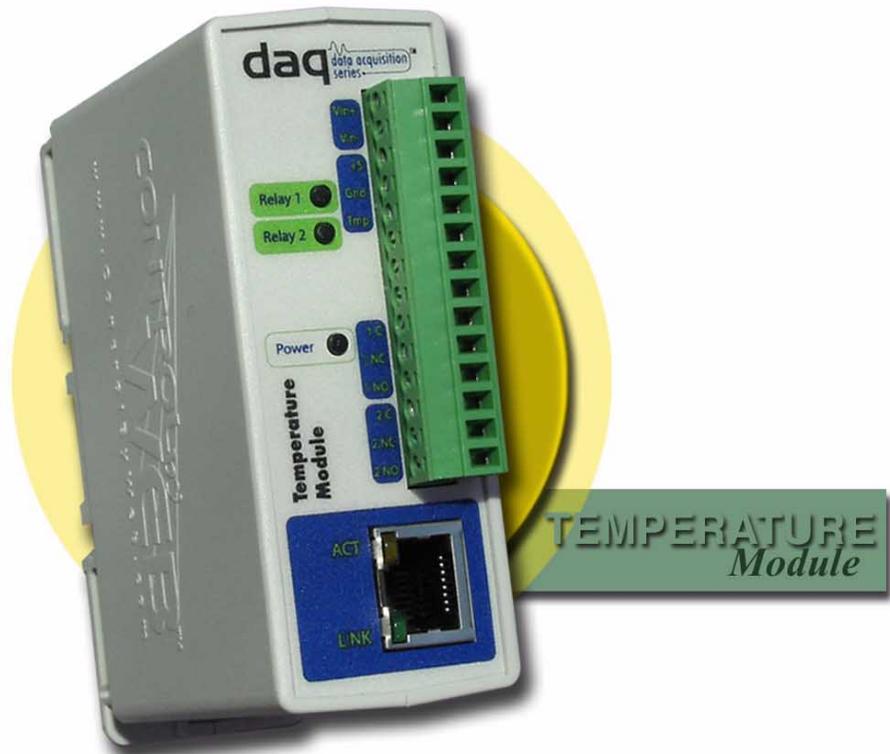


Temperature Module

Ethernet-Based Temperature Acquisition

Users Manual



Revision: 1.1 - June 9, 2008

Covers: X-DAQ-2R1-4T-5
X-DAQ-2R1-4T-I
X-DAQ-2R1-4T-E

CONTROL by **WEB**™
www.ControlByWeb.com

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

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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 (Class A for POE models) 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. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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

Notice: Changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Installation Guidelines (Read Before Installing)

- Do not open the Temperature Module enclosure. This will void the warranty.
- 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.

Notes about security:

By design, the DAQ Series™ product are very secure. They do not support terminal or file transfer programs such as telnet, ftp, ssh, etc. This means that it is not possible for someone to 'break in' to this module and access other devices on your local network. These products do not support remote firmware updates which means that it is not possible for someone to remotely install malicious software. The simplicity of this series of products make them very secure devices. As with any device to be installed on a network, there are some security precautions that should be observed. If this module is installed on the Internet, it is recommended that passwords be enabled for the control page. Make sure secure passwords are used. Passwords should be at least 8 characters in length and should be a combination of upper case letters, lower case letters, and numbers. Don't use passwords that would be easy to guess. For additional security, a firewall may be used to limit access only to selected IP addresses. Another option may be to set up a Virtual Private Network (VPN) between the network where the module resides and the client machine (web browser, PLC, etc.).

Final installation note. This ControlByWeb™ product supports connection to 10Mbps and 100Mbps networks. Although 100Mbps 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 100Mbps. There are advantages however, to operate this device at 10Mbps. At 10Mbps, less power is required, the unit runs cooler, and the lifetime of the product will be extended.

Section 1: Introduction

The DAQ Series™ Temperature Module is an industrial grade, Ethernet data acquisition module for monitoring temperature within the range of -55°C to $+125^{\circ}\text{C}$. It has with two electro-mechanical relays and the ability to communicate with up to four Digital Temperature Sensors. It can be controlled and/or monitored over any IP network including private networks, IP-based industrial control networks, and the Internet. Users can operate the module using a web browser or a custom application. Computers, PLCs, or automation controllers may control and monitor the state of the module without user intervention. This works by sending text commands over the network and reading XML status pages from the module, or by using Modbus/TCP protocol. The electro-mechanical relays can be controlled through the web server interface as well as be setup to respond to alarm conditions based on the temperature sensors. Up to two other ControlByWeb™ products can be controlled by the Temperature Module as the temperature readings of the Digital Temperature Sensors change.

The Temperature Module is very easy to set up using a web browser. It has a simple “Control Page”, which displays the temperature readings of digital temperature sensors that are connected to the module, as well as the current states of the relays.

The Temperature Module provides an XML status page for easy integration with custom monitor and control applications. For interoperability with devices and software produced by other manufacturers, the Temperature Module incorporates Modbus/TCP functionality.

1.1 Features

The Temperature Module is very simple but has many features. Some features include...

- No programming required.
- Easy to use as a stand alone device or as part of a large control system.
- Built-in web server provides simple, web based configuration and control.
- Control page can be customized with appropriate text and buttons.
- 10/100 Ethernet connectivity.
- Two 1 Amp/28V relays.
- Removable terminal connectors (included) simplifies wiring and service.
- Connect one to four digital temperature sensors.
- Set high/low alarms for digital temperature sensors which can control the relays, send out alert emails, and control remote ControlByWeb™ devices.
- Custom applications can control the module with simple text commands and read XML formatted status.
- Modbus/TCP protocol support provides inter-interoperability with devices/software from other manufacturers.
- Password protection.
- Selectable TCP ports.
- On/Off, toggle, or pulse mode.

1.2 Available Models

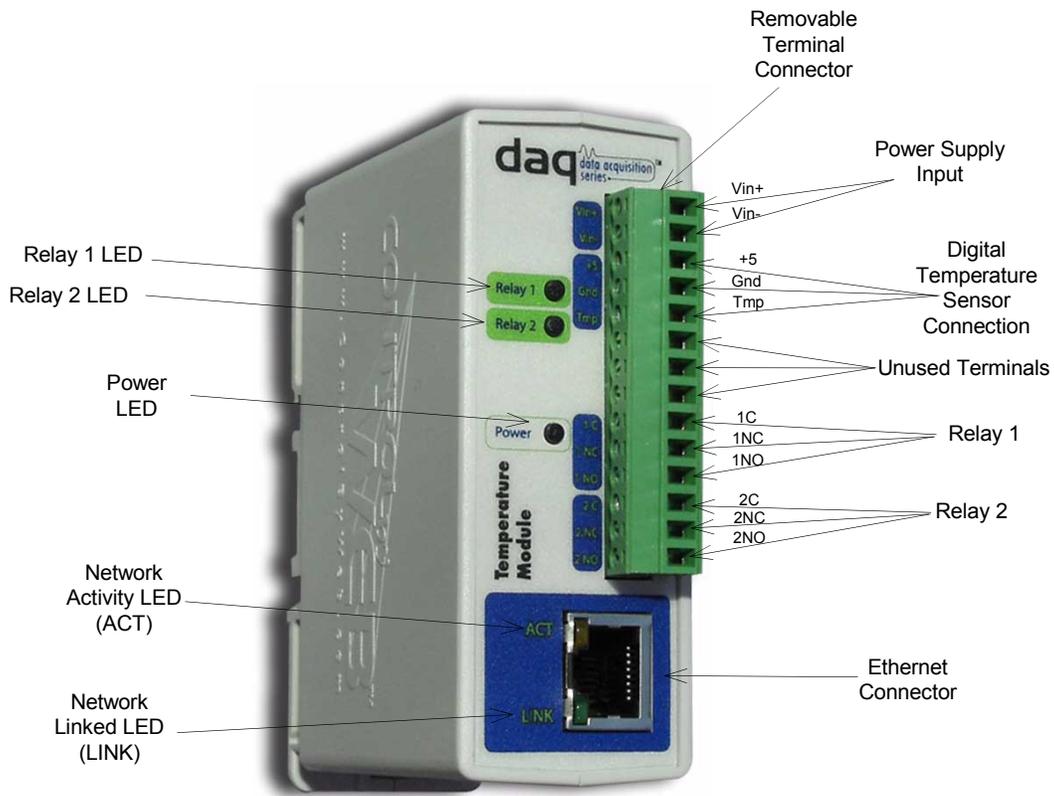
The Temperature Module is currently available in three models. The only difference between the three models is the power supply requirements.

Part Number	Power Supply Requirements
X-DAQ-2R1-4T-5	5VDC
X-DAQ-2R1-4T-I	9-28VDC
X-DAQ-2R1-4T-E	Power Over Ethernet or 5VDC

1.3 Connectors & Indicators

The temperature module has a removable 14-position terminal connector and an Ethernet connector. The 14-position terminal connector is used to provide power to the module as well as connections for the digital temperature sensors. Up to four digital temperature sensors may be connected at one time. Terminals are also available for direct connection to relay contacts which can be used to control other devices.

There are five LED indicators on the temperature module labeled POWER (green), RELAY1 (green), RELAY2 (green), LINK (green), and ACT (amber). Note that the LINK and ACT LEDs are located on the Ethernet connector. The RELAY LEDs indicate that an internal relay coil is energized. When a relay coil is energized, the NO (Normally Open) contact is closed and the NC (Normally Closed) contact is open. The load device that is connected to the relay contacts may be on or off when the coil is energized depending on how it is wired. LINK means the temperature module is properly connected to an Ethernet network. The ACT LED flashes when activity is detected on the network.



1.4 Digital Temperature Sensors

External digital temperature sensors are required for temperature acquisition. The Temperature Module is shipped with one digital temperature sensor however additional temperature sensors can be purchased from ControlByWeb™ and other vendors. Up to four digital temperature sensors can be connected to the Temperature Module at one time. The sensors measure the temperature and convert the analog temperature measurement to a digital format. The digital temperature readings are sent to the Temperature Module periodically (approximately every 800mS). By converting the analog temperature measurement to a digital format, the temperature readings can be transmitted long distances without loss of accuracy and much greater noise immunity.

The temperature sensor components are manufactured by Dallas Semiconductor (Dallas part number DS18B20). These sensors have three leads for Power, Ground, and Temperature Data. Temperature sensors purchased from third-party vendors must be compatible with the Dallas sensors. Additionally, the sensors must support the standard 3-wire connection (the 2-wire connection scheme that Dallas offers is not supported).

The image below shows the sensor that is shipped with the Temperature Module. It includes the sensor with 12 inch lead wires. The lead wires are protected at the sensor using over-molding.

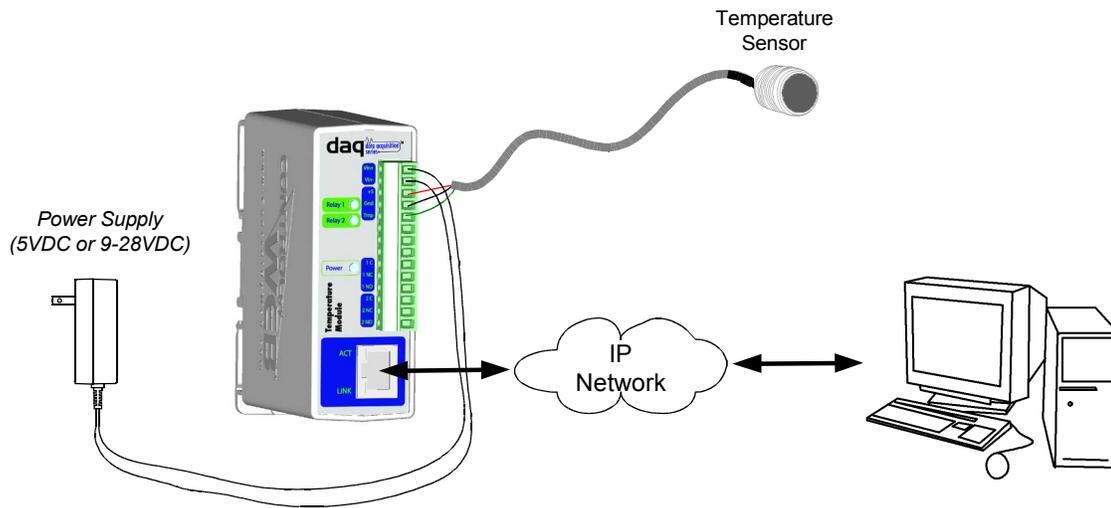


1.5 Example Configurations and Applications

The Temperature Module is very versatile and can be used in many applications. Several basic installation schemes are illustrated in this section.

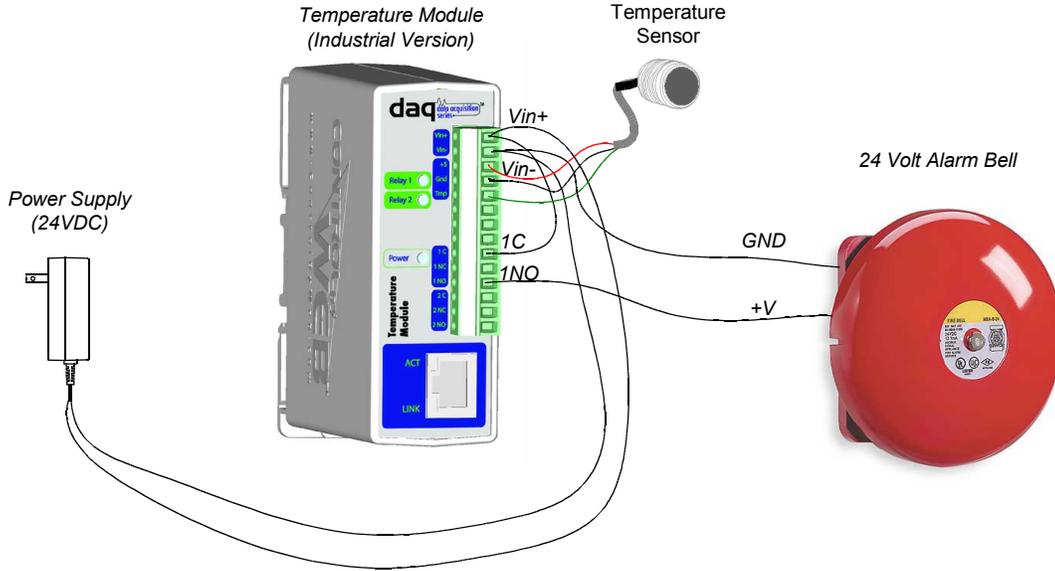
1.5.1 Monitoring Temperature

Monitoring a the temperature read from a digital temperature sensor requires a sensor to be attached to the temperature module, a device capable of requesting and displaying web pages (Computers, PDA's, etc.), and a network through which the temperature module and monitoring device can communicate. Below is an illustration demonstrating how to connect a temperature sensor and monitor it on a personal computer. Up to four temperature sensors can be connected and monitored through the temperature module at one time. Also, the temperature readings can be requested in a XML format which can then be saved to a database, spreadsheet, file, etc. Software can be created to perform these readings periodically for record keeping.



