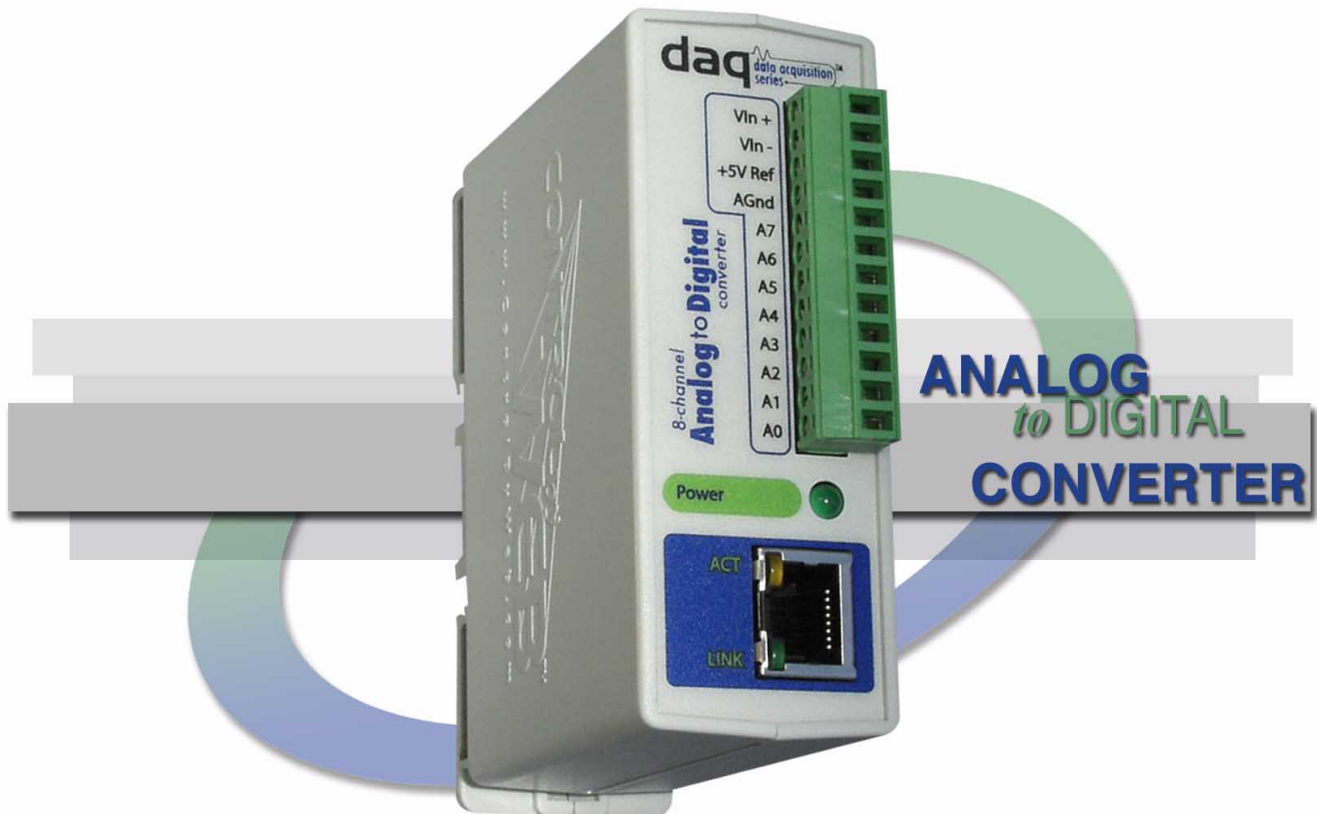# Analog Module

Ethernet 8-Channel Analog Data Acquisition

Users Manual

Revision: 1.0 - March 24, 2008

Covers: **X-DAQ-8A5-6**
X-DAQ-8A5-I

Contents

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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 Analog 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™ Analog Module is an industrial grade, Ethernet data acquisition module with eight analog inputs. It can be configured and monitored over standard networks including private networks, IP-based industrial control networks, and the Internet. Users can view the value of the analog inputs using a web browser or a custom application. Computers, PLCs, or automation controllers may monitor input values by sending text commands over the network and reading XML status pages from the module, or by using Modbus/TCP protocol.   Up to four other ControlByWeb™ products can be controlled by the Analog Module as the analog inputs change state.

The Analog Module is very easy to set up using a web browser. It has a simple "Control Page", which displays the analog readings of the module. The Analog Module can be setup to accept either eight single-ended analog signals, four differential analog signals, or a combination of singled ended and differential inputs. For example, inputs 0 and 1 could be setup to accept a differential signal and the other 6 inputs could be setup to accept single ended signals.

1.1 Features

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

- ✔ Eight analog input channels (can be configured as eight single ended inputs, four differential inputs, or a combination of single ended and differential inputs).
- ✔ 10µV resolution.
- ✔ High input impedance.
- ✔ Full 0 to 5V Input Range (Input range can be changed with external resistors at inputs).
- ✔ 4-20mA Inputs (with external 250 ohm resistors.)
- ✔ 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.
- ✔ Removable terminal connectors (included) simplifies wiring and service.
- ✔ Set high/low alarms for analog inputs which can send out alert emails and control remote ControlByWeb™ devices.
- ✔ Apply a different slope and offset to each raw voltage reading.
- ✔ 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.

1.2 Available Models

The Analog Module is currently available in two models. The only difference between the two models are the power supply requirements.

Part Number	Power Supply Requirements
X-DAQ-8A5-6	6VDC
X-DAQ-8A5-I	9-28VDC

1.3 Connectors & Indicators

The Analog Module has a removable 12-position terminal connector and an Ethernet connector. The 12-position terminal connector is used to provide power to the module as well as connections for eight analog inputs. In addition, a 5 VDC reference voltage output is provided as a convenient voltage source for analog sensors.

There are three LED indicators on the Analog Module labeled POWER (green), LINK (green), and ACT (amber). Note that the LINK and ACT LEDs are located on the Ethernet connector. LINK means the Analog Module is properly connected to an Ethernet network. The ACT LED flashes when activity is detected on the network.
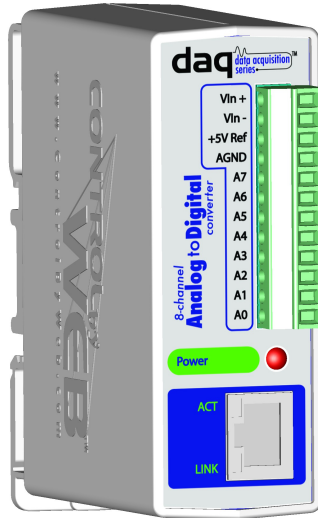
1.4 Example Configurations and Applications

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

1.4.1 Monitoring Height, Position, Etc.

The illustration below shows a simple example of using the Analog Module with a potentiometer based sensor commonly used to measure position, height, etc.
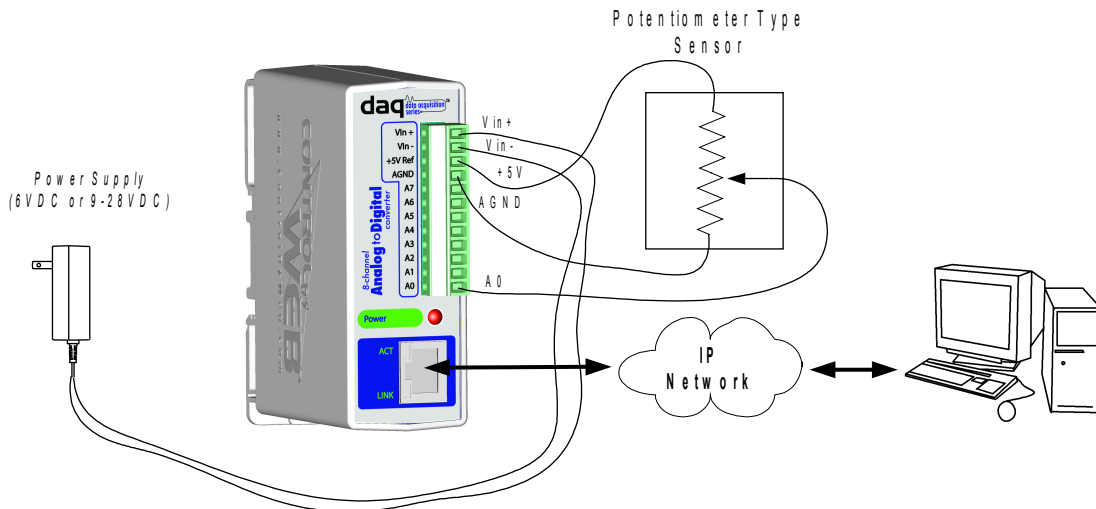
Potentiometer based sensors have three connections: power, ground, and output. Typically, the +5V reference from the Analog Module, and the Agnd are used for power and ground (note that the 5V reference is a very low power output so make sure sensor(s) don't draw more than the rated current output). The output

