure 1.2j, 1.2k)

- Power, network and indoor temperature sensor.
- Relay 2 is wired in series with the cooling system.

Software Configuration

- Mode: ***Temperature Monitor***
- Settings under the **Sensors** tab:
    • Enter temperature set point into ***Alarm 1*** field.
    • Set ***Alarm 1*** to ***High*** alarm
    • Set ***Relay 2 Action*** to ***Turn On*** when ***Alarm 1***.
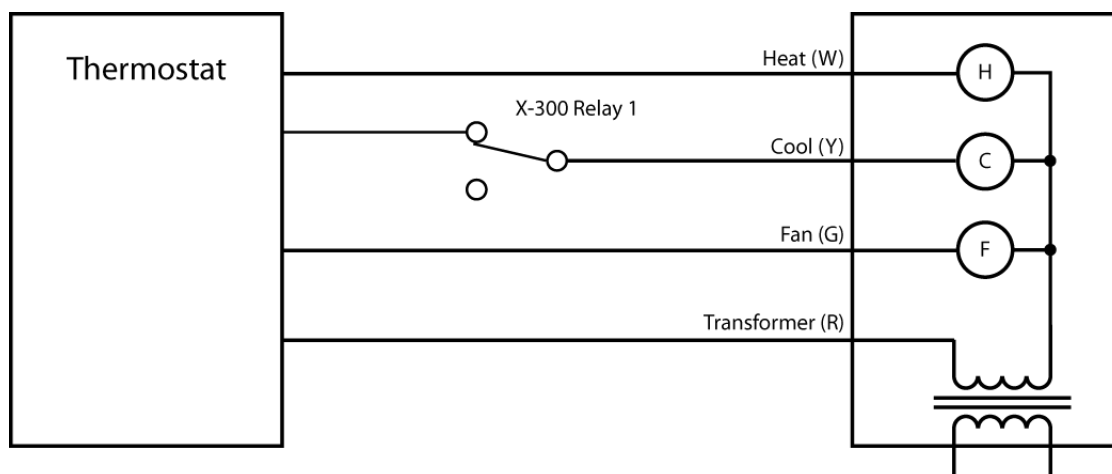
Figure 1.2j - X-300™ Disables Cooling System when Space is not Occupied (Schematic View)
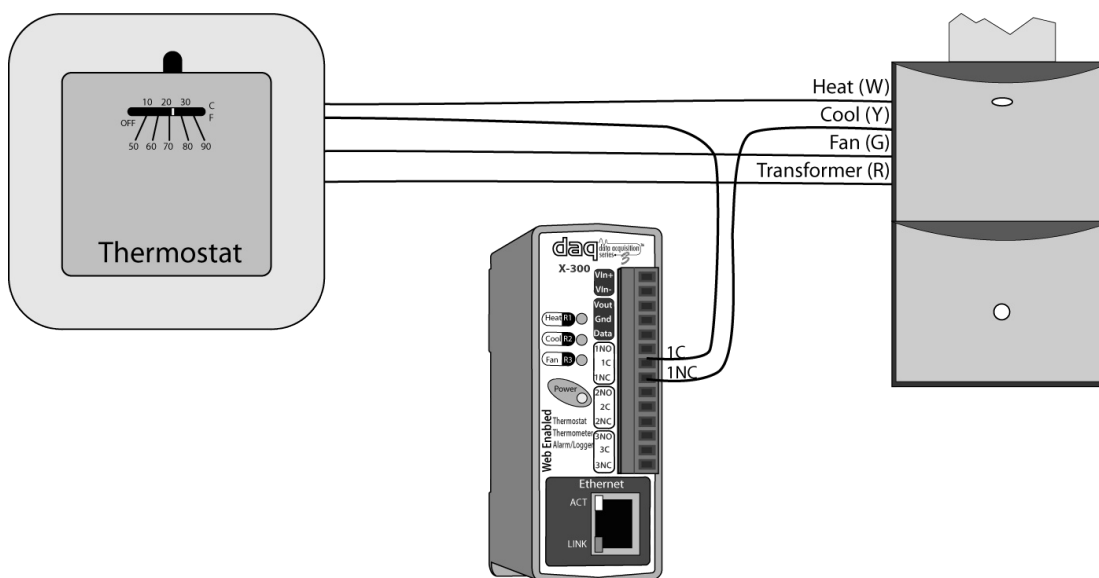
Figure 1.2k- X-300™ Disables Cooling System when Space is not Occupied (Wiring View)

1.3 X-300™ Models Available

X-300™ is currently available in 2 models. The main differences between each model are listed below.

Model Number	Power Supply Requirement
X-300-I	9-28VDC
X-300-E	Power Over Ethernet (802.3af) or 5VDC

Optional Accessories

Accessory	Description	Part Number
Temperature Sensor	Digital temperature sensor with 12 inch wire leads. Note: Leads may be extended	X-DTS-U
Temperature Sensor (Wall Mount)	Digital temperature sensor housed in vented plastic enclosure	X-DTS-WM
Temperature/Humidity Sensor (Wall Mount)	Digital temperature and humidity sensor housed in vented plastic enclosure.	X-DTHS-WM
Submersible Probe	Submersible Temperature Probe with 12 foot wire leads.	X-DTS-S12

1.4 Connectors & Indicators
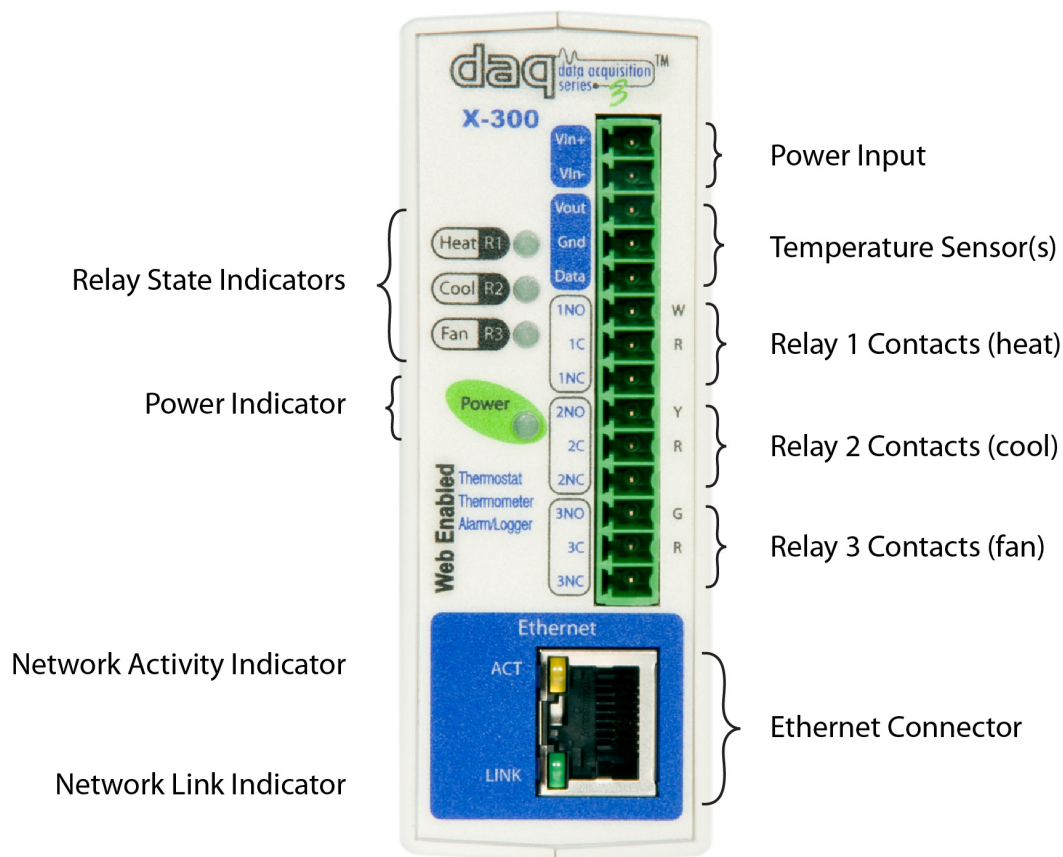
Figure 1.4a - Connectors & Indicators

Terminal Connector

X-300™ has a 14-position removable terminal connector and an Ethernet connector. The terminal connector is used to provide power to the module, connect Digital Temperature Sensors, and, depending on the application, also to Relay Contact connections.

Network Connector

The Ethernet connector is a standard, 8-position modular receptacle.

Module Power Indicator

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

Relay Indicators

Three amber LEDs illuminate when the corresponding Relay is active.

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 amber when activity is detected on the network.

1.5 Accessing X-300™

1.5.1 Standard Access Using a Web Browser

X-300™ 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, 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 any computer.

*Note: Network routers may need to be configured to allow access from computers outside of the local network (see **Appendix C: Accessing X-300™ Over The Internet**).*

1.5.2 Accessing X-300 with Custom Software or Third Party Applications

The X-300™ provides a programming interface that allows applications running on a computer to have full access to it. Custom applications can send commands to the X-300™ for monitoring and control. Custom applications can be used to provide a custom user interface, provide access to multiple units in a single screen, automation, logging, etc. The benefit of using custom software to access the X-300™ is that flexibility is almost unlimited.

1.5.3 Using an External Web Server

Rather than accessing X-300™ 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 or IIS) that is not the web server built into the X-300™ . In this scenario, users access custom web pages that reside on the external web server and the external web server communicates with the X-300™. Users would not communicate directly with the X-300™ .

An external web server can be integrated multiple X-300s™ into a single control page so that they appear as part of a larger system rather than individual devices. Rather than accessing individual units, the user sees a single page that shows the temperature in every room in a building. In addition, the use of an external web server allows programmers to create a custom user interface that takes advantage of the additional resources 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 X-300™ and other ControlByWeb™ devices. The first approach is for the external server to create a TCP connection whenever it needs to access the X-300™. In this case, the external server opens the connection, sends commands and/or reads the device, and closes the connection.

The second approach is for X-300™ to initiate the connection. Using the "Remote Services" settings under the Advanced Network tab in the setup pages, the X-300™ can be configured 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.

Each of the two approaches is appropriate for different applications. The first approach is ideal when the the web server and all of the X-300™ devices are on the same network (without routers between them). In this case, the server can communicate with the X-300™ devices directly and security concerns are minimal because data never has to leave the local network. When the server and the X-300™ devices are on different networks, the first approach can still be used, but routers that are installed between them must be configured to allow appropriate access. For companies that own or control the networks where all of these devices are installed this is not a problem. Anytime a public network is used (the Internet), however, security precautions should be implemented.

The second approach described above uses "Remote Services" features and is ideal for installations

where the server and the X-300™ devices are installed on different networks. This is especially useful when each X-300™ is installed on a separate private network. An example is used to illustrate the use of this approach.

Remote Services Application Example

XYZ resort is a 4-star condominium resort with 310 privately owned condominiums. When the condo owners are not using their property, ABC company offers the service of renting them out. Since each condominium is privately owned, each unit has independent utilities and its own Internet service. To keep costs down, ABC company installed an X-300™ in each condominium unit to control the temperature when units are unoccupied.

In order to automate the temperature control to vacant units, ABC company wrote a custom computer application that communicates with all of the X-300™ devices and automatically turns off the cooling systems when the condominiums are not being used.

Since ABC company doesn't own or control any of the network connections inside each condominium, they use the "Remote Services" settings in the X-300™. By also enabling DHCP on X-300™, the installers do not need to reconfigure the networks in the condos, just plug them in.

Each X-300™ initiates the connection to the ABC company "external server" that runs the cooling system control software. The ABC server presents a unified user interface for the reservation and front desk personnel.

See the description of the **Advanced Network** tab in **Section 2.4.3** for more information on Remote Services and DHCP.

Section 2: Installation and Setup

Installation consists of mounting X-300™, connecting it to an Ethernet network, providing power, configuring via a web browser, and wiring the Relays and Temperature and/or Humidity Sensors.

2.1 Mounting

X-300™ can be mounted to a standard (35mm by 7.55mm) DIN-Rail. Or it can be wall mounted. It should be mounted in a clean, dry location where it is protected from the elements. Ventilation is recommend for installations where ambient air temperatures are expected to be high

See **Appendix J: Mechanical Information** for additional mechanical details.

2.1.1 Wall Mounting

Mount the X-300™ 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.

2.1.2 DIN-Rail Mounting

 Attach the X-300™ 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-300™ 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.
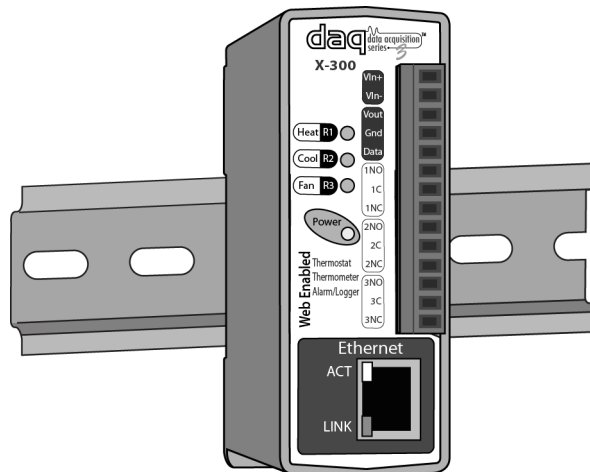
2.2 Connection

CAUTION: MAKE SURE POWER IS SHUT OFF BEFORE WIRING!

CAUTION: THIS UNIT SHOULD BE INSTALLED BY A QUALIFIED TECHNICIAN.

MIS-WIRING OR MIS-CONFIGURATION COULD CAUSE PERMANENT DAMAGE TO THE X-300™, THE EQUIPMENT TO WHICH IT IS CONNECTED, OR BOTH.

A removable terminal connector is provided for simple wiring. The correct wiring procedure is as follows:

1. Make sure power is turned off.
2. Remove the terminal connector from the X-300™ and make wiring connections to the terminals.
3. Reconnect the terminal connector.
4. Apply power.

It is recommended that the load (device to be controlled) not be connected to the X-300™ until after the X-300™ has been configured and tested. By doing this, wiring and configuration mistakes will not cause the load device to turn on unexpectedly.

IMPORTANT: MAKE SURE WIRES ARE PROPERLY ATTACHED TO THE TERMINALS AND THAT THE TERMINALS ARE TIGHT!

Bad Connector Example

Strand(s) of wire are loose

Wires are stripped too far back

Good Connector Example

Wires are stripped correct amount and there are no loose strands that can cause shorts

14-pin Connector Pinout	
Pin	**Description**
Vin+	Power Supply VDC+ 9-28VDC (X-300-I) Power Over Ethernet (X-300-E): These units do not require a power supply to be connected to this pin when the unit is connected to an 802.3af compliant network. Alternatively, this model can be powered using a 5VDC power supply. DO NOT EXCEED MAXIMUM POWER SUPPLY VOLTAGE.
Vin-	VDC- (Ground) power supply input.
Vout	+5VDC Out. This output voltage is used to provide power for the digital temperature sensors.
Gnd	Ground connection for 5VDC output. Connect to the digital temperature sensors.
Data	Temperature Data. This is the data line connection for the digital temperature sensors.
1 NO (W)	Relay 1 Normally Open (Thermostat heat connection: white wire. When white wire is connected to red wire (by closing relay contact), thermostat calls for heat.)
1 C (R or RH)	Relay 1 Common (HVAC system 24VAC transformer: red wire) (Heat transformer if separate transformers are used)
1 NC	Relay 1 Normally Closed
2NO (Y)	Relay 2 Normally Open (Thermostat cool connection: yellow wire. When yellow wire is connected to red wire (by closing relay contact), thermostat calls for cool)
2C (R, or RC)	Relay 2 Common (HVAC system 24VAC transformer: red wire) (Cool transformer if separate transformers are used)
2NC	Relay 2 Normally Closed
3NO (G)	Relay 3 Normally Open (Thermostat fan connection: green wire. When green wire is connected to red wire (by closing relay contact), thermostat forces fan on.)
3C (R or RC)	Relay 3 Common (HVAC system 24VAC transformer: red wire) (Typically connected to cool transformer if separate transformers are used)
3NC	Relay 3 Normally Closed

HVAC Note: In cases where separate transformers are used for heat and cool, the red wire is for the

heat transformer is usually marked as (RH) and the red wire for the cooling transformer is usually
marked as (RC). The common terminals on the X-300™ are not internally connected so it will
accommodate separate heating and cooling transformers.

2.2.1 Power Supply Connection

X-300™ requires power for its internal logic circuits. Connect appropriate power supply to the Vin+ and
Vin- terminals. Note that 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 X-300™ (See **Appendix J:
Specifications** for current requirements.)
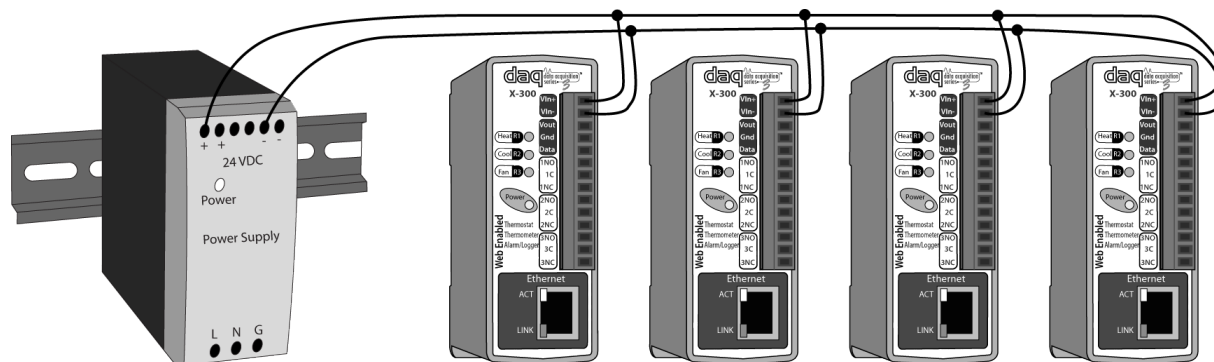
Figure 2.2a - Multiple Unit Power Supply Connection

Multiple X-300™ units may be connected to a single power supply by connecting the power supply input
terminals in parallel. The power supply must have a high enough current rating to power all units
connected. (See **Appendix I: Specification**s for current requirements.)

X-300 -E models: (POE)

X-300™ units with the Power Over Ethernet option may be connected to an 802.3af compliant Ethernet
port instead of connecting to an external power supply. In this case, the X-300™ is powered through the
network port. In 802.3af compliant networks, a 48 Volt power source is injected into the Ethernet line.
This power source is provided by an 802.3af compliant hub, switch, or power injector which may be
located in a utility closet which could be a distance away from the X-300™. This option is very useful for
installations where local power is not available. The power injector may inject the 48 Volt power source
through the data lines or the spare lines in the Ethernet cable.
**DO NOT USE A POWER INJECTOR THAT APPLIES A VOLTAGE TO BOTH THE DATA LINES AND
THE SPARE LINES.**

2.2.2 Temperature/Humidity Sensor Connection

Temperature or humidity sensors can be used for monitoring environmental conditions. The digital sensors use a one-wire data bus, which allows up to eight sensors to share the same terminals (+5V, Ground, Data). Every sensor on the one-wire bus is assigned a unique serial number when it is manufactured. That number is used to address the device during communication.

The sensors have three wires; the wire color is show in the table below.

Sensor Wire Color	Connection
Red	Vout
Black	Gnd
Blue (or White)	Data
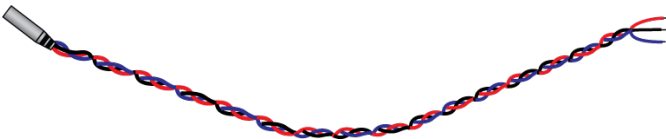
Figure 2.2b - Temperature Sensor
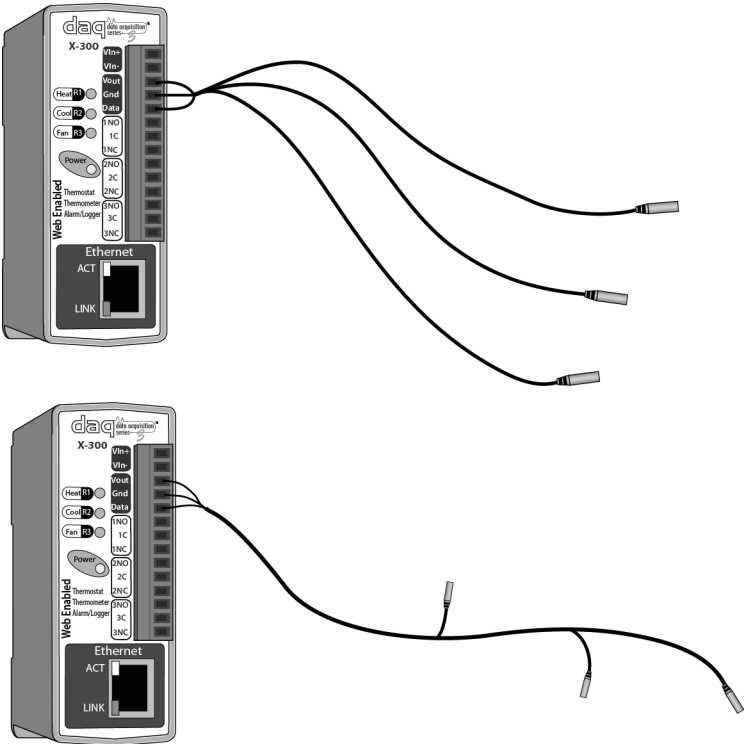
Figure 2.2c - Direct Connection (Star) and Daisy Chain Connection(Linear)

Multiple sensors can be connected in two ways, directly connected to the unit (star topology) or "daisy chained" (linear topology) as shown in Figure 2.2i. Many factors will determine the maximum length of cable used to connect sensors to X-300™. Some of these factors include, but are not limited to, the type of cable used, the number of sensors, ambient electromagnetic noise, and sensor network topology. 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 permanent installation.

The following are general recommendations that will maximize sensor runs and minimize problems.

Cat 5 and Cat 5e network cable has proven to be an effective and low-cost solution for long runs. Other cable types can be used, but cable capacitance may limit the length. Figure 2.2j shows the recommended connection using Cat 5 network cable.
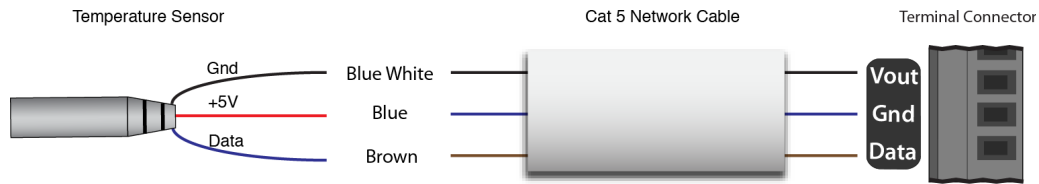
Figure 2.2d - Recommended connection using Cat 5 cable

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

Appropriate strain relief should be used at the X-300™ and other connections that may be subjected to vibration, movement, or repeated handling.