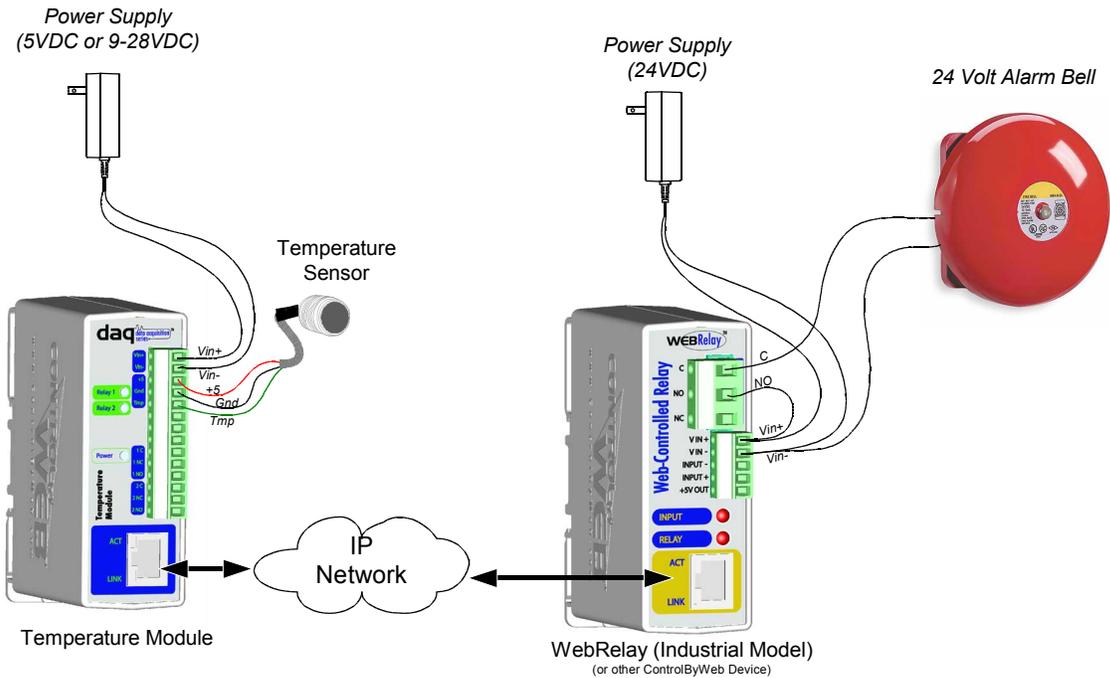
1.5.2 Monitoring Application with Local Alarm

The illustration below shows a simple example of using the temperature module to monitor temperature. The method for wiring the sensor to the temperature module is shown. The relays have been wired to an alarm so that temperatures outside the desired range will sound the alarm. When the temperature falls below the lower set point or rises above the upper set point, the alarm will sound. Relay one has been configured to close when a high alarm occurs, and relay two has been configured to close when a low alarm occurs. See section 2.5.5 for more information on how to configure the relays, as well as section 3.4.2 to understand how alarm conditions work.



1.5.3 Monitoring Application with Remote Alarm

The following illustration shows an example of using the temperature module to monitor temperature. In this example the temperature module has been configured to send messages to another ControlByWeb™ device with a relay. This relay has then been wired to sound an alarm. When the temperature falls below the lower set point or rises above the upper set point, a message will be sent to the remote unit to close it's relay contacts causing the remote alarm to sound. See section 2.5.5 for more information on how to configure the remote messages, as well as section 3.4.2 to understand how alarm conditions work.



Section 2: Installation and Setup

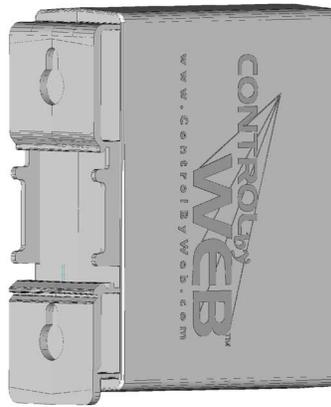
Installation consists of mounting the temperature module, placing and connecting Digital Temperature Sensors, connecting to an IP network, providing power, configuring via a web browser, and wiring relay contacts to the device that will be controlled.

2.1 Mounting

The Temperature Module can be wall mounted or DIN rail mounted. It should be mounted in a clean dry location where it is protected from the elements. Ventilation is recommended for installations where ambient air temperature is expected to be high.

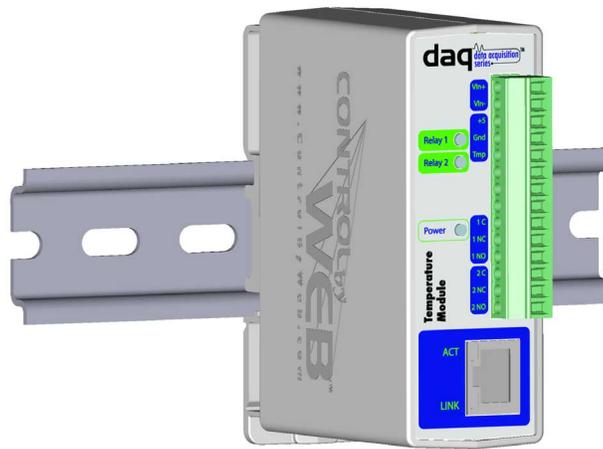
2.1.1 Wall Mounting

Mount the temperature module 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 screws should be about 1/10 inch away from the wall. See Appendix C for mechanical details.



2.1.2 DIN-Rail Mounting

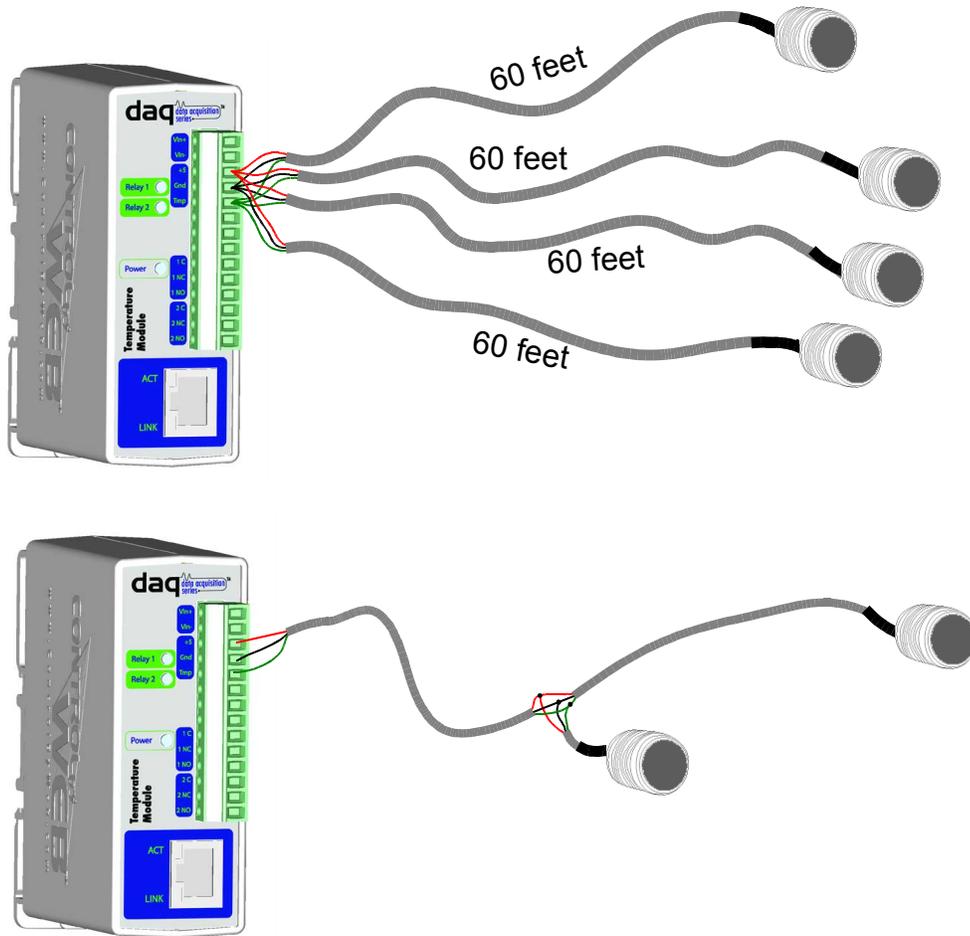
The Temperature Module can be mounted to a standard (35mm by 7.55mm) DIN rail. Attach the temperature module to the DIN rail by hooking the top hook on the back of the enclosure to the DIN rail and then snap the bottom hook into place. Remove temperature module from the DIN rail using a flat-head screwdriver. Insert the screwdriver into the notch in the release tab and pry against the enclosure to release the bottom hook.



2.2 Digital Temperature Sensor Placement

2.2.1 Temperature Sensor Network Design and Limitations

The connection and placement of the digital temperature sensors in relation to each other and to the temperature module form a network called a '1-wire' network. There are different ways in which the network can be configured. Many factors will determine the maximum length of cable used to connect sensors to the temperature module. Some of these factors include, but are not limited to, the gauge and type of the wire used, and the number of sensors connected to the temperature module. In general, the more sensors you have connected to the temperature module, the less distance there can be between them and the temperature module. For example, when connecting four sensors directly to the temperature module each sensor can be a distance of 60 feet away from the temperature module using 24 gauge wire. When using only one sensor, the distance can be lengthened. Note that the sensors can be connected directly to the Temperature Module or the sensors can be “daisy-chained”. These two wiring methods are illustrated below.



When daisy chaining sensors, make sure each sensor is attached to the main cable as close as possible. Having long stubs connecting the sensors to the main cable will cause reflections that can make the network less reliable. In addition, if longer distances are required, using a heavier gauge wire will help.

Another approach is to place the Temperature Module close to the sensor(s) and use a longer Ethernet cable to connect the module to the router or switch.

2.2.2 Digital Temperature Sensor Placement in Monitoring Applications

The placement of the digital temperature sensors depend on the application. The temperature module can act both as a temperature monitor, and a temperature controller. In both cases, cable length limitations must be considered as described in section 2.2.1 but additional considerations are described in this section and the next section.

To accurately measure outdoor air temperature, it is recommended that the sensor be placed 5 feet above ground in an open area where it will not be exposed to direct sunlight. If the sensor is exposed to direct sunlight, or is too close to the ground or other objects that are exposed to direct sunlight, the temperature reading measured by the sensor will be the current temperature of the sensor itself instead of the temperature of the air, as the sun's rays will heat up the sensor.

If, you need to measure the temperature of a specific object, then the temperature sensor should be mounted as close to the object as possible, possibly even touching the object.

Regardless of the location of the sensor, if the sensor is placed outside, make sure it is protected from the elements and that it is secure so wind doesn't blow it around. Also, it is suggested that the wires be run through a PVC conduit if they are to be placed on the ground to protect them from the elements.

2.2.3 Digital Temperature Sensor Placement in Control Applications

The temperature module can be configured to control a heater or cooling unit. As with monitoring applications it is important to place the sensor in a location where it will accurately measure the air temperature and not the temperature of the sensor itself or the temperature of some other object. Note that in control applications, the reading of the sensor will determine how often the heater or cooler turns on as well as the duration. If the sensor is located too far from the heater or cooler, the heater or cooler will stay on too long leading to over heating or over cooling. If the sensor too close to the heater or cooler, then the area surrounding the heater or air conditioner will maintain the desired temperature, but the rest of the area of interest will be too hot or cold. As a general rule, sensor placement midway between the heating or cooling unit and the location farthest away from the heating or cooling unit.

2.3 Connection

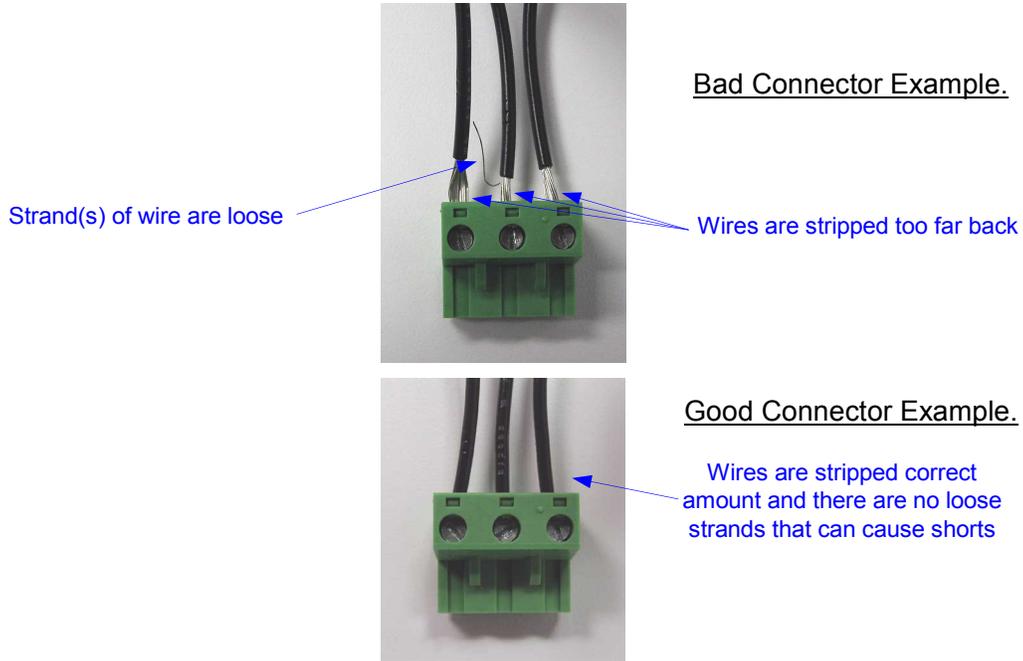
CAUTION: MAKE SURE POWER IS SHUT OFF BEFORE WIRING!

A removable 14-terminal connector is provided for simple wiring to the temperature module. The correct wiring procedure is as follows;

1. Make sure power is turned off.
2. Remove terminal connectors from the temperature module and make wiring connections to the terminals.
3. Reconnect terminal connectors.
4. Apply power.

It is recommended that the loads (devices to be controlled) not be connected to the temperature module until after the module has been configured and tested. By doing this, wiring and configuration mistakes will not cause the load devices to turn on unexpectedly.

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



14-pin connector pinout:

Pin	Description
VIn+	Power supply input +. Connect to the positive side of the appropriate power supply. DO NOT EXCEED MAXIMUM POWER SUPPLY VOLTAGE. <u>Model X-DAQ-2R1-4T-5</u> 5VDC Power Supply <u>Model X-DAQ-2R1-4T-I</u> 9-28VDC Power supply <u>Model X-DAQ-2R1-4T-E</u> Power Over Ethernet model. 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.
Vin-	Vin- Negative power supply input.
+5	+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.
Tmp	Temperature Data. This is the data line connection for the digital temperature sensors.
1C	Relay 1 Common
1NC	Relay 1 Normally Closed
1NO	Relay 1 Normally Open

2C	Relay 2 Common
2NC	Relay 2 Normally Closed
2NO	Relay 2 Normally Open

2.3.1 Power Supply Connection

The temperature module requires power for its internal logic circuits. Connect appropriate power supply to the Vin+ and Vin- terminals. Alternatively, temperature units with the Power Over Ethernet option may be powered through the Ethernet connection instead of using an external power supply.