connection can be connected to any of the eight analog inputs on the input module. This input can then be
monitored through the Analog Module's control page.
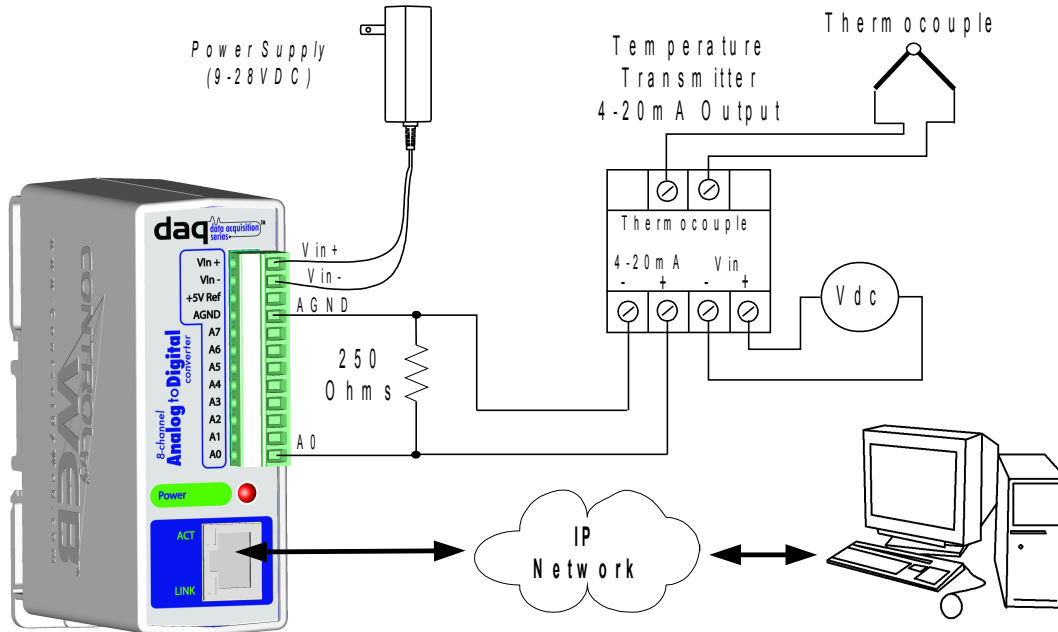
1.4.2 Monitoring Temperature and Using 4-20mA Sensors
The illustration below shows an example of using the Analog Module to monitor temperature. The example
illustrates both measuring temperature and using 4-20mA sensors with the Analog Module.

There are many different types of sensors that can be used to measure temperature. Most of these sensors,
such as the thermocouple in this example, provide an output signal that is nonlinear. In order for the Analog
Module to be used with a sensor that outputs a nonlinear signal, the signal must be converted to a linear
signal. Many devices exist that will convert a nonlinear signal to a linear voltage or current. In this example
a temperature transmitter is used to convert the signal from a thermocouple to a linear 4-20mA current. The
temperature transmitter outputs a current that changes as the temperature changes.

The Analog Module has an input range of 0-5VDC. Since the output from the temperature transmitter is a
4-20mA current, a resistor is used to convert the signal to a voltage at the input of the Analog Module. A
250 Ohm resistor is the proper value for any sensor that outputs 4-20mA.

Once the Analog Module and supporting components are properly wired, they must be configured. The
temperature transmitter is configured for the specific characteristics and type of thermocouple. The user
may specify the expected temperature range that the thermocouple will be used, and the current output for
that range. For example, if the expected range is -160 degrees Celsius to 400 degrees Celsius, the
temperature transmitter may be set to output 4mA at -160 degrees and 20mA at 400 degrees. The
documentation provided by the manufacturer of the temperature transmitter should be used for this step.

The final step is to configure the Analog Module so that it reports the proper temperature by assigning a
slope and offset value for the input which the thermocouple is connected.   The Analog Module calculates
the final value for each input using the following formula.

Final Value = Measured Value * Slope + Offset

By default the slope is set to 1 and the offset is set to 0. Using these settings, the Analog Module will
display the raw input value (0-5volts) on its control page (as well as the xml page and modbus registers). By
properly setting the slop and offset, the Analog Module will properly display the temperature. The slope in
this case, is the change in temperature that causes the Input 0 voltage to change by 1 volt. To determine the

slope, first determine the maximum voltage range that will be applied to Input 0. In this example the temperature transmitter will output 4mA to 20mA. This can be converted to voltage using Ohms law V=IR.

Vmin = 4mA*250ohms = 1VDC
Vmax = 20mA*250ohms = 5 VDC

Now to get the slope, divide the temperature range by the voltage range.

Slope = (400°C - (-160°C))/(5VDC – 1VDC) = 140°C/VDC

Once you have the slope, you can find the offset by using the linear equation (given above).

-160°C = 1VDC * 140°C/VDC + Offset
Offset = -300°C

The slope and offset can now be entered into the setup pages of the Analog Module so that temperature will be properly displayed. The example illustrated determining the slope and offset for displaying temperature in Celsius. To display the temperature in Fahrenheit, a new slope and offset can be calculated using the steps presented above, except the temperature range will be -256°F to 752°F instead of -160°F to 400°F.

Slope = (752°F - (-256°F))/(5VDC – 1VDC) = 252°F/VDC

-256°F = 1VDC * 252°F/VDC + Offset
Offset = -508°F

1.4.3 Monitoring Current
The illustration below shows an example of using the Analog Module in conjunction with a current sensor to measure current draw of a motor.
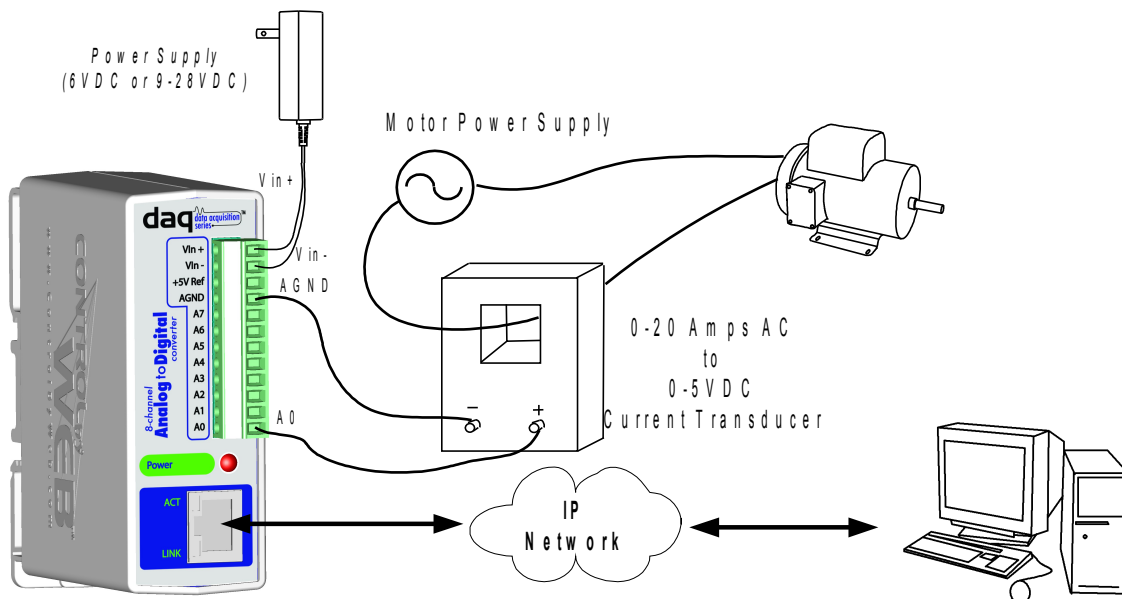
This example uses a self-powered current sensor that will measure current up to 20 Amps AC. The sensor chosen produces a linear output with a range of 0-5VDC so it can be connected directly to the input of the Analog Module. Note that the Analog Module has a high input impedance so self-powered sensors will work properly when connected to its inputs. The illustration shows how the sensor is connected. The slope should be calculated and entered into the setup pages of the Analog Module. The slope calculation is given below.