Avoid sensor runs adjacent to industrial equipment power cables. These cables can have high current spikes that may induce noise on the sensor signals. Similarly, avoid running sensor cables near any radio transmission antennas or coaxial feed-lines.

Protect any electrical connections with appropriate weather shielding.

Due to the broad range of applications and environments were the X-300™ may be employed, installation success on long sensor runs may vary significantly.

2.2.3 Network Connection

Connect the Ethernet port to a 10 Base-T or 10/100 Base-T Ethernet connection. This typically connects to an Ethernet hub, switch, or router. For configuration, X-300™ may be connected directly to the Ethernet port on a computer using a "crossover" cable. Otherwise, for connection through a hub or router, a standard "straight-through" cable should be used.
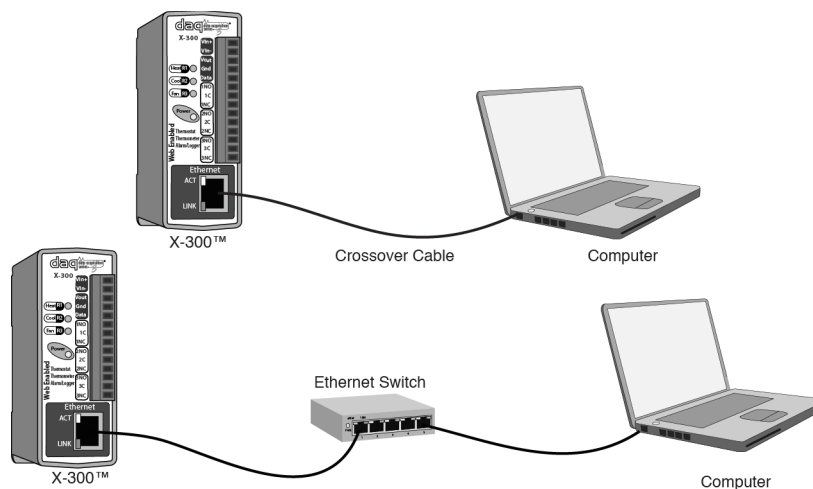
Figure 2.2e - Network Connection

X-300™ can be used on a wireless network by connecting through an Ethernet bridge or a wireless router.
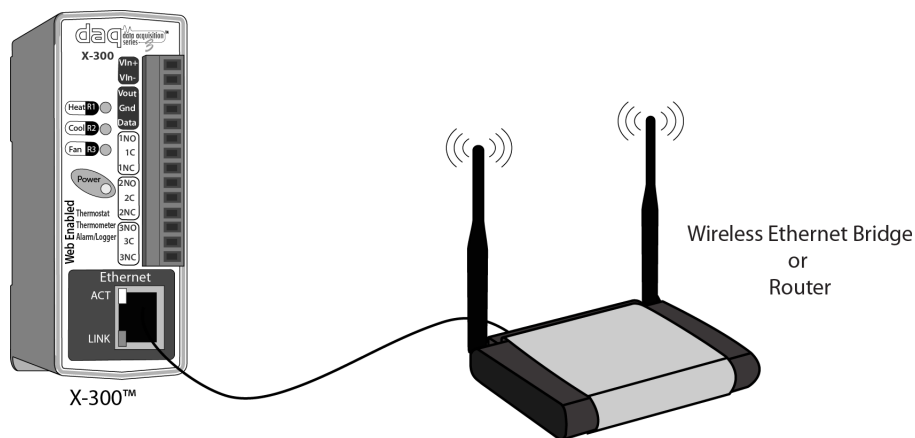
Figure 2.2lf - Wireless Connection

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

2.2.4 Relay Connection

Three internal relays are included in the X-300™ that may be used to control external devices such as alarms, signals, motors, heaters, etc. The relays can be configured to control devices based upon temperature measurements or they can simply be turned on and off over the network. In order to provide the X-300™ with the greatest versatility, the relay contacts (Common, Normally Open, and Normally Closed) internally connect directly to the terminal connector with no internal over-current or contact protection. If the power source connected to the relay contacts can deliver more than rated maximum contact current, an external fuse or circuit breaker must be used. The relay contacts may be wired in series with the power source for a device that will be controlled (the load). For loads greater than the maximum relay contact rating, an external relay may be used. The illustration below shows how a 20-Amp motor can be controlled using an external relay. In the example, the X-300™ controls the external relay and the external relay controls the load.
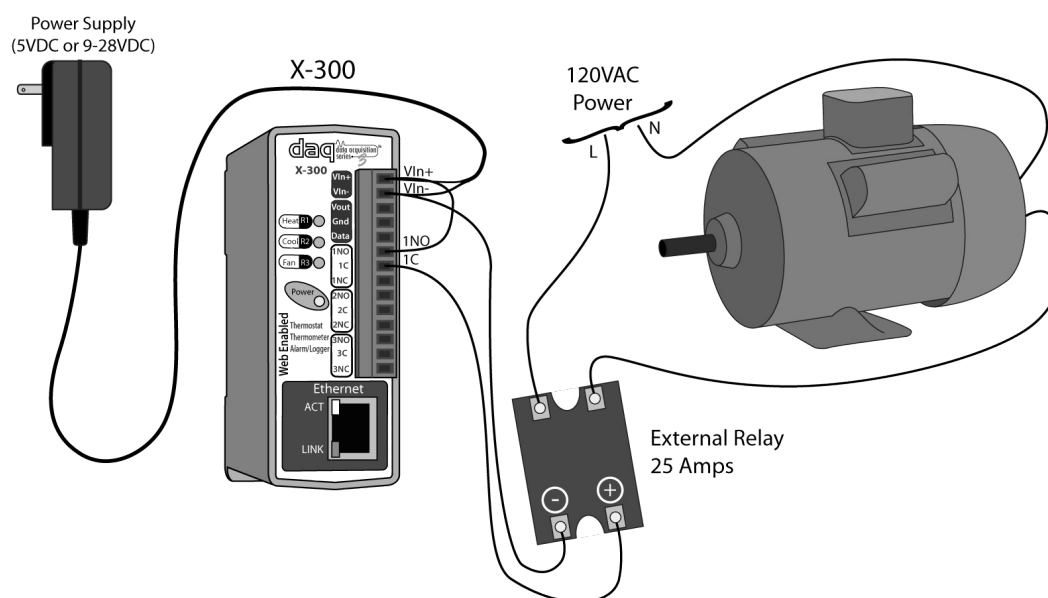
Figure 2.2g - External Relay Connection

When relays switch inductive loads such as motors, transformers, relays, etc., electricity will arc across the internal relay contacts each time the contacts open. Over time, this causes wear on the relay contacts which can shorten their life span. When switching an inductive load, it is recommended that simple relay contact protection devices are used. Note that the X-300™ does not provide relay contact protection in order to provide the greatest versatility and because appropriate protection differs for various loads. Below is an example of relay contact protection for a DC circuit (Figure 2.8) and an AC circuit (Figure 2.9). For component values required to provide sufficient contact protection for your application, refer to appropriate references.
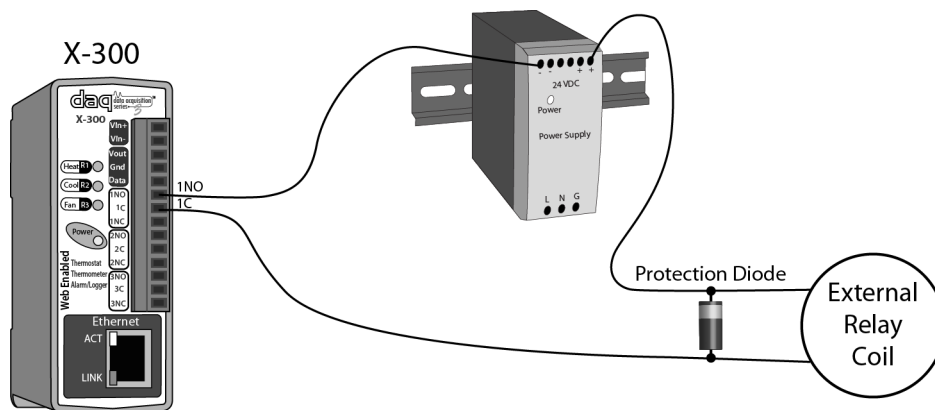
Figure 2.2h - DC Contact Protection
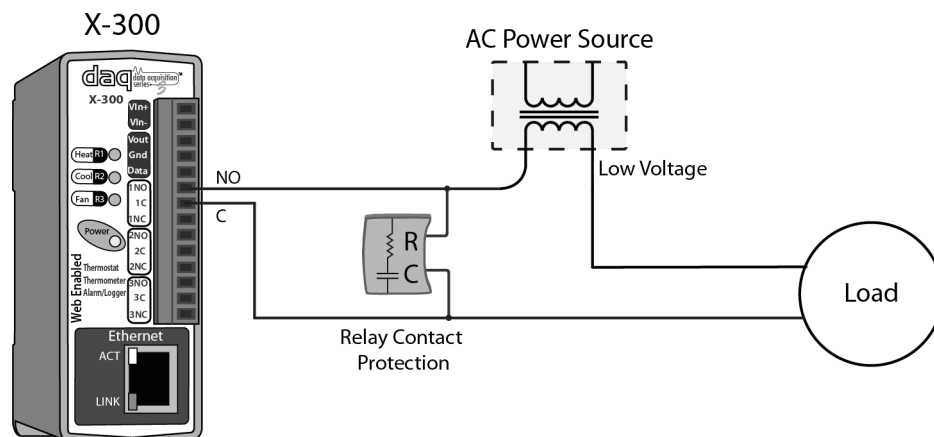
Figure 2.2i - AC Contact Protection

2.3 Establishing Communications for Setup

In order to configure X-300™ with the web browser interface, X-300™ must be connected to an Ethernet computer network. This can be done by one of two methods:

Method 1 – Assign a temporary IP address to X-300™ to work on an existing network.

-or-

Method 2 – Temporarily change the IP address of a connected computer to the match the default IP address used by X-300™.

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 (`arp -d`).

2.3.1 Method 1: Assign a Temporary IP address to X-300™

This option is used to TEMPORARILY assign an IP address to X-300™ without the need to change the IP address of the configuration computer. X-300™ will use this IP address as long as power is maintained. Once power is lost, X-300™ will use the IP address assigned in the setup page and not the temporary address assigned here.

Make sure that X-300™ and the configuration computer are connected to the same network.

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, 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 X-300™ }

    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 X-300™ (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 X-300™ setup in section 2.4.

    Once setup is complete, it may be necessary to clear the 'arp' cache to configure additional WebRelays. 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 X-300™ }
   ```

   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 X-300™ (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 X-300™ setup in section 2.4.

   Once setup is complete, it may be necessary to clear the 'arp' cache to configure additional WebRelays. 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 X-300™ }
   ```

   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 a X-300™ (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 X-300™ setup in section 2.4.

Once setup is complete, it may be necessary to clear the 'arp' cache to configure additional WebRelays. 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.

2.3.2 Method 2: Assign a Temporary IP Address to Configuration Computer

If the first option above is not used, you can use this option to communicate with X-300™. By default, X-300™ comes from the factory with an IP address of 192.168.1.2. Communications with X-300™ may be established by assigning an IP address to the configuration computer that is on the same network as X-300™ (for example, the configuration computer could be assigned to 192.168.1.50)

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

1. Windows XP – Open the control panel by clicking on the start menu and then on Control Panel.

    Windows Vista/7 – Select the Windows Icon (Start Menu) and enter `ncpa.cpl` into the search bar and press Enter (Figure 2.3a).
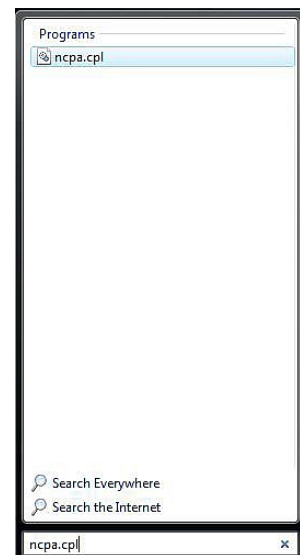
Figure 2.3a- Vista/7 Start Menu

Note: The control panel shown (Figure 2.3b) is in "Classic View." If the control panel is in "Category View," select the "Classic View" option before proceeding.
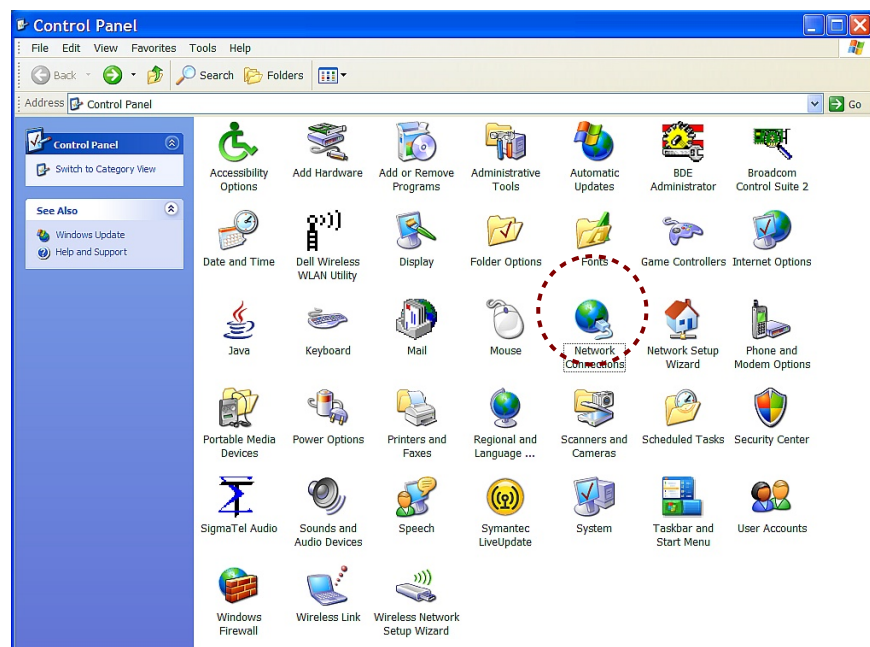
Figure 2.3b- Control Panel

2. Double click on the icon labeled Network Connections. The Network Connections window will open (Figure 2.3c).
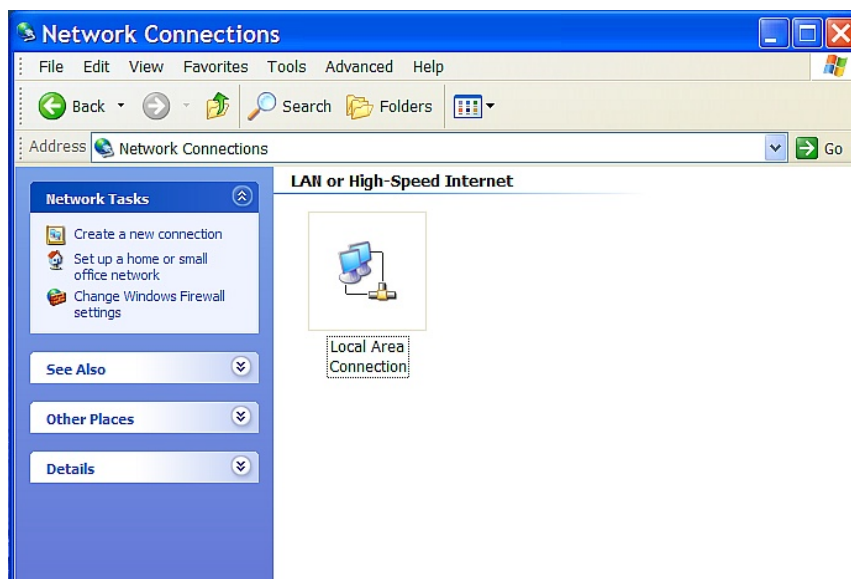
Figure 2.3c- Network Connection

3. Right click on the icon labeled Local Area Connection. In the menu that follows, select the option at the bottom of the menu labeled Properties. The Local Area Connection Properties window will appear (Figure 2.3d).
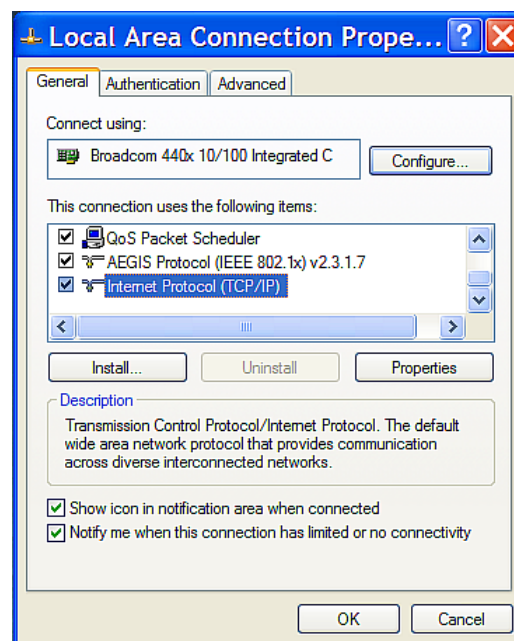
Figure 2.3d- Local Area Connection

4. In the Local Area Connection Properties window in the Connection Uses box, scroll down and highlight "Internet Protocol (TCP/IP)." Click the button labeled "Properties." The "Internet Protocol (TCP/IP)" Properties menu appears (Figure 2.3e).

    Note: 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 IP address of the computer can be restored once the IP address of the X-300™ has been successfully changed.

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

        192.168.1.50

6. Type in the subnet mask:

        255.255.255.0

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

7. Open the setup pages as described in section 2.4. If the setup pages are not accessible, verify that X-300™ is powered on and that the LINK light is illuminated. Check all network connections and settings.

    Another way to check communications is to ping X-300™ from the command prompt by typing ping {X-300™ IP address}.
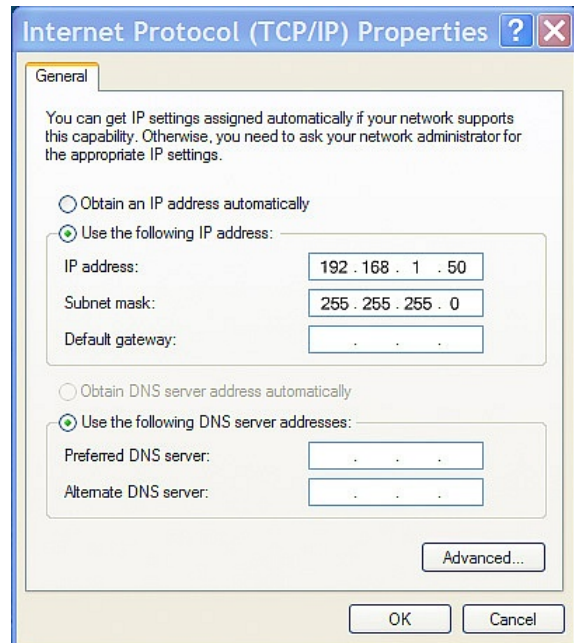
Figure 2.3e- TCP/IP Properties