Multiple temperature modules (and other ControlByWeb™ products) 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 specifications for current requirements for a specific model number).

Temperature Module 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 temperature module 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 temperature module. 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.**

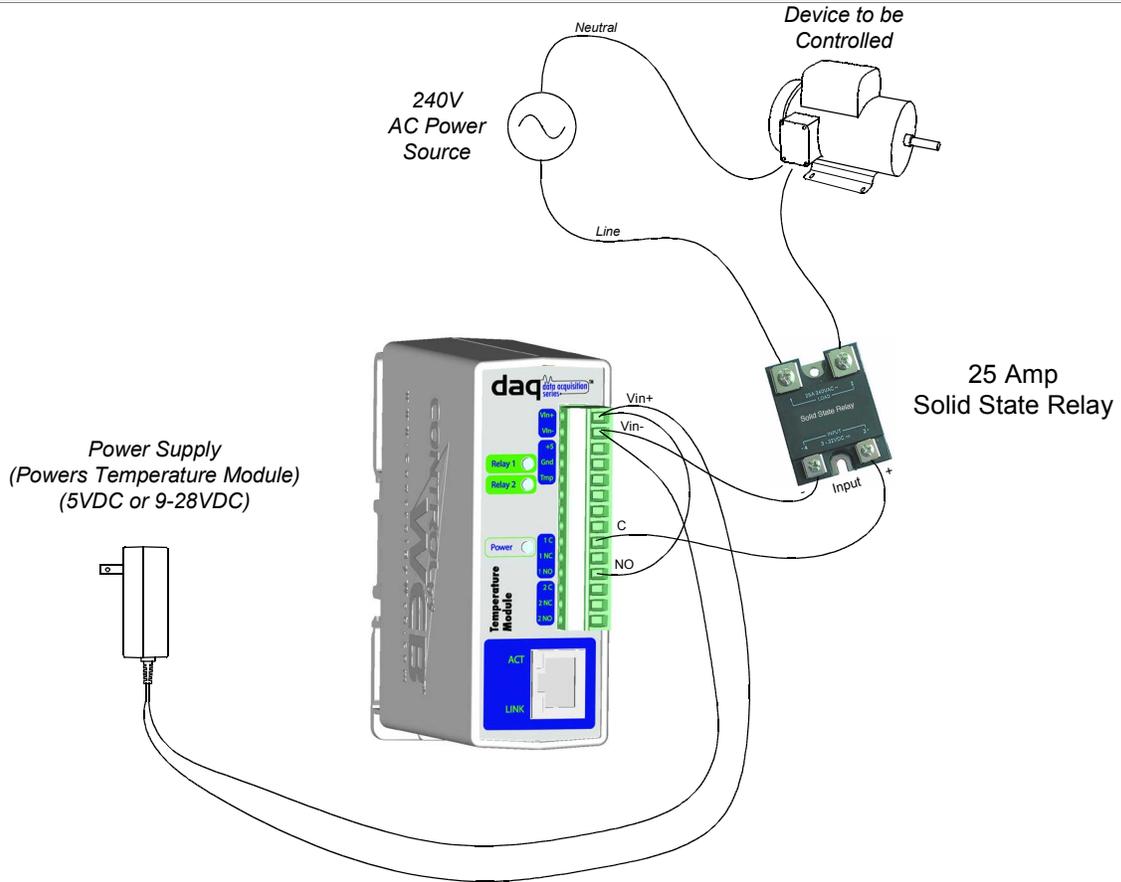
2.3.2 Network Connection

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, the temperature module may be connected directly to the Ethernet port on a computer using a “crossover” cable. Otherwise, for connection through a hub, switch, or router, a standard “straight-thru” cable should be used.

2.3.3 Relay Connection

The temperature module has two internal relays 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. The relay contacts internally connect directly to the terminal connector. 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. Direct access to Common, Normally Open, and Normally Closed contacts are provided. 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 temperature module controls the external relay and the external relay controls the load.

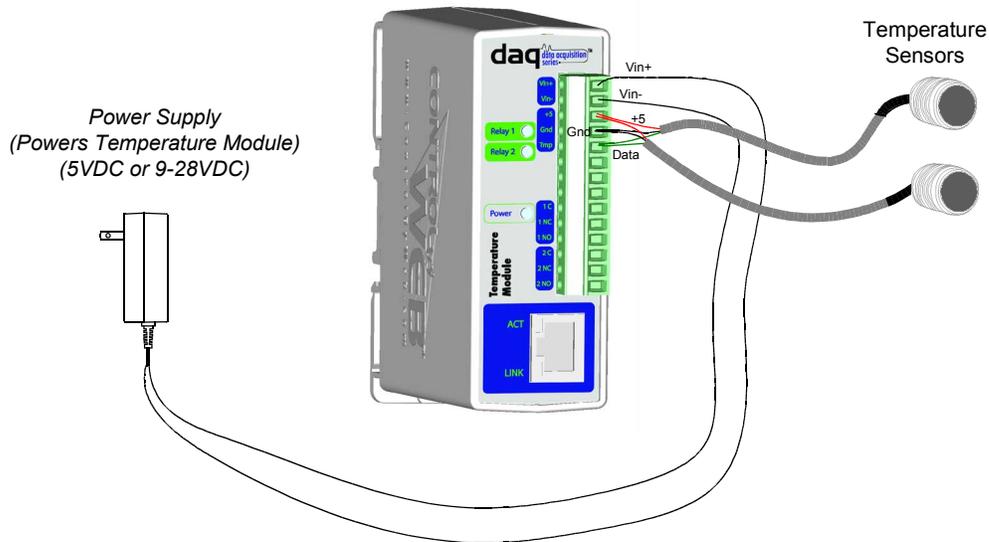


2.3.4 Digital Temperature Sensor Connection

Up to four digital temperature sensors can be connected to the temperature module in parallel using the +5, Gnd, and Tmp terminals (all sensors are connected to the same three terminals).

Sensors purchased from ControlByWeb™ have a red wire for connection to the +5 terminal, a black wire to connect to the Gnd terminal, and another wire for connection to the Tmp terminal (may be white, green, or blue). The Tmp terminal is used to connect to the data line of the temperature sensor. Sensors purchased from other vendors may use different colors so consult the documentation for the sensor before connecting.

As digital temperature sensors are connected and removed, the temperature module maintains a record of the unique ID numbers of the sensors. This ID number is then used by the temperature module to communicate with the temperature sensors as well as to specify which temperature sensor is associated with which user options.



2.4 Establishing Communications for Setup

The Temperature Module is set up using a web browser. The first task is to establish communications between a computer and the temperature module so that the browser-based configuration can begin. To do this, the computer and the temperature module must be physically connected to the same network and both must have IP addresses on the same network. There are two ways to set up the computer and the temperature module so that they are on the same network. The first way (Option 1), is to change the IP address of the temperature module to an address that is on the same network as the computer. The second way (Option 2) is to change the IP address of the computer to an address that is on the same network that the temperature module is set to by default.

2.4.1 Option 1: Assign a temporary IP address to the Temperature Module

This option is used to TEMPORARILY assign an IP address to the temperature module without the need to change the IP address of the configuration computer. Note that the temperature module will only use this IP address as long as power is maintained. Once power is lost and restored, the temperature module will use the IP address assigned in the setup page and not the temporary address assigned here. This means that once communications are established, the desired IP address should be entered into the network setup page using the browser.

To assign the temporary IP address...

1. Make sure the temperature module and the configuration computer are connected to the same physical network. This will not work through routers or gateways.
2. Assign the address as follows...

Windows:

Open a Command Prompt (on Windows XP, select START, then RUN, then type "cmd").

Type...

```
arp -s {new IP address} {serial number of temperature module }
```

Note: IP address format is: xxx.xxx.xxx.xxx
Serial number format is: ss-ss-ss-ss-ss-ss

For example, to set a temperature module (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
```

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
```

Linux/Unix:

Open a terminal, change to root user (su -, then enter root password).

Type...

```
arp -s {new IP address} {serial number of temperature module}
```

Note: IP address format is: xxx.xxx.xxx.xxx
Serial number format is: ss:ss:ss:ss:ss

For example, to set a temperature module (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
```

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
```

Mac OS X

Open a terminal,

Note that the terminal is in the “Utilities” directory which is in “Applications” directory.

```
type  
sudo arp -s {new IP address} {serial number of temperature module}
```

Note: Administrator password is required.
IP address format is: xxx.xxx.xxx.xxx
Serial number format is: ss:ss:ss:ss:ss