Slope = (20 Amps – 0Amps)/(5 VDC – 0VDC) = 4 Amps/VDC

1.4.4 Control Application
The illustration below shows a simple example of using the Analog Module in conjunction with a remote device to sound an alarm.
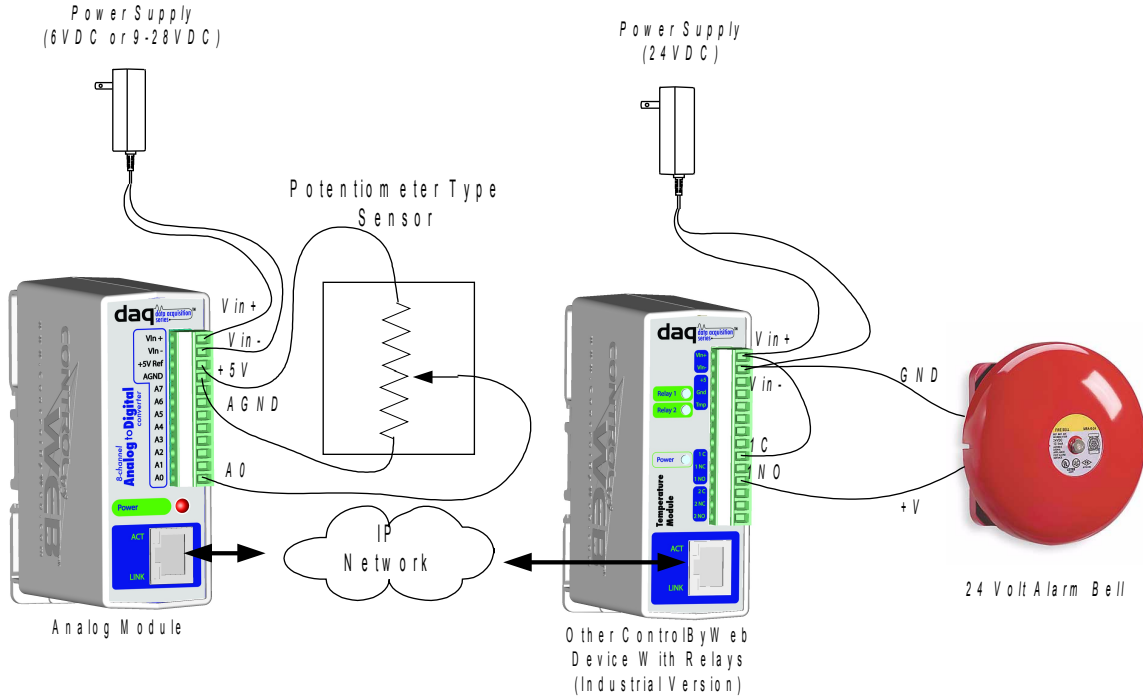
This example is similar to the potentiometer example above accept that the Analog Module has been configured to control a remote device. Each analog input can be configured to send messages to a remote ControlByWeb™ device when a high or low threshold is passed. This message can turn a remote relay on, off, etc. In this example the Analog Module has been configured to send a remote message that in turn will sound an alarm when a given level is exceeded. This could be used, for example, to sound an alarm when water level becomes too high or too low.

Section 2: Installation and Setup

Installation consists of mounting the Analog Module, wiring analog inputs, connecting to an IP network, providing power, and configuring via a web browser.

2.1 Mounting

The Analog Module can be 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 Analog 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 Analog Module can be mounted to a standard (35mm by 7.55mm) DIN rail. Attach the Analog 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 Analog 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.
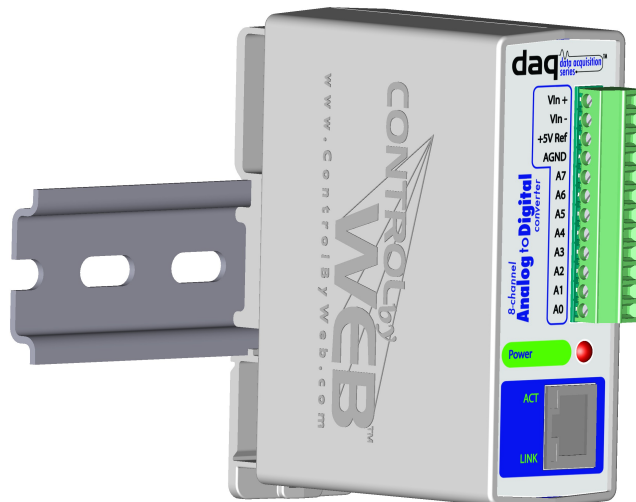
2.2 Connection
CAUTION: MAKE SURE POWER IS SHUT OFF BEFORE WIRING!

A removable 12-terminal connector is provided for simple wiring to the Analog Module. The correct wiring procedure is as follows;
1. Make sure power is turned off.
2. Remove terminal connectors from the Analog Module and make wiring connections to the terminals.
3. Reconnect terminal connectors.
4. Apply power.

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
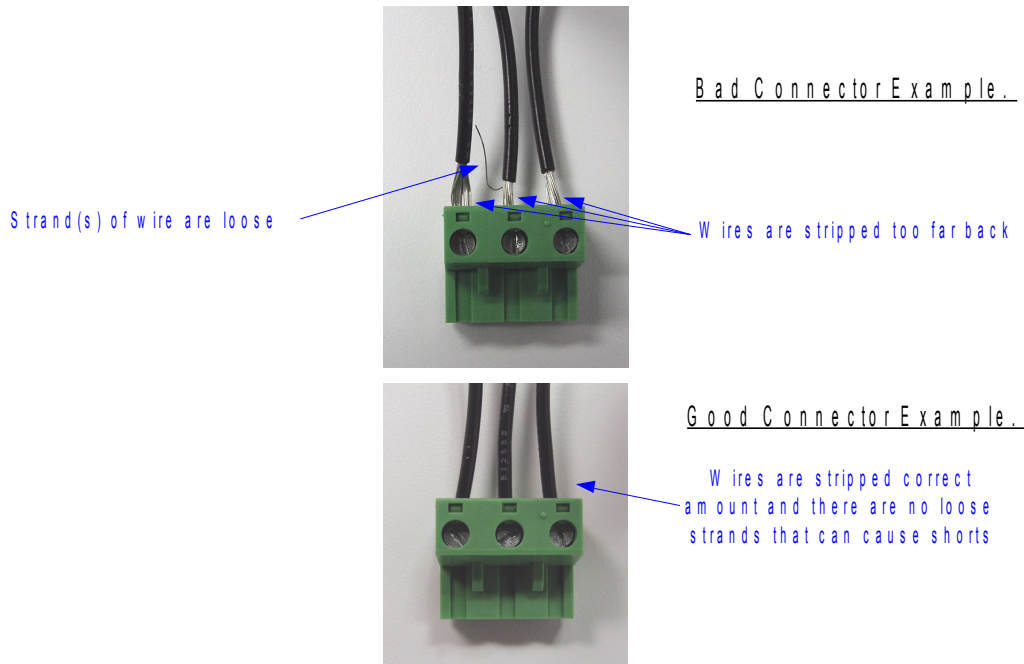
12-pin connector pinout:

Pin	Description
VIn+	Power supply input +. Connect to the positive side of the appropriate power supply. DO NOT EXCEED MAXIMUM POWER SUPPLY VOLTAGE. Model X-DAQ-8A5-6 6VDC Power Supply Model X-DAQ-8A5-I 9-28VDC Power supply
Vin-	Vin- Negative power supply input (Ground).
+5V Ref	+5VDC Reference Output
AGnd	Common ground for analog inputs in single-ended mode
A7	Analog input 7+ (single ended mode) or Analog input 3- (differential mode)

A6	Analog input 6+ (single ended mode) or Analog input 3+ (differential mode)
A5	Analog input 5+ (single ended mode) or Analog input 2- (differential mode)
A4	Analog input 4+ (single ended mode) or Analog input 2+ (differential mode)
A3	Analog input 3+ (single ended mode) or Analog input 1- (differential mode)
A2	Analog input 2+ (single ended mode) or Analog input 1+ (differential mode)
A1	Analog input 1+ (single ended mode) or Analog input 0- (differential mode)
A0	Analog input 0+ (single ended mode) or Analog input 0+ (differential mode)

2.2.1 Power Supply Connection

The Analog Module requires power for its internal logic circuits. Connect appropriate power supply to the Vin+ and Vin- terminals.

Multiple Analog Modules 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).

2.2.2 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 Analog Module 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-thru" cable should be used.

2.2.3 Analog Inputs

There are a variety of analog sensors that can be used with the Analog Module. To interface analog sensors to the Analog Module it may be necessary sometimes to add some simple external circuitry to set the range of the Analog Module input. Analog sensors that provide an output voltage in the range of 0 to 5 volts can be directly connected to the Analog Module. Other common sensors have a higher output voltage of 0 to 10 volts, or output a current in the in the range of 4 to 20 milliamps instead of a voltage. These sensors can be connected to the Analog Module using some simple resistive circuits shown below. Also, some sensors such as bridge-type sensors have two output signals instead of one. The output signals from these sensors are referenced to each other instead of ground. Using these sensors with the Analog Module requires that two analog inputs be used together in differential mode. Following are some examples of different sensor types and how they can be interfaced to the Analog Module.