2.4 X-300™ Setup Pages

X-300™ is configured using a web browser. 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
```

After the page is requested, a password prompt will appear. Enter the username and password. The default username is `admin` and the default password is `webrelay` (password is case sensitive).

2.4.1 Main Tab

This is the initial page that is displayed when setup.html is entered into the address bar of the browser. It displays model and serial number information, and allows the user to select the desired temperature units.
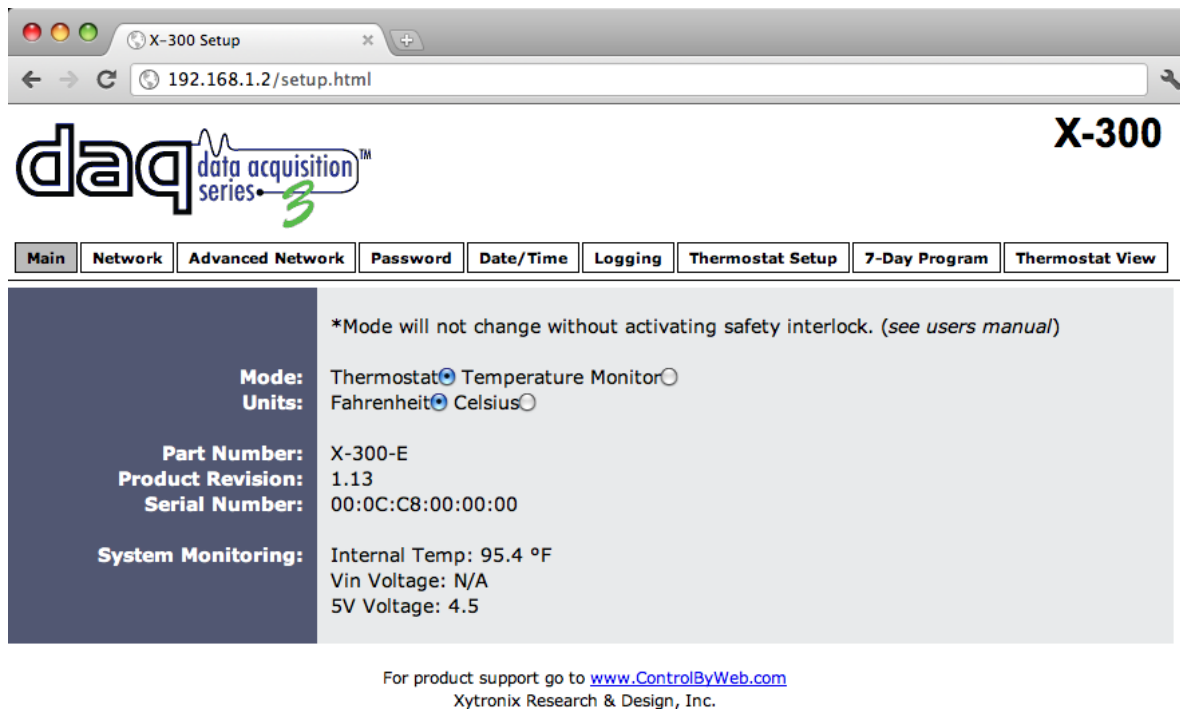
Figure 2.4a - Main Tab

Mode

The X-300™ can function in two different modes. The mode selection determines the function of the X-300™. The default setting is Thermostat mode.

Note: when the mode is changed, the current log file (if enabled) will be erased. A pop-up window will warn the user of this before changing.

- Thermostat: This option configures the X-300™ to operate as an advanced, single-stage thermostat. In this mode, all settings and features are geared toward using the X-300™ as a thermostat and non-thermostat related features are not included.
- Temperature Monitor: This option is ideal for temperature monitoring, logging, alarming, and control of non HVAC systems. This mode offers the greatest degree of versatility.

IMPORTANT NOTE: HVAC systems can be damaged if both heat and cool relays are turned on at the same time. If the X-300™ is used as a thermostat, the system firmware will not allow both relays to be turned on at the same time. If however, a user changes modes to Temperature Monitor mode, the relays can be turned on in any combination. To prevent errors due to mode changes, a safety interlock has been integrated into the X-300™. The mode will not change without activating the safety interlock.

STEPS to CHANGE MODES:

1. Activate the Safety Interlock by briefly pressing the reset button while the unit is powered
2. Change the mode within 60 seconds after activating the safety interlock. If the mode is not changed within 60 seconds, the mode will not change without repeating step 1.
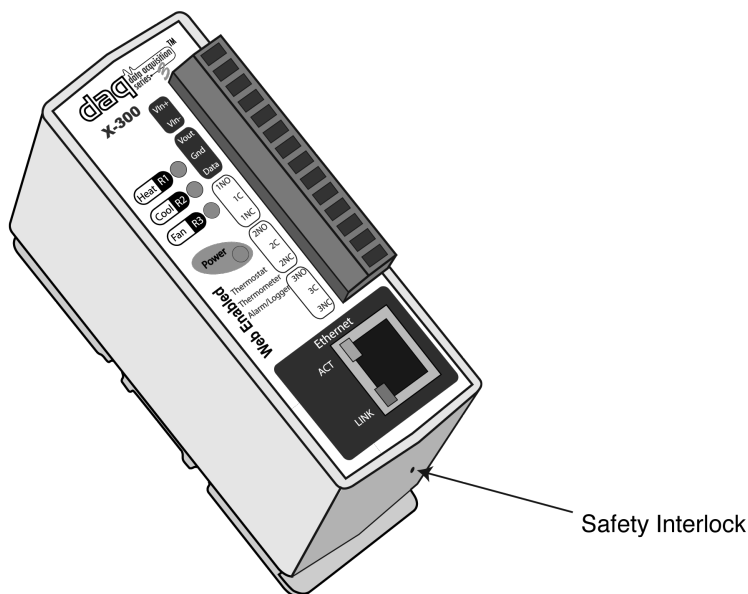
Safety Interlock

Figure 2.4b - Safety Interlock Switch

Note: The reset button is located on the bottom of the unit and can only be pressed by inserting a thin object such as a toothpick straight through the access hole. Care must be taken not to damage the reset button or any other internal components by pressing too hard or inserting the object at an angle and missing the reset switch. Do not use a metal object to access the reset button.

Units

This allows the user to select between the temperature units of **Fahrenheit** and **Celsius**. All settings

entered and displayed on subsequent pages will be in the units selected.

Part Number

This is the full model number of X-300™.

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.

System Monitoring:

Internal Temp: This displays the current temperature inside the X-300™. Note that it is normal for this to be significantly higher than room temperature.

Vin Voltage: This is the DC voltage that is applied to the Vin+ and Vin- terminals.

Internal 5V Voltage: Internally, the unit operates on a 5 VDC power supply. This field is used to view the current value.

Note: The values in these fields are only updated when the webpage is refreshed.

2.4.2 Network Tab

The network parameters are set on this page.

Note: X-300™ must be power-cycled (power disconnected, then reconnected) before network settings take effect. Only the settings on the Network tab require power-cycling before taking effect.

Figure 2.4c - Network Tab

Use DHCP

This option allows DHCP to be enabled or disabled. If this option is set to **Yes**, X-300™ will wait for an IP address from a DHCP server each time it is powered. The default setting is **No** (this is recommended for most installations). If DHCP is set to **Yes**, the Network page must be submitted and X-300™ must be rebooted before an IP address will be assigned. Once X-300™ is assigned an IP address by the DHCP, the new IP address can be found through the list of clients kept by the DHCP server. For most instances, this is found on the local gateway or router. (See **Brief Notes About DHCP** at the end of this section for more information.)

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 devices) 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 and dynamically assigns the IP address to that computer. 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. Since X-300™ is a server, it is usually recommended to manually assign the IP address.

IP Address

Enter the IP address for X-300™ in this field. The IP address is specific to the network where X-300™ will be installed, and must be obtained from the network administrator. For more information on IP addresses and remotely accessing X-300™ over the Internet, see **Appendix C: Accessing X-300™ Remotely 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).
- **Mail Server** (when server name 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 X-300™ requires DNS services and the preferred DNS server is not available. The default setting for this field is 192.168.1.1.

HTTP Port

The TCP port used for HTTP communications (web browser, xml, get commands) with X-300™ 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 X-300™ Remotely Over the Internet**.

Speed

This option sets the data rate (clock rate) of the Ethernet port. Either *10 Mbps* or *100 Mbps* can be selected. The *100 Mbps* option offers faster communications but the amount of data to and from X-

300™ is so small that users will not likely notice much (if any) difference. When the X-300™ is set to *10 Mbps*, it draws less power and runs a little cooler, which may translate into a longer product life. The default setting for this field is *10 Mbps*.

IT IS RECOMMENDED THAT THIS SETTING BE LEFT AT **10 Mbps** UNLESS THE USER HAS A SPECIFIC REASON TO USE **100 Mbps.**

Mode

This option allows the Ethernet port to be set to *Half Duplex* or *Full Duplex*. Legacy Ethernet operates in *Half Duplex* mode which means that devices can either send data or receive data, but not both at the same time. *Full Duplex* means that devices can send and receive data at the same time. The default setting for this field is *Half Duplex*.

Mail Server (SMTP)

The name of the SMTP (Simple Mail Transfer Protocol) mail server (for example mail.example.com) or the IP address of the mail server (for example 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.

Mail Server Port

This field is used to specify the SMTP Mail Server Port. The default setting is 25, which is the standard SMTP port.

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

X-300™ will not receive email messages, but when X-300™ sends email messages, it must include a return email address. This field is used to specify the return email address. Note that although X-300™ 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 5

Enter the email addresses of up to five recipients for alarm messages in these fields. There are no default settings for these fields.

Email Length

Choose either "full" or "short" email lengths. When "full" is selected, all visible fields in the control page will be included in the email message to be sent out; however if "short" is selected, the email content will only be a brief description of what triggered the email message.

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/networkSetup.srv?rbt=1 The username and password will be requested before the reboot will occur, so that only administrators of the device can cause the reboot.

MTU Setting

To change the MTU, manually enter the advSetup.html (case sensitive) page into the address bar. (http://192.168.1.2/advSetup.html). This new setup page will have a text box that will allow the MTU to be changed. The valid range is 256 to 1476 bytes. MTU is a network parameter that stands for Maximum Transmission Unit. This defines the max size, in bytes, of the TCP packets sent out from the device. 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 just discard the packets. To fix this, the MTU can be adjusted until the TCP packets do not get split up.

2.4.3 Advanced Network Tab

Note: These settings are not used for most installations.

Figure 2.4d - Advanced Network Tab

Modbus Enabled

X-300™ can support Modbus/TCP. 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 **3.4 Modbus Operation** for more information on using X-300™ on a Modbus network.)

Note: Modbus communications are disabled whenever the Control Password is enabled.

Modbus Port

This specifies the port used for Modbus/TCP communications with X-300™. By default this is set to port 502 which is the standard Modbus port. It can be set within the range of 0 to 65535.

Remote Services Enabled

This option enables or disables Remote Services. If *Yes* is selected, Remote Services will be enabled as soon as the submit button is pressed and X-300™ 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. Proper connection with the remote server can be verified by viewing the system status log file (see **Appendix D: Log Files**). The default setting for this field is *No*. Most users should leave this setting at its default. (See **Remote Services** at the end of this section for more information.)

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 and has no default setting.

Server Port

Enter the TCP port used for the Remote Services server. This can be set within the range of 0-65535. 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 at 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. Default text is provided only as an example placeholder. The default text is [<`Serial Number`>]:ControlByWeb,X-320.

Connection Interval

This field specifies the periodic interval in which X-300™ attempts to connect to the remote server, or if X-300™ is already connected, it is the interval in which X-300™ sends the connection string. This field can be set within the range of 1 to 34452 minutes. The default setting for this field is 1 minute.

SNMP Enabled

When this option is set to *Yes*, X-300™ will support SNMP. The default setting for this option is *No*. (See **SNMP** at the end of this section for more information.)

SNMP Manager IP

When SNMP is used, this field is used to specify the IP address of the SNMP manager. The default setting for this field is 192.168.1.25.

SNMP Port

When SNMP is used, this field is used to specify the SNMP port that X-300™ listens on. The default setting for this field is 161.

SNMP Trap Port

When SNMP is used, this field is used to specify the SNMP Trap port of the SNMP manager. The default setting for this field is 162.

IP Filter Range 1 and IP Filter Range 2

For additional security, X-300™ has a simple built-in firewall. If desired, X-300™ can be configured to only allow access to client devices (computers, servers, other ControlByWeb™ devices, etc) with certain IP addresses. Two IP address ranges are provided and only client devices with addresses that fall within those two ranges will be allowed access. Devices with IP addresses that fall outside of those ranges will not receive any response from X-300™. The following are examples.

To allow access from any device (this is the default setting):

    IP Filter Range 1:   `0.0.0.0`
                          `255.255.255.255`

    IP Filter Range 2:   `0.0.0.0`
                          `0.0.0.0`

To limit access to only one device (address 192.168.1.33):

    IP Filter Range 1:   `192.168.1.33`
                          `192.168.1.33`

    IP Filter Range 2:   `0.0.0.0`
                          `0.0.0.0`

To limit access to only devices on the local network and one device on the internet (address 10.143.100.32):

    IP Filter Range 1:   `192.168.1.0`
                          `192.168.1.255`

    IP Filter Range 2:   `10.143.100.32`
                          `10.143.100.32`

Note: The address specified for the Remote Services server (if applicable) is automatically allowed through the firewall no matter how the filter is set.

Send State Msg/Trap On (Thermostat Mode Only)

The X-300™ can push messages when one or more relays change state. It can push state messages to a remote services server and/or an SNMP trap. If remote services and/or SNMP is set up, the X-300TM will push messages when one or more of the options below are selected.

- **Heat State Change:** When this is selected, state information will be sent when heat relay changes state.
- **Cool State Change:** When this is selected, state information will be sent when cool relay changes state.
- **Fan State Change:** When this is selected, state information will be sent when fan relay changes state.

Note that this option only appears on the Advanced Network tab in Thermostat Mode. In Temperature Monitor mode, similar options appear in the Relays setup tab.

Remote Services

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-300™ and other ControlByWeb products. Users access X-300™ through the 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.

Remote Services initiates the connection to the external web server (rather than the web server initiating communications to X-300™). This has two main benefits. First, the web server does not need to know the IP address of X-300™. This means that X-300™ can get its IP address dynamically from a DHCP server, simplifying the installation. Second, since the connection from X-300™ is outgoing, rather than incoming, the local router on the network where X-300™ resides doesn't need to be configured to forward sockets. This also 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 Appendix E: External Server and Remote Services**.

SNMP

Simple Network Management Protocol (SNMP) is used to manage and administer network devices. X-300™ supports SNMP V1.0 and can be configured here. Using SNMP, the Relay states, and Sensors of X-300™ can be read as well as some basic information about the device. See **Appendix F: SNMP Requests** for information about how to request information from X-300™ using an SNMP manager, as well as where to find MIB files for X-300™.

Note: The read and write community strings used for SNMP is the Control Password found on the Password setup tab (see Section 2.4.4). If the Control Password is disabled, then X-300™ does not check for the community string when issued a Get or GetNext request from the SNMP manager.

2.4.4 Password Tab

X-300™ requires a password to log into the setup pages. The password can be changed on this page. Additionally, a password can be enabled for the **Control Page**.

Figure 2.4e - Password Tab

Setup Password

The Setup Password, which is required to access the setup pages, can be modified by entering a new password here. Passwords that are 8 characters or longer (up to 13 characters can be entered in this field) with both alphabetic and numeric characters are recommended. For security purposes, the password will not be displayed as it is entered. Note that the username required for accessing the setup pages is `admin` (all lower case). The default Setup Password is `webrelay` (also all lower case).

Re-enter Setup Password

When the Setup Password is changed, it must be entered twice. One time in the previous field and a second time in this field. If the password is not entered identically in both fields, the password will not be changed.

Enable Control Password

The **Control Page** can be viewed without entering a password. For security purposes, a password can be required for access to the **Control Page**. 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*.

*Note: The **Control Page** password will not take effect if Modbus is enabled. This is because Modbus has no provision for passing passwords.*

Control Password

When the *Enable Control Password* option above is set to *Yes*, this field is used to specify the password which will be required to access the **Control Page**. Passwords that are 8 characters or longer with both alphabetic and numeric characters are recommended. For security purposes, the password will not be displayed as it is entered.

Note: A user name is not used to access the **Control Page**. However, some browsers require that a user name be entered. In this instance leave the user name field blank. The default *Control Password* is `webrelay`.

Re-enter Control Password

When the *Control Password* is changed, it must be entered twice. One time in the previous field, and a second time in this field. If the password is not entered identically in both fields, the password will not be changed.

2.4.5 Date/Time Tab

X-300™ uses the time for scheduled events, such as thermostat schedules and for logging (a time stamp is included with each logged event). The time is stored and displayed in 24-hour time format. X-300™ has a capacitor-backed real-time-clock circuit that will keep track of time for several days in the event of a power failure.

Figure 2.4f - Date/Time Tab - Set Manually

Current Date/Time

This is the current date and time stored in X-300™. 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 first selecting the correct month and year, using the left and right arrows at the top of the calender. The single arrows (<, >) change the month and the double arrows (<<, >>) change the year. Once the current month and year are displayed, select the correct day, which will then be highlighted.

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].)

NTP Time Configuration

Figure 2.4g - Date/Time Tab - Sync with NTP Server

Server Name/IP Address

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 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

Sync With Server

This option allows the user to specify how often the time on X-300™ will be synchronized with the time server. When the submit button on this page is pressed, X-300™ will immediately synchronize with the time server. If Daily, Weekly, or Monthly options are selected, X-300™ will thereafter re-synchronize with the time server at the period interval specified starting at 12:00 AM (00:00).

The exact time the NTP Request occurs is 12:00 AM (00:00) plus the minute equivalent of the last two digits in the models 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,* X-300™ will be synchronized with the time server each time it is powered.

*Note: If X-300™ 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.***

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
> Central Standard Time: -6
> Mountain Standard Time: -7
> Pacific Standard Time: -8

Daylight Savings

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 X-300™ will automatically be shifted forward by one hour at 12:02 AM (00:02) on the Daylight Savings Start date set below, and it will shift back to standard time at 12:02 AM (00:02) on the Daylight Savings End date set below. The default setting is **Yes**.

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, so it is possible to duplicate log times in the spring and miss log times in the fall. 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

This is the date that daylight savings will start. Note that on this date, at 12:02 AM (00:02) the current time will be shifted forward by one hour (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

This is the date that daylight savings will end. On this date, at 12:02 AM (00:02) the current time will be shifted backward by one hour (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.

2.4.6 Logging Tab

X-300™ can be configured to record data such as changes in relay state and sensor data. 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-300 IP address}/log.txt.` For more information on logging, see **Appendix D: Log Files**.

The log is stored in non-volatile, flash memory using a circular buffer (old date is over written). 512 kB of memory space is reserved for logging. Log entries are composed of the following components, 8-byte header, and 4 bytes for each log feature selected. A log of Indoor Air Sensor 1 (4 bytes) and Relay 1 (1 byte) will occupy 13 bytes per entry.

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

Figure 2.4h - Logging Tab - Thermostat Mode

Logging Enabled

When this option is set to **Yes**, X-300™ 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 logging rate 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. The default setting for this field is 01:00.

Logging Rate

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 1-20864. Time units are **Minutes**, **Hours**, and **Days**. Periodic logging can be disabled by selecting

the Event Logging Only radio button.

Sensor Trigger Delta

X-300™ can be configured to log data when the temperature, or humidity measured by a sensor changes by the amount specified in this field. This can be set from 1.0 to 9999 units, in 0.1 increments. The default setting for this fields is 2.

Logging Configuration

This table is used to select which relays, sensors and events get logged and which events trigger the logging. The first column in the table identifies the relays and sensors that can be logged or cause logging events. The second column is used to specify what gets logged. The third column is used to specify which events can cause a log entry to be created.

When relays are selected as an *Event Trigger*, logging will occur whenever the selected relay is turned **ON** or **OFF**. When sensors are selected as an *Event Trigger*, logging will occur whenever the sensor changes by the trigger delta. When Vin is selected with a trigger delta entered, if the Vin changes by the specified value, the device will log.

The following *Log/Event Trigger* options are available:

Thermostat Mode

- Set Temp
- Sensor 1/Indoor Air
- Sensor 2/Outdoor
- Relay 1/ Heat
- Relay 2/Cool
- Relay3/Fan

- Vin

Temperature Monitor Mode

- Sensor 1-8
- Relay 1-3
- Vin

Figure 2.4i - Logging Tab - Temperature Monitor Mode

Next Log Time

This field displays the next periodic log time. If logging is disabled, the next log time will indicate "Disabled." If logging is enabled, but periodic logging is disabled (by selecting **Event Logging Only**) the next log time will indicate "Event Logging Only."

Note: This information is updated only when the page is refreshed.

2.4.7 Thermostat Setup

The following setup pages are only available when *Thermostat* mode is selected on the **Main** tab.

This tab is used to setup the thermostat functionality.

Figure 2.4i - Thermostat Setup

Main Header Text

The text entered here will be displayed as the header and the title of the **Thermostat View** page. In addition, when email alerts are enabled this text is included in email messages. This text can be up to 40 characters in length. The default text in this field is X-300.

*Note: When the X-300™is installed for use as a thermostat, one or two temperature sensors may be connected for indoor/outdoor temperature monitoring, and a third sensor can be used to monitor either temperature or humidity. If one sensor is used, it must be mounted in a position where it can accurately measure indoor air temperature. If two sensors are used, one sensor is used for measuring indoor air temperature and the other for measuring outdoor temperature. Values from all connected sensors are displayed in the **Thermostat View** page.*

The following fields are used to identify the location for each of the the sensors. Each sensor has a unique serial number. When sensors are connected to the X-300™, the sensors are automatically discovered and the serial numbers for each sensor are listed in the drop-down list.

Select the appropriate sensor for each of the two locations. The typical approach to identifying sensors is as follows. Connect only one sensor. Press the Refresh Lists button to update the drop-down lists. Select the sensor in the appropriate drop-down list. Connect the second sensor. Press the Refresh Lists button. Select the sensor in the appropriate drop-down list. Repeat for the remaining sensor(s). Each sensor has an offset field. The value of the offset will be added to the sensor's reading. Normally the offset should be set to zero.

Indoor Air Sensor

This field is used to identify the indoor air temperature sensor. This sensor is required and should be mounted in a location where it can accurately measure the indoor air temperature.

Outdoor Sensor

This field is used to identify the outdoor sensor. This sensor is used to display outdoor temperature on the **Thermostat View** page. This sensor is optional.

Extra Sensor

This field is used to identify an additional temperature/humidity sensor. You may give this sensor a custom description that will appear on the thermostat control page.

Refresh Lists

When this button is pressed, the X-300™ will re-scan the bus and update the sensor drop-down lists. Any sensors that were added or removed from the bus since the last scan will be added or removed from the drop-down lists.

Min Cycle Time

The time specified in this field (in minutes) is the minimum time that the HVAC system will run, even if the set point is reached. It is also the minimum time that the HVAC system will remain off. This prevents HVAC turning on an off too frequently. This field can be set within the range of *2* to *15* minutes. The default is *4* minutes.

Global Max Set Temp

This is the maximum temperature that can be set by the user in the **7-Day Program**. This can be set between *48* and *127* degrees Fahrenheit. The default value is *95* degrees Fahrenheit.

Global Min Set Temp

This is the minimum temperature that can be set by the user in the **7-Day Program** page. This can be set between *32* and *124* degrees Fahrenheit. The default value is *45* degrees Fahrenheit. The **Global *Min Set Temp*** must always be set to at least 3 degrees lower than the **Global *Max Set Temp***.

Manual Max Set Temp

This is the maximum temperature that can be set by the user in the **Thermostat View** page. This can be set between *48* and *127* degrees Fahrenheit. The default value is *95* degrees Fahrenheit.

Manual Min Set Temp

This is the minimum temperature that can be set by the user in the **Thermostat View** page. This can be set between *32* and *124* degrees Fahrenheit. The default value is *45* degrees Fahrenheit. The ***Min Set Temp*** must always be set to at least 3 degrees lower than the ***Max Set Temp***.

Heat Anticipation

When a heating system heats a building, the temperature rises until it reaches the desired temperature and the thermostat shuts off the heat. Due to thermal inertia, the temperature may continue to rise and over-shoot the set temperature after the heat is turned off. The X-300™ can be set to anticipate the overshoot and turn off the heat slightly before the set temperature is reached to reduce the over-shoot. The X-300™ will turn off the call for heat at the set temperature minus the value entered in this field. This value can range from *0* to *20*. Default value is *0* (no anticipation).

Cool Anticipation

This works similar to heat anticipation. The X-300™ will turn off the call for cool at the set temperature plus the value entered in this field. This value can range from 0 to 20. Default value is 0 (no anticipation).

Fan On with Heat

Many heating systems will automatically turn on the fan as they heat. Some systems require that the thermostat turn on the fan and heat simultaneously.

- **Yes:** Thermostat turns on the fan (Relay 3) when it turns on the heat (Relay 1).
- **No:** Thermostat does not turn on the fan when it turns on the heat (this is the correct setting for most systems). Default setting is No.

Fan Shut-Off Delay

The time specified in this field (in seconds) is the amount of time that the Fan will continue to run after the set temperature is reached, and the minimum cycle time is expired. This field can be set within the range of 0 to 600 seconds. Default is 30 seconds.

Notification Email

When this option is set to **On**, the X-300™ will send email messages to the email recipients listed under the **Network** tab whenever the indoor air temperature exceeds the **High Temp Email** setting, falls below the **Low Temp Email** setting, or when the **Filter Change Period** reaches 0 days. The default setting for this field is Off.

High Temp Email

This is the high temperature threshold for sending email messages. When the indoor air temperature reaches this value, notification email messages will be sent if email is properly set up and Notification Email setting is set to **Yes**. The default value for this field is 99.0 degrees Fahrenheit.

Low Temp Email

This is the low temperature threshold for sending email messages. When the indoor air temperature falls below this value, notification email messages will be sent if email is properly set up and Notification Email settings is set to **Yes**. The default value for this field is 5.0 degrees Fahrenheit.

Filter Change Period

The X-300™ provides a reminder to change HVAC system filters. The number of days between filter changes is entered here. When this page is submitted, a counter will be set with this value. Each day, the counter will decrement by one. When the counter gets to zero, a filter change notice will appear on the Thermostat View page and an email message will be sent (if enabled). Once the filter change period expires, the user can reset the counter on the Thermostat View page. Note that each time this page is submitted, the filter change period will be set to the value in this field. The default value for this field is 60 days.

2.4.8 7-Day Program Tab

This tab allows for the setup of a 7-day thermostat program. Here the unit can be programmed to change the set thermostat temperature at specified times during the day and week.

Figure 2.4j - 7 Day Program

7 Day Programming

Enable or Disable the set program

Schedule

This field is used to specify the seven day temperature schedule. Temperatures can be set to change up to four times each day. Note that for each set time, two temperatures (a heat temperature and a cool temperature) can be specified.

When the X-300™ is operating in Heat mode, the listed Heat set temperature will be used. When the X-300™ is operating in cool mode, the listed Cool set temperature will be used. When the X-300™ is operating in automatic mode, it will use the listed Heat set temp whenever it heats the building and the listed Cool set temp whenever it cools the building. See **Section 3.1 Browser Operation | Thermostat Mode** for details on *Auto* mode.
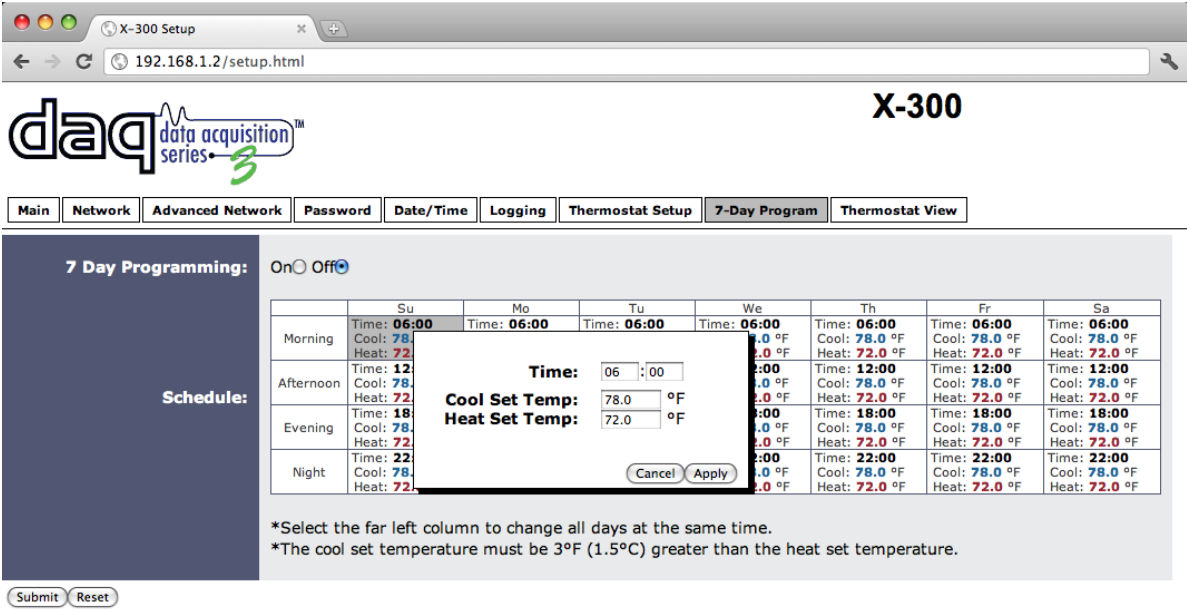
Figure 2.4k - Schedule Setup