For example, to set a temperature module (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
```

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.

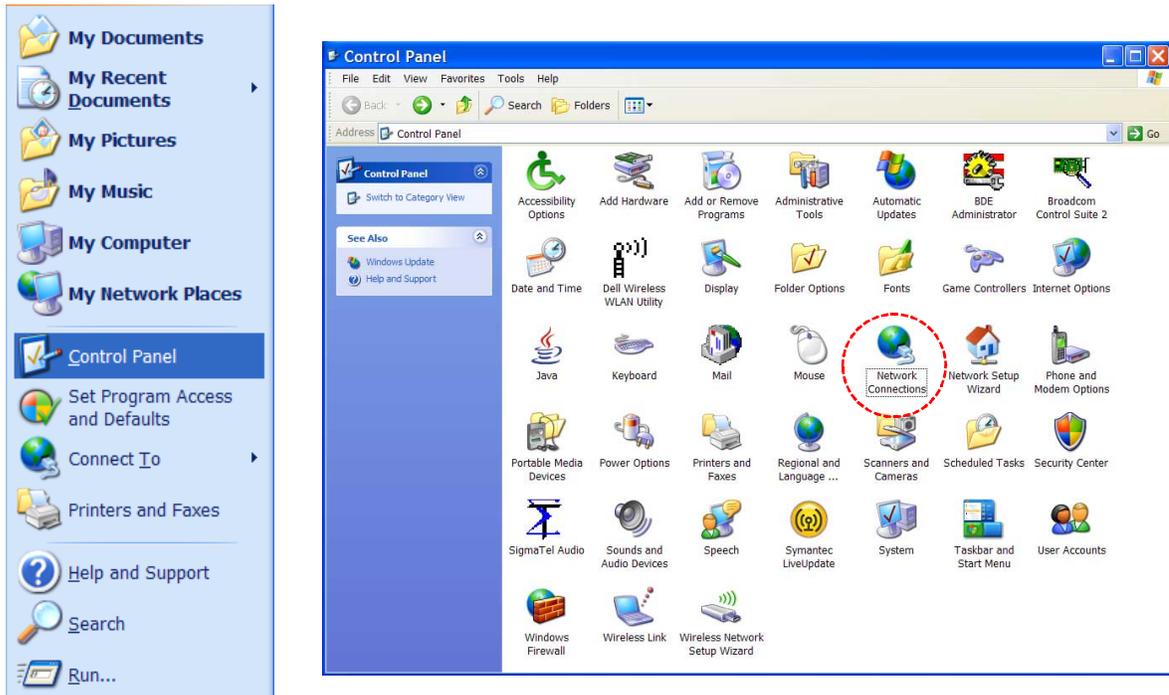
```
ping -s 102 10.10.10.40
```

2.4.2 Option 2: Assign a temporary IP address to configuration computer

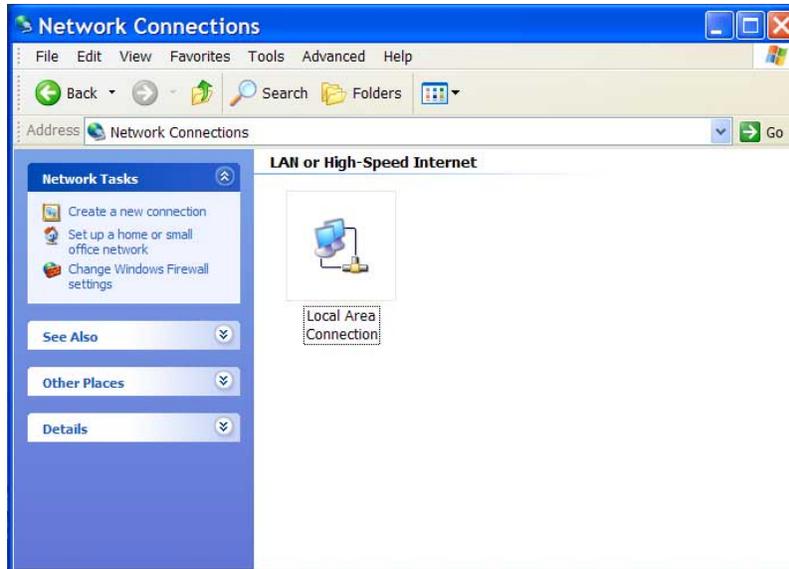
If the first option above is not used, you can use this option to communicate with the temperature module . By default, temperature module comes from the factory with an IP address of 192.168.1.2. Communications with temperature module may be established by assigning an IP address to the configuration computer that is on the same network as temperature module(for example, the configuration computer could be assigned to 192.168.1.5) .

Instructions for changing the IP address of the computer that will be used for the temperature module configuration are given here. Note that these instructions are specifically for computers with the Windows XP operating system. For setup using other operating systems, refer to the appropriate users manual.

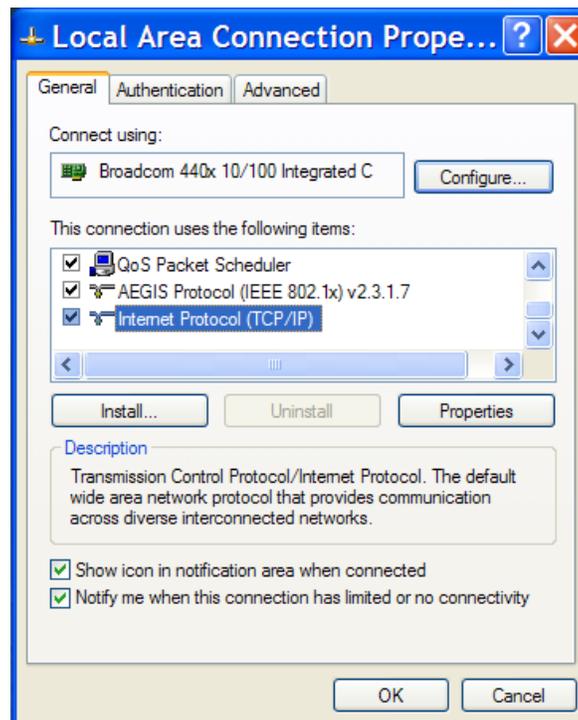
Step 1: Open the control panel by clicking on the start menu and then clicking on Control Panel. (Note that control panel shown is in “Classic View”. If control panel is in “Category View” select the “Classic View” option before proceeding.)



Step 2: Double click on the icon labeled Network Connections. The following menu will pop up.

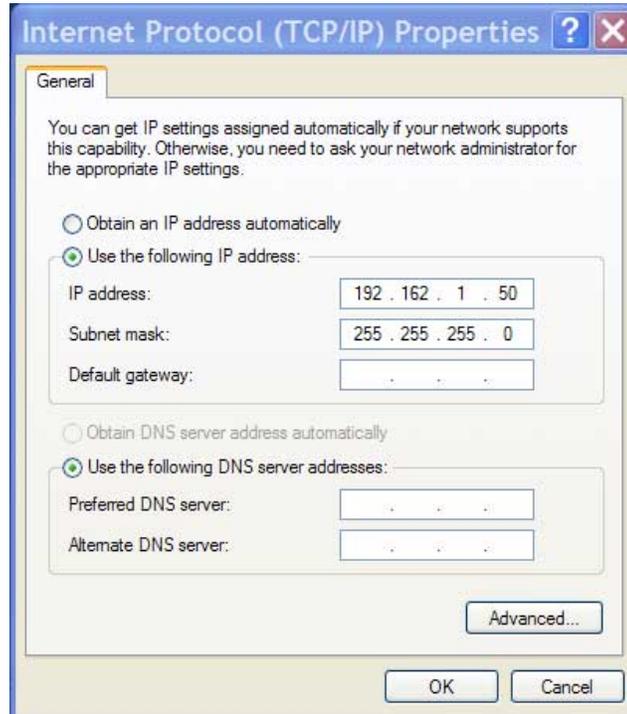


Step 3: Right click on the icon labeled Local Area Connection. Another menu will appear. Select the option at the bottom of the menu labeled Properties. The Local Area Connection Properties window will appear.



Step 4: On the Local Area Connection Properties page scroll down to Internet Protocol (TCP/IP), select it, and then click the button labeled properties.

Step 5: Before making any changes to the network settings, write down the current settings so that they can be restored once the temperature module is configured. Next, select the radio button labeled “Use the following IP address,” and type in the IP address 192.168.1.50. Type in a subnet mask of 255.255.255.0. Leave the default gateway field blank. Click OK to apply the new settings.



2.4.3 Open Configuration Web Page

Once the network is set up, open the configuration setup page by typing the following URL into the browser: <http://192.168.1.2/setup.html> (note that if option 1 above was used for initial configuration, replace the IP address given here with the newly assigned IP address). A password is required to change any parameters. The default password is ‘webrelay’ (do not include quotes, password is case sensitive).

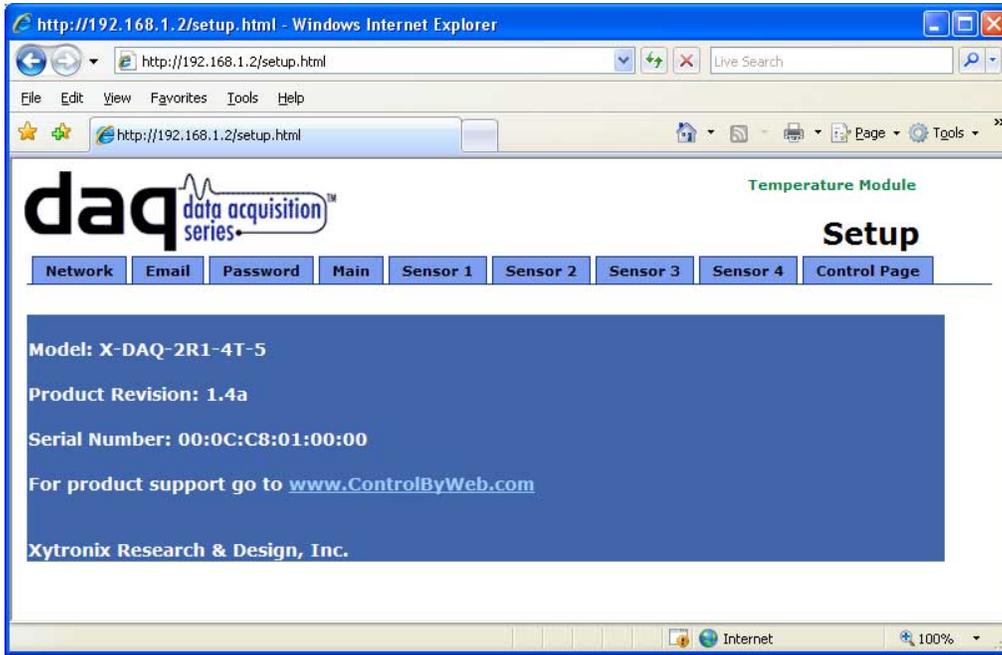
2.5 Web-Based Setup

The Temperature Module is fully configurable through HTML 4.0 compliant web browsers such as Internet Explorer and Mozilla Firefox. It’s easy to use tab based menu system has been designed to allow the unit to be configured easily. Note that in this chapter, the default IP address of 192.168.1.2 is used in all examples. If the IP address has been changed, substitute the new IP address for the address shown in the examples.

Before proceeding, make sure a network connection has been established between the computer and the temperature module. This is done by typing the following URL into the web browser: <http://192.168.1.2/setup.html>. Another way to check communications is to ping the temperature module (from the command prompt (type ping 192.168.1.2)). Each setup page is described below.

2.5.1 Setup Page

This is the initial page that appears when the URL <http://192.168.1.2/setup.html> is entered into the web browser. It provides basic information about the unit. Navigating between setup pages is done by clicking on the tabs at the top of the page.



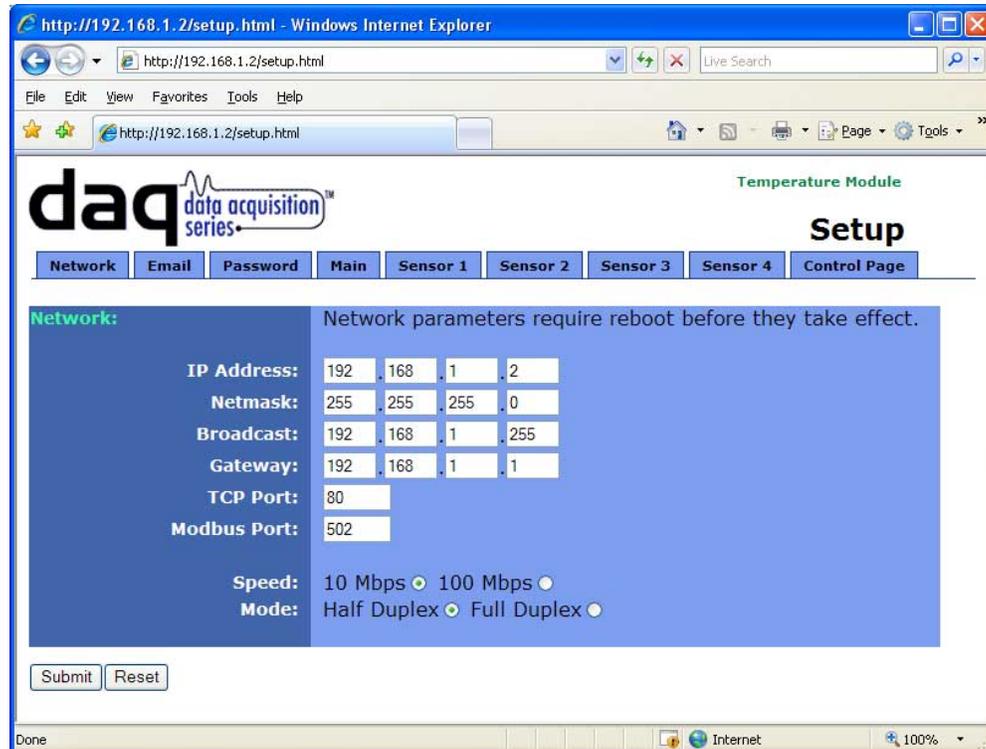
All setup pages require a password. The default password is ‘webrelay’ (no quotes, all lower case) and no user name is required.



Each setup page has a “Submit” button and a “Reset” button at the bottom of the page. After entering the desired parameters into each page, the “Submit” button must be pressed before any parameters will be saved. If a mistake is made in entering the parameters, the “Reset” button may be used to restore all parameters on the page to their current settings. The “Reset” button is only effective before the “Submit” button is pressed.

2.5.2 Network Setup Page

The network parameters are changed on this page. Note that if multiple temperature modules are used on the same network, install one unit at a time and set the IP address of each unit before connecting the next unit to the network. This avoids having multiple units installed on the network with the same factory default IP address at the same time. It may be necessary to clear the arp cache each time you swap temperature modules on the network (this is because each unit has the same default IP address but a different mac address). This is done by typing `arp -d` in the command prompt of a Windows computer (`arp -d -a` as super user on Apple OSX). Also note that the unit must be power-cycled (power disconnected, then reconnected) before network settings take effect. No other setup page requires power-cycling for the settings to take effect.



1. IP Address:

The temperature module requires a static IP address. This is a unique address that identifies the temperature module on the network. Dynamic IP address assignment is not supported. The lack of dynamic IP addressing support is intentional because dynamically changing the IP address would make it difficult for a client to access the web server built into the temperature module. The IP address is specific to the network where the unit will be installed, and must be obtained from the network administrator.

This guide is not meant to be a tutorial on IP addressing, however a few comments about IP addressing are given here.

If the temperature module will be used over the Internet, the IP address must be a routable address assigned by the upstream Internet Service Provider (ISP).

In cases where the ISP only provides a single routable IP address for the entire network (this is typical with ISPs such as cable providers), a proxy server (or gateway router) may be used. A proxy server allows multiple devices to connect to the Internet using a single

routable IP address. Many small routers from LinkSys, Dlink, and Netgear perform proxy server functions. If a proxy server is used, the temperature module will not be accessible from the Internet until the proxy server is properly configured (forward proper port to the temperature module). This information is mentioned for convenience but details of setting up a configuration such as this is beyond the scope of this manual.

If the temperature module is used on a private network only and is NOT used over the Internet, a routable IP address is not necessary. This may be the case when the temperature module is used to control a device in another room or a nearby building.

If the temperature module will be installed on a simple, private network that does not connect to the Internet, the default IP address may be used as long as no other device on the network uses the same address. If multiple units are installed on the same network, each unit must have its own unique IP address. For example, the temperature module comes from the factory with a default IP address of 192.168.1.2. If multiple units are used, change the IP address for each unit (192.168.1.3, 192.168.1.4, 192.168.1.5 etc.).

2. Netmask:

This specifies the size of the local network. This must be obtained from the network administrator. By default, the netmask is set to 255.255.255.0.

3. Broadcast:

This specifies the broadcast address. This must be obtained from the network administrator. By default, this is set to 192.168.1.255.

4. Gateway:

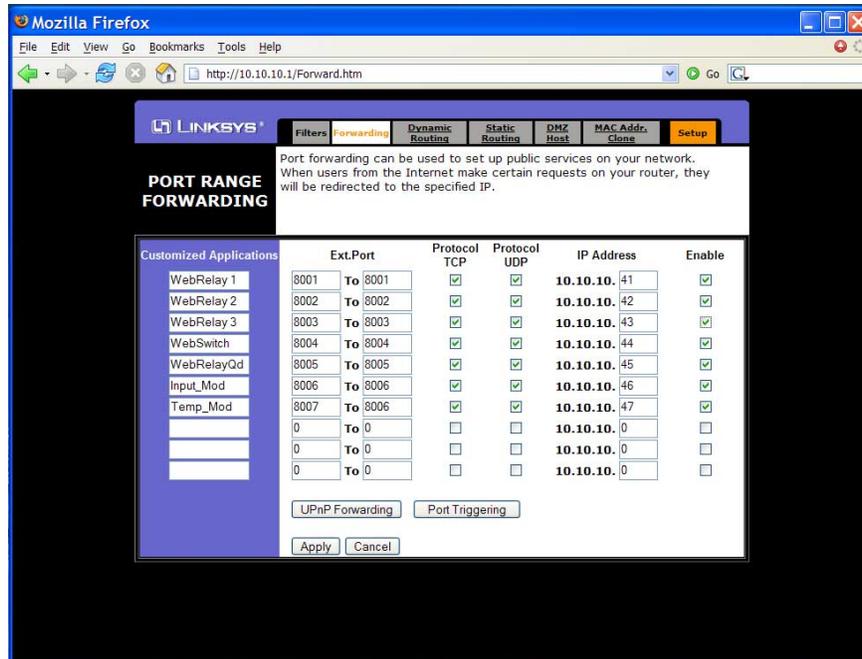
This specifies the IP address of the gateway router. This must be obtained from the network administrator. By default, this is set to 192.168.1.1.

5. TCP Port:

This specifies the TCP port used for communications with the temperature module. By default, the port is set to 80 which is the standard http port. It is recommended that the port not be changed without an understanding of TCP/IP and ports.

Changing the port can be useful for accessing multiple temperature modules which are installed behind a gateway router on a private network that uses non-routable IP addresses (192.168.x.x, 10.x.x.x, and 172.16.x.x through 172.31.x.x are non-routable or private IP addresses). In this case, each temperature module would be assigned a different port (for example 8000, 8001, 8002, etc). The gateway router would be set up to forward all traffic for each of the assigned ports to the IP address of the temperature module which uses that port. The temperature modules could then be accessed from outside the private network by entering the IP address of the gateway and the port for the desired temperature module. Note that whenever any port is assigned other than port 80, all communications with that temperature module must include the port. For example, if the temperature module is assigned port 8000, access to the setup page would require the following URL to be entered; <http://192.168.1.2:8000/setup.html>.

An example screenshot of a gateway router configuration is given below. This setup allows seven ControlByWeb™ products to be accessed on a private network behind a gateway router. Note that this screenshot is simply an example of a typical router setup page. Routers will vary.



In the example, the seven ControlByWeb™ products are assigned IP addresses of 10.10.10.41 to 10.10.10.47. The first device labeled WebRelay 1 has an IP address of 10.10.10.41 and is assigned port 8001. Note that in the WebRelay™ setup page (under Network settings tab), TCP Port 8001 must be specified for this device. The second device, labeled WebRelay 2 has an IP address of 10.10.10.42 and is assigned port 8002. This WebRelay™ must have its TCP Port set to 8002 in its network settings page. This pattern continues through 10.10.10.77 which is assigned the port 8007. To access the ControlByWeb™ units from the Internet, enter the IP address of the gateway plus the port number of the desired device.

6. Modbus Port:

This specifies the port used for Modbus/TCP communications with the temperature module. By default this is set to port 502 which is the standard Modbus port. For users not familiar with Modbus, 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. If Modbus is not used, this setting can be ignored. Modbus communications are disabled whenever the control password is enabled.

7. Speed:

This option sets the data rate of the Ethernet port. Both 10Mbps and 100Mbps can be selected. The 100Mbps option offers faster communications but the amount of data to and from the temperature module is so small that users will not likely notice much of a difference. When the temperature module is set to 10Mbps, it draws less power and runs a little cooler which translate into a longer product life. **IT IS RECOMMENDED THAT THIS SETTING BE LEFT AT 10MBPS UNLESS THE USER HAS A SPECIFIC REASON TO USE 100MBPS.**

8. 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.

2.5.3 Email Setup Page

The settings on this page are used when the device has been configured to send email messages. The temperature module requires a SMTP server to send email messages and can be configured to use basic authentication.

The screenshot shows a web browser window displaying the 'Temperature Module Setup' page. The 'Email' tab is active. The form fields are as follows:

DNS:	0 . 0 . 0 . 0
Mail Server(SMTP):	
Mail Server Port:	25
Domain:	controlbyweb.com
User Name(Optional):	
Password(Optional):	
Return Email:	noreply@controlbyweb.com
Email 1:	
Email 2:	
Email 3:	

Buttons: Submit, Reset

1. DNS Address:

If Email notification will be used, enter the IP address of a DNS server. This is used to lookup the IP address of the mail server. If the IP address of the SMTP server is known, the DNS server can be bypassed by leaving the Mail Server field blank and entering the IP address of the SMTP server directly into the DNS Address field.

2. Mail Server (SMTP):

If email notification will be used, enter the SMTP email server in this field. This is the name of the server (for example... mail.example.com). To use this SMTP server, the Temperature module must first determine the IP address of the SMTP server. This is usually done by using a DNS server. If the IP address of the SMTP server is known, the use of a DNS server can be eliminated. This is done by leaving this field blank and entering the IP address of the SMTP server directly into the DNS Address field. This will skip the domain name lookup.

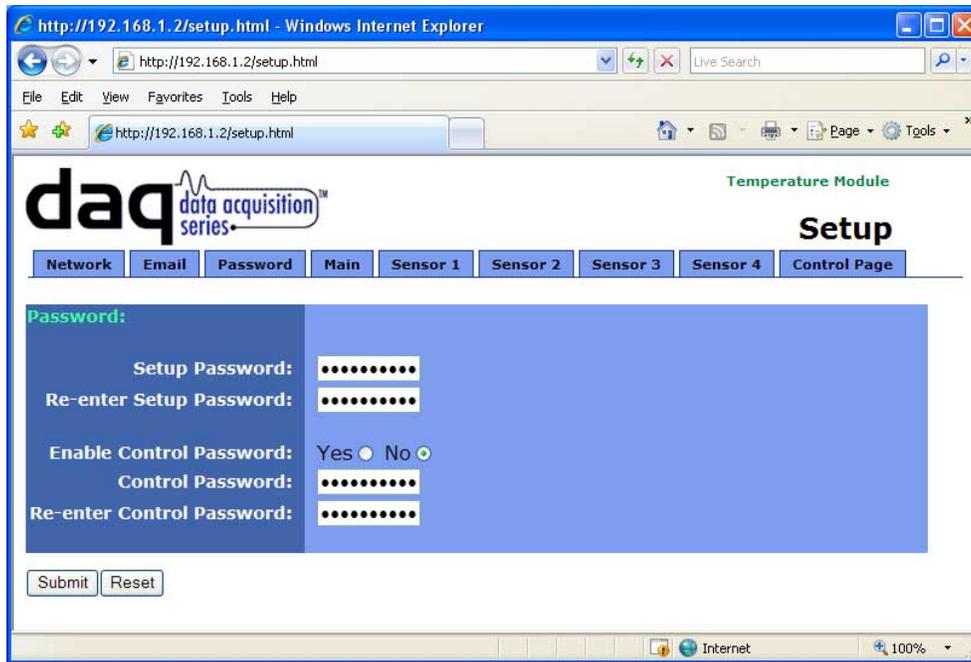
3. Mail Server Port:

If email notification will be used, enter the port number used by the SMTP server. Port 25 is the standard port for SMTP.

4. Domain:
If email notification will be used, enter a domain name that will be used when communicating with the SMTP server.
5. User Name:
Most ISPs require authentication to access their mail servers from outside the network, but do not require authentication from inside the network. If authentication is required, enter the user-name here. If authentication is not used, leave this field blank.
6. Password:
Most ISPs require authentication to access their mail servers from outside the network, but do not require authentication from inside the network. If authentication is required, enter the password here. If authentication is not used, leave this field blank.
7. Return Email:
If email notification will be used, enter the return email address (sender email address) here.
8. Email 1 Address:
If email notification will be used, enter the email address of the first recipient of notification messages.
9. Email 2 Address:
If email notification will be used and messages will be sent to at least two recipients, enter the email address of the second recipient of email notification messages.
10. Email 3 Address:
If email notification will be used and messages will be sent to three recipients, enter the email address of the third recipient of email notification messages

2.5.4 Password Setup Page

The password setup page is used to change and enable passwords. A password is required for the setup pages but is optional for the control page. The password is enabled or disabled for the control page by using the *Yes* or *No* radio buttons. Enabling the control page password also enables the requirement for a password when reading/writing XML pages. Enabling the control page password also disables the ability to communicate with the temperature module using Modbus. Note that when the password is changed, the password may be displayed in the browser's history in clear text. It is advisable to clear the browsers history after setting the password. Passwords may be up to 10 characters.



2.5.5 Main Setup Page

The main setup page is used mainly to set parameters that effect the view of the control page, how often it will refresh, etc. It is here that the units of measurement may also be specified.

http://192.168.1.2/setup.html - Windows Internet Explorer

http://192.168.1.2/setup.html

File Edit View Favorites Tools Help

http://192.168.1.2/setup.html

Temperature Module

Setup

Network Email Password Main Sensor 1 Sensor 2 Sensor 3 Sensor 4 Control Page

General Setup:

Units: Fahrenheit Celsius

Control Page Setup:

Main Header Text:

Auto Refresh Page: Yes No

Duration: sec

Display Sensor 1 Temp: Yes No

Display Sensor 1 Set Temp: Yes No

Set Temp Displayed: High Alarm Low Alarm

Display Sensor 2 Temp: Yes No

Display Sensor 3 Temp: Yes No

Display Sensor 4 Temp: Yes No

Display Relay 1 State: Yes No

Display Relay 1 ON/OFF Buttons: Yes No

Display Relay 1 Pulse Button: Yes No

Display Relay 2 State: Yes No

Display Relay 2 ON/OFF Buttons: Yes No

Display Relay 2 Pulse Button: Yes No

Internet 100%

1. Units:

This option specifies the units which will be used for temperature readings. The available options are degrees Fahrenheit and Celsius.

2. 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 25 characters in length.

3. Auto Refresh Page:
Web pages traditionally display static information. The temperature module control page, however, displays information that is dynamic. Each time the control page is loaded to the browser, it displays a snapshot of the current status of the unit. Whenever the state of a sensor changes, the control page will be obsolete until the page is refreshed. The temperature module cannot force the web page to be updated when the sensors update. 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.
4. Duration:
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.
5. Display Sensor 1 Temp:
When this options is set to **Yes**, the most recent reading of the digital temperature sensor associated with sensor 1 will be displayed in the control page. This setting also enables or disables the sensor 1 status in email alert messages (must be set to **Yes** for the most recent temperature reading associated with sensor 1 to appear in email alert messages.)
6. Display Sensor 1 Set Temp:
When this option is set to **Yes**, a editable text field, along with a button labeled 'Apply', will appear on the control page. The set temperature for sensor 1 can be changed by editing the temperature in the text field and pressing the 'Apply' button. The set temp applies either to the high alarm or low alarm for sensor 1. Whether or not it applies to the high or low alarm is determined by the next option.