High Output Sensors > 5VDC

In the case of a sensor whose output levels are higher than 5 volts, a simple voltage divider can be used to scale down the output. The following diagram shows a simple voltage divider circuit. In the example, Vin can range from 0 to 10 volts and resister values for R1 and R2 will be chosen so that Vout will have a range that falls within the 0 to 5 volt range of the Analog Module.
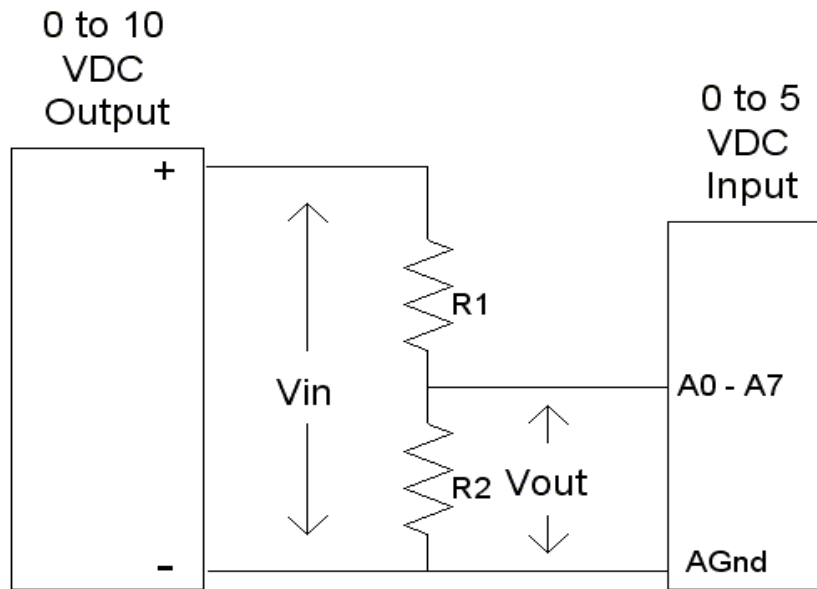
Generally, you can choose a 1K Ohm resistor for R2 and then calculate the value of R1 using the following formula.

$$Vout = Vin * (R2 / (R1 + R2))$$

To determine the proper resister value to use in the example above, use the maximum output of the sensor (10 VDC) as Vin in the equation, the maximum input value of the Analog Module (5 VDC) as Vout, and R2=1K Ohms.   Solving for R1 gives 1K Ohms.

R1=1K
R2=1K

As another example, if the maximum output voltage of the sensor is 15VDC, choose R2=1K and by solving the equation, R1=2K.

4-20mA Sensors (Current level conveys information, not voltage levels)
Some sensor are designed to change the output current instead of the voltage level. To use these sensors, a resister is placed in parallel with the sensors. Placing a resister across the terminals of the sensor creates a voltage drop between them that changes as the current changes. This voltage drop can be measured by the Analog Module. The following diagram shows how to connect one of these sensors to the Analog Module.
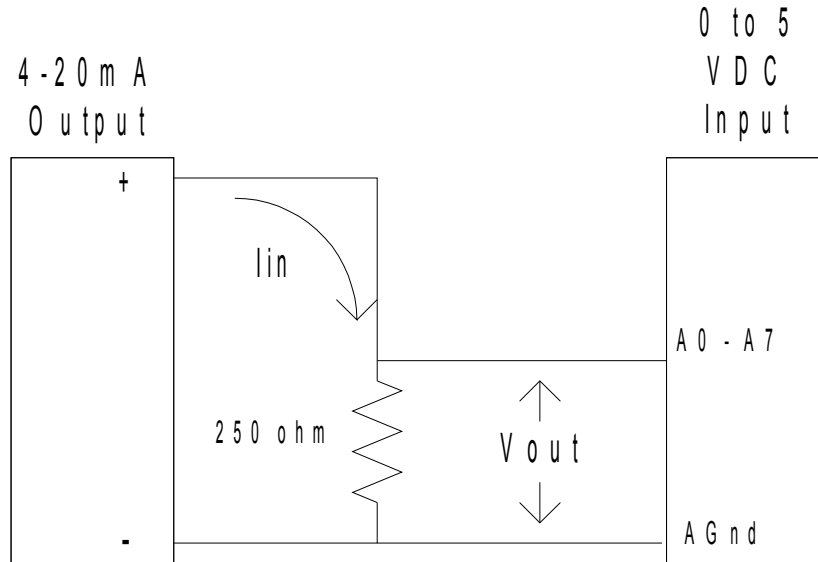
For sensors that have an output of 4-20mA a resistor value of 250 ohms can be used to get the desired output voltage between 0 and 5 volts.

Bridge-Type Sensors (Differential Mode)
Sensors that have an output that is referenced to ground are called single-ended sensors. Differential sensors have two outputs that reference each other instead of of ground. The Analog Module can be used with both types of sensors. The mode is set by selecting the desired mode in the web-based setup pages. Note that differential mode uses two analog inputs instead of one. The following illustration shows how a differential sensor is connected to the Analog Module.
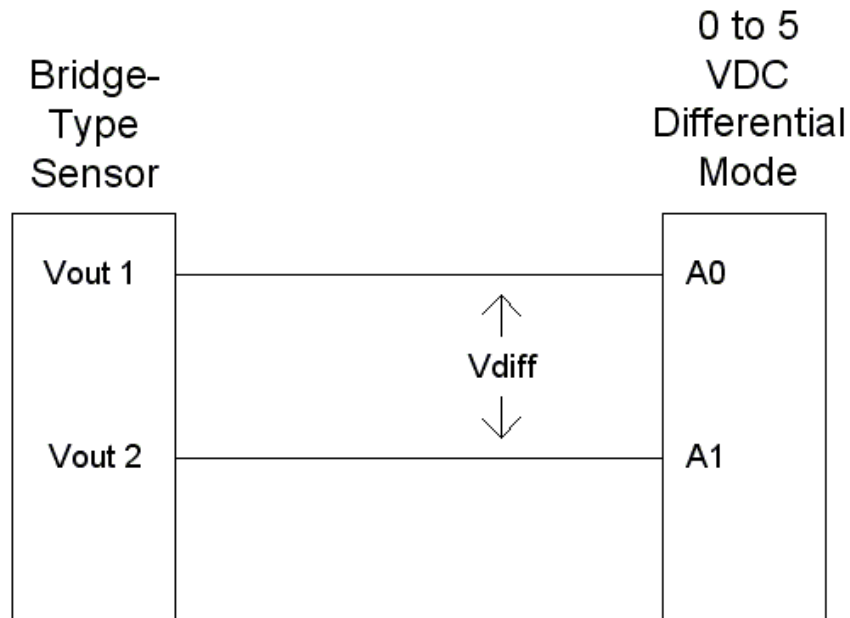
The illustration above consists of a bridge-type sensor with two output signals. The outputs are connected to inputs 0 and 1 of the Analog Module. These two inputs have been placed in differential mode through the

analog setup page An 0/1. The analog reading taken by the Analog Module will be Vdiff, which is Vout 1 – Vout2. If, for example, if Vout1 equals 2.5 volts and Vout2 equals -2.5 volts, then the Analog Module will read 5 volts. If, on the other hand, Vout 1 equals 2.5 volts and Vout 2 equals 2.5 volts, then the analog module will read a difference of 0 volts. When using sensors that provide two output signals make sure the sensor doesn't exceed the 5 VDC output for Vdiff. If the sensor is outside this range external circuitry such as the voltage divider mentioned above should be used.

2.4 Establishing Communications for Setup

The Analog Module is set up using a web browser. The first task is to establish communications between a computer and the Analog Module so that the browser-based configuration can begin. To do this, the computer and the Analog 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 Analog Module so that they are on the same network. The first way (Option 1), is to change the IP address of the Analog 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 Analog Module is set to by default.

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

This option is used to TEMPORARILY assign an IP address to the Analog Module without the need to change the IP address of the configuration computer. Note that the Analog Module will only use this IP address as long as power is maintained. Once power is lost and restored, the analog 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 Analog 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...