The cool temperature must be set at least 3 degrees Fahrenheit (1.5 degrees Celsius) higher than the heat temperature. To change a setting, click the desired time period from the calendar. A pop up box appears (as shown). Enter the time at which this period will start (in 24 hour time) and temperatures in the option box. Note that to make a change for the entire week at a specified time period, the far left hand columns, labeled Morning, Afternoon, etc., may be selected. Both the option box and 7-Day Program page must be submitted before settings will take effect.

2.5 Temperature Monitor Mode

The following pages are available only when *Temperature Monitor* mode is selected on the Main setup tab.

2.5.1 Sensor Tab

This tab is used to configure temperature/humidity sensors and associated alarms. X-300™ will automatically detect whether a temperature or humidity sensor is connected.

2.5a - Sensors Tab

Sensor

Up to eight sensors can be connected to X-300™. This drop-down list selects the sensor to be configured. The fields below are the same for each sensor.

Sensor Description

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 is enabled. This field can be up to 24 characters in length. The default text in this field is `Sensor #`.

Sensor Address

Each sensor connected to X-300™ should be associated (or assigned) to a sensor number. This identifies the name, location, and function of the sensor. Every temperature/humidity sensor comes from the factory with a unique, non-changeable address. When the sensors tab is selected (or the Refresh List button is pressed), X-300™ scans the bus for sensors. The addresses of the sensors that are found on the bus are listed in the drop-down list. For each sensor number (**Sensor 1... Sensor 8**), select the address of the corresponding sensor from the drop-down list.

Selecting sensors is simplest when the sensors are connected to the bus one at a time. The procedure is to start with one sensor and associate it with the appropriate sensor number by selecting the sensor address within the appropriate drop-down list. Submit the page, connect a second sensor, and press the Refresh List button. Associate the second sensor to the appropriate sensor number. Continue this procedure until all sensors are set up.

Offset

The value of the offset will be added to the sensor's reading. Normally this should be set to zero.

Alarm 1

This setting is used to set the trigger point for an alarm condition. The number field specifies the temperature/humidity at which the alarm is triggered. The "High" and "Low" radio buttons indicate whether the alarm is triggered as a high or low alarm. A high alarm is triggered when the sensor reading exceeds the alarm value, and a low alarm is occurs when the sensor reading falls below the alarm value.

Alarms are automatically cleared when they cross the deadband range.

Alarm 2

This is a second alarm trigger that works similar to Alarm 1.

Deadband

The **Deadband** prevents alarms from triggering excessively when the sensor measurement vacillates around the trigger point.

With high alarms, the measurement must fall below the high alarm point minus the deadband before the alarm is cleared and can be triggered again. Likewise the deadband on the low alarm requires the measurement 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 dead band ensures that once the high alarm is triggered, it won't be cleared and will not trigger again until the temperature first drops below 94 degrees (95 - 1).
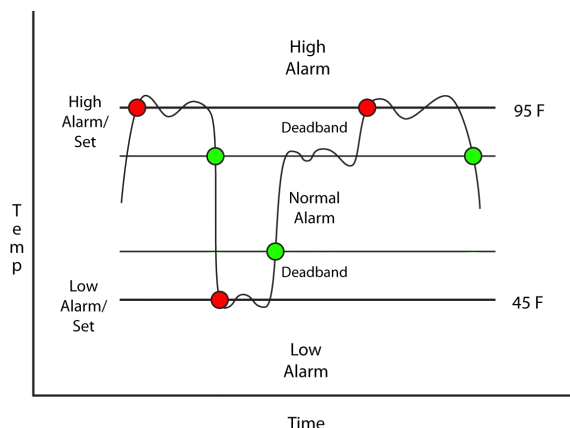
Figure 2.5b - Alarm Deadband

Email/Action Delay

Allows the user to set a time period that the device will wait before performing an action. For example, if sensor 1 is configured to send emails when the temperature is about 80 degrees and the Email/Action Delay has been set to 20 seconds, then there will be a delay of 20 seconds after the temperature goes about 80 degrees before the email goes out. At the end of the 20 second delay, before the email is sent, the temperature will be checked again, if the temperature has dropped below 80 degrees, no email will be sent out. The range for the Email/Action Delay is 10 to 180 seconds.

Email Option

Simple email messages can be sent in response to alarm conditions. This parameter is used to specify what alarm conditions, if any, will cause email messages to be sent.

*Note: Email notification will work only if email is correctly setup in the **Network** setup page.*

- **No Email Messages**: No email messages will be sent due to alarm conditions.
- **Send Email on Alarm 1**: Email notifications will be sent due to Alarm 1 conditions.
- **Send Email on Alarm 2**: Email notifications will be sent due to Alarm 2 conditions.
- **Send Email on Alarm 1 and Alarm 2**: Email notifications will be sent due to Alarm 1 or Alarm 2 conditions.
- **Send Email on Alarm 1, Alarm 2, and Normal**: Email notifications will be sent due to Alarm 1, Alarm 2, or when normal conditions are regained.

Use Email Address

If email messages are to be sent out based on alarm conditions, these check boxes specify to which email addresses the message will be sent. Email address specified on the **Network** setup tab will be shown next to each check box.

Relay 1-3 Action

This field is used to set the state of Relays 1-3 due to an alarm condition. The first drop down box specifies the action. The following actions are available:

- **No Action**: No action is taken by the relay.
- **Turn On**: Turns the relay on due to an alarm condition. The relay will turn off when alarm conditions are no longer met.

- *Turn Off*: Turns the relay off due to an alarm condition. The relay will turn on when alarm conditions are no longer met.
- *Pulse*: Pulses the relay for a specified amount of time due to an alarm condition.
- *Latch On*: Turns on the relay due to an alarm condition. Once the relay is on it will stay on (unaffected by alarm conditions) until it is turned off via the web by a user or the X-300TM is powered off. This option is useful for alarming functions.
- *Latch Off*: Turns off the relay due to an alarm condition. Once the relay is off it will stay off (unaffected by alarm conditions) until it is turned on via the web by a user or the X-300TM is powered off. This option is useful for alarming functions.

The second drop down box specifies the conditions that will cause the action previously specified. The following alarm conditions are available:

- *Alarm 1*: The specified relay action occurs due to Alarm 1.
- *Alarm 2*: The specified relay action occurs due to Alarm 2.
- *Alarm 1 or Alarm 2*: The specified relay action occurs due to Alarm 1 or Alarm 2.

Remote Relay 1-3

The X-300™ can be configured to control relays in other ControlByWeb™ products that are located at a remote location on the network. The same actions for the local relays also apply to remotely controlled relays. This field determines the action taken by Remote Relay due to an alarm condition. The following actions are available:

- *No Action*: No action is taken by the relay.
- *Turn On*: Turns the relay On due to an alarm condition. The relay will turn Off when alarm conditions are no longer met.
- *Turn Off*: Turns the relay Off due to an alarm condition. The relay will turn On when alarm conditions are no longer met.
- *Pulse*: Pulses the relay for a specified amount of time due to an alarm condition.
- *Latch On*: Turns On the relay due to an alarm condition. Once the relay is On, it will stay On (unaffected by alarm conditions) until it is turned Off via the web by a user or the X-300™ is powered off. This option is useful for alarming functions.
- *Latch Off*: Turns Off the relay due to an alarm condition. Once the relay is Off, it will stay Off (unaffected by alarm conditions) until it is turned on via the web by a user or the X-300™ is powered off. This option is useful for alarming functions.

The second drop down box specifies the conditions that will causes the action previously specified.

- *Alarm 1*: The specified relay action occurs due to Alarm 1.
- *Alarm 2*: The specified relay action occurs due to Alarm 2.
- *Alarm 1 or Alarm 2*: The specified relay action occurs due to Alarm 1 or Alarm 2.

Remote Service/SNMP

This field specifies the action with a remote server due to an alarm condition.

- *No Action*: No action is taken.
- *Send State Msg/Trap*: An event string will be sent to the remote server.

The second drop down box specifies the conditions that will cause an alarm trigger. The following alarm conditions are available:

- *Alarm 1*: The specified action occurs due to Alarm 1.
- *Alarm 2*: The specified action occurs due to Alarm 2.
- *Alarm 1 or Alarm 2*: The specified action occurs due to Alarm 1 or Alarm 2.

2.5.2 Relays Tab

This page provides configuration options for the three relays built into the X-300™, and up to three remote relays across the network. The remote relays can be any ControlByWeb™ products that have relays.

Relay

This field selects the relay for which the options below will apply.

- *Relay 1-3*: Selects the built-in relays.
- *Remote Relay 1-3*: Selects remote relays.

The following screen appears when one of the internal relays is selected

Figure 2.5c - Relays Tab

Relay Description

This text field is used to describe the function of the selected relay. The text appears to the left of the corresponding relay status on the **Control Page**. This text will also appear in email messages when email alerts are enabled. This field may be up to 30 characters long. The default text is `Relay #.`

On Button Label

The text in this field appears in the *ON* button for the corresponding relay on the **Control Page**. This field may be up to 15 characters long. The default text is `ON.`

Off Button Label

The text in this field appears in the 'OFF' button for the corresponding relay on the **Control Page**. This field may be up to 15 characters long. The default text is `OFF`.

Pulse Button Label

The text in this field appears in the 'PULSE' button for the corresponding relay on the **Control Page**. This field may be up to 15 characters long. The default text is `PULSE`.

On Status Text

The text in this field appears in the status field for the corresponding relay on the **Control Page** when the relay coil is energized. This field may be up to 15 characters long. The default text is `ON`.

Off Status Text

The text in this field appears in the status field for the corresponding relay on the **Control Page** when the relay coil is not energized. This field may be up to 15 characters long. The default text is `OFF`.

On Status Color

This field specifies the color that will be displayed on the control page when the Relay is On. Options are Green, Red Yellow, Blue, Grey. The default color is Green.

Off Status Color

This field specifies the color that will be displayed on the control page when the Relay is considered **Off**. Options are Green, Red, Yellow, Blue, Grey. The default color is Red.

Pulse Time

When the X-300™ receives a pulse command for the relay (through the web page or the command interface), the relay will turn on for the time specified in this field and then turn off. Note that when a pulse command is sent through the command interface, the command can include a pulse time which will over-ride this value (for that pulse only). The time is specified in seconds and can range from `0.1` seconds to `86400` seconds in `0.1` second increments. Default time is `1.5` seconds.

Remote Service/SNMP

When *Send State Msg/Trap on Relay Change* is checked, SNMP traps and/or State messages will be sent whenever the relay state changes.

The following screen appears when a Remote Relay is selected

This page is used to configure network settings and access to remote relays. Relay action and triggers for the remote relays are defined on the **Sensors** tab.

Figure 2.5e - Remote Relay Setup

IP Address

The IP address of the remote relay is entered here. The default value is `192.168.1.15`

TCP Port

The TCP port number used to access the remote relay is entered here. This must match the TCP port (HTTP port) set in the remote relay. The valid range is `0` to `65530`. The default port number is `80`

Password

If the remote relay requires a password for control, the password must be entered here

Relay

The remote relay device may have multiple relays. This field is used to identify the specific relay to be controlled on the remote device. If the remote device is a single WebRelay™, this field should be zero. If the remote device has multiple relays, this field should be set to the relay number. For example if relay 2 is to be controlled on another ControlByWeb™ product, the Relay # would be set to 2. This field by be set from `0` to `255`.

Periodic State Interval

When the X-300™ is configured to control a remote device, a connection is established. If the device does not receive a message for 50 seconds the connection is terminated. In order for the connection to be maintained, a message containing the state of the relay can be sent at a periodic interval. This field sets the time interval at which the message is sent. The default setting is `50` seconds, thus just maintaining the connection. If the connections should not be maintained enter a value of `0`. This field may be set to `0` or `5-50` seconds.

2.5.3 Script Tab

X-300™ can be used to run simple custom programs written in a language similar to BASIC. This page is used to load and execute these programs. Before it can be loaded to X-300™, a script must first be written as a .txt file. The file must then be uploaded to X-300™. The maximum size of script that can be uploaded to the device is 2K bytes. Information on writing a basic program for X-300™ can be found in **Appendix G: Basic Scripts**.

Note: An ASCII text file format should be used, such as Windows Notepad, Programmer's Notepad, vi, or other text editor that outputs the file as a .txt. The Rich Text Format (.rtf) used by Microsoft WordPad is NOT compatible.
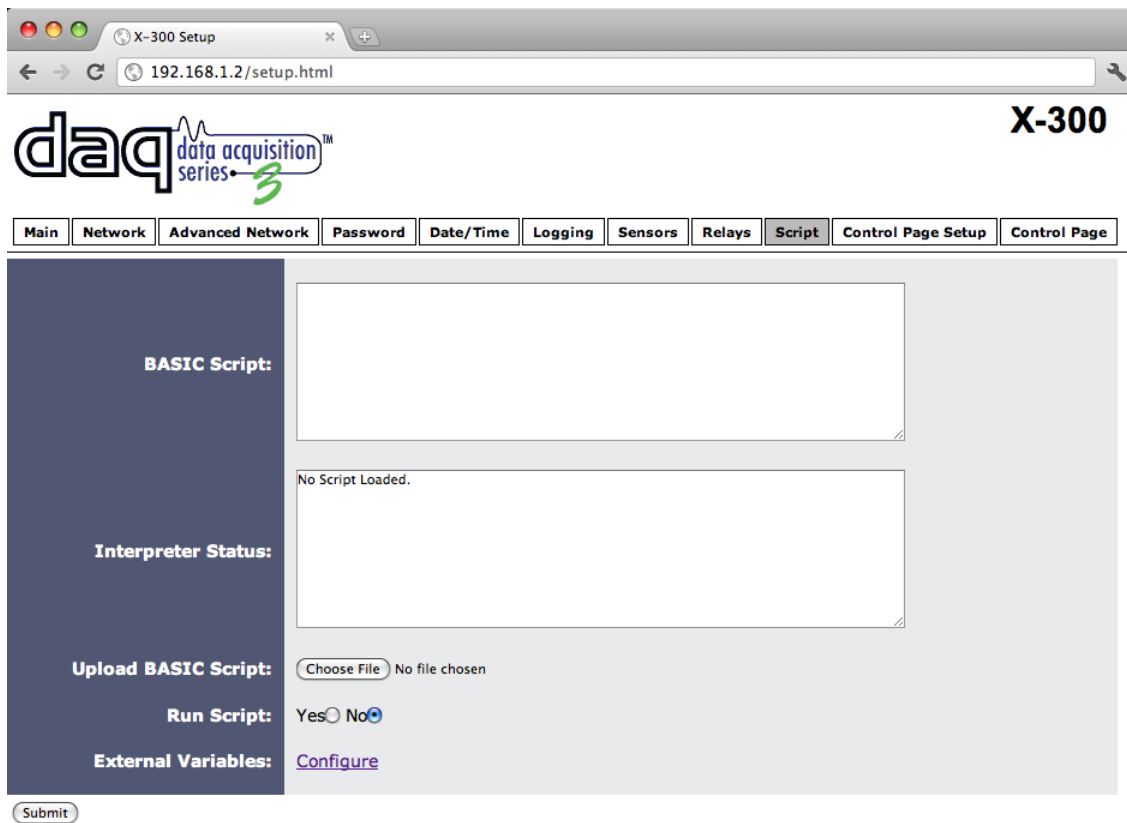
Figure 2.5f - Script Tab

BASIC Script

This field displays the .txt file that is uploaded to X-300™. Text displayed in this screen cannot be edited. In order to edit any script, it must be rewritten in the .txt file and uploaded to the unit again.

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.

Upload BASIC Script

This field displays the script selected to be uploaded to the device. To upload a script to X-300™, click the 'Choose File' button, find the .txt file previously written, and select 'Open.' The location of

the file should appear in the neighboring field. To upload the script to the unit, select 'Submit.'

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.

External Variables

External Variables are variables that can be used in BASIC scripts. They are called External Variables because their values can be changed externally to the BASIC script using XML requests, or through the **Control Page**. This allows basic scripts to react to user input. These variables are considered to be floating point numbers, just like other variables in the BASIC script.

The following page is displayed when configuring External Variables (extvar0 - extavar2):

Figure 2.5g - ExtVar0-2 Configuration

External Variable

This drop down menu offers the option to configure each of the four External Variables.

Display State

Checking this box will display the state of the selected External Variable on the **Control Page**.

Description

Text entered here will be displayed in the left column of the control page. Up to 19 characters may be entered here. The default text is extVar#.

Units

Text entered here will be displayed on the control page. Up to 4 characters may be entered here. There is no default text.

Upper Limit

The text entered here will allow the user to specify the upper limit of the selected extvar.

Lower Limit

The text entered here will allow the user to specify the upper limit of the selected extvar.

The following page is displayed when configuring External Variables (extvar3 - extvar4)

Figure 2.5h - ExtVar3-4 Configuration

External Variable

This drop down menu offers the option to configure each of the four External Variables.

Display State

Checking this box will display the state of the selected External Variable on the **Control Page**.

Display Button 1

Checking this box will display a button on the **Control Page**. Clicking this button on the **Control Page** will set the extVar to 1.

Display Button 2

Checking this box will display a button on the **Control Page**. Clicking this button will clear the extVar to value 0.

Description

Text entered here will be displayed in the left column of the control page. Up to 19 characters may be entered here. The default text is `extVar#`.

Units

Text entered here will be displayed on the control page. Up to 4 characters may be entered here. There is no default text.

Button 1 Label

This text field is used to describe the function of button 1 of the selected extVar. The text also appears to the right of the corresponding extVar status. Up to 9 characters may be entered here. By default, this text is ON.

Button 2 Label

This text field is used to describe the function of button 2 of the selected extVar. The text also appears to the right of the corresponding extVar status. Up to 9 characters may be entered here. By default, this text is OFF.

Status 1 Text

The text in this field specifies the text that will be displayed when the extVar is value 1, with a gray background. The text also appears in the status column on the **Control Page**. Up to 9 characters may be entered here. By default the text is ON.

Status 2 Text

The text in this field specifies the text that will be displayed when the extVar is value 0, with a gray background. The text also appears in the status column on the **Control Page**.

If the extVar is any other value than 1 or 0, the value will be displayed in the same column, with a gray background. Up to 9 characters may be entered here. By default the text is OFF.

Status 1 Color

This field specifies the color that will be displayed on the control page when Status 1 is selected. Options are Green, Red Yellow, Blue, Grey. The default color is Yellow.

Status 2 Color

This field specifies the color that will be displayed on the control page when Status 2 is selected. Options are Green, Red Yellow, Blue, Grey. The default color is Grey.

2.5.4 Control Page Setup Tab (Temperature Monitor Mode Only)

The **Control Page Setup** page is used mainly to set parameters that affect the view of the **Control Page**, how often it will refresh, etc.

Figure 2.5j - Control Page Setup (Temperature Monitor Mode Only)

Main 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 40 characters in length. The default text is `X-300`.

Auto Refresh

The Auto Refresh Page option will cause the **Control Page** to continually update its contents by setting a timer in the web page that causes it to be reloaded at a specified time interval. When set to *Yes*, the web page will be refreshed at the time interval specified in the Refresh Rate setting. When set to **No**, the web page will need to be manually refreshed to show the current status of the unit on the control page.

Refresh Rate

When the Auto Refresh Page option is set to *Yes*, this field specifies the time interval in seconds that the page will be refreshed. It can be set from 1 to 32 seconds. The default Refresh Rate is `3` seconds

Display Configuration

This field sets the options that are displayed on the **Control Page**.

- *Display Temperature/State*: For Sensors 1 through 8 this controls whether the temperature for the specified sensor is displayed. For Relays 1 through 3 this controls whether the state of the relay is displayed.
- *Display On/Off Button*: When checked, an ON/OFF button is displayed on the Control Page for direct user control.
- *Display Pulse Button*: When checked, a button allowing a user to manually pulse a specified relay is displayed.

Section 3: Remote Operation

X-300™ can be operated using a web browser, by sending text commands to an XML status page, and XML control page, or by sending Modbus/TCP requests. X-300™ also allows automatic control of relays using set temperatures, which is covered in the previous sections.

3.1 Browser Operation | Thermostat View

Once X-300™ is set up, users can access the **Control Page** using a web browser by typing the IP address of X-300™ 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 is changed from the default, the user must use the new IP address.

Note: 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`.

When the X-300™ is set to *Thermostat* mode, the **Control Page** appears as a digital thermostat. Using this virtual thermostat is very simple. Users must select the operating mode (Heat, Cool, Auto) and select the desired temperature. Other features are optional.

The following image shows the **Thermostat View**.
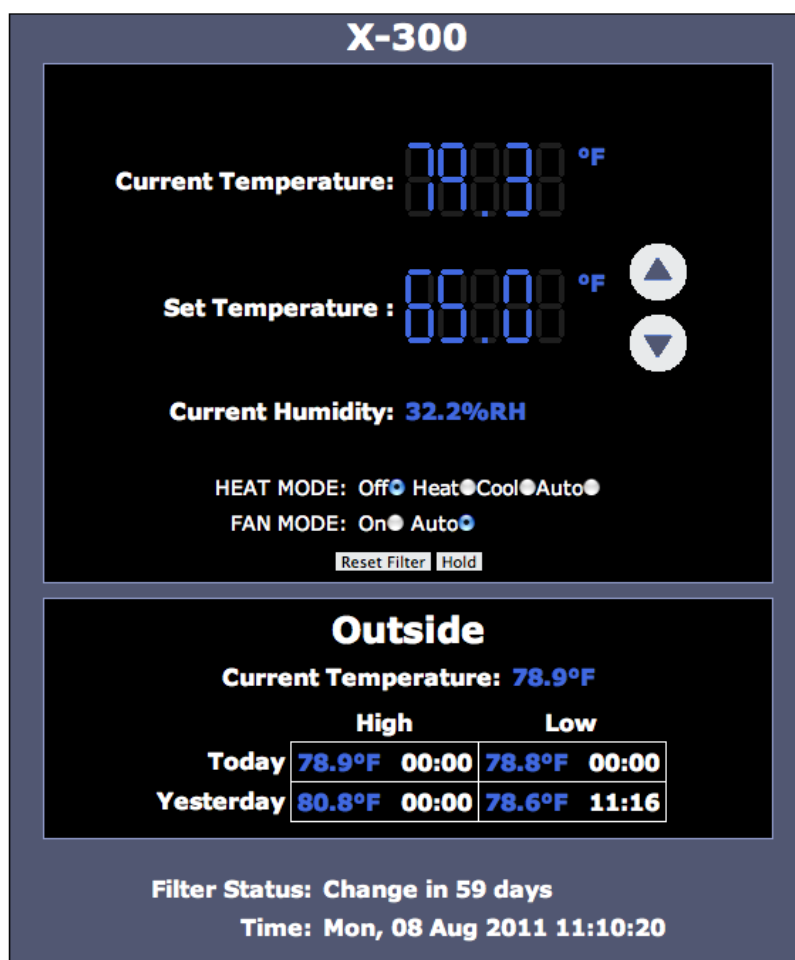
Figure 3.1a - Thermostat View

Header

Displays the text entered in the **Main Header Text** field on the **Control Page Setup** tab in the setup pages.

Thermostat Status

The status line is directly below the Main Header Text. This line contains the current state of the thermostat. State is indicated by text that pops up as appropriate. The following indicators may appear on this time.

Status Message	Description
HEAT: ON	This indicates that the heat relay is currently on.
COOL: ON	This indicates that the cool relay is currently on.
FAN: ON	This indicates that the fan relay is currently on.
7-DAY	This appears when the 7-day programming is enabled.
HOLD	This indicates that the thermostat is currently in hold mode.
SYNCING	This is shown when the set temperature is changed, and a data transfer process is occurring. Whenever the set temperature is changed, the new value must be submitted to the X-300™. The value is also returned to the browser to confirm proper setting.
COMMUNICATIONS ERROR	This indicates that the browser cannot read data from the X-300™. This message will automatically disappear when communication is restored.

Current Temperature

This indicates the current indoor temperature. If a sensor has not been assigned or the unit cannot communicate with the sensor (but the browser is able to communicate with the X-300™), the temperature will display '-.-'.

Set Temperature

This indicates the desired temperature. The X-300™ will enable heating or cooling until the current temperature equals this temperature or the minimum cycle time expires. The set temperature can be changed by the user using the up and down arrows located to the right of the set temperature or the set temperature can be changed using the seven-day scheduling.

Heat Mode

These radio buttons set the mode of the X-300™. The three options are described below.

- **Cool**: This mode is used to enable the cooling system. When in this mode, the X-300™ will turn on the cooling system whenever the current temperature is warmer than the set temperature. When the seven day schedule is enabled, the set point is controlled by the schedule.
- **Heat**: This mode is used to enable the heating system. When in this mode, the X-300™ will turn on the heating system whenever the current temperature is colder than the set temperature. When the seven day schedule is enabled, the set point is controlled by the schedule.
- **Auto**: In this mode the X-300™ will automatically switch between heating and cooling when necessary to achieve the desired temperature. Auto mode works as explained below.
- **Off**: This mode disables heating and cooling.

When the seven day schedule is enabled (and HOLD is not on):

The X-300™ will enable the heating system when the current temperature is below the *Heat* temperature specified for the current time in the seven day schedule. The X-300™ will enable the cooling system when the current temperature is above the *Cool* temperature specified for the current time in the seven day schedule.

When changing from heating to cooling operation, cooling will only activate for the first time when the cooling set point is exceeded by 6°F (1.5°C). Thereafter, cooling will operate normally. Similarly, if the thermostat has been actively cooling and needs to heat, it will not change over to heat operation until the current temperature drops 6°F below the heat set point.

The heat and cool set points are individually controlled. This allows for better energy conservation. Refer to the 7-Day Program tab for more information.

When the seven day scheduled is disabled (manual set point):

The X-300™ will try to hold the temperature at the user set temperature by enabling the heating system or the cooling system as appropriate.

When changing from heating to cooling operation, cooling will only activate for the first time when the cooling set point is exceeded by 6°F (1.5°C). Thereafter, cooling will operate normally. Similarly, if the thermostat has been actively cooling and needs to heat, it will not change over to heat operation until the current temperature drops 6°F below the heat set point.

Since the thermostat will operate around the single, manual set point, the temperature will be controlled to a more narrow window that when scheduling is used.

Fan Mode

These radio buttons set the fan mode. When the fan mode is set to On, the fan will be on no matter what the current heat/cool/fan state is. When the fan mode is set to Auto, the fan will be turned on only when required for heating or cooling.

Reset Filter

When the change filter indicator (see below) is displayed, the user should change the filter. After changing the filter, the user should press this button to reset the filter timer. The filter timer can only be reset when the change filter indicator is displayed.

Hold

When the seven-day scheduling feature is enabled, the set temperature will change as according to the preset schedule. This button is used to put the scheduling on hold which temporary disables the scheduling feature and holds the set temperature at value displayed. When the scheduling is on hold, the word 'HOLD' will appear in the status line at the top of the window. Scheduling is re-enabled by pressing this button once again.

Current Time

Displays the current time that is set using the **Date/Time** tab in the setup pages.

The following section appears only when the humidity sensor is connected
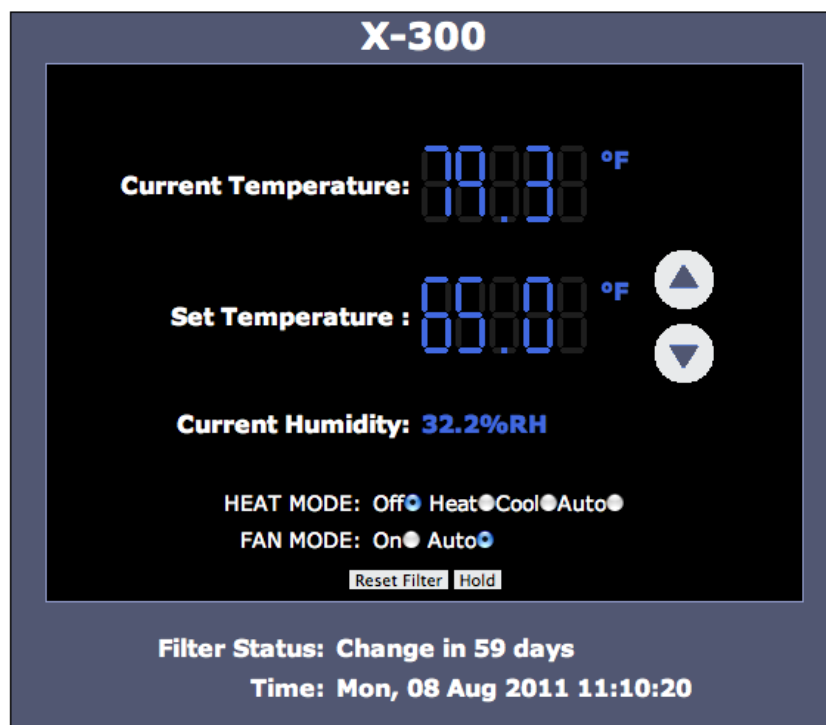
Figure 3.1b - Humidity Sensor

Current Humidity

This shows the current humidity at the sensor.

The following section appears only when the outside temperature sensor is connected
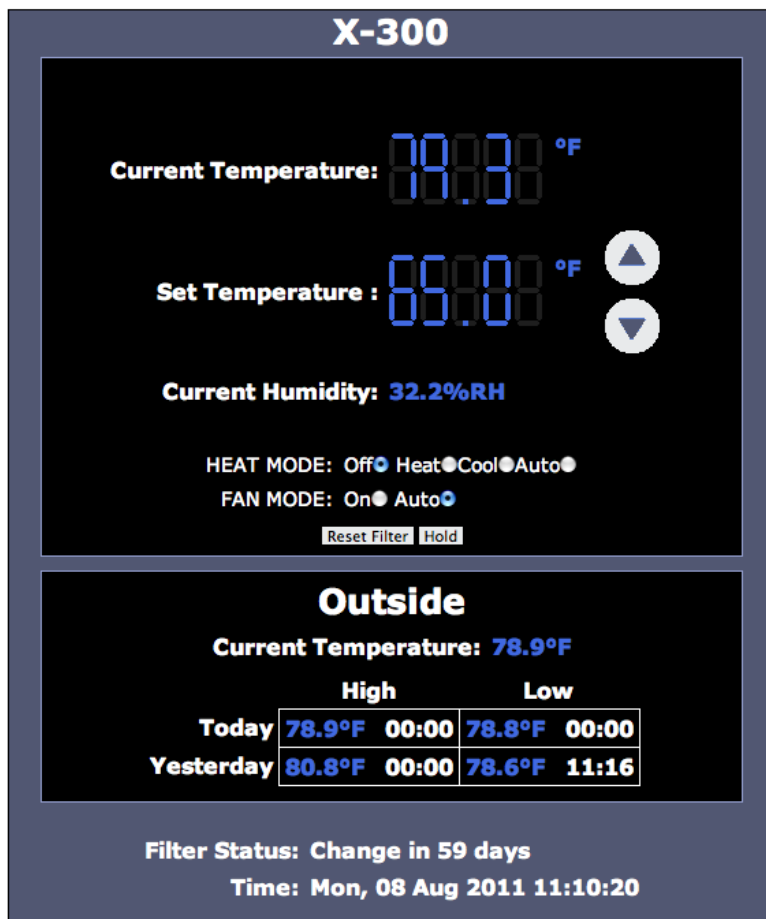
Figure 3.1c - Outside Air Temperature Sensor

Current Temperature

This is the current outdoor temperature.

High/Low Temperatures

The X-300™ tracks the high and low outside temperatures for the current day and yesterday. These temperatures for both days and the times that the temperatures were recorded are displayed in a table.

3.2 Browser Operation | Temperature Monitor Mode

When the X-300™ is set to Temperature Monitor mode, the **Control Page** appears differently than it does when the X-300™ is set in Thermostat mode. A **Control Page** with default settings is shown below.

Figure 3.2a - Temperature Monitor Mode | Control Page

Header

Displays the text entered in the Main Header Text field on the **Control Page Setup** tab in the setup pages.

Sensors(1-8)

These rows display the current temperatures measured by the associated sensors. Each of these rows can be displayed as shown or not displayed by checking or clearing the appropriate boxes under the **Control Page Setup** tab in the setup pages. The text in the left column (by default reads Sensor 1 through Sensor 8), is specified in the *Sensor Description* field under the **Sensors** tab in the setup pages.

Note: If sensors are not configured (sensor addresses selected for each sensor) or are unreadable, the display will read 'x.x' rather than displaying a false numerical value.

Relays (1-3)

These rows display the current relay state and allow users to change the relay state. Each of these rows can be displayed (as shown) or not displayed by checking or clearing the appropriate boxes under the **Control Page Setup** tab in the setup pages. The text in the left column (by default reads Relay 1, Relay 2, and Relay 3) is specified in the *Relay Description* field under the **Relays** tab in the setup pages. The state of the relays is shown to the right of the relay description text. By default, the status text will read *ON* or *OFF*, however the status text can be changed under the **Relays** tab. To the right of the relay status, buttons are provided to control the relays. The buttons can be removed when appropriate and the text within the buttons can be customized using the **Relays** tab settings.

External Variables

These rows display the current state of the four external variables used in the BASIC script. These rows can be displayed (figure 3.1a) or not displayed (figure 3.1b) by checking or clearing the appropriate boxes in the extvar setup page. The **External Variables** setup page is found in the **Script** tab (*Configure* link).

The text in the left column is specified in the *Description* field on the *extVar Setup* page. The state of the extvar is shown to the right of the description text. By default the status text will read *ON* or *OFF*. To the right of the extvar status, buttons are provided to control the state/value of the external variable.

More information on external variables can be found in **Appendix G: BASIC Scripts**.

Current Time

Displays the current time that is set using the **Date/Time** tab in the setup pages.

3.3 XML Operation

Custom XML computer applications may be created to monitor and control X-300™. This method does not use a web browser. There are three XML pages that can be used to monitor or control X-300™, state.xml, eventX.xml. and Diagnostics.xml.

Refer to **Appendix E: External Server and Remote Services** for more information on network configurations when using XML.

3.3.1 state.XML

Custom computer applications may be created to monitor and control the X-300TM without using a web browser. Monitoring the state of the device is done by sending an HTTP GET request for the file state.xml. This file returns the current status of the device and is different depending on the current mode of the device.

XML Monitor All Functions

To simply request the state of the device, use the following command.

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

Thermostat Mode

The following state.xml page is returned when operating in thermostat mode:

```
<datavalues>
        <units>F</units>
        <indoorTemp>72.3</indoorTemp>
        <humidity>H37.4</humidity>
        <outdoorTemp>89.3</outdoorTemp>
        <setTemp>66.0</setTemp>
        <heat>0</heat>
        <cool>0</cool>
        <fan>0</fan>
        <hold>00</hold>
        <minTemp>00:01 78.8</minTemp>
        <maxTemp>14:12 97.4</maxTemp>
        <minTempY>03:45 76.2</minTempY>
        <maxTempY>14:39 95.4</maxTempY>
        <heatMode>0</heatMode>
        <fanMode>1</fanMode>
        <filtChng>59</filtChng>
        <maxSTemp>80.0</maxSTemp>
        <minSTemp>60.0</minSTemp>
        <mode>6</mode>
        <time>1230941820</time>
        <serialNumber>00:0C:C8:00:00:00</serialNumber>
</datavalues>
```

The numbers enclosed by the tags, $<tag>$, indicate the current state or value monitored by X-300™. Values for each tag are described in the table below.

XML computer applications will open a TCP/IP socket with the X-300™ and send a GET command followed by the state.xml command string. (See **Section 3.4** for instructions on using GET.)

XML Tags	Monitor Values
`<units>`	*F - Degrees Fahrenheit* *C Degrees Celsius*
`<indoorTemp>`	x.x - Indicates that no digital temperature sensor is associated with the indoor temperature sensor 72.3 - Temperature reading from the digital temperature sensor associated with the indoor temperature sensor
`<humidity>`	H37.4 - Relative humidity measured by the digital humidity sensor
`<outdoorTemp>`	x.x - Indicates that no digital temperature sensor is associated with the outdoor temperature sensor 89.3 - Temperature reading from the digital temperature sensor associated with the outdoor temperature sensor
`<setTemp>`	66.0 - Indicates the set temperature
`<heat>`	Indicates whether the heat relay is energized 0 = OFF 1 = ON
`<cool>`	Indicates whether the cool relay is energized 0 = OFF 1 = ON
`<fan>`	Indicates whether the fan relay is energized 0 = OFF 1 = ON
`<hold>`	Indicates whether the *Hold* or 7-day program is enabled. The first number shows whether hold is enabled and the second number indicates whether the 7-day programming is enabled. 00 = both hold and 7-day program are disabled 01 = hold is disabled; 7-day program is enabled 11 = both hold and 7-day program are enabled 10 = hold is enabled, 7-day program is disabled
`<minTemp>`	*Indicates the minimum 24 hour temperature reading,* *12:01 78.8 = Time Temp*
`<maxTemp>`	Indicates the maximum 24 hour temperature reading, 14:12 97.4 = Time Temp
`<minTempY>`	Indicates the minimum temperature reading for yesterday 03:45 76.2 = Time Temp
`<maxTempY>`	Indicates the maximum temperature reading for yesterday 14:39 95.4 = Time Temp
`<heatMode>`	Indicates current Heat Mode 0 = OFF 1 = Heat only 2 = Cool only 3 = Auto
`<filtChng>`	Indicates number of days until filter should be changed 59
`<maxSTemp`	Indicates maximum allowable set temperature 80

XML Tags	Monitor Values
`<minSTemp>`	Indicates the minimum allowable set temperature 60
`<mode>`	Indicates the current mode 6 = Thermostat Mode 7 = Temperature Monitor Mode *Note: <mode> xml tag is not displayed in Temperature Monitor Mode.*
`<time>`	Time displayed in "epoch time" (number of seconds since January 1, 1970) 1230941820
`<serialNumber>`	Indicates the Serial Number of the X-300™ 00:0C:C8:02:00:00

Temperature Monitor Mode

The following state.xml page is returned when operating in temperature monitor mode:

```
<datavalues>
        <units>F</units>
        <sensor1temp>72.3</sensor1temp>
        <sensor2temp>67.9</sensor2temp>
        <sensor3temp>22.3</sensor3temp>
        <sensor4temp>36.5</sensor4temp>
        <sensor5temp>80.9</sensor5temp>
        <sensor6temp>97.8</sensor6temp>
        <sensor7temp>99.5</sensor7temp>
        <sensor8temp>x.x</sensor8temp>
        <relay1state>0</relay1state>
        <relay2state>0</relay2state>
        <relay3state>0</relay3state>
        <extvar0>80.00</extvar0>
        <extvar1>50.00</extvar1>
        <extvar2>45.00</extvar2>
        <extvar3>0.00</extvar3>
        <extvar4>1.00</extvar4>
        <time>1230944202</time>
        <serialNumber>00:0C:C8:00:00:00</serialNumber>
</datavalues>
```

The numbers enclosed by the tags, `<tag>`, indicate the current state or value monitored by X-300™. Values for each tag are described in the table below.

XML computer applications will open a TCP/IP socket with the X-300™ and send a `GET` command followed by the state.xml command string. (See **Section 3.4** for instructions on using GET.)

XML Tags*	Monitor Values
`<units>`	*F - Degrees Fahrenheit* *C Degrees Celsius*
`<sensorXtemp>`	x.x - Indicates that no digital temperature sensor is associated with sensorX. 72.3 - Temperature reading from the digital temperature sensor associated with sensorX. H34.5 - Humidity reading from the digital humidity sensor associated with sensorX.
`<relayXstate>`	Indicates whether relayX is energized 0 = OFF 1 = ON
`<extvarX>`	Indicates the current value of extvarX 80.0
`<time>`	Time displayed in "epoch time" (number of seconds since January 1, 1970) 1230941820
`<serialNumber>`	Indicates the Serial Number of the X-300™ 00:0C:C8:00:00:00

*'X' is replaced by the Relay number, or Sensor number.

XML Control

Thermostat Mode

In Thermostat Mode there are five parameters that can be sent to the X-300™ for control. The current set temperature, heat mode, fan mode, hold state, and filter change counter can all be set/configure through the use of HTTP Get requests for the file state.xml.

The supported parameters are:

Command	Description
`state.xml?setTemp=75.0`	Set the temperature to 75.0 (must be within the set maximum and minimum values.)
`state.xml?heatMode=0`	Set the heat mode 0 = OFF 1 = Heat 2 = Cool 3 = Auto
`state.xml?hold=1`	Hold the current set temperature (Toggles the 7 day programming on/off) 1 = Toggle Hold
`state.xml?fanMode=0`	Change the fan mode 0 = Fan Always On 1 = Fan Automatic
`state.xml?rstFilt=1`	Reset the filter counter to the filter change interval in the setup pages 1 = Reset

These parameters can be sent individually or chained together in one request. The previous parameters, for example could all be sent in one request as follows:

```
http://192.168.1.2/state.xml?setTemp=75&heatMode=1&fanMode=1&hold=1
```

Note that when commands are sent to the X-300™, its current state is returned in the form of an XML page. The command can also be sent without having the X-300™ return the XML page. This is accomplished by adding the noReply parameter as follows:

```
http://192.168.1.2/state.xml?setTemp=75&noReply=1
```

Temperature Monitor Mode

Relay State Control

Commands are sent using a variable called relayXState (X is replaced by 1 for relay 1, 2 for relay 2, and 3 for relay 3). An example of using relayXState are given here.

Command	Description
state.xml?relayXState=0	Change the state of relay 0 = OFF 1 = ON 2 = Pulse 3 = Toggle

*'X' is replaced by the Relay number.

Pulse Relay

When the pulse command is sent, the relay will turn *ON* for the Pulse Duration specified in the **Relay** 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-300™ 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 Relay 1, you would issue the following commands.

Command	Description
state.xml?relay1State=2	Pulse Relay 1 for the preset time (1.5 seconds).
state.xml?relay1State=2&pulseTime1=5	Pulse Relay 1 for 5 seconds.
state.xml?relay1State=2&pulseTime1=5	Pulse Relay 1 for 5 seconds.
state.xml?relay1State=2&pulseTime1=5	Pulse Relay 1 for 5 seconds.
state.xml?relay1State=2	Pulse Relay 1 for the preset time (1.5 seconds).

Message Acknowledgment

By default, when commands are sent to X-300™, the state.xml page is returned. The xml reply can be disabled by adding the noReply field as follows:

Command	Description
state.xml?relay1State=1&noReply=1	Turn Relay 1 *ON* without returning state
state.xml?relay1State=0&noReply=1	Turn Relay 1 *OFF* without returning state

3.3.2 Diagnostics.XML

There is a special diagnostics.xml that can be requested by by entering the following in the web browser address bar:

```
http://192.168.1.2/diagnostics.xml
```

The following diagnostics.xml file is returned.