7. Set Temp Displayed:
This option determines whether or not the set temperature is applied to the **High Alarm** or **Low Alarm** when it is changed through the control page.
8. Display Sensor 2 Temp:
When this options is set to **Yes**, the most recent reading of the digital temperature sensor associated with sensor 2 will be displayed in the control page. This setting also enables or disables the sensor 2 status in email alert messages (must be set to **Yes** for the most recent temperature reading associated with sensor 2 to appear in email alert messages.)
9. Display Sensor 3 Temp:
When this options is set to **Yes**, the most recent reading of the digital temperature sensor associated with sensor 3 will be displayed in the control page. This setting also enables or disables the sensor 3 status in email alert messages (must be set to **Yes** for the most recent temperature reading associated with sensor 3 to appear in email alert messages.)
10. Display Sensor 4 Temp:
When this options is set to **Yes**, the most recent reading of the digital temperature sensor associated with sensor 4 will be displayed in the control page. This setting also enables or disables the sensor 4 status in email alert messages (must be set to **Yes** for the most recent temperature reading associated with sensor 4 to appear in email alert messages.)
11. Display Relay 1 State:
When this options is set to **Yes**, the relay status for relay 1 will be displayed on the control page. If it is set to **No**, the relay status for relay 1 will not be displayed.

12. Display Relay 1 ON/OFF Buttons:

When this option is set to **Yes**, the ON/OFF buttons for relay 1 will be displayed in the control page. If it is set to **No**, the ON/OFF buttons for relay 1 will not be displayed.

13. Display Relay 1 Pulse Button:

When this option is set to **Yes**, the Pulse button for relay 1 will be displayed in the control page. If it is set to **No**, the Pulse button for relay 1 will not be displayed.

14. Display Relay 2 State:

When this options is set to **Yes**, the relay status for relay 2 will be displayed on the control page. If it is set to **No**, the relay status for relay 2 will not be displayed.

15. Display Relay 2 ON/OFF Buttons:

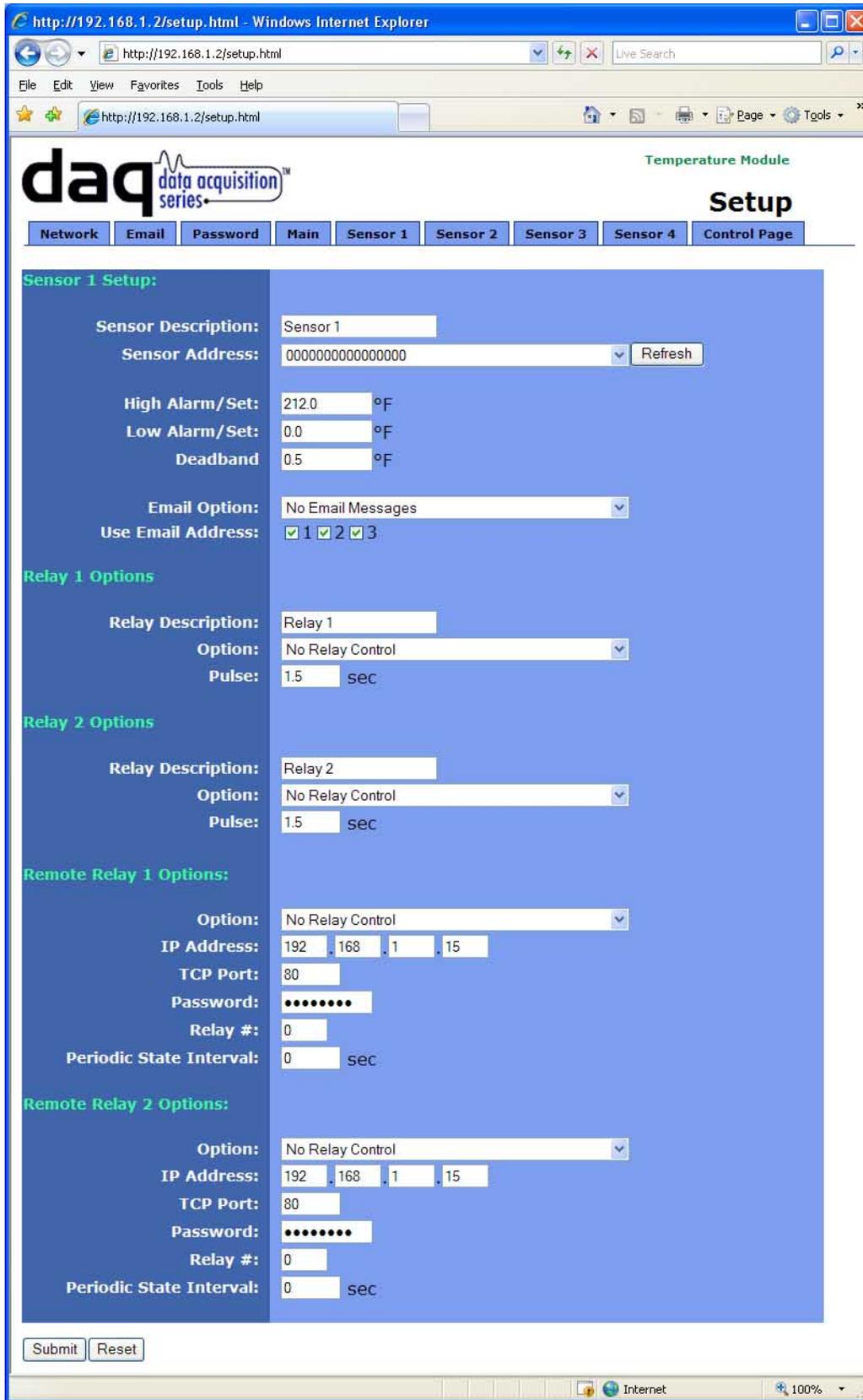
When this option is set to **Yes**, the ON/OFF buttons for relay 2 will be displayed in the control page. If it is set to **No**, the ON/OFF buttons for relay 2 will not be displayed.

16. Display Relay 2 Pulse Button:

When this option is set to **Yes**, the Pulse button for relay 2 will be displayed in the control page. If it is set to **No**, the Pulse button for relay 2 will not be displayed.

2.5.6 Sensor Setup Pages

These pages (Sensor 1 through Sensor 4) define which digital temperature sensor is associated with which sensor number, and define how alarms and email alert messages are handled. All four pages are identical with the exception of the Sensor 1 page which also includes additional settings for controlling both the local relays as well as remote ControlByWeb™ devices based on alarm conditions.



The first 6 parameters appear on all the Sensor pages. The remaining parameters appear on the Sensor 1 page only.

1. Sensor Description:

The text in this field appears to the left of the temperature reading associated with the sensor. This text also appears in the email status messages when that feature is enabled. This field can be up to 20 characters in length.

2. Sensor Address:

Every digital temperature sensor has a unique id number associated with it. In order to associate a digital temperature sensor with a sensor number, this field should be set to correspond with the id number of the desired digital temperature sensor. The drop down box will list the id numbers of all the digital temperature sensor currently connected to the temperature module (these are automatically detected.) When first connecting the digital temperature sensor, it is useful to connect one at a time and then press the refresh button in the browser to update the list of id numbers in the drop down box. This way it can be determined which id number belongs to which digital temperature sensor. If for some reason the id number associated with one of the digital temperature sensors doesn't appear in the drop down box, you may select the option **Other...** at which point the the drop down box will change into a text box where the id number can be directly entered. If the id number entered isn't valid, temperature readings will cannot be read.

3. High Alarm/Set:

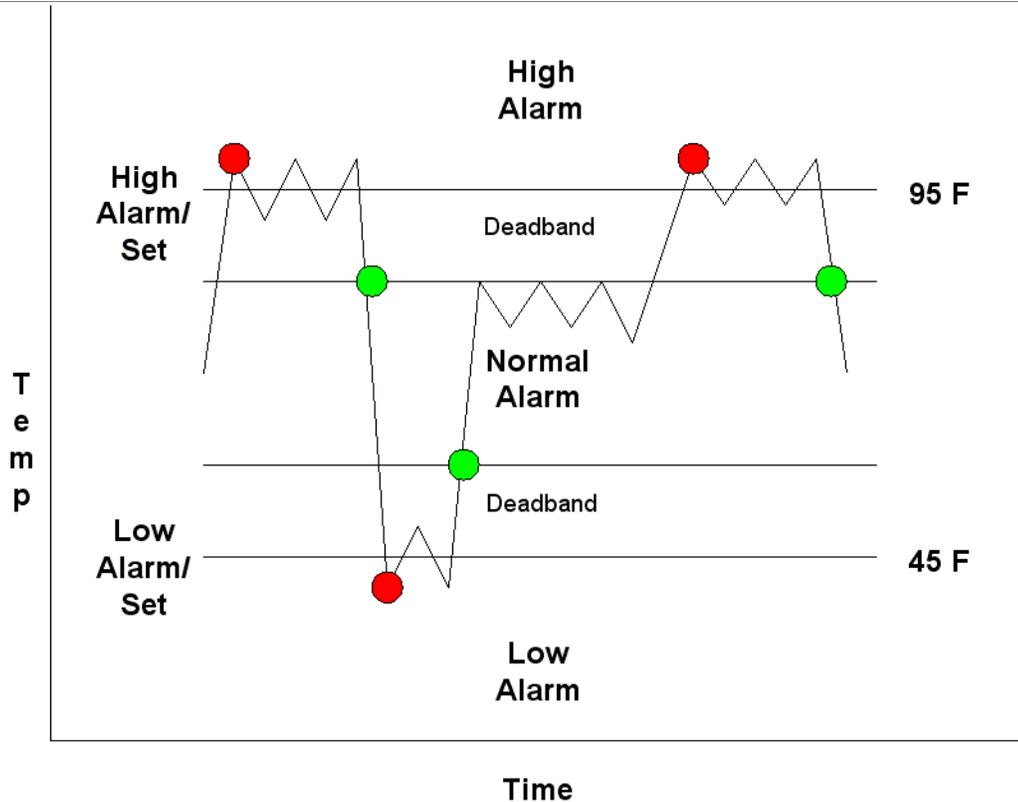
This option determines the trigger point for high alarms. This value should be greater than the low alarm set point. When the temperature read from the digital temperature sensor is greater than this value, a high alarm condition exists. The actions taken as a result are determined by the other parameters on this setup page. Sensors 2 through 4 can only send alert emails as a result of a high alarm. Sensor 1 can send out alert emails as well as change the state of the local relays and up to two remote relays on other ControlByWeb™ devices.

4. Low Alarm/Set:

This option determines where the trigger point is for low alarms. This value should be less than the high alarm set point. When the temperature read from the digital temperature sensor is lower than this value, a low alarm condition exists. The actions taken as a result are determined by the other parameters on this setup page. Sensors 2 through 4 can only send alert emails as a result of a low alarm. Sensor 1 can send out alert emails as well as change the state of the local relays and up to two remote relays found on other ControlByWeb™ devices.

5. Deadband:

This option specifies the deadband used when evaluating alarm conditions. Deadband prevents alarms or relays from toggling excessively when measured temperature is at the set point. This is due to normal fluxuating. For example, if the deadband is set to 1 degree, and a high alarm is to occur at 95 degrees, the dead band ensures that once the high alarm is triggered, it won't go off until the temperature return below 94 degrees ($95 - 1$). This reduces problems with small fluctuations in temperature readings triggering multiple alarms. The deadband is also used during low alarm conditions. If for example a low alarm is to occur at 45 degrees and the dead band is set to 1 degree, then once the low alarm is triggered, it won't go off until the temperature returns higher than 46 degrees ($45 + 1$).



6. Email Options:

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 that email notification will work only if the 'DNS Address', Mail Server (SMTP), and 'Email 1 Address' are correctly set up in the Network setup page.

-No Email Messages- No email messages will be sent due to alarm conditions.

-Send High Alarm, and Low Alarm Messages- Email messages will be sent out due to high and low alarm conditions.

-Send High Alarm, Normal, and Low Alarm Messages- Email messages will be sent out due to high, normal, and low alarm conditions.

7. 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. Each check box corresponds to one email address specified on the email setup page.

8. Relay 1 Description:

This text is used to describe the function of relay 1 on the control page. This text will not appear unless the relay 1 status is visible, or the ON/OFF buttons or Pulse button for relay 1 are enabled. This field can be up to 20 characters in length.

9. Relay 1 Options:

This parameter is used to specify if and how relay number 1 will react to high alarm conditions. Note that relay 1 only reacts to high alarm conditions, meaning it can be setup to change states when a high alarm condition exists, and then return to its previous state when a normal alarm occurs. The options in the drop down list are described below. Also note that once the relay reacts to an alarm condition, users may change the state of the relay from the web browser

even if the alarm condition remains.

- **No Relay Control** – Take no action when a high alarm occurs.
- **Relay On when High Alarm** – Turn the relay on when a high alarm occurs.
- **Relay Off when High Alarm** – Turn the relay off when a high alarm occurs.
- **Relay Pulse when High Alarm** – Pulse the relay when a high alarm occurs.

10. Relay 1 Pulse:

This parameter determines the pulse duration used when relay 1 is set to pulse when a high alarm occurs or when the pulse button is pressed on the control page. This time can be set from 0.1 seconds to 86,400 seconds (1 day).

11. Relay 2 Description:

This text is used to describe the function of relay 2 on the control page. This text will not appear unless the relay 2 status is visible, or the ON/OFF buttons or Pulse button for relay 2 are enabled. This field can be up to 20 characters in length.

12. Relay 2 Option:

This parameter is used to specify if and how relay number 2 will react to low alarm conditions. Note that relay 2 only reacts to low alarm conditions, meaning it can be setup to change states when a low alarm condition exists, and then return to its previous state when a normal alarm occurs. The options in the drop down list are described below. Also note that once the relay reacts to an alarm condition, users may change the state of the relay from the web browser even if the alarm condition remains.

- **No Relay Control** – Take no action when a low alarm occurs.
- **Relay On when Low Alarm** – Turn the relay on when a low alarm occurs.
- **Relay Off when Low Alarm** – Turn the relay off when a low alarm occurs.
- **Relay Pulse when Low Alarm** – Pulse the relay when a low alarm occurs.

13. Relay 2 Pulse:

This parameter determines the pulse duration used when relay 2 is set to pulse when a low alarm occurs or when the pulse button is pressed on the control page. This time can be set from 0.1 seconds to 86,400 seconds (1 day).

14. Remote Relay 1 Option:

This parameter is used to specify if and how the remote relay number 1 will react to high alarm conditions. Note that remote relay 1 only reacts to high alarm conditions, meaning it can be setup to change states when a high alarm condition exists, and then return to its previous state when a normal alarm occurs. The options in the drop down list are described below. Also note that once the remote relay reacts to an alarm condition, user may change the state of the relay from the web browser even if the alarm condition remains.

- **No Relay Control** – Take no action when a high alarm occurs.
- **Relay On when High Alarm** – Turn the remote relay on when a high alarm occurs.
- **Relay Off when High Alarm** – Turn the remote relay off when a high alarm occurs.
- **Relay Pulse when High Alarm** – Pulse the remote relay when a high alarm occurs. Note that the amount of time the remote relay will pulse is determined by the user settings in that unit and not by any of the local settings.

15. Remote Relay 1 IP Address:

When any option in the 'Remote Relay 1 Option' setting is selected other than **No Relay Control**, commands are sent over the IP network to this address as alarm conditions change.

16. Remote Relay 1 TCP Port:

When any option in the 'Remote Relay 1 Option' setting is selected other than **No Relay Control**, commands are sent over the IP network to this TCP port on the remote ControlByWeb™ device as alarm conditions change.

17. Remote Relay1 Password

If remote messages are to be sent to a remote device that requires a password, the password entered in this field will be used.

18. Remote Relay 1 Relay #:

When any option in the 'Remote Relay 1 Options' setting is selected other than **No Relay Control**, commands are sent to the remote device with this relay offset. This option should ALWAYS be set to 0, unless the remote device is something other than WebRelay™. This is used, for example, when the remote device has multiple relays. For example, WebRelay-Quad™ has 4 relays. To send commands to the third relay on WebRelay-Quad™, this option would be set to 3. To send commands to the first relay on WebRelay-Quad™, this option would be set to 1. This field may be set from 0 to 255.

19. Remote Relay 1 Periodic State Interval:

When any option in the 'Remote Relay 1 Option' setting is selected other than **No Relay Control**, this parameter controls whether or not periodic messages should be sent out as well as messages that get sent out as alarm conditions change. This setting has the range of 10 to 4223173 seconds (roughly 48 days).

20. Remote Relay 2 Options:

This parameter is used to specify if and how the remote relay number 2 will react to low alarm conditions. Note that remote relay 2 only reacts to low alarm conditions, meaning it can be setup to change states when a low alarm condition exists, and then return to its previous state when a normal alarm occurs. The options in the drop down list are described below. Also note that once the remote relay reacts to an alarm condition, users may change the state of the relay from the web browser even if the alarm condition remains.

- **No Relay Control** – Take no action when a low alarm occurs.
- **Relay On when Low Alarm** – Turn the remote relay on when a low alarm occurs.
- **Relay Off when Low Alarm** – Turn the remote relay off when a low alarm occurs.
- **Relay Pulse when Low Alarm** – Pulse the remote relay when a low alarm occurs. Note that the amount of time the remote relay will pulse is determined by the user settings in that unit and not by any of the local settings.

21. Remote Relay 2 IP Address:

When any option in the 'Remote Relay 2 Option' setting is selected other than **No Relay Control**, commands are sent over the IP network to this address as alarm conditions change.

22. Remote Relay 2 TCP Port:

When any option in the 'Remote Relay 2 Option' setting is selected other than **No Relay Control**, commands are sent over the IP network to this TCP port on the remote ControlByWeb™ device as alarm conditions change.

23. Remote Relay 2 Password

If remote messages are to be sent to a remote device that requires a password, the password entered in this field will be used.

24. Remote Relay 2 Relay #:

When any option in the 'Remote Relay 2 Option' setting is selected other than **No Relay Control**, commands are sent to the remote device with this relay offset. This option should ALWAYS be set to 0, unless the remote device is something other than WebRelay™. This is used, for example, when the remote device has multiple relays. For example, WebRelay-Quad™ has 4 relays. To send commands to the third relay on WebRelay-Quad™, this option would be set to 3. To send commands to the first relay on WebRelay-Quad™, this option would be set to 1. This field may be set from 0 to 255.

25. Remote Relay 2 Periodic State Interval:

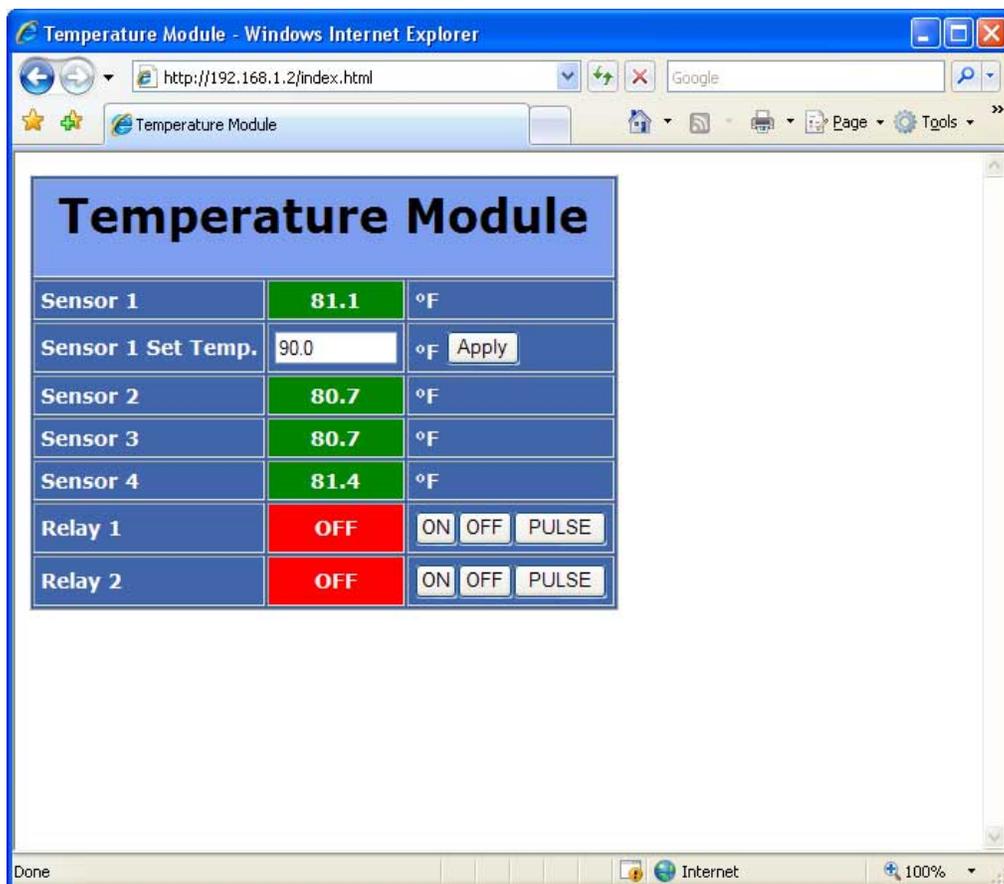
When any option in the 'Remote Relay 2 Option' setting is selected other than **No Relay Control**, this parameter controls whether or not periodic messages should be sent out as well as messages that get sent out as alarm conditions occur. This setting has the range of 10 to 4223173 seconds (roughly 48 days).

Section 3: Operation

The temperature module can be operated using a web browser, by sending text commands to an XML status/control page, or by sending Modbus/TCP requests. The temperature module can also be configured to control the local relays as well as remote ControlByWeb™ devices based on alarm conditions.

3.1 Browser Operation

Once the unit is set up, the control page may be accessed by typing the following URL into the web browser: <http://192.168.1.2> (Note that if the IP address was changed, replace the default IP address shown with the new address that was assigned. Note also that if any port is used other than port 80, the port must also be included in the request: <http://192.168.1.2:8000>) The new control page will appear. A control page with default settings is shown below. Note that any sensors that have not been assigned to a specific digital temperature sensor will display xx.x in the control page, XML page, and alert emails. The control page allows the user to turn the individual relays on and off as well as monitor the current temperature of the digital temperature sensors. It is here that the set temperature for sensor 1 alarms can be changed. To change the set temperature for sensor 1 through the control page enter the new set temperature in the text field to the right of the heading 'Sensor 1 Set Temp.' and then push the 'Apply' button. The set temperature will apply to either the high alarm set temperature or low alarm set temperature depending on the setting of the parameter 'Set Temp Applies To' on the main setup page. When the set temperature is changed, all active alarms will be reevaluated immediately and the local relays as well as remote devices will be updated based on the user settings. Email alerts will be sent out accordingly as well.



3.2 XML Operation

Custom computer applications may be created to monitor and control the temperature module without using a web browser. Monitoring the temperatures and the relays is done by sending a request to port 80 (or port specified in setup) for the XML page. Control of the relay is done by sending GET requests to the same page on port 80 (or port specified in setup). This can be demonstrated by entering commands into the URL line of a web browser.

Request the current state: `http://192.168.1.2/state.xml`

This will return the following XML page.:

```
<?xml version="1.0" encoding="utf-8" ?>
-<datavalues>
  <units>F</units>
  <sensor1temp>xx.x</sensor1temp>
  <sensor2temp>xx.x</sensor2temp>
  <sensor3temp>xx.x</sensor3temp>
  <sensor4temp>xx.x</sensor4temp>
  <relay1state>0</relay1state>
  <relay2state>0</relay2state>
</datavalues>
```

The tags `<units>`, `<sensortemp>` and `<relaystate>` indicate the current state of the temperature module. Values for each tag are described below.

<code><units></code>	F (Degrees Fahrenheit) C (Degrees Celsius)
<code><sensortemp></code>	xx.xx (indicates that no digital temperature sensor is associated with the sensor number) 80.10 (temperature reading from digital temperature senso associated with the sensor number)
<code><relaystate></code>	0=off(coil off) 1=on (coil energized)

Commands can be sent to the temperature module that control the relays and change their states. Commands are sent using a variable called `relayState`. Two examples of using `relayState` are given here.

Turn relay 1 'off': `http://192.168.1.2/state.xml?relay1State=0`

Turn relay 2 'on': `http://192.168.1.2/state.xml?relay2State=1`

All `relayState` options are contained in the following list.

<code>relayState</code>	0=Turn relay off 1=Turn relay on 2=Pulse relay 5=Toggle the state of the relay
-------------------------	---

When the pulse command is sent to one of the relays, the relay will pulse for the time specified in the setup page. It is possible however to specify a pulse time that is different than the pulse time configured in the setup page. This is done by sending an additional variable called `pulseTime` and the desired pulse time.

`state.xml?relay1State=2` This will pulse relay 1 for the time specified in the setup page.

`state.xml?relay1State=2&pulseTime1=5.5` This will pulse relay 1 for 5.5 seconds.

(Note that `http://192.168.1.2/` would be included on both commands above, and that to achieve the same thing with relay 2 we would replace `relay1State` with `relay2State` and `pulseTime1` with `pulseTime2`)

The pulseTime variable does not change the pulse time specified in the setup page and it is not stored or recorded. The pulseTime variable only changes the pulse duration for the single pulse initiated by that command. In other words, you must issue the pulseTime for each pulse command that differs from the preset pulse time. For example, suppose the pulse time for relay 2 is set to 1.5 seconds in the configuration pages. To issue one 1.5 second pulse, three five second pulses, and a 1.5 second pulse once again, you would issue the following commands...

state.xml?relay2State=2	This will pulse relay 2 for the preset time (1.5 seconds)
state.xml?relay2State=2&pulseTime2=5	This will pulse relay 2 for 5 seconds.
state.xml?relay2State=2&pulseTime2=5	This will pulse relay 2 for 5 seconds
state.xml?relay2State=2&pulseTime2=5	This will pulse relay 2 for 5 seconds
state.xml?relay2State=2	This will pulse relay 2 for the preset time (1.5 seconds)

(Note that <http://192.168.1.2/> would be included on all commands above)

Note that when commands are sent to the temperature module, its current state is returned in the form of an XML page. The commands can also be sent without having the temperature module return the XML page. This is accomplished by adding the noReply field as follows.

Turn relay 1 'on' without returning state: <http://192.168.1.2/state.xml?relay1State=1&noReply=1>
 Turn relay 1 'off' without returning state: <http://192.168.1.2/state.xml?relay1State=0&noReply=1>

Set Temperature for Sensor 1:

The set temperature can be changed through the control page as well as issuing commands directly from another application. For example, to change the set temperature of sensor 1 through another application issue the following command.

<http://192.168.1.2/index.srv?setTemp=90.2&7=Apply>

In response to this command the temperature module will return the control page with the updated set temperature.

Password :

If the control password is enabled in the temperature module and the XML page is requested through a browser, the browser will prompt the user for the password. If the XML request is sent from another application and not a browser, the html request will need to contain the password encoded using the base 64 encoding scheme. The html request header without the password looks like this:

GET /state.xml?noReply=1 HTTP/1.1 (Ends with two \r\n)

The html request header with the password looks like this:

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

where bm9uZTp3ZWJyZWxheQ== is the base 64 encoded version of the username and password
 none:webrelay

A utility is provided at <http://www.ControlByWeb.com/encoder> that can be used to encode the password. The utility is used by simply typing the string username:password into the website and pressing encode.

3.3 Modbus Operation

The temperature module can be controlled (and read) using Modbus/TCP protocol. This provides a standard means of using the temperature module in conjunction with devices and software from other manufacturers. This section contains the information necessary to communicate with the temperature module using Modbus/TCP. This 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>.

It is important to note that when the control password in the temperature module is enabled, Modbus/TCP communications are disabled. This is because Modbus/TCP does not provide a mechanism for password protection. Make sure the control password is disabled (default) before using Modbus with the temperature module.

The temperature module functions as a Modbus server (slave). Client (master) devices open a connection with the temperature module on port 502 (unless another modbus port is selected) and send commands or requests to read the state of the relays, read the current value of the temperature sensors, or change the relay states. When the temperature module receives a command, it will perform the desired function and return a response. The following commands are available:

Read Coils (Modbus function 01 (0x01)) - read the status of the relays.
 Read Holding Registers (Modbus Function Code 03 (0x03)) – read temperature values of connected sensors
 Write Single Coil (Modbus function 05 (0x05)) - change one relay state
 Write Multiple Coils (Modbus Function Code 15 (0x0F)) - change one or both relay states
 Write Multiple Registers (Modbus function 16 (0x10)) - pulse the relay

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. To keep the connection open, a read request can be sent periodically. Two TCP sockets are available for Modbus communications. If two masters each have a socket open (or a single master using two sockets) and a third master attempts to open a socket for Modbus communications, the request to open a third socket will be rejected.

3.3.1 Read Coils (Modbus Function Code 01 (0x01))

This function returns the state of the relay coils.

Valid Starting Address and Quantity of coils combinations

Starting address 0x0000 quantity of coils 0x0001 (read relay 1 state only)

Starting address 0x0000 quantity of coils 0x0002 (read relay 1 state and relay 2 state)

Starting address 0x0001 quantity of coils 0x0001 (read relay 2 state only)

Starting address 0x0001 quantity of coils 0x0002 (not valid)

Request

Modbus/TCP:

Transaction identifier (2 Bytes): 0x0001

Protocol identifier (2 Bytes): 0x0000

Length (2 Bytes): 0x0006

Unit identifier (1 Byte): 0xff

Modbus:

Function code (1 Byte): 0x01 (read coils)

Starting address (2 Bytes): 0x0000 (0x0000 or 0x0001)

Quantity of coils (2 Bytes): 0x0002 (0x0001 or 0x0002)

Character String Example:

```
char read_coils_mb_request[] = {0x00, 0x01, 0x00, 0x00, 0x00, 0x06, 0xff, 0x01, 0x00, 0x00, 0x00, 0x02 };
```

Response

Modbus/TCP:

Transaction identifier (2 Bytes): 0x0001

Protocol identifier (2 Bytes): 0x0000

Length (2 Bytes): 0x0004

Unit identifier (1 Byte): 0xff

Modbus:

Function code (1 Byte): 0x01 (Read coils)

Byte count (1 Byte): 0x01

Coil status (1 Byte): 0x00, 0x01, 0x02, or 0x03 (bit 0 = relay 1 state, bit 1 = relay 2 state)

Data Byte (hex)	LS Data Bits (binary)	Relay 2State	Relay 1 State
0x00	00	off	off
0x01	01	off	on
0x02	10	on	off
0x03	11	on	on

Modbus Error:

Function code (1 Byte): 0x81

Exception code (1 Byte): 0x01 or 0x02

Exception codes:

0x01 - Function code not supported

0x02 - Incorrect starting address / quantity of outputs combination

Character String Example:

```
char read_coils_mb_response[] = {0x00, 0x01, 0x00, 0x00, 0x00, 0x04, 0xff, 0x01, 0x01, 0x01};
```

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

This function is used to read the temperature values of the sensors. One, multiple, or all values can be read at the same time using this function.

Valid address/quantity combinations

Reading these registers requires that the address be in the range of 16 to 22 (0x10 and 0x16). Also, the address must be evenly divisible by 2. In other words, only address 0x10, 0x12, 0x14 and 0x16 are valid. Each value is returned as two registers in IEEE 754 floating point format. The four data bytes are treated as two individual big endian 16-bit words with the least significant word being sent first. In other words, the 32 bit floating point number represented as ABCD is sent as CDAB. For example, if we were to read two registers starting at address 0x10, and sensor 1 measured the temperature to be 81.25 degrees, then we would get the following value 800042A2. The least significant word would be 8000 hex and the most significant word would be 42A2. Using a conversion utility we could then convert this hexadecimal value into the temperature reading of 81.25 degrees. The following table lists the addresses that correspond to each input.

Sensor	Address
1	0x10
2	0x12
3	0x14
4	0x16

Request:

Modbus/TCP

Transaction identifier (2 Bytes): 0x0001

Protocol identifier (2 Bytes): 0x0000

Length (2 Bytes): 0x0006

Unit identifier (1 Byte): 0xff

Modbus

Function code (1 Byte): 0x03 (read holding registers)
 Reference number (2 Bytes): 0x0010 to 0x0016
 Register count (2 bytes): 0x02 to 0x08

```
char write_registers_mb_request[] = {0x00, 0x01, 0x00, 0x00, 0x00, 0x06, 0xff, 0x03, 0x00, 0x10, 0x00, 0x04};
```

Response:

Modbus/TCP

Transaction identifier (2 Bytes): 0x0001
 Protocol identifier (2 Bytes): 0x0000
 Length (2 Bytes): 0x000B
 Unit identifier (1 Byte): 0xff

Modbus

Function code (1 Byte): 0x03 (read holding registers)
 Byte count (1 Byte): 0x08
 Register values (2 Bytes): 0xffff – (register count x 2 bytes)

Modbus Error:

Function code (1 Byte): 0x83
 Exception code (1 Byte): 0x01 or 0x02

Exception codes:

0x01 – Function code not supported
 0x02 – Incorrect starting address / quantity of outputs combination

```
char write_registers_mb_request[] = {0x00, 0x01, 0x00, 0x00, 0x00, 0x0B, 0xff, 0x03, 0x08, 0x00, 0x00, 0x00,
                                     0x00, 0x00, 0x00, 0x00, 0x00};
```

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

Request:

Modbus/TCP

Transaction identifier (2 Bytes): 0x0001
 Protocol identifier (2 Bytes): 0x0000
 Length (2 Bytes): 0x0006
 Unit identifier (1 Byte): 0xff

Modbus

Function code (1 Byte): 0x05 (write coil)
 Output address (2 Bytes): 0x0000 – 0x0001 (0x0000 = relay 1, 0x0001= relay 2)
 Output value (1 Byte): 0xff - turn relay on, 0x00 - turn relay off
 Padding (1 Byte): 0x00

```
char write_coil_mb_request[] = {0x00, 0x01, 0x00, 0x00, 0x00, 0x06, 0xff, 0x05, 0x00, 0x00, 0xff, 0x00};
```

Response:

Modbus/TCP

Transaction identifier (2 Bytes): 0x0001
 Protocol identifier (2 Bytes): 0x0000
 Length(2 Bytes): 0x0006
 Unit identifier (1 Byte): 0xff

Modbus

Function code (1 Byte): 0x05 (write coil)
 Output address (2 Bytes): 0x0000
 Output value (1 Byte): 0xff - relay on, 0x00 - relay off
 Padding (1 Byte): 0x00

Modbus Error:

Function code (1 Byte): 0x85
 Exception code (1 Byte): 0x01 or 0x02
 Exception codes:
 0x01 - Function code not supported
 0x02 - Incorrect starting address / quantity of outputs combination

```
char write_coil_mb_response[] = {0x00, 0x05, 0x00, 0x00, 0x00, 0x06, 0xff, 0x05, 0x00, 0x00, 0xff, 0x00 };
```

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

This function allows you to control relays one and two simultaneously using one command.

Valid starting Address and Quantity of coils combinations

Valid starting address can fall in the range of 0x0000 and 0x0001. Valid quantities can fall in the range of 0x0001 and 0x0002. The only restriction is that the sum of the starting address and the quantity of coils must not be greater than 0x0002. For example, if you want to control both relays, then the starting address must be 0x0000. On the other hand, you may want to control the second relay only. This can be achieved by starting at address 0x0001 and using a quantity of 0x0001.

Request:

Modbus/TCP

Transaction identifier (2 Bytes): 0x0001
 Protocol identifier (2 Bytes): 0x0000
 Length (2 Bytes): 0x0008
 Unit identifier (1 Byte): 0xff

Modbus

Function code (1 Byte): 0x0F (write coils)
 Output address (2 Bytes): 0x0000 or 0x0001 (relay 1 = 0x0000, relay 2 = 0x0001)
 Bit count (2 Bytes): 0x0001 or 0x0002 (control one relay or both relays)
 Byte count (1 Byte): 0x01 (always 0x01)
 Output value (1Byte): 0x00 through 0x03 (bit 0 = relay 1, bit 1 = relay 2)

```
char write_coils_mb_request[] = {0x00, 0x01, 0x00, 0x00, 0x00, 0x08, 0xff, 0x0f, 0x00, 0x00, 0x00, 0x02, 0x01, 0x03};
```

Response:

Modbus/TCP

Transaction identifier (2 Bytes): 0x0001
 Protocol identifier (2 Bytes) 0x0000
 Length (2 Bytes) 0x0006
 Unit identifier (1Byte): 0xff

Modbus

Function code (1 Byte): 0x0F (write coils)
 Output address (2 Bytes): 0x0000 or 0x0001 (relay 1 = 0x0000, relay 2 = 0x0001)
 Bit Count (2 Bytes): 0x0001 or 0x0002 (control one relay or both relays)

Modbus Error:

Function code (1 Byte): 0x8F
 Exception code (1 Byte): 0x01 or 0x02

Exception codes:

0x01 – Function code not supported
 0x02 – Incorrect starting address / quantity of outputs combinations

```
char write_coils_mb_response[] = {0x00, 0x01, 0x00, 0x00, 0x00, 0x06, 0xff, 0x0f, 0x00, 0x00, 0x00, 0x02};
```

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

This is used to pulse the relays for a specified time. When the temperature module receives this command, it immediately turns the relay coil on (if it is not on already on) and starts the pulse timer. The pulse time is specified in the register value field and the time can range from 0.1 seconds to 86400 seconds (1 day).

When the pulse time expires, the relay coil will be turned off. If a pulse time command is sent with a value greater than 86400, the pulse timer will be set to 86400. If a pulse time command is sent with a value less than 0.1, the pulse timer will be set to 0.1. If any commands are sent to the temperature module (commands may be modbus, xml, html) before the pulse timer has expired, the pulse timer will be canceled immediately and the new command will be executed.

Valid address/quantity combinations

Writing to these register requires that the address be in the range of 0x18 and 0x1A. Also, the address must be evenly divisible by 2. In other words, only address 0x18 and 0x1A are valid addresses. When the address 0x18 is used, both relays can be sent pulse times (8 bytes), or just the first relay can be sent a pulse time (4 bytes.) If the address 0x1A is used, only relay 2 will be sent a pulse time (4 bytes.)

Note that the pulse time is provided in IEEE 754 floating point format. The four data bytes are treated as two individual big endian 16-bit words but the least significant word is sent first. In other words, the 32-byte floating point number represented as ABCD is sent as CDAB. 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.

Request:

Modbus/TCP

Transaction identifier (2 bytes): 0x0001

Protocol identifier (2 bytes): 0x0000

Length (2 bytes): 0x000b

Unit identifier (1 byte): 0xff

Modbus

Function code (1 Byte): 0x10 (Write Multiple Registers)

Starting address (2 Bytes): 0x0018, or 0x001A

Number of registers (2 Bytes): 0x0002, or 0x0004

Byte count (1 Byte): 0x04

Registers value (4 Bytes): 00 00 41 20 (10 second pulse time)