> <u>Windows</u>**:**
> Open a Command Prompt (on Windows XP, select START, then RUN, then type "cmd").
> Type...
> > *arp -s {new IP address} {serial number of analog module }*
> >
> > Note: IP address format is: xxx.xxx.xxx.xxx
> >   Serial number format is: ss-ss-ss-ss-ss-ss
> >
> > For example, to set an analog 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
> > ```
>
> <u>Linux/Unix:</u>
> Open a terminal, change to root user (su -, then enter root password).
> Type...
> > *arp -s {new IP address} {serial number of analog module}*

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

For example, to set an Analog 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 Analog Module}

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

For example, to set an Analog 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 analog module . By default, the Analog Module comes from the factory with an IP address of 192.168.1.2. Communications with Analog Module may be established by assigning an IP address to the configuration computer that is on the same network as the analog 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 Analog 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.)
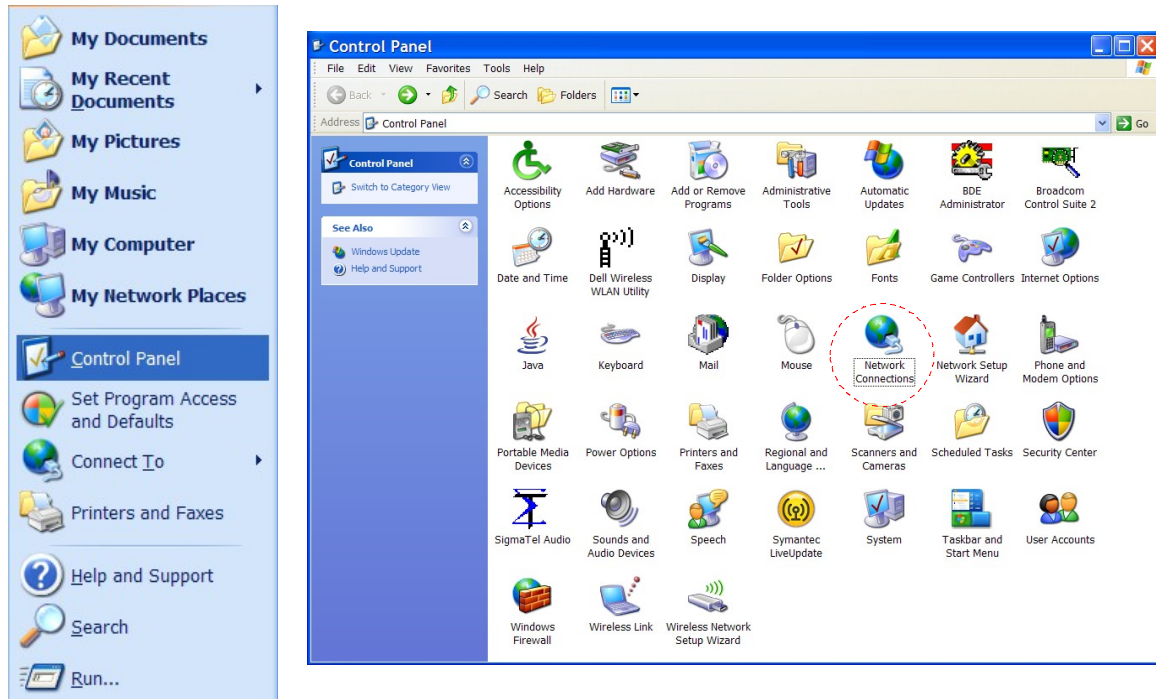
Step 2: Double click on the icon labeled Network Connections. The following menu will pop up.
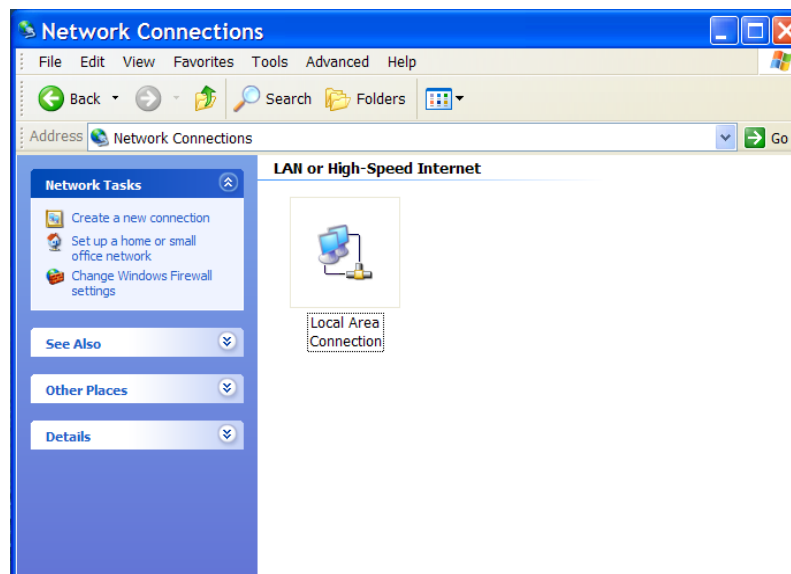
Step 3: Right click on the icon labeled Local Area Connection. Another menu will appear.

Select the option at the bottom of the menu labeled Properties. The Local Area Connection Properties window will appear.
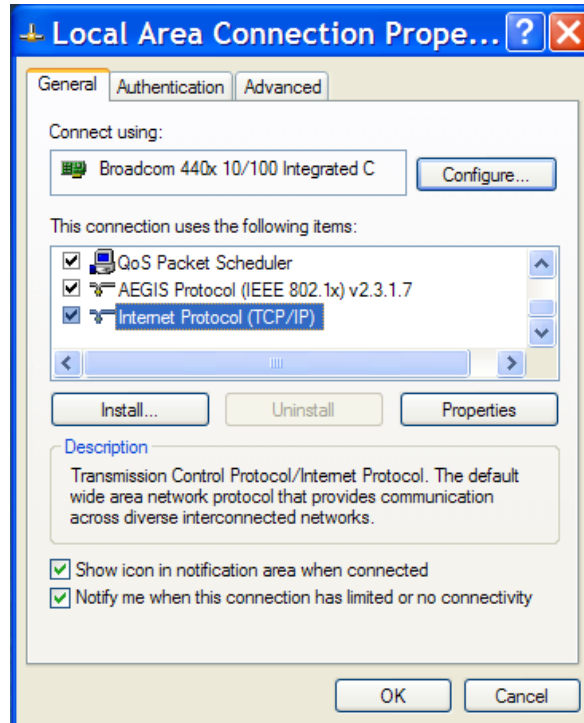
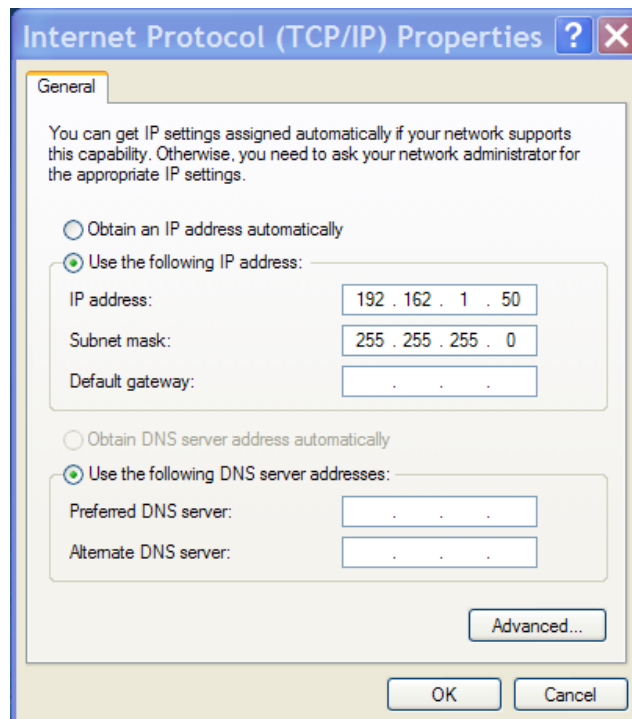Step 4: On the Local Area Connection Properties page scroll down to Internet Protocol (TCP/IP), select it, and then click the button labeled properties.