```
<datavalues>
        <internalTemp>89.3</internalTemp>
        <vin>12.0</vin>
        <fiveVolt>5.0</fiveVolt>
        <memoryPowerUpFlag>1</memoryPowerUpFlag>
        <devicePowerUpFlag>1</devicePowerUpFlag>
        <powerLossCounter>1</powerLossCounter>
</datavalues>
```

Diagnostic tags are given in the table below.

Tag	Description
<internalTemp>	Indicates the internal temperature of the device.
<vin>	Indicates the DC voltage that is applied to the VIn+ and Vin- terminals.
<fiveVolt>	Indicates the DC voltage of the internal 5V power supply.
<memoryPowerUpFlag>	Indicates a loss of power to the capacitor-backed real-time clock. A value of 1 indicates that the real-time clock lost power. This should only happen if the device has lost power for several days. There is an internal capacitor that can power the real-time clock for an extended period of time, even if the main power is lost. If the real-time-clock loses power, the time will have to be reset. By default, this will read 1 until it is set to 0.
<devicePowerUpFlag>	Indicates a loss of power to the device. This field can also be set to 0. A value of 1 means the X-300™ has lost power at least one time since the flag was set to 0.
<powerLossCounter>	This field is a count of how many times the X-300™ has lost main power.

The above flags may be cleared by requesting the diagnostics.xml file along with request parameters.

To clear the real-time clock power loss flag:

```
http://192.168.1.2/diagnostics.xml?memoryPowerUpFlag=0
```

To clear the device power loss flag:

```
http://192.168.1.2/diagnostics.xml?devicePowerUpFlag=0
```

To clear the powerLossCounter flag:

```
http://192.168.1.2/diagnostics.xml?powerLossCounter=0
```

Resetting of multiple flags may be done at one time by placing & between each request:

```
http://192.168.1.2/diagnostics.xml?memoryPowerUpFlag=0&devicePowerUpFlag=0
```

Note: Requests for the diagnostics.xml file do not require a password.

3.4 GET Requests

3.4.1 Using GET for Control and Monitoring

No Password

GET requests to the device for XML files.

Example request about.html:

```
GET /about.html HTTP/1.1\r\n\r\n
```

Example turn Relay 1 On:

```
GET /state.xml?relay1State=1 HTTP/1.1\r\n\r\n
```

Password Enabled

If the Control Password is enabled on X-300™ and the state.xml page is requested through a browser, the user will be prompted for a password. If the XML request is sent from an XML application, the html request will need to contain the password, encoded as Base64.

The following is an html request header without the password:

```
GET /state.xml?relay1State=1&noReply=1 HTTP/1.1 (Terminated with two \r\n.)
```

The following example adds the password:

```
GET /state.xml?relay1State=1&noReply=1 HTTP/1.1 (Terminated with \r\n.)
Authorization: Basic bm9uZTp3ZWJyZWxheQ== (Terminated with two \r\n.)
```

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

A utility is provided at http://www.controlbyweb.com/encoder to encode the password. Simply type the string username:password into the website and press 'Encode'.

3.5 Modbus Operation

X-300™ can be controlled and monitored using Modbus/TCP protocol. This provides a standard means of using X-300™ 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 Control Password is enabled. This is because Modbus/TCP does not provide a mechanism for password protection. Make sure the Control Password is disabled (default) and Modbus functionality is enabled on the Advanced Network.

X-300™ functions as a Modbus slave. Host devices, such as PLCs, open a connection with X-300™ on port 502 (configurable under **Advanced Network** tab) and then send requests to read or set relay states, or sensor values. When X-300™ receives a command, it will perform the desired function and return a response.

The following sections provide an overview and explanation of Modbus operation. **Appendix H: Modbus Details** provides further packet and protocol information.

3.5.1 X-300™ Function Code Summary

X-300™ supports the following function codes:

Code Name	Modbus Function	X-300 Feature	X-300 Start Address	
			Hexadecimal	Decimal
Read Coils	01	Relays 1-3	0x0000-0x0002	0-2
Read Sensors	03	Sensors 1-8	0x0110-0x011E	272-286
Read Set Temperature	03	Set Temperature		
Read Thermostat Modes	03	Fan Mode Heat Mode Hold State		
Write Single Coil	05	Relays 1-3	0x0000-0x0002	0-2
Write Multiple Coils	15	Relays 1-3	0x0000-0x0002	0-2
Pulse Coils	16	Relays 1-3	0x000A-0x000E	10/14/11
Write Set Temperature	16	Set Temperature	0x0210	528
Write Thermostat Modes	16	Fan Mode Heat Mode Hold State	0x0212-0x0214	530-532

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.

X-300™ 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 relay combination.

3.5.2 PLC Device Addressing

There are generally two schemes for accessing Modbus devices, The first is by specifying the Modbus function code, memory type, and address. The second, sometimes called PLC addressing, requires only the address.

Modbus protocol uses four different address ranges for discrete inputs, coils, input registers, and holding registers. The function code determines the address range of the message. The following are common function codes and their respective address ranges.

Code Name	Modbus Function	Data Type*	PLC Address Mode 485	PLC Address Mode 584/984
Coils (Read/Write)	01, 05, 15	Discrete	1-1000	1-10000
Discrete Inputs (Read only)	02	Discrete	1001-2000	10001-20000
Holding Registers (Read/Write)	03, 06, 16	8-64 bits	4001-5000	40001-50000

* Data types may be implemented at the discretion of the manufacturer. Address ranges may also over lap. Discrete is a binary or boolean value, 1 or 0.

Function codes, memory types, and addresses can be converted to the PLC addressing equivalent using the table below. To use the table, look up the row corresponding to the Modbus function code. Then take the desired X-300™ feature address and add to it the address offset in the PLC address mode column.

>   *Input Address + PLC Base Address = PLC Address*

For example, to read Relay 1

>   Relay Address   1

>   PLC Base address   1001

>   PLC Address   1002

Programming the PLC to read from 1002 will return the value of Relay 1.

Summary of X-300 Addressing

Code Name	Modbus Function	X-300 Addresses (Decimal)	Data Type	PLC Address Mode 485	PLC Address Mode 584/984
Read Coils	01	0-2 (Relays 1-3)	Discrete	Addr + 1	Addr + 1
Read Holding Registers	03	272-286 (Sensors 1-8) 528-532 (Thermostat Modes)	32-bit float	Addr + 4001	Addr + 40001
Write Coils	05	0-2 (Relays 1-3)	Discrete	Addr + 1	Addr + 1
Write Multiple Coils	15	0-2 (Relays 1-3)	Discrete	Addr + 1	Addr + 1
Write Multiple Registers	16	10-14 (Pulse Relays 1-3) 210-214 (Thermostat Modes)	32-bit float	Addr + 4001	Addr + 40001

For 32-bit numbers, two registers must be read starting at the desired address, examples of each are given for the applicable functions.

3.5.3 X-300™ Full Address Table

The table below gives commonly used function code, memory types, data sizes, and equivalent PLC addresses for accessing the X-300™. The data size will be the same regardless of the addressing mode.

	Function Code	Address (Decimal)	Data Size	PLC Address Mode 485	PLC Address Mode 584/984
Read Relay 1	01	0	Discrete	1	1
Read Relay 2	01	1	Discrete	2	2
Read Relay 3	01	2	Discrete	3	3
Read Sensor 1 (Indoor Sensor)	03	272	32-bit Float	4273	40273
Read Sensor 2 (Outdoor Sensor)	03	274	32-bit Float	4275	40275
Read Sensor 3	03	276	32-bit Float	4277	40277
Read Sensor 4*	03	278	32-bit Float	4279	40279
Read Sensor 5 *	03	280	32-bit Float	4281	40281
Read Sensor 6*	03	282	32-bit Float	4283	40283
Read Sensor 7*	03	284	32-bit Float	4283	40283
Read Sensor 8*	03	286	32-bit Float	4283	40283
Read Set Temperature (Thermostat Mode)	03	528	32-bit Float	4529	40529
Read Fan Mode	03	530	16-bit Integer	4531	40531
Read Heat Mode	03	531	16-bit Integer	4532	40532
Read Hold State (Thermostat Mode)	03	532	16-bit Integer	4533	40533
Write Relay 1*	05	0	Discrete	1	1
Write Relay 2*	05	1	Discrete	2	2
Write Relay 3*	05	2	Discrete	3	3
Pulse Relay 1*	16	10	32-bit Float	4017	40017
Pulse Relay 2*	16	12	32-bit Float	4019	40019
Pulse Relay 3*	16	14	32-bit Float	4021	40021
Write Set Temperature (Thermostat Mode)	16	528	32-bit Float	4529	40529
Write Fan Mode (Thermostat Mode)	16	530	32-bit Integer	4531	40531
Write Heat Mode (Thermostat Mode)	16	531	32-bit Integer	4532	40532
Write Hold State (Thermostat Mode)	16	532	32-bit Integer	4533	40533

* Only available in Temperature Monitor Mode.

The remaining sections give details about the supported Modbus functions.

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

This function returns the state of the relay coils. This function is available in both *Thermostat* and *Temperature Monitor* modes.

Request

Start Address: 0x0000 (coil 1) to 0x0002 (coil 3)

Coil Quantity: 0x0001 (1 coil) to 0x0003 (3 coils)

All three relay coils may be read at the same time by specifying the correct starting address and quantity of coils to be read.

In Thermostat Mode, Relay 1 is Heat, Relay 2 is Cool and Relay 3 is Fan.

Response

The X-300™ will respond to the request with a data field of one byte, each bit representing the coil status. A '1' indicates the Relay is *ON*. A '0' indicates that the Relay 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 Relay 2.

The following tables presume a start address of 0x0000 and a coil quantity of 0x0003.

Coil State Byte							
Bit 7	6	5	4	3	2	1	Bit 0
X	X	X	X	X	Relay 3	Relay 2	Relay 1

Data Byte			Relay 3 State	Relay 2 State	Relay 1 State
Hexadecimal	Decimal	Binary			
0x00	0	000	OFF	OFF	OFF
0x01	1	001	OFF	OFF	ON
0x02	2	010	OFF	ON	OFF
0x03	3	011	OFF	ON	ON
0x04	4	100	ON	OFF	OFF
0x05	5	101	ON	OFF	ON
0x06	6	110	ON	ON	OFF
0x07	7	111	ON	ON	ON

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 Relays

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

The Read Holding Registers function is used for the temperature and humidity sensors in Temperature Monitor Mode, and will also read the set temperature, fan mode, heat mode, and holding state in Thermostat Mode.

32-bit floating-point values for temperature and humidity are returned as little-endian numbers. With little-endian ordering, a temperature reading of sensor 1 (0x0110) would return 0x800042A2. The least significant word would be 0x8000 and the most significant word would be 0x42A2 . This hexadecimal value (0x42A2800) 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.

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

Temperature and Humidity Sensor Start Addresses

Request

Note: Only Sensors 1-3 can be read in Thermostat Mode.

Start Address: 0x110 (Sensor Input1) to 0x11E (Sensor Input 8)

Input Quantity: 0x0002 to 0x0016 (0x0002 to 0x0006 in Thermostat Mode)

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

Response

32-bit floating-point temperature value in little-endian format.

Read Set Temperature (Thermostat Mode Only)

Note: This function will return a value of 65°F when it is called in Temperature Monitor mode.

Request

Start Address: 0x210

Input Quantity: 0x0002

32-bit sensor values are read from two 16-bit registers in little-endian format.

Response

32-bit floating-point temperature value in little-endian format.

Read Fan Mode Address (Thermostat Mode Only)

Note: This function will not return an error when called in Temperature Monitor mode.

Request

Start Address: 0x212

Input Quantity: 0x0001

Response

A single 32-bit word is returned for the fan mode.

> 0 – On
>
> 1 – Automatic

Read Heat Mode Address (Thermostat Mode Only)

Note: This function will not return an error when called in Temperature Monitor mode.

Request

Start Address: 0x213

Input Quantity: 0x0001

Response

A single 32-bit word reports the current heat mode.

> 0 – Off
>
> 1 – Heat
>
> 2 – Cool
>
> 3 – Auto

Read Hold State Address (Thermostat Mode Only)

Note: This function will not return an error when called in Temperature Monitor mode.

Request

Start Address: 0x214

Input Quantity: 0x0001

Response

A single 32-bit word gives the hold status.

> 1 – On
>
> 2 – Off

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

This function changes the state of a single relay coil. The valid addresses and quantities correspond to the relay coils described in Section 3.5.4. This function is only available in Temperature Monitor Mode.

Request

Start Address (2 bytes):   0x0000 (Relay 1) – 0x00002 (Relay 2)

Relay 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.

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

One byte can be written to set the state of all three relays, each bit representing a relay. This function is only available in Temperature Monitor Mode.

Request

Relay states are controlled by specifying the start address of the first relay to be controlled, the count of the relays to be affected, and the relay state byte.

A relay value of 0xFFFF would be used to turn **ON** all of the Relays in the range or 0x0000 to turn them **OFF**. In the above example, the relay value 0xFF would turn Relays 1-2 **ON**.

Start Address (2 bytes):   0x0000 (Relay 1) – 0x0002 (Relay 3)

Relay Quantity (2 bytes):   0x0001 – 0x0003

Byte Count (1-2 bytes):   0x01

Relay Value (1 bytes):   0x0000 – 0x0007

Relay State Byte							
Bit 7	6	5	4	3	2	1	Bit 0
X	X	X	X	X	Relay 3	Relay 2	Relay 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 Relay quantity

                                  0x03 – Byte count out of range.

3.5.8 Write Multiple Registers – Modbus Function Code 16 (0x10)

The Modbus Write Multiple Registers function can be used to pulse the relays for a specified time, as well as control the device in thermostat mode. The operation is determined by the register(s) accessed.

Set Relay Pulse (Temperature Monitor Mode Only)

The Modbus Write Multiple Registers function is used to pulse the relay(s) for a specified time. When X-300™ receives this command, it immediately turns the appropriate relay(s) *ON* (if not already on) and starts the pulse timer. The relay(s) are selected by writing the pulse time in seconds to the register(s) associated with the desired relay(s).

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 relay(s) 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 X-300™ (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.

Request

Start Address (2 bytes):	0x0010 (Relay 1), 0x0012 (Relay 2), 0x0014 (Relay 3)
Register Quantity (2 bytes):	0x0002 – 0x0006 (2 registers for each relay, even number)
Byte Count (1 byte):	0x04 – 0x12 (Multiples of 4)
Pulse Duration (4 bytes/Relay):	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 Relay count.

Set Thermostat Temperature (Thermostat Mode Only)

The thermostat set point may be changed using Modbus function 16. The maximum and minimum values may be restricted by setting the Global Max/Min Set Temp in the **Thermostat Setup** tab. The Modbus function overrides the Manual Max/Min Set Temp.

Request

Start Address (2 bytes):   0x0210

Register Quantity (2 bytes):   0x0001

Byte Count (1 byte):   0x02

Temperature (4 bytes/Relay):   0x00004200-0x000042FE (32°F to 127°F) – Little-endian

0x00000000-0x00004252 (0°C to 52.5°C) – Little-endian

Response

The request is acknowledged by responding with the address and byte count.

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 Relay count.

Set Heat/Fan/Hold Modes (Thermostat Mode Only)

When writing to the Heat Mode, Fan Mode, and Hold State registers, the values with special meaning are used to change modes/states. These values are sent in an integer format, and are:

Mode/State	Starting Address (Decimal)	Starting Address (Hexadecimal)	Request Values (Decimal)
Fan Mode	530	0x0212	1 - Auto 0 - On
Heat Mode	531	0x0213	0 - Off 1 - Heat 2 - Cool 3 - Auto
Hold State	532	0x0214	0 - Off 1 - On

Request

Start Address (2 bytes):   0x0212 (Fan Mode)

0x0213 (Heat Mode)

0x0214 (Hold State)

Register Quantity (2 bytes):   0x0001 – 0x0003 (1 registers for each relay)

Byte Count (1 byte):   0x01 – 0x03

Mode (2 bytes/Relay):   0x0000 – 0x0003

Response

The request is acknowledged by responding with the register quantity that was requested.

Errors

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 Relay count.

3.6 Email Notification

3.6.1 Email Notification Description

X-300™ can be configured to send messages to five email addresses when a set temperature condition is reached

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

Thermostat Mode	Temperature Monitor Mode

```X-300 - Email Notification```
 	
```Email Alert - High Temperature.```
 	
```Indoor air sensor: 85.7 °F```
```Outdoor air sensor: 93.7 °F```
```Humidity sensor: 33 %RH```
```Change filter in 30 Days.```
	```X-300 - Email Notification```
	
	```Email alert triggered by Sensor 1```
	
	```Sensor 1 Current Temp: 86.4 °F```
	```Sensor 2 Current Temp: 86.4 °F```
	```Sensor 3 Current Temp: 22.5 °F```
	```Sensor 4 Current Temp: 95.8 °F```
	```Sensor 5 Current Temp: 64.6 °F```
	```Sensor 6 Current Temp: 32.1 °F```
	```Sensor 7 Current Temp: 73.5 °F```
	```Sensor 8 Current Temp: xx.x```

Note: Sensor names be customized by the user (installer) in the setup pages. The same field names are used on the Control Page (Temperature Monitor Mode only).

Subject Line

The top line (that reads X-300), 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 **Control Page Setup** tab.

Trigger

The first line displayed in the body of the message shows the event that triggered the message. The text "Email Alert" will always appear and cannot be changed. The remaining text includes the trigger name, and what caused the alert.

Current Status of the 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 **Control Page Setup** page.

3.6.2 Email Notification Setup

Email notification requires that the following fields are properly configured. See **Section 2.4.2 Network Tab** for a description of each field.

Network Tab

    IP Address
    Subnet Mask
    Gateway
    Preferred DNS Server (this is required if Mail Server is entered by name and not by IP address)
    Alt DNS Server
    Mail Server (SMTP)
    User Name (If Required)
    Password (If Required)
    Return Email
    Email 1
    Email 2
    Email 3
    Email 4
    Email 5

*Note: X-300™ must be power-cycled (power disconnected, then reconnected) before network settings take effect. Only the settings on the **Network** tab require power-cycling before taking effect.*

Email triggers can be generated within a BASIC script (See **Appendix G: BASIC Scripts**), or can be explicitly defined for each sensor.

The email options and recipients for each Sensor are configured separately. Select the the Email Option and the checkbox for the desired email recipient for each Sensor.

Once the email settings are entered, the email functionality can be tested manually by entering the following command:

```
http://IP address/state.xml?testEmail=1
```

For example, using the default IP address, enter:

```
http://192.168.1.2/state.xml?testEmail=1
```

This will cause an email message to be sent immediately. If an email message is not received, the system log file may have some clues to assist in diagnosing the problem (http://192.168.1.2/syslog.txt). See **Appendix D: Log Files** for additional Logging Information.

Appendix A: Restoring Factory Default Settings

In the event that the IP address or passwords are forgotten, X-300™ may be restored to its original factory default settings.

1. Remove the DC power from the unit. This will also turn off and Relay(s).

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 2.3 Establishing Communications for Setup** to begin reconfiguration of the device.
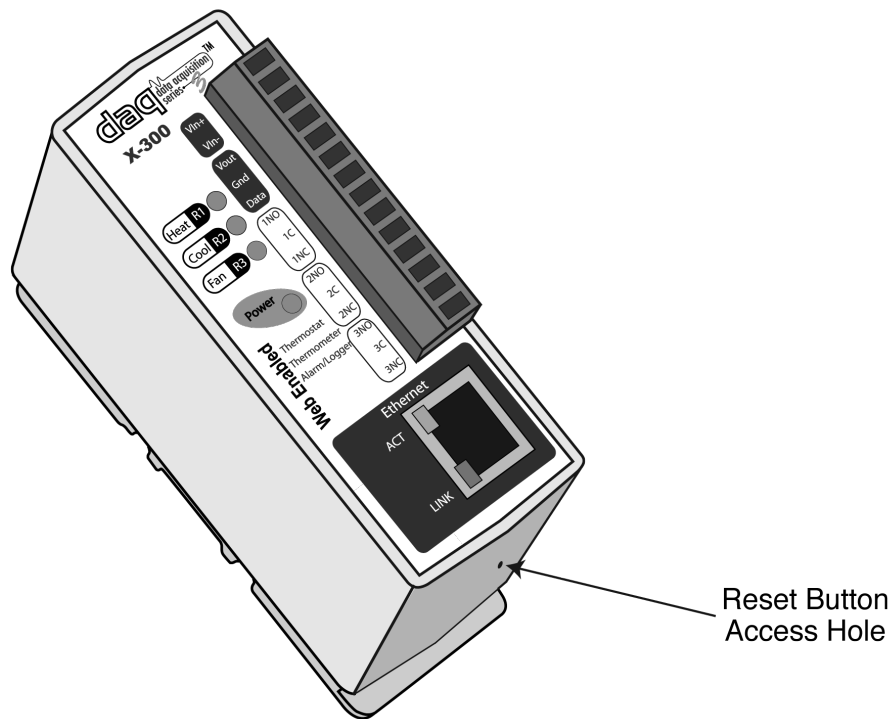
Figure Appendix A.1 - Restore Factory Defaults

Appendix B: Installing New Firmware

From time to time, updates are made to the X-300™ firmware. 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 XP/Vista/7 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. Download the firmware zip file from the ControlByWeb website. Only a X-300™ image can be installed on X-300™ so make sure the correct image is being downloaded.

2. bootloader.exe will connect to the the X-300™ using default IP address 192.168.1.2, not the address currently assigned to the X-300™. 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 **2.3 Establishing Communications for Setup**.

Note: The IP address of X-300™ will automatically be set to the default 192.168.1.2 during the update process.
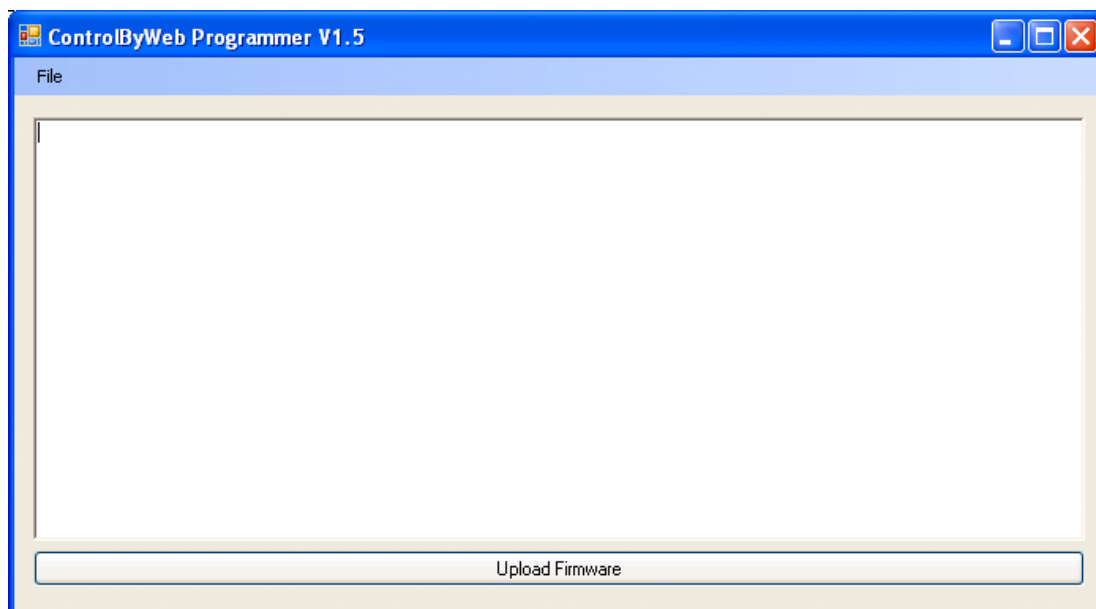
Figure Appendix B.1 - Firmware Update Utility

Note: A crossover cable cannot be used during the update procedure, an ethernet switch will be necessary to properly update the firmware. Open the bootloader.exe utility on the computer by double clicking on the downloaded file (Figure Appendix B.1).

---

3. Within the ControlByWeb™ Programmer utility, 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-300™ into bootloader mode and perform the upgrade:

1. Remove DC power from X-300™.

2. Using a small, non-conductive tool, press and hold the reset button.

3. While holding the reset button, apply power to X-300™. 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 20-30 seconds, the LINK LED will stop flashing and remain lit. X-300™ will be set to factory defaults with an IP address of 192.168.1.2.

6. Refer to section **2.3 Establishing Communication for Setup** to reconfigure the X-300™. 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).
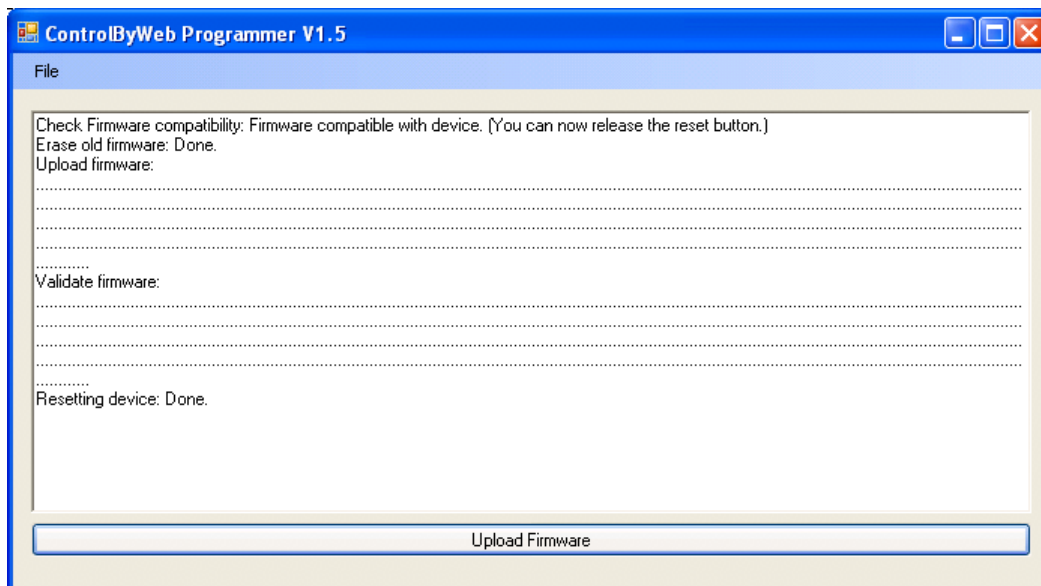
Figure Appendix B.2 - Firmware Update Complete

Appendix C: Accessing X-300™ Over the Internet

X-300™ can be monitored and/or controlled from a remote location over the Internet. Once X-300™ can be accessed on the local network, almost all of the settings required to provide remote access are in the router and not in X-300™. 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. X-300™ can be assigned a public IP address for direct connection to the Internet. Typically, a public IP address to would only be assigned to X-300™ 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
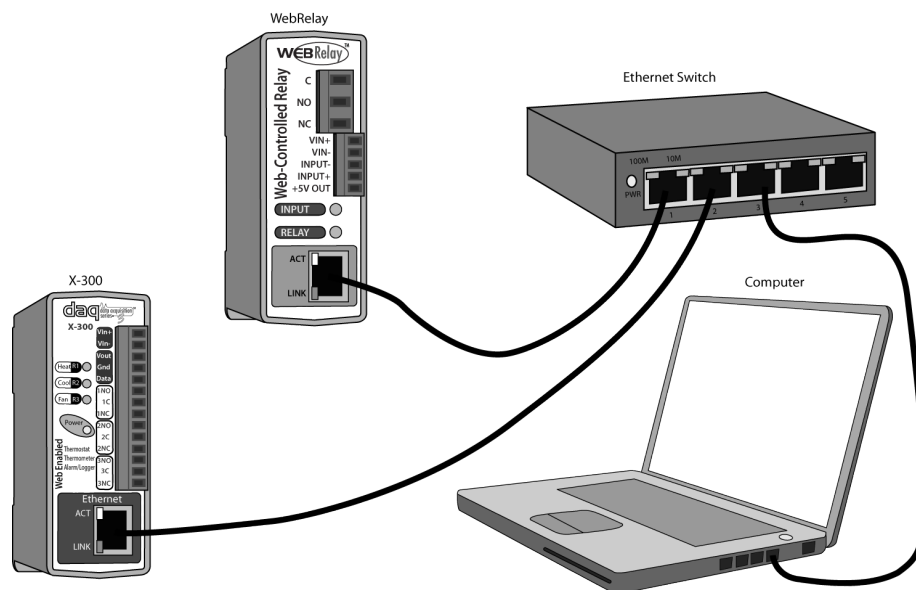
Figure Appendix C.1 - Local Area Network

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-300™, and a WebRelay™. In this example, the computer is assigned an IP address of 192.168.1.10, X-300™ 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 X-300™ by entering its IP address in the URL line in the browser,http://192.168.1.25. Similarly, 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
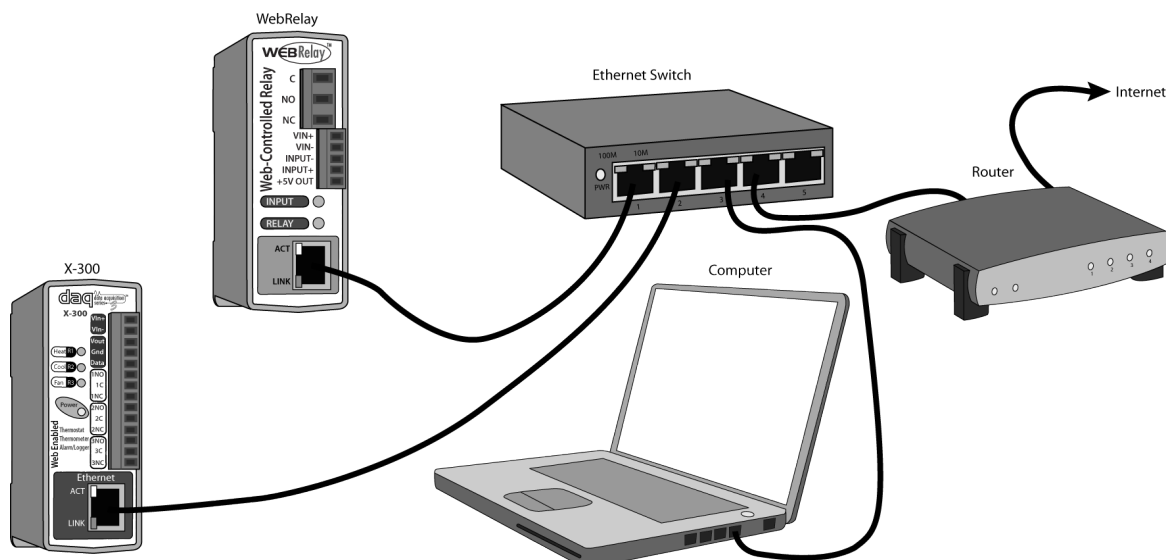
Figure Appendix C.2 - LAN Connected to the Internet

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 266.70.164.97. (This is not a valid IP address because each number cannot be larger than 255 It is used in this example for illustration purposes only.)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 266.70.164.97. 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 X-300™ and WebRelay™. All requests from the Internet to any device on the local network must use the public IP address (266.70.164.97). 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 65235. 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, X-300™ 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 X-300™ would be associated with port 8000. The address 192.168.1.26 for WebRelay™ would be associated with port 8001. X-300™ would be accessed from the Internet by entering the public IP address of the router, plus the port number assigned to X-300™ in the URL

window of the browser, http://266.70.164.97:8000. All Internet requests to the router for port 8000 would be forwarded to X-300™. 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://266.70.164.97), the router will handle this as a port 80 request (default HTTP port). In other words, http://266.70.164.97 is exactly the same as http://266.70.164.97:80.

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://266.70.164.97:8000 would be forwarded to http://266.70.164.97:80, 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.
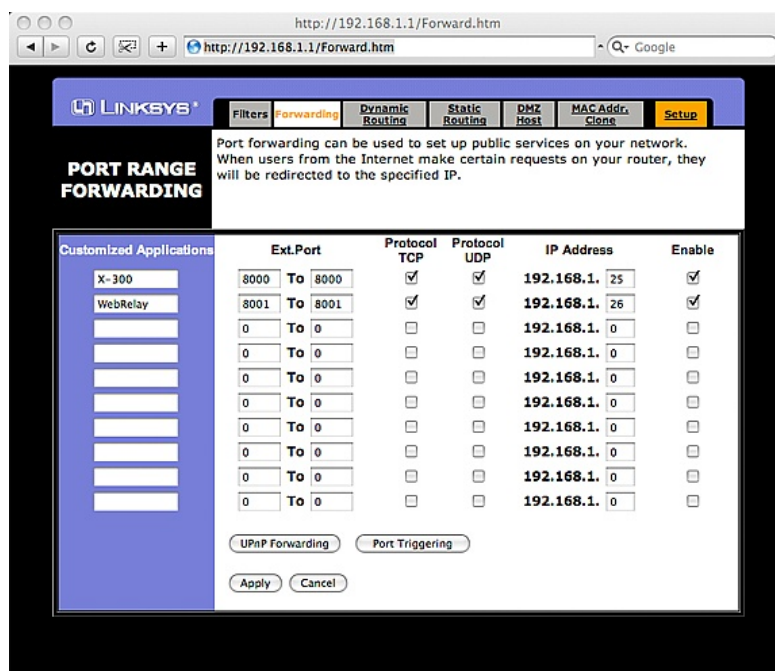
Figure Appendix C.3- Port Range Forwarding
Note: This screen shot is simply an example of a typical router setup page. Routers will vary.

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 X-300™:

```
http://266.70.164.97:8000/setup.html
```

Appendix D: Log Files

X-300™ 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 is also 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** setup tab, and stores real-world data such as temperatures and events such as relay state changes (see section **2.4.6 Logging Tab** for more information). It can be up to 512K bytes long and is stored using a compressed numerical format. When transferred it is converted to a comma separated format.

Relays 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 X-300™. 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
```

File Format:

Thermostat Mode

```
        MM/DD/YYYY HH:MM:SS, Set Temp, Indoor Sensor, Outdoor Sensor, Heat,
Cool, Fan
```

Temperature Monitor Mode

```
        MM/DD/YYYY HH:MM:SS, Sensors 1-8, Relays 1-3,
```

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)

Sample Files:

Thermostat Mode

```
Date Time, Set Temp, Indoor Sensor, Outdoor Sensor, Heat, Cool, Fan
08/04/2011 22:05:58,065.0,080.9,080.9,0,1,0
08/04/2011 22:05:58,065.0,080.9,080.9,0,1,1
08/04/2011 22:06:11,072.0,080.9,080.9,0,1,1
```

Temperature Monitor Mode

```
Date Time, Sensors 1-8, Relays 1-3
08/08/2011 10:51:02,088.1,088.0,082.8,083.5,081.0,081.0,070.8,034.5,1,0,0
08/08/2011 10:51:03,088.1,088.0,082.8,083.5,081.0,081.0,070.8,034.5,1,0,1
08/08/2011 10:51:06,087.5,087.5,082.8,083.5,080.9,080.9,070.6,034.5,1,1,1
08/08/2011 10:51:08,087.2,087.3,082.8,083.5,080.9,080.9,070.8,034.5,1,0,1
08/08/2011 10:51:10,087.0,087.1,082.8,083.5,080.9,080.9,070.8,034.6,1,0,1
```

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
```

After erasing the file, it might be necessary to refresh the page.

Note: If the Control Password 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
```

Appendix E: External Server and Remote Services

Note: The following methods are supported by X-300™; however, Xytronix Research & Design, Inc. does not provide or support custom third party applications, or external web servers.

Accessing X-300™ with Custom Software or Third Party Applications

Custom applications can send commands to X-300™ for monitoring and control functions using XML. (See **3.3 XML Operation** 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.

Using an External Web Server

Rather than accessing X-300™ 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 or IIS) that is not the web server built into X-300™. In this scenario, users access custom web pages that reside on the external web server and the external web server communicates with X-300™.

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 X-300™ 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 X-300™. 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 the web server and all of X-300™ devices are on the same network (without routers between them). In this case, the server can communicate with X-300™ devices directly and securely since data never has to leave the local network.

When the server and X-300™ 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 X-300™ to initiate a connection using the "Remote Services." The settings under the **Advanced Network** tab in the setup pages will enable the X-320™ 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 X-300™ are installed on different networks. This is especially useful when each

X-300™ is installed on a separate private network. For example, if the user doesn't control the network connections where X-300™ is installed, "Remote Services" would initiate a TCP connection over the Internet with the control computer. Since X-300™ initiates the connection, the control computer doesn't have to know the IP address of X-300™. This means that X-300™ can be installed using DHCP. In addition, no special router configuration is required. This makes the network installation of X-300™ very

simple, and since no incoming ports need to be opened in the router, security is not compromised. See section **2.4.3 Advanced Network Tab** for more information.

X-300™ can be configured to establish a connection when triggered by an event, such as a Relay state changing. This is done by setting the Remote Service/SNMP checkbox in the Relay setup tabs.

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. Once the connection is established state.xml will be sent.

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 is a user-defined character string configured in the **Advanced Network** tab.

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.

Appendix F: SNMP Requests, Objects and Community Strings

Relay states, Temperature/Humidity measured by the X-300™, and some simple network parameters can be retrieved using Simple Network Management Protocol(SNMP). The states of the Relays can be changed through SNMP requests. 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. X-300™ can make use of the following MIB files: RFC1213-MIB and XYTRONIX.mib.

Note: As additional ControlByWeb products are introduced, the Xytronix MIB file will remain reverse compatible, older MIB files can be overwritten.

SNMP is configured under the **Advanced Network** setup tab. See section **2.4.3 Advanced Network Tab** for more information.

X-300™ supports the following Packet Data Units (PDU):

- GetRequest
- GetNextRequest
- SetRequest
- Trap

Standard Objects

X-300™ 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-300 - Thermostat/Temperature Controller
system.sysObjectID	X300: 13.6.1.4.30586.10
system.sysUpTime	Time in hundredths of seconds since X-300™ was last powered.
system.sysName	X-300*

*The sysName is customizable under the **Control Page Setup** tab.

Xytronix Objects

X-300™ also supports some special objects that can be found in the XYTRONIX.mib. This MIB can be downloaded from our website.

Read Only Objects:

Sensors

Object	Response
x300_sensorOne	Value: x.x (Decimal temperature or humidity.)
x300_sensorTwo	Value: x.x (Decimal temperature or humidity.)
x300_sensorThree	Value: x.x (Decimal temperature or humidity.)
x300_sensorFour	Value: x.x (Decimal temperature or humidity.)
x300_sensorFive	Value: x.x (Decimal temperature or humidity.)
x300_sensorSix	Value: x.x (Decimal temperature or humidity.)
x300_sensorSeven	Value: x.x (Decimal temperature or humidity.)
x300_sensorEight	Value: x.x (Decimal temperature or humidity.)
x300_tempIndoor	Value: x.x (Decimal temperature.)
x300_tempOutdoor	Value: x.x (Decimal temperature.)

Read/Write Objects:

Relays – Read/Write

A Get request will return the current state. A Set request of 0 or 1 will turn the Relay **ON** or **OFF**. A Set request of 2 will pulse the Relay for the time configured in the setup page.

Object	Response	Set Value
x300_relayOne	Value: 0 or 1	0 - OFF, 1 - ON, 2 - PULSE
x300_relayTwo	Value: 0 or 1	0 - OFF, 1 - ON, 2 - PULSE
x300_relayThree	Value: 0 or 1	0 - OFF, 1 - ON, 2 - PULSE

TRAPS

X-300™ can send SNMP messages when an Relay changes state, or when a particular Sensor value is reached. The SNMP Trap must be configured for each Relay, and Sensor in the setup pages. The following Traps are supported:

Relay Traps

A change in state of the Relay will cause the X-300™ to send a Trap message.

Object	Description	Value
X300.75	Relay one state change.	0 or 1 (0 – OFF, 1 – ON)
X300.76	Relay two state change.	0 or 1
X300.77	Relay three state change.	0 or 1

Sensor Traps

Two alarm thresholds can be configured for each sensor. An SNMP Trap message can be sent when the temperature boundaries are crossed. See **2.3.9 Sensor Tab** for more information on configuring the sensor alarms.

Object	Description	Value
X300.65	Sensor one alarm.	xx.x
X300.66	Sensor two alarm.	xx.x
X300.67	Sensor three alarm.	xx.x
X300.68	Sensor four alarm.	xx.x
X300.69	Sensor five alarm.	xx.x
X300.70	Sensor six alarm.	xx.x
X300.71	Sensor seven alarm.	xx.x
X300.72	Sensor eight alarm.	xx.x

Password

X-300™ uses the Control Password for both the read and write community strings. If the Control Password is disabled, any object can be read without the need for a correct community string. By default the Control Password is webrelay.

Appendix G: BASIC Scripts

BASIC (Beginners All-purpose Symbolic Instruction Code) is a computer programming language that has been in use for many years. The X-300™ has an integrated BASIC interpreter for simple BASIC scripts. 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 computers. Some non-standard commands have been added, and some commands may function differently on the X-300™ BASIC interpreter than on other platforms. The following is a short tutorial on the supported BASIC functions.

Contact customer support if further assistance is required.

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 2 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.

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. Spaces must be used between

all statements, numbers, variables, operators, expressions, etc. Multiple spaces are valid.

Comments may be inserted, but must begin with an apostrophe. All text on a line after the apostrophe is ignored.

Examples:

```
LET a=1             'this will return an error because of insufficient spacing
LET a = 1           'this is valid
LET a = 1           'this is valid
```

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 + 2 is to the left of =).

```
IF a + 2 = 3 THEN 'this will return an error
```

To fix the above line, replace 'a + 2'. One of the following options may be used:

```
IF a = 1 THEN
LET b = a + 2

IF b = 3 THEN
```

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

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

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. The event that triggered the email is given, followed by the Relay or Sensor that you want to email. The format is:

EMAIL (feature state – relayX, inputX, tempX)   'X represents the feature number such as relay2

Examples:

```
    EMAIL        'Status email sent to addresses listed under Network tab.
```
...or...
```
    EMAIL relay2 'Sends state change message to emails setup in Relay tab.
```
...or...
```
    EMAIL input1 'Input state change message to emails setup in Relay tab.
```
...or...
```
    EMAIL temp2  'Temp alarm message sent to recipients in the Sensors tab.
```

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.

PRINT

The PRINT statement displays a variable or message to the display. The PRINT statement is only available for the PC version of the BASIC interpreter. The device will not recognize the command since it does not have an operator display. The format is:

PRINT (variable)   *'show variable value to screen*

PRINT "(message)"   *'show '(message)' to screen*

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
```

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

Six timers are available for use in BASIC scripts.

t0, t1, t2, t3, t4, t5

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
```

Relay Variables

The following variables are available for controlling the relay states.

relay1   *'relay 1*

relay2   *'relay 2*

rmt_relay1   *'remote relay 1*

rmt_relay2

rmt_relay3

Note: Commands can be sent to remote relays, but the states of those relays cannot be read. Consequently, remote relays should not be used in safety or security-critical applications.

Relays can be turned ON, turned OFF, pulsed, toggled, or read in BASIC scripts. The LET statement is used to set the relay state. The state options available are:

0 – turn relay off

1 – turn relay on

2 – pulse relay

5 – toggle relay

The pulse time is specified in the **Relay** setup tab. Relays are designated as relay1, relay2, and relay3.