```
char write_registers_mb_request = {0x00, 0x01, 0x00, 0x00, 0x00, 0x0b, 0xff, 0x10, 0x00, 0x18, 0x00, 0x02, 0x04,
0x00, 0x00, 0x41, 0x20 };
```

Response:

Modbus/TCP

Transaction identifier (2 Bytes): 0x0001

Protocol identifier (2 Bytes): 0x0000

Length (2 Bytes): 0x0006

Unit identifier: 0xff

Modbus

Function code (1 Byte): 0x10 (Write Multiple Registers)

Starting address (2 Bytes): 0x0018 or 0x001A

Number of registers(2 Bytes): 0x0002 or 0x0004

Modbus Error:

Function code (1 Byte): 0x90

Exception code (1 Byte): 0x01 or 0x02

Exception codes:

0x01 - Function code not supported

0x02 - Incorrect starting address / byte count combination

```
char write_registers_mb_response[] = {0x00, 0x01, 0x00, 0x00, 0x00, 0x06, 0xff, 0x10, 0x00, 0x18, 0x00,
0x02 };
```

3.4 Special Functions

3.4.1 Email Alerts

Each of the four sensors on the temperature module can be configured to send an email message to up to three email addresses when alarm conditions occur. Email messages can be sent to one, two, or three different email addresses. The header, descriptions and temperature units are taken from the entries in the setup pages.

The message is shown below with default text settings. The text shown in bold indicates that it can be changed by the user.

Temperature Module - Email Notification

Email alert triggered by high alarm from **Sensor 1**: 87.0° F

Sensor 1 Current Temp: 87.4° F

Sensor 2 Current Temp: xx.x

Sensor 3 Current Temp: xx.x

Sensor 4 Current Temp: xx.x

Quite a bit of the text above is shown in bold. These items can be changed by the user using the fields described below from the setup pages.

Temperature Module – This text is set in the 'Main Header Text' field under the Main tab.

F – The units are set through the radio button field 'Units' under the Main tab.

Sensor 1 – This text is set in the 'Sensor Description' field under the Sensor 1 tab.

Sensor 2 – This text is set in the 'Sensor Description' field under the Sensor 2 tab.

Sensor 3 – This text is set in the 'Sensor Description' field under the Sensor 3 tab.

Sensor 4 – This text is set in the 'Sensor Description' field under the Sensor 4 tab.

*Note: The email message will only contain the temperature for sensors that have the 'Display Sensor Temp' field set to **Yes** on the Main setup page.

Email notification requires that the following field are set. See section 2 for a description of each field.

Network Page:

IP Addressing

Netmask

Broadcast

Gateway

Email Page:

DNS Address

Mail Server (SMTP)

Port

Domain

Return Email

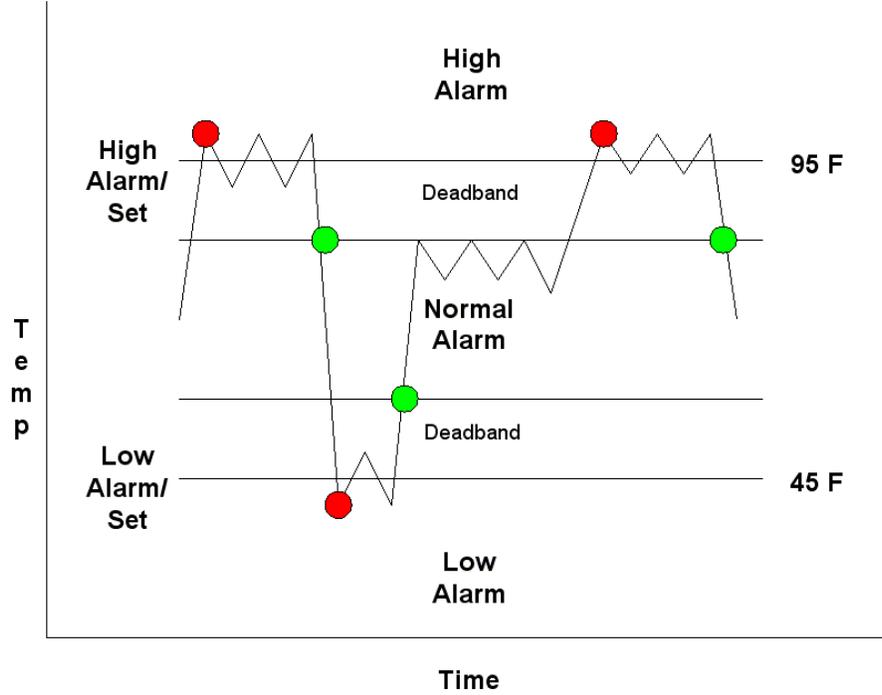
Email 1 Address (Email 2,3 Address are optional)

Sensor 1,2,3, or 5 Pages:

Email Options
Use Email Address

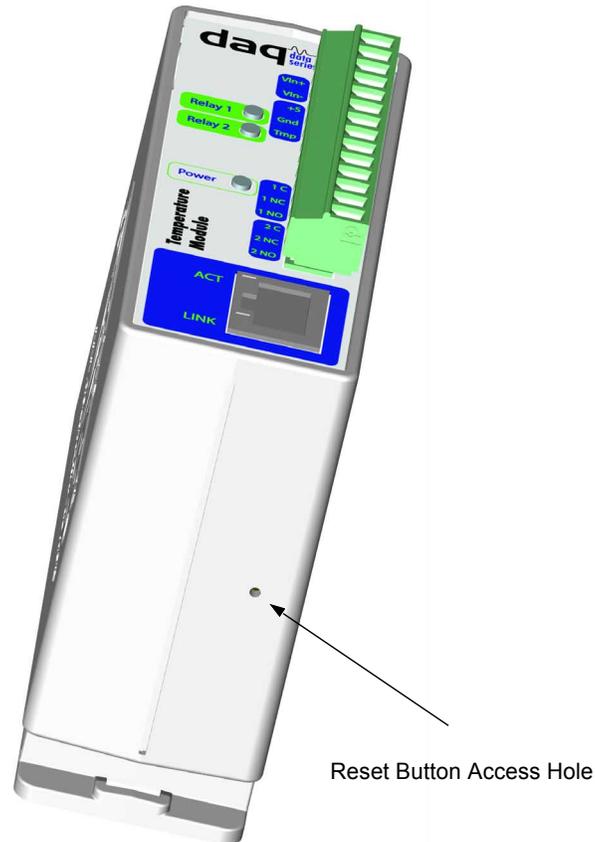
3.4.2 Alarm Conditions

The diagram below shows a visualization of the high alarm set point and low alarm set point options when one of the temperature sensors is configured to send out emails or remote messages based on the set points. When the temperature goes above the high alarm set point a high alarm occurs. This high alarm condition remains until the temperature drops below the deadband. The same is true when the temperature falls below the low alarm set point. In this situation the low alarm condition remains until the temperature rises past the deadband. Red dots indicate high and low alarms while the green dots indicate a return to the normal operating condition. Note that relays are only changed when the alarm condition changes. Users can still manually change relays using the web page.



Appendix A: Restoring Factory Default Settings

In the event that the IP address or passwords are forgotten, the temperature module may be restored to its original factory default settings. To do this, first remove the power from the unit. Next, insert a thin object (such as a toothpick) through the small hole in the bottom of the unit to press the small button that is located inside the unit. When the object is inserted, a tactile feel can be detected as the button is depressed. While holding the button down, apply power and wait for about 10 seconds. After about 10 seconds, release the button. Now all settings will be back to the original factory defaults. **CAUTION: DO NOT USE METAL OBJECTS FOR THIS FUNCTION.**



Appendix B: Specifications

Power Requirements:

Model X-DAQ-2R1-4T-5

Voltage: 5VDC \pm 5%

Current: See table below for typical values

	10 Mbps Network	100 Mbps Network
No Relays / 1 Sensor	128mA	272mA
2 Relays / 4 Sensors	282mA	421mA

Model X-DAQ-2R1-4T-I

Voltage: 9~28VDC

Current: See table below for typical values

	10 Mbps Network	100 Mbps Network
9VDC - No Relays / 1 Sensor	85mA	176mA
9VDC - 2 Relays / 4 Sensors	152mA	240mA
12VDC - No Relays / 1 Sensor	66mA	133mA
12VDC - 2 Relays / 4 Sensors	114mA	180mA
24VDC - No Relays / 1 Sensor	35mA	69mA
24VDC - 2 Relays / 4 Sensors	60mA	93mA
28VDC - No Relays / 1 Sensor	30mA	60mA
28VDC - 2 Relays / 4 Sensors	52mA	81mA

Model X-DAQ-2R1-4T-E

POE Class 1 (0.44Watt to 3.84Watt range). Optionally can be powered with external 5VDC power supply.

Relay Contacts:

Contact Form: SPDT

Contact Material: Ag (Au clad)

Max Voltage: 28VAC

Max Current: 1A

Relay Control Options: ON/OFF or Pulsed

Pulse Timer Duration: 100ms to 86400 Seconds (1 day)

Accuracy of pulse timer: 99.99%

Network: 10/100 Base-T Ethernet

Network Setup: static IP address assignment, TCP port selectable

Connectors:

Power/Relay Contacts/Digital Temperature Sensors: 14-position, removable terminal strip, 3.81 mm terminal spacing
(Replacement part number, Phoenix Contact 1803691)

Network: 8-pin RJ-45 socket

Digital Temperature Sensors:

1-Wire Digital Thermometer based on Dallas Semiconductor part DS18B20.

Temperature Range: -55°C to $+125^{\circ}\text{C}$ (-67°F to $+257^{\circ}\text{F}$)

Accuracy: $\pm 0.5^{\circ}\text{C}$ from -10°C to $+85^{\circ}\text{C}$

LED Indicators: 5

- Power on
- Relay coils (1-2) engaged
- Network linked
- Network activity

Physical:

Operating Temperature: -20° to 70°C (-4° - 158°F)

Size: 1.41in (35.7mm) wide X 3.88in (98.5mm) tall X 3.1 in(78.0mm) deep

Weight: 5oz (142 grams)

Enclosure Material: Lexan 940 (UL94 V0 flame rated)

Password Settings:

Password protection on setup page: Yes

Password protection on control page: Optional

Password Encoding: Base 64

Max password length: 10 characters

Regulatory Compliance:

Electromagnetic Compliance:

IEC CISPR 22, CISPR 24

FCC 47CFR15 (-I and -5 Models class B, POE Model Class A)

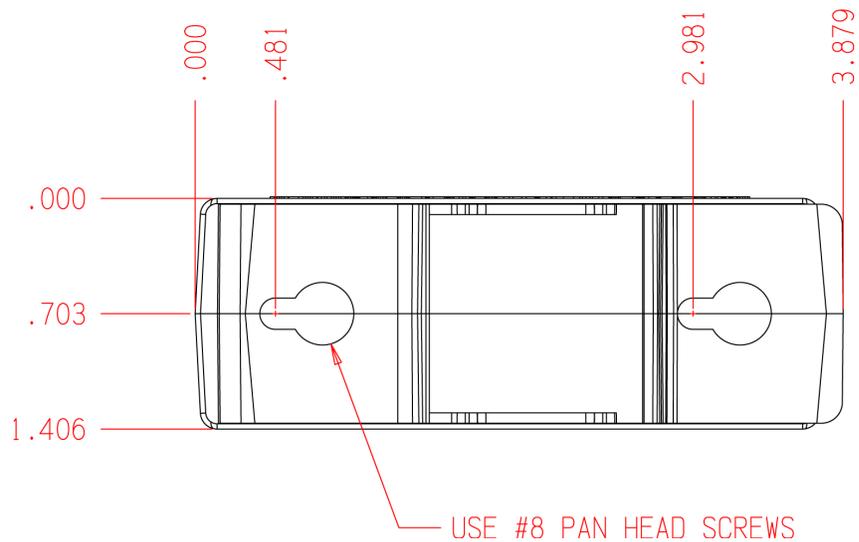
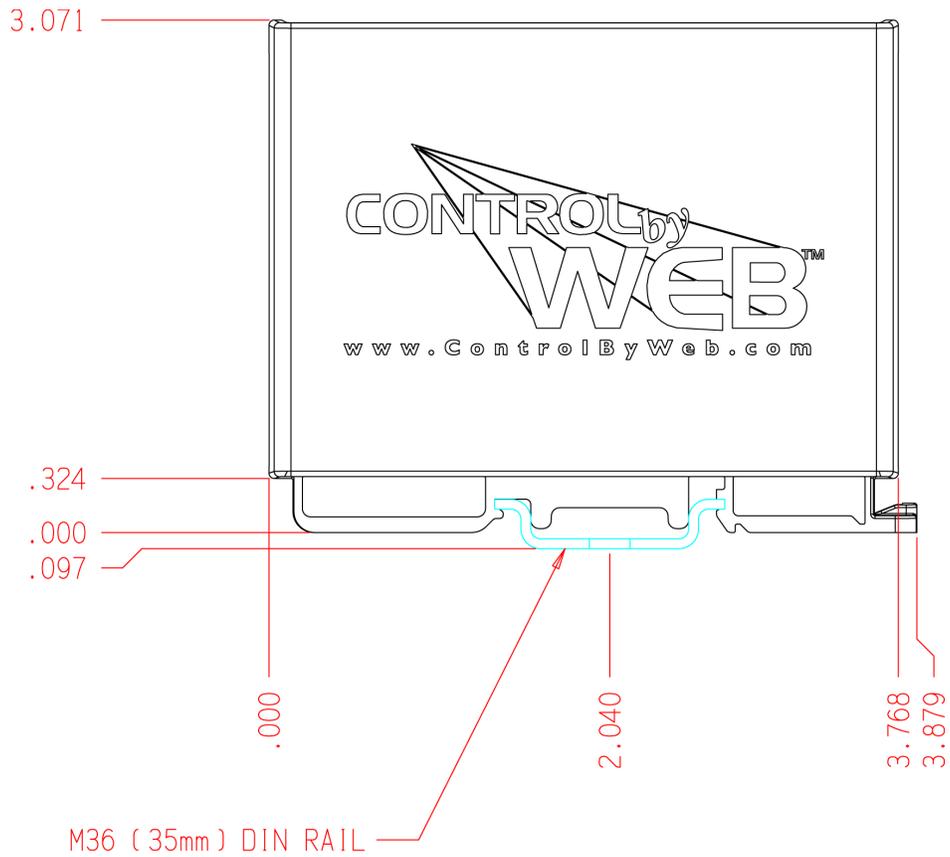
EU EN55024, EN55022

Product Safety:

IEC 60950-1 / EN 60950-1



Appendix C: Mechanical Information



Appendix D: Open TCP Legal Notice

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