Step 5: Before making any changes to the network settings, write down the current settings so that they can be restored once the Analog 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 Analog 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 Analog 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 Analog 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.
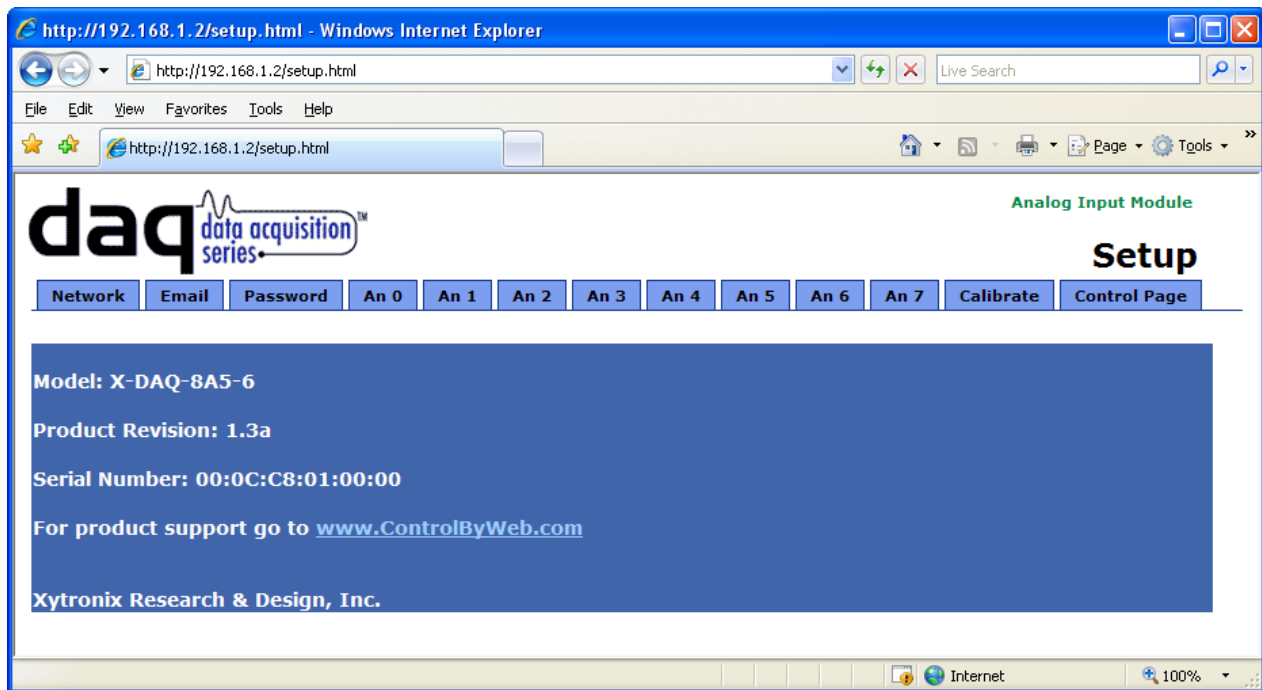
All setup pages require a password. The default password is 'webrelay' (no quotes, all lower case) and no user name is required.
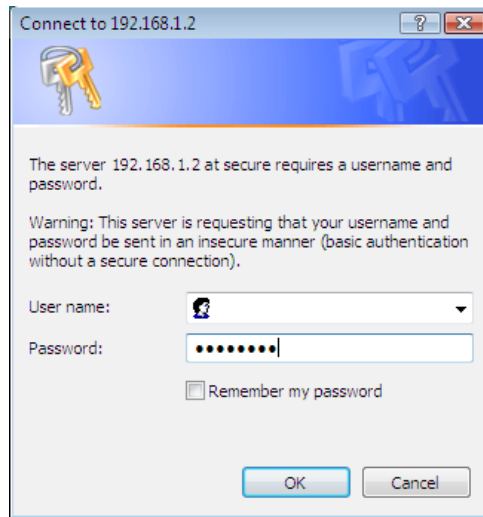
Each setup page has a "Submit" button and a "Reset" button at the bottom of the page. After entering the desired parameters into each page, the "Submit" button must be pressed before any parameters will be saved. If a mistake is made in entering the parameters, the "Reset" button may be used to restore 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 analog 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 Analog 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.
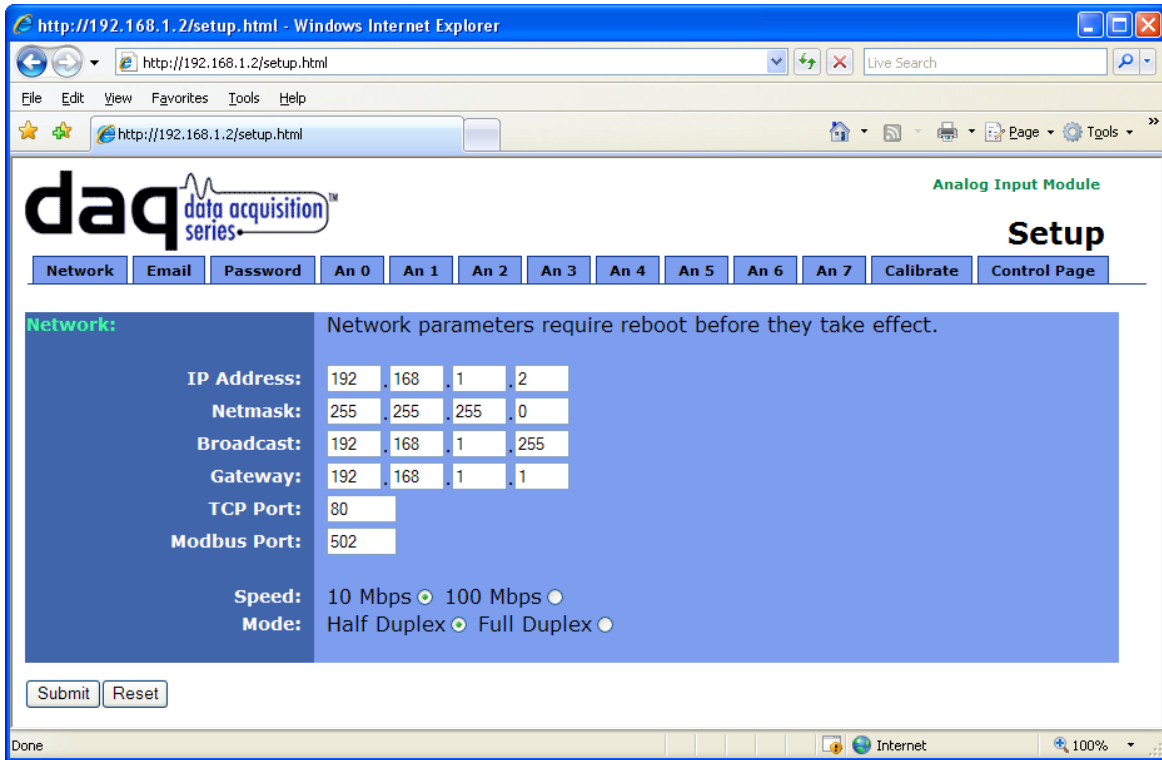
1. IP Address:

        The Analog Module requires a static IP address. This is a unique address that identifies the Analog 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 Analog 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 Analog 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 Analog Module will not be accessible from the Internet until the proxy server is properly configured (forward proper port to the Analog 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 Analog 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 analog module is used to control a device in another room or a nearby building.

        If the Analog 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 Analog 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 Analog 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 Analog 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 Analog 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 Analog Module which uses that port. The Analog Modules could then be accessed from outside the private network by entering the IP address of the gateway and the port for the desired Analog Module. Note that whenever any port is assigned other than port 80, all communications with that Analog Module must include the port. For example, if the Analog Module is assigned port 8000, access to the setup pages would require the following URL to be entered; http://192.168.1.2:8000/setup.html.

An example screen shot 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 screen shot is simply an example of a typical router setup page. Routers will vary.
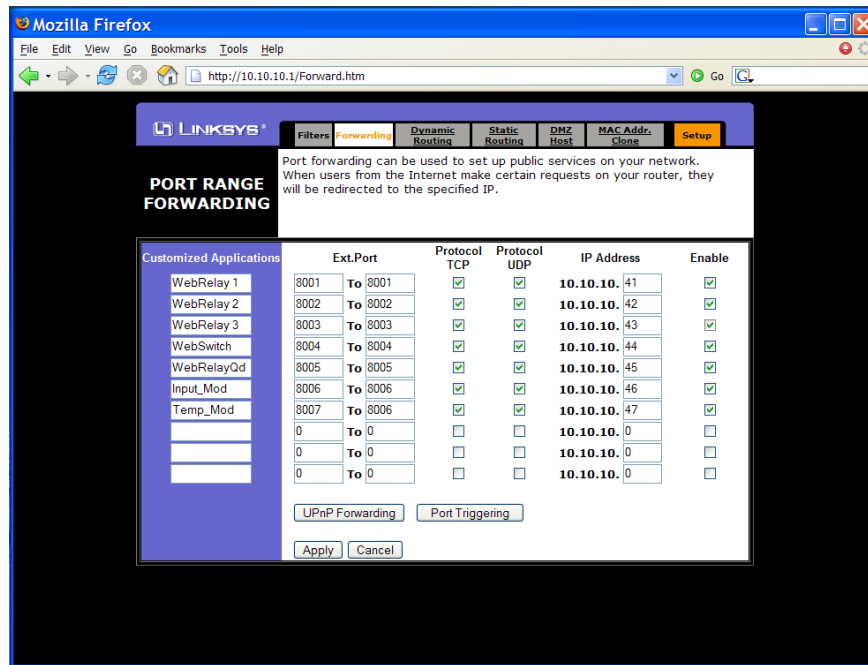
In the example, the seven ControlByWeb™ products are assigned IP addresses of 10.10.10.41 to 10.10.10.47. The first device labeled WebRelay 1 has an IP address of 10.10.10.41 and is assigned port 8001. Note that in the WebRelay™ setup page (under Network settings tab), TCP Port 8001 must be specified 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 it's 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 analog 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 Analog Module is so small that users will not likely notice much of a difference. When the Analog 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 email setup page is used to configure the device for use with a SMTP server, as well as to define up to three recipient email addresses . The settings on this page will be used when inputs are configured to send email messages. If none of the inputs are configured to send email messages then the settings on this page can be left at there default values.

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 mail server is known, it can be directly entered into this field. If this is the case, the Mail Server field should be left blank. This will cause the Analog Module to attempt to send email messages directly to this IP address, bypassing the need for a DNS server.

2. Mail Server (SMTP):
> If email notification will be used, enter the name of an SMTP email server here. If this field is left blank, the Analog Module will try and send email messages directly to the IP address specified in the DNS Address field. This allows the DNS server to be bypassed if the IP address of the SMTP server is already known.

3. Mail Server Port:
> This is the port which the SMTP server will be listening on for incoming messages. By default most SMTP servers use port 25.

4. Domain:
> This is the domain name for the sender. This value usually follows the @ sign in the senders email address. By default this is set to controlbyweb.com, and the return email address is noreply@controlbyweb.com

5. User Name (Optional):

If the SMTP server requires authentication, the Analog Module supports the AUTH LOGIN method of authentication. With this method the user name and password entered on this page are sent to the SMTP server in a Base64 encoded string. If the user name and password are found to be valid for the SMTP server then the email will be delivered. If the user name and password fields are left blank then an attempt to send the email will be made without any authentication.

6. Password (Optional):

This field is used to specify the password used for authentication with an SMTP server. See the explanation of the User Name field for more information.

7. Return Email:

This is the email address that will show up in the From: line of the email. If there are problems delivering the email, error messages will be sent to this email address. Also, recipients of emails from this device can respond back to this email address.

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 Analog 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.
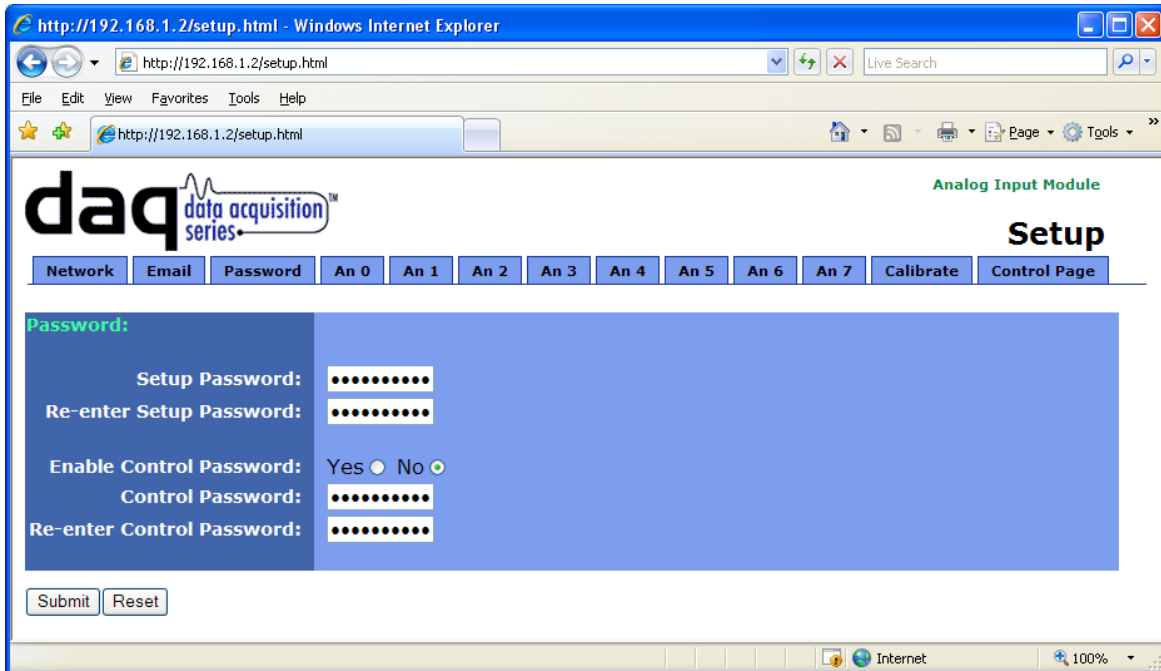
2.5.5 Analog Input Setup Pages

These pages (An 0 through An 7) define how the analog inputs function and what inputs appear on the control page. All eight pages are almost identical with a few exceptions. Setup page An 0 includes some additional settings for the control page that aren't present on the other setup pages, and setup pages An 0, An 2, An 4, and An 6 have settings that apply to remote communication with other devices as well as the option to enable differential mode. When one of these inputs has been configured as a differential input, the next higher numbered input is used as the -IN and the settings for that input aren't editable. For example, if An 4 is placed in differential mode, then analog input 4 will act as +IN for the differential pair, and analog input 5 will act as -IN for the differential pair. The settings for An 4 will apply to the differential pair, and the settings for An 5 will not appear as long as differential mode is enabled.

The first 3 parameters appear on the Analog 0 setup page only. The input parameters appear on all the Analog input setup pages accept for the Differential Mode setting which appears on even numbered input setup pages only. The final three parameters appear on even numbered input setup pages and apply to that analog input as well as the odd numbered analog input directly following. This is because each pair of analog inputs communicate with the same remote device.

1. 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.

2. Auto Refresh Page:

Web pages traditionally display static information. The Analog 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 Analog 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.

3. 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.

4. Differential Mode:

This option determines whether or not two inputs will act together in differential mode or whether they are independent of each other in single-ended mode. When in differential mode, only one set of options for the first input will be displayed. These options will apply to the differential pair while they are in the differential mode. When two inputs are in differential mode, the first input acts as the positive input and the second input acts as the negative input. When the inputs are in single-ended mode, each input individually acts as the positive input while the common ground (pin 4) acts as the negative input.

Differential mode can be used with sensors that have two analog outputs that are referenced to each other instead of ground.

Mode	Input								
	0	1	2	3	4	5	6	7	AGnd
Single-Ended	IN+								IN-
		IN+							IN-
			IN+						IN-
				IN+					IN-
					IN+				IN-
						IN+			IN-
							IN+		IN-
								IN+	IN-
Differential	IN+	IN-							
			IN+	IN-					
					IN+	IN-			
							IN+	IN-	

5. Input Description:

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

6. Units:

The contents of this field will be displayed after the analog measurement in the control page, XML

page, and email messages. This field doesn't change the value in any way, it is simply used to add units to the value shown. It can be up to 4 characters long. By default this field is cleared.

7. Display Input Status:
When this parameter is set to **YES**, the analog value will appear on the control page and in emails. When this parameter is set to **NO**, the analog value for this input will not appear on the control page or in email messages.

8. Slope:
The analog inputs have an input range from 0-5VDC. In many cases, the inputs must be scaled to represent "real-world" measurements that are outside the range of 0-5. The Analog Module reads the "raw" value from each input, and calculates the number that represents the "real-world" measurement that the user is actually interested in. This real-world value (referred to as the "scaled" value in this section) is calculated using the following linear formula.

Scaled Analog Value = Slope*Raw Voltage + Offset

The scaled value is the only number that the the Analog Module keeps track of and uses. This is the value which is used to determine alarm conditions and is the value that is displayed on the control page, the XML page, and it is also returned when modbus values are read.

The "slope" in the formula above is provided by the user and is entered in this field. The default value for this field is 1. When both the slope and offset are set to their default values, the Scaled Value = the Raw Voltage.

Note: The slope and offset can be calculated by hand and entered directly into these fields, or can be calculated automatically by the Analog Module through the calibration setup page described in section 2.5.6.

9. Offset:
See the description of slope and offset in the previous paragraph.

The "offset" in the formula above is provided by the user and is entered in this field. The default value for this field is 0. When both the slope and offset are set to their default values, the Scaled Value = the Raw Voltage.

Note: The slope and offset can be calculated by hand and entered directly into these fields, or can be calculated automatically by the Analog Module through the calibration setup page described in section 2.5.6.

10. Message Options:
Each input has the capability of sending out a variety of messages to a variety of destinations based on the current analog reading of the input and the trigger and delta values. The Message Options parameter defines the type of message is sent (email, on/off, analog value) and where the message should be sent to (email server, other device defined by IP address). The following options are available:
-Disabled- Don't send messages out for this input.
-Send email on triggers-
When the scaled analog value moves above the upper trigger or below the lower trigger, an email message will be sent to the email recipients selected. If the scaled analog value falls back within the limits of the upper and lower triggers, another email message will be sent to the same recipients to indicate the scaled analog value has returned to its normal state. To avoid an excess of email messages, the scaled analog value must move back into the normal range by the amount specified in the 'delta' parameter. For example, suppose the upper trigger is set to 25 and delta is set to 0.5. In this case, a high alarm will occur when the scaled analog value rises above 25, and a normal alarm will occur when the measured value returns below 24.5, which is the upper trigger minus the delta. The delta value can be considered the dead band when email messages are to be sent out based on

the triggers.

-Send email when value changes by delta- When the scaled analog value changes by the amount defined in the parameter 'delta', an email message will be sent to the selected email recipient(s). When power is applied to the unit, the current value is recorded and used as the initial reference (message will be sent immediately when power is applied and this option is selected). When this option is first enabled in the setup pages, the current value is recorded at that time and used as the initial reference (message will be sent immediately when this option is selected).

-Send on/off message to remote unit on triggers- When the scaled analog value is above the upper trigger or below the lower trigger, a command is sent to the remote device at the IP address defined in the field 'Remote Unit IP Address' field to turn a relay within that device on. When the scaled analog value returns to a value that falls within the upper and lower triggers, a command is sent to the remote device to turn the relay within that device off. To avoid an excess of commands being sent, the 'delta' parameter is used as a deadband region. When the scaled analog value rises above the upper trigger or falls below the lower trigger, the message will be sent immediately. When the scaled analog value moves back into normal range, it must move into the normal range by the amount of the "delta"value before the message is sent. For example, suppose the upper trigger is set to 25 and delta is set to 0.5. In this case, a high alarm will occur when the scaled analog value rises above 25, and a normal alarm will occur when the measured value returns below 24.5, which is the upper trigger minus the delta.

-Send value to remote unit on triggers- When the scaled analog value is above the upper trigger or below the lower trigger, the raw voltage measurement will be sent to the remote device at the IP address defined in the field 'Remote Unit IP Address'. When the scaled analog value of the input returns to a value that falls within the normal range, the raw voltage reading will be sent to the remote device. To avoid an excess of messages being sent, the ' delta' parameter is used as a deadband region. When the scaled analog value rises above the upper trigger or falls below the lower trigger, the message will be sent immediately. When the scaled analog value moves back into normal range, it must move into the normal range by the amount of the "delta"value before the message is sent. For example, suppose the upper trigger is set to 25 and delta is set to 0.5. In this case, a high alarm will occur when the scaled analog value rises above 25, and a normal alarm will occur when the measured value returns below 24.5, which is the upper trigger minus the delta.

-Send value to remote unit on each change by delta- When the scaled analog value changes by the amount defined in the 'delta' field, the raw voltage measurement will be sent to the remote device at the IP address defined in the field 'Remote Unit IP Address'. When power is applied to the unit, the current value of the value is recorded and used as the initial reference (message will be sent at power-up when this option is selected). When this option is first enabled in the setup pages, the current value is   recorded at that time and used as the initial reference (message will be sent immediately when this option is enabled).

11. Use Email Address:

When the input is set to send email messages, this field specifies which email address the message will be sent to. There are three check boxes which specify which email address on the Email Setup page will be used. When the input is set to send email messages, the message can be sent to one, two, or all of the email addresses specified on the Email Setup Page.

12. Upper Trigger:

This option defines the upper alarm trigger. This value should be greater than the lower trigger. When the scaled analog value moves from lower than this value to greater than or equal to this value, the input is in a high alarm state.   The actions taken as a result of this state are determined by the 'Message Options' parameter. To effectively disable the upper trigger while using the lower trigger, set this value to a very high number.

13. Lower Trigger:

This option defines the lower alarm trigger. This value should be lower than the upper trigger. When the scaled analog value moves from the greater than this value to less than or equal to this

value, the input will be in a low alarm state.   The actions taken as a result of this state are determined by the 'Message Options' parameter. To effectively disable the lower trigger while using the upper trigger, set this value to a very low number.

14. Delta:
> This field is used to specify the delta value. The delta value is used in two ways. First, it is used when the input is configured to send messages based upon a delta. In this case, the when the scaled analog value changes by the amount specified in this field, a messages will be sent. Secondly, when upper and/or lower triggers are used, the delta value is used as a deadband that eliminates alarm state toggling quickly when the scaled analog value is close to the trigger values. In this case, when the scaled analog value changes from a normal value to a value that is above the upper trigger or lower than the lower trigger, the input is in an alarm condition. The input will stay in the alarm condition until the scaled analog value moves back into the normal range by a minimum of the delta value.   For example, suppose the upper trigger is set to 25 and delta is set to 0.5. In this case, a high alarm will occur when the scaled analog value rises above 25, and a normal alarm will occur when the measured value returns below 24.5, which is the upper trigger minus the delta. The delta value can be considered the dead band when email messages are to be sent out based on the triggers.

15. Send Periodic Message:
> When this field is set to **Yes**, and the 'Message Option' parameter is set to send commands to a remote device (not email), messages will be sent periodically to the remote device (even if input value does not change). The type of message sent (on/off command or value) is determined by which 'Message Option' is selected.   The rate at which the periodic messages are sent is determined by the parameter 'Period'.

16. Period:
> This field specifies the rate at which periodic message are sent to a remote device when the 'Send Periodic Message' field is set to **Yes**, and a 'Message Option' is selected that sends messages to a remote unit. This field can be set within the range of 10 to 4223173 seconds (roughly 48 days).

17. Remote Output #:
> When the 'Message Option' field is set to send messages to a remote unit (not email messages) the messages are sent to the remote device with this output number. For example, if an on/off command is sent to a WebRelay-Quad™, this field specifies which if the four relays will be affected. Note this when sending commands to a single WebRelay™, (with only 1 relay) this filed should be set to 0.

18. Remote Unit IP Address:
> When an input is configured to send messages to a remote device, this field specifies IP address of the remote device. Note that the Analog Module is capable of sending messages to up to four devices Each IP address setting is shared between two analog inputs (An 0/1, An 2/3, An 4/5, An 6/7). Both inputs that share the IP address can send different messages to the device, but they cannot send messages to different devices.

19. Remote Unit TCP Port:
> When an input is configured to send messages to a remote device, this field specifies TCP port used on the the remote device. Like the IP Address setting, each TCP Port setting is shared between two analog inputs (TCP Port settings are associated with the same analog input pairs as IP address settings).

20. Remote Unit Password
> When an input is configured to send messages to a remote device, this field specifies the password used to access the device. This is necessary whenever password authentication is enabled on the remote device.
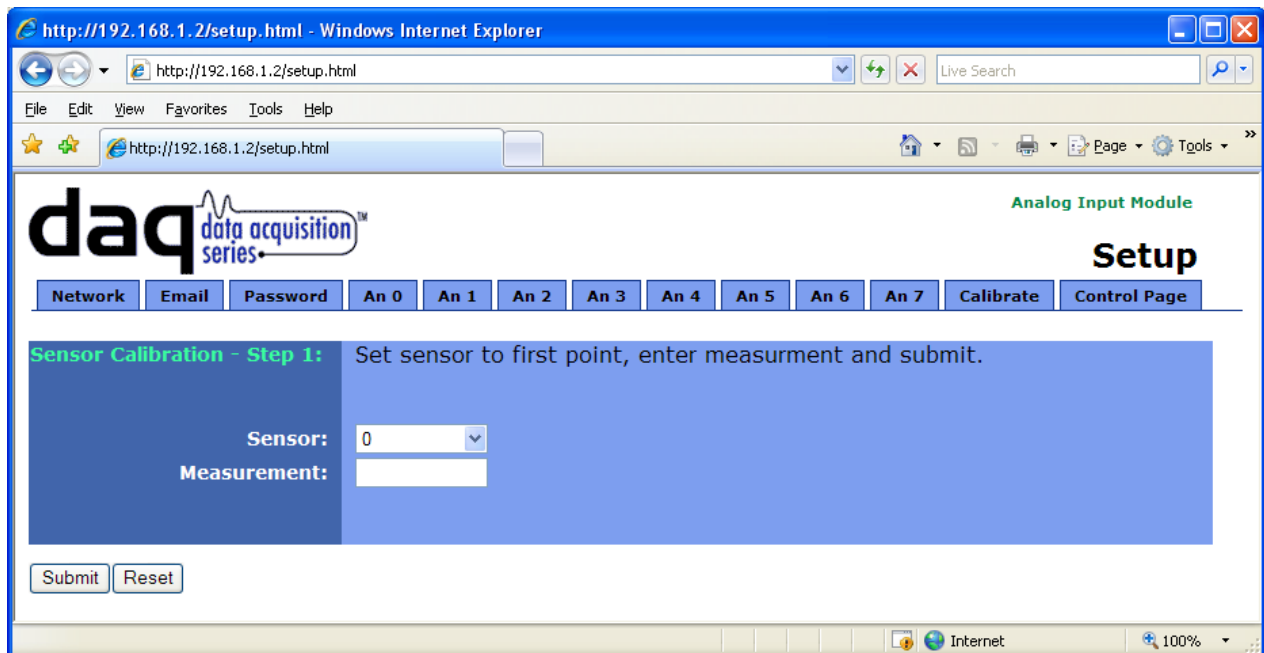