Examples:

```
Let relay1 = 1      'turn on relay 1
Let relay2 = 0      'turn off relay 2
Let relay1 = 2      'pulse relay 1
Let relay2 = 5      'toggle relay 2
Let a = relay2      'read the state of relay 2, state will be 0 or 1
```

Temperature/Humidity Sensor Variables

Each temperature sensor or humidity sensor can be read in BASIC scripts.

temp1	'temp or humidity sensor 1
temp2	'temp or humidity sensor 2
…	'temp3, temp4, temp5
temp8	'temp or humidity sensor 1

Example:

```
If temp2 >= 80 Then      'If temperature sensor reads greater than 80
                         ' degrees, then
 Let relay2 = 1          'Turn on relay 2
End If
```

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 Relays. 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 relay2 = 1
  Let relay3 = 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 five date variables are available.

ed1	'event date variable 1
…	'ed2, ed3, ed4
ed5	'event date variable 5

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.

et1   'event time variable 1

...   ' et2, et3, et4

et5   'event time variable 5

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).
      Print "Event"              'Event to occur
  End If
 End If
Loop
End
```

External Variables

External variables are similar to general purpose variables and can be used in the same manner. The difference between general purpose variables and external variables is that external variables can be accessed by the user through a web browser and modified while the script is running. Scripts can use external variables as a method of retrieving user input.

extvar1   'external variable 1

…   'extvar2, extvar3

extvar4   'external variable 4

The following example demonstrates this by creating a script that will turn Relay 1 **ON** if extvar1 equals 1 and turn Relay 1 **OFF** if extvar1 equals 0.

Example:

```
Do
 If extvar1 = 1 Then
  Let rmt_relay1 = 1
 Else
  Let rmt_relay1 = 0
 End If
```

```
                Loop
                End
```

External variables can also be used to show numeric values, such as a count down timer. If the extVar is any other value than 1 or 0, the value will be displayed in the Status 2 column, with a gray background. See section **2.4.13 Script Tab** for instructions on configuring external variables for visibility on the **Control Page**.

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 extvar0 = 10

        'Main Loop
        Do
                if t0 = 0                    'when timer reaches 0 decrement counter
                        let extvar0 = extvar0 - 1
                        let t0 = 10
                end if

                if extvar0 < 0          'restart when counter reaches zero
                        let etxvar0 = 10
                end if
        loop
        end
```

Extvar1 can be set and cleared by entering the following requests into a web browser or by configuring on and off buttons to appear on the **Control Page** for extvar0:

```
        http://192.168.1.2/state.xml?extvar1=1
        http://192.168.1.2/state.xml?extvar1=0
```

Example Scripts

Example 1:

If temperature sensor 1 is above 80.5, relay 1 is turned on. If temperature sensor 1 is below 65, relay 2 is turned on.

Note: The relays will turn off as soon as conditions return to normal (between 65 and 80.5 degrees)

```
        DO                                   'The IF THEN statements are looped
                                             'continuously
                IF temp1 > 80.5 THEN         'Tests if sensor 1 is greater than 80.5
                degrees
                        LET relay1 = 1       'Turns on Relay 1 if condition is true
                ELSE
                        LET relay1 = 0       'Turns off Relay 1 if condition is
                                             'false
                END IF
                IF temp1 < 65 THEN           'Tests if sensor 1 is less than 65
                                             'degrees
                        LET relay2 = 1       'Turns on Relay 2 if condition is true
                ELSE
                        LET relay2 = 0       'Turns off Relay 2 if condition is
                                             'false
                END IF
        LOOP
        END
```

Example 2:

Relay 1 is triggered if sensor 1 is above 32 degrees for 10 minutes. It will check every 5 minutes to see if sensor 1 has dropped below 32 degrees. If the sensor has dropped below 32 degrees before the 10 minutes are up, the relay will not be triggered. In addition to the relay being triggered, we also want to log the time at which the relay is triggered and send an email notification.

```
DO                                  'Loops statements continuously
      DO WHILE temp1 > 32           'Loops IF THEN statements if sensor 1 is
                                    'greater than 32 degrees
      CALL delay                    'Waits 5 minutes
      IF temp1 > 32 THEN            'If sensor 1 is still greater than 32 degrees,
then
            CALL delay             'Waits another 5 minutes
            IF temp1 > 32 THEN  'If sensor 1 is still greater than 32 degrees,
then
                  LET relay1 = 1      'Triggers relay 1
                  LOG               'Logs according to selected log settings
                  EMAIL temp1   'Sends an email notification from sensor 1
            END IF
      END IF                        'If sensor 1 drops below 32 degrees before 10
                                    'minutes are up,
      LOOP                          'then the program restarts because the IF
                                    'statement failed
      LOOP
END

SUB delay                           'Subroutine delays script by 5 minutes
LET t1 = 3000
DO WHILE t1 <> 0
LOOP
END SUB
```

Testing and Debugging

A copy of the BASIC interpreter for Windows is also available on our website for the use of testing and debugging. The X-300™ will only acknowledge errors as it runs. This means that if a path of the script is not encountered, errors may still exist. The Windows version of the interpreter, however, will check for errors before the script is run.

The PRINT function is available for use with the Windows version of the BASIC interpreter. The interpreter on the device, however, will not recognize this command.

Note: The script will be restarted by submitting any of the setup pages or by power cycling the unit.

MISSING END OF LINE error may be caused by misspelled names or a program that is too long. 1900 bytes of memory is reserved for BASIC scripts. Each text character, space, punctuation mark, tab, or carriage return uses one byte. If the script is too long, the script will be truncated and will not function as desired.

Appendix H: Modbus Details

Additional Modbus details are provide in this section regarding packet structure and field data. Basic Modbus information is contained in **3.5 Modbus Operation**.

Read Coils - Modbus Function Code 01 (0x01)

This function returns the state of the Relay. `0` denotes that the relay is *OFF*, 1 denotes that the relay is *ON.*

Request

Valid starting address can fall in the range of 0x0000 and 0x0002. Relay 1 is at address 0x0000, Relay 2 is at address 0x0001, Relay 3 is at address 0x0002. All three relays may be read at the same time by specifying the correct starting address and quantity of coils to be read.

Start Address: 0x0000 (coil 1) to 0x0001 (coil 3)

Coil Quantity: 0x0001 (1 coil) to 0x0003 (3 coils)

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

Modbus TCP Request Frame Example – Read Coils 1 through 2			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0006`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Read Coils	`0x01`
Data	4 bytes	Start Address (0x0000-0x0002) Quantity of coils to read (0x0001-0x0003)	`0x0000` `0x0003`

Tx String: 00 01 00 00 00 06 FF 01 00 00 00 03

Response

The X-300™ will respond to the request with a data field of one byte, each bit representing the coil status. A `1` indicates the Relay is *ON*. A `0` indicates that the Relay 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 Relay 2.

Coil State Byte							
Bit 7	6	5	4	3	**2**	**1**	**Bit 0**
X	X	X	X	X	Relay 3	Relay 2	Relay 1

X-300™ Response Frame Example – Status of Relay 1, Relay 2, and Relay 3			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0004`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Read Coils	`0x01`
Data	2 bytes	Byte Count (`0x01`) Coil status (`0x00 to 0x03`)	`0x01` `0x03`

RX String: 00 01 00 00 00 06 FF 01 01 03

Errors

The following are possible error responses for function code 0x01.

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 Relays

Error Response Frame Example			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization between messages of server and client.	0x0001
Protocol Identifier	2 bytes	Zero for Modbus/TCP	0x0000
Message Length	2 bytes	Number of bytes in frame (below)	0x0003
Unit Identifier	1 byte	Slave Address (0xFF if not used)	0xFF
Function Code	1 byte	Function code	0x81
Data	1 byte	Exception code (0x01 - 0x02)	0x02

Rx String: 00 01 00 00 00 03 FF 81 02

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

Read Temperature Sensors and Thermostat Temperature Setting

The Read Holding Registers function is used for temperature and humidity sensors.

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

Request

Start Addresses

Sensor #	Address
1*	0x110
2*	0x112
3*	0x114
4	0x116
5	0x118
6	0x11A
7	0x11C
8	0x11E
Set Point*	0x0210

Note: Only can be read in Thermostat mode.

Modbus TCP Request Frame Example – Read Temperature/Humidity Sensors			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	0x0001
Protocol Identifier	2 bytes	Zero for Modbus/TCP	0x0000
Message Length	2 bytes	Number of bytes in frame (below)	0x0006
Unit Identifier	1 byte	Slave Address (0xFF if not used)	0xFF
Function Code	1 byte	Read Multiple Registers	0x03

Data	4 bytes	Start Addresses for sensors
		    Temp/RH (0x0110-0x011E)
		Start Address for Thermostat
		    Set Temp (0x210)
		Quantity (0x0002-0x0010)
			0x0110
			
			0x0006

TX String: 00 01 00 00 00 06 FF 03 01 10 00 06

Response

The X-300™ uses little-endian transmission. With little-endian ordering, a temperature reading of sensor 1 (0x0110) 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.

Modbus TCP Request Frame Example – Read Sensor 1 and 2			
Field Name	Length	Function	Example Data
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x000B`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Read Sensors	`0x03`

Data	5-13 bytes	Byte Count: (0x04-0x18)
		Value: (0x00000000-0xFFFFFFFF)
			`0x0C`
			`0x533342A2`
			`0x96274053`
			`0x95314053`

Rx:00 01 00 00 00 0B FF 03 0C 53 33 42 A2 96 27 40 53 95 31 40 53

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

Error Response Frame Example			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization between messages of server and client.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0003`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Error code	`0x83`
Data	1 byte	Exception code (0x01 - 0x02)	`0x02`

RX String: 00 01 00 00 00 03 FF 83 02

Read Thermostat Modes (Thermostat Mode Only)

Request

Start Address: 0x0212 to 0x214 (Read Set Point)

Quantity: 0x0006

Modbus TCP Request Frame Example – Read Temperature/Humidity Sensors			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0006`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Read Multiple Registers	`0x03`

Data	4 bytes	Start Addresses for Thermostat
		　　　Fan Mode　　　(0x212)
		　　　Heat Mode　　　(0x213)
		　　　Hold State　　　(0x214)
		Quantity (0x0002-0x0006)
			`0x0212`
			
			`0x0003`

TX String: 00 01 00 00 00 06 FF 03 02 12 00 03

Response

The response is on 16-bit word for each parameter requested. The following a possible response values.

Mode/State	**Address**	**Response Values**
Fan Mode	0x212	0 – On 1 – Automatic
Heat Mode	0x213	0 – Off 1 – Heat 2 – Cool 3 – Auto
Hold State	0x214	1 – On 2 – Off

Modbus TCP Request Frame Example – Read Sensor 1 and 2			
Field Name	Length	Function	Example Data
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x000B`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Read Sensors	`0x03`

Data	2 to 8 bytes	Byte Count: (0x01-0x03)
		Value: (0x0000 to 0x0007)
			`0x06`
			`0x0001`
			`0x0000`
			`0x0000`

Rx:00 01 00 00 00 0B FF 03 06 00 01 00 00 00 00

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

Error Response Frame Example			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization between messages of server and client.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0003`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Error code	`0x83`
Data	1 byte	Exception code (0x01 - 0x02)	`0x02`

RX String: 00 01 00 00 00 03 FF 83 02

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

This function allows you to control the Relays one at a time. Only available in Temperature Monitor Mode.

Relay Address (2 bytes):   0x0000 (Relay 1) – 0x00002 (Relay 3)

Relay Value (1 byte):   0x00 (OFF), 0xFF(ON)

Padding (1 byte):   0x00

Request

Modbus TCP Request Frame Example – Write Coil 2 ON			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0006`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Write Coil	`0x05`

Data	4 bytes	Relay address (0x0000 – 0x0002)
		Relay value (0x00, 0xFF)
		Padding (0x00)
			`0x0001`
			`0xFF`
			`0x00`

Tx String: 00 01 00 00 00 06 FF 05 00 01 FF 00

Response

X-300™ Response Frame Example – Write Coil 2 ON			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0006`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Write coil	`0x05`

Data	4 bytes	Relay address (0x0000 - 0x0002)
		Relay value (0xFF, 0x00)
		Padding (0x00)
			`0x0001`
			`0xFF`
			`0x00`

Rx String: 00 01 00 00 00 06 FF 05 00 01 FF 00

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.

Error Response Frame Example

Field Name	Length	Function	Example Data
Transaction Identifier	2 bytes	Synchronization between messages of server and client.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0003`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Error code	`0x85`
Data	1 byte	Exception code (0x01-0x03)	`0x03`

RX String: 00 01 00 00 00 03 FF 85 03

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

One byte can be written to set the state of all the relays, each bit representing one relay. Only available in Temperature Monitor Mode.

Start Address (2 bytes):   0x0000 (Relay 1) – 0x0002 (Relay 3)

Relay Quantity (2 bytes):   0x0001 – 0x0002

Byte Count (1-2 bytes):   0x01

Relay Value (1-2 bytes):   0x0000 – 0x0003

Relay State Byte							
Bit 7	6	5	4	3	2	1	Bit 0
X	X	X	X	X	Relay 3	Relay 2	Relay 1

Request

Relay states are controlled by specifying the start address of the first Relay to be controlled, the number of relays to be affected, and the relay state byte.

Modbus TCP Request Frame Example – Write Coils 1 ON, 2 OFF			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	0x0001
Protocol Identifier	2 bytes	Zero for Modbus/TCP	0x0000
Message Length	2 bytes	Number of bytes in frame (below)	0x0009
Unit Identifier	1 byte	Slave Address (0xFF if not used)	0xFF
Function Code	1 byte	Write Multiple Coils	0x0F
Data	8-9 bytes	Start address (0x0000 – 0x0002) Relay quantity (0x0001 - 0x0003) Byte count (0x01) Byte value (0x00 – 0x03)	0x0000 0x0002 0x01 0x01

TX String: 00 01 00 00 00 09 FF 0F 00 00 00 02 01 01

A relay value of 0xFFFF would be used to turn **ON** all of the relays in the range or 0x0000 to turn them **OFF**. In the above example, the relay value 0xFF would turn Relays 1-2 **ON**.

Response

X-300™ Response Frame Example – Write Coils 1-2 ON			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	0x0001
Protocol Identifier	2 bytes	Zero for Modbus/TCP	0x0000
Message Length	2 bytes	Number of bytes in frame (below)	0x0004
Unit Identifier	1 byte	Slave Address (0xFF if not used)	0xFF
Function Code	1 byte	Write Multiple Coils	0x0F
Data	4 bytes	Start address (0x0000 – 0x0002) Relay count (0x0001)	0x0000 0x0001

RX String: 00 01 00 00 00 06 FF 0F 00 00 00 01

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 Relay quantity

0x03 – Byte count out of range.

Error Response Frame Example			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization between messages of server and client.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0003`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Error code	`0x8F`
Data	1 byte	Exception code (`0x01 - 0x02`)	`0x02`

Rx String: 00 01 00 00 00 03 FF 8F 03

Write Multiple Registers – Modbus Function Code 16 (0x10)

Function 16 may be used for pulsing the relays in temperature monitor mode, as well as control the device when it is in thermostat mode.

Pulse Relays (Temperature Monitor Mode Only)

The Modbus Write Multiple Registers function is used to pulse the Relay(s) for a specified time. When X-300™ receives this command, it immediately turns the appropriate Relay(s) **ON** (if not already on) and starts the pulse timer. The Relay(s) are selected by writing the pulse time in seconds to the register(s) associated with the appropriate Relay(s).

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 Relay 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 X-300™ (Modbus, xml, 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.

Request

Pulse Coil Function Code (1 byte):   0x10

Start Address (2 bytes):   0x0010 (Relay 1) – 0x0014 (Relay 3)

Register Quantity (2 bytes):   0x0002 – 0x0004 (2 registers for each Relay, even number)

Byte Count (1 byte):   0x04 – 0x08 (Multiples of 4)

Pulse Duration (4 bytes, per Relay):   0xCCCC3DCC – 0xC00047A8 (little-endian)

In the example shown below, the Relay will pulse for 10 seconds. Ten seconds is represented using a floating point number of 41200000. It is transferred as 00004120, using little-endian.

Modbus TCP Request Frame Example – Pulse Coil 1 for 10 s			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x000B`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Pulse Coils (Write Multiple Registers)	`0x10`

Data	9-13 bytes	Start address (0x0310 – 0x0312)
		Register quantity (0x0002 – 0x0004)
		Byte count (0x04 - 0x08)
		Pulse Duration (0xCCCC3DCC – 0xC00047A8)
			`0x0310`
			`0x0002`
			`0x04`
			`0x00004120`

Tx String: 00 01 00 00 00 0B FF 10 00 10 00 02 04 00 00 41 20

Response

X-300™ Response Frame Example – Write Coils 1-2 ON			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0004`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Write Multiple Coils	`0x0F`
Data		Start address (0x0000 – 0x0001) Relay count (0x0001 – 0x0002)	`0x0000` `0x0002`

Rx String: 00 01 00 00 00 04 FF 10 00 00 00 02

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 Relay count.

Error Response Frame Example			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization between messages of server and client.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0003`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Error code	`0x90`
Data	1 byte	Exception code (0x01 - 0x02)	`0x02`

Rx String: 00 01 00 00 00 03 FF 90 02

Set Fan/Heat/Hold Modes (Thermostat Mode Only)

When writing to the Heat Mode, Fan Mode, and Hold State registers, the values are sent as 32-bit integers. The table below gives the possible values.

Request

Start Address (2 bytes):   0x0212 (Fan Mode)

                                        0x0213 (Heat Mode)

                                        0x0214 (Hold State)

Register Quantity (2 bytes):   0x0001 – 0x0003 (1 registers for each relay)

Byte Count (1 byte):   0x01 – 0x03

Mode (2 bytes/Relay):   0x0000 – 0x0003

Mode/State	Starting Address (Decimal)	Starting Address (Hexadecimal)	Request Values (Decimal)
Fan Mode	530	0x0212	1 - Auto 0 - On
Heat Mode	531	0x0213	0 - Off 1 - Heat 2 - Cool 3 - Auto
Hold State	532	0x0214	0 - Off 1 - On

Modbus TCP Request Frame Example – Set Fan Mode to Auto and Turn Heat On			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0006`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Write Multiple Registers (0x16)	`0x16`

Data	4 bytes	Start address (0x0212 – 0x0214)
		Register quantity (0x0001 - 0x0003)
		Byte count (0x01 - 0x03)
		Register value (0x00 – 0x07)
			`0x0212`
			`0x0001`
			`0x02`
			`0x0001`

Tx String: 00 01 00 00 00 06 FF 16 02 12 00 01 02 00 01

Response

The request is acknowledged by responding with the register and quantity that was requested.

Modbus TCP Request Frame Example – Set Fan Mode to Auto and Turn Heat On			
Field Name	**Length**	**Function**	**Example Data**
Transaction Identifier	2 bytes	Synchronization number.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0004`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Write Multiple Coils	`0x0F`
Data		Start address (0x0212 – 0x0214) Quantity (0x0001 – 0x0003)	`0x0212` `0x0001`

Tx String: 00 01 00 00 00 06 FF 16 02 12 00 01

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 Relay count.

Error Response Frame Example

Field Name	Length	Function	Example Data
Transaction Identifier	2 bytes	Synchronization between messages of server and client.	`0x0001`
Protocol Identifier	2 bytes	Zero for Modbus/TCP	`0x0000`
Message Length	2 bytes	Number of bytes in frame (below)	`0x0003`
Unit Identifier	1 byte	Slave Address (0xFF if not used)	`0xFF`
Function Code	1 byte	Error code	`0x90`
Data	1 byte	Exception code (0x01 - 0x02)	`0x02`

Rx String: 00 01 00 00 00 03 FF 90 02Pulse Function code Error (1 Byte):   0x90

Appendix I: Specifications

Power Requirements

- Voltage Input:
    • Model X-300-I : 9-28 VDC
    • Model X-300-E : Power Over Ethernet (48V injected into Ethernet Line as per 802.3af specification) POE Class 1 (0.44Watt to 3.84Watt range) or 5 VDC ± 5%.
- Current - See table below for typical values at 25°C.

10 Mbps Network Speed

Power Supply	No Relays Energized	3 Relays Energized
5 VDC	184 mA	407 mA
9 VDC	118 mA	287 mA
12 VDC	89 mA	217 mA
24 VDC	48 mA	111 mA
28 VDC	43 mA	99 mA

100 Mbps Network Speed

Power Supply	No Relays Energized	3 Relays Energized
5 VDC	314 mA	530 mA
9 VDC	201 mA	378 mA
12 VDC	151 mA	281 mA
24 VDC	81 mA	145 mA
28 VDC	71 mA	125 mA

Terminal Connector

- 14-position, removable terminal strip, 3.81 mm spacing (Replacement part number, Phoenix Contact 1803691)

Relay Contacts

- Contact Form: SPDT (form c)
- Contact Material: $AgSnO_2$
- Contact Resistance: 100 milli-ohm max.
- Max Voltage: 28 VAC, 24 VDC
- Max Current: 5 A

Temperature/Humidity Sensors

- 8 Sensor maximum
- 600 ft (180 m) maximum combined cable length

Temperature Sensors

- "1-Wire" Digital Thermometer (Maxim Semiconductor DS18B20)
- +/-0.5°C from -10°C to +85°C

Humidity Sensors

- "1-Wire" Digital Sensor
- 0-100% RH +/- 1.8%

Network

- 10 Base-T or 100 Base-T Ethernet IPv4
- Static IP address assignment or DHCP
- HTTP port selectable
- Standard 8-pin RJ-45 Modular Socket
- Supports Web Browser (HTTP), XML, Modbus/TCP, SNMP protocols

6 LED Indicators

- Power On
- Relays (1-3)
- Network Linked
- Network Activity

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) Power Backup

Capacitor Power Backup

- Supports Real-Time Clock, External Variables, Relay State
- 3 days Minimum Duration

Nonvolatile Memory

- Flash Memory
- All user settings are stored in nonvolatile memory. Settings will not be lost when power is disconnected.

Environmental

- Operating Temperature: -30ºC to 70ºC (-22ºF to 158ºF)
- Storage Temperature: -40ºC to 85ºC (-40ºF to 185ºF)

Mechanical

- Size: 1.41 x 3.88 x 3.1 in. (35.7 x 98.5 x 78 mm), connector not included
- Weight: 4.8 oz (136 g)

Logging

- Stored in Nonvolatile Flash
- Circular Buffer
- 512 kB (Up to 42000 log entries)
- Unlimited data storage possible through web services.

Password Settings

- Password protection on Setup Page
- Optional Password protection on **Control Page**
- Base 64 Password Encoding

- 13 Character, Case-Sensitive Password Length

Electromagnetic Compliance

- IEC CISPR 22, CISPR 24
- FCC 47CFR15 (-I Models:Class B, POE Model: Class A)
- EU EN55024, EN55022

Product Safety Compliance

- IEC 60950-1 / EN 60950-1

Appendix J: Mechanical Information

3.071

.324

.000

.097

.000

2.040

3.768
3.879

M36 (35mm) DIN RAIL

.000

.481

2.981

3.879

.000

.703

1.406

USE #8 PAN HEAD SCREWS

Alphabetical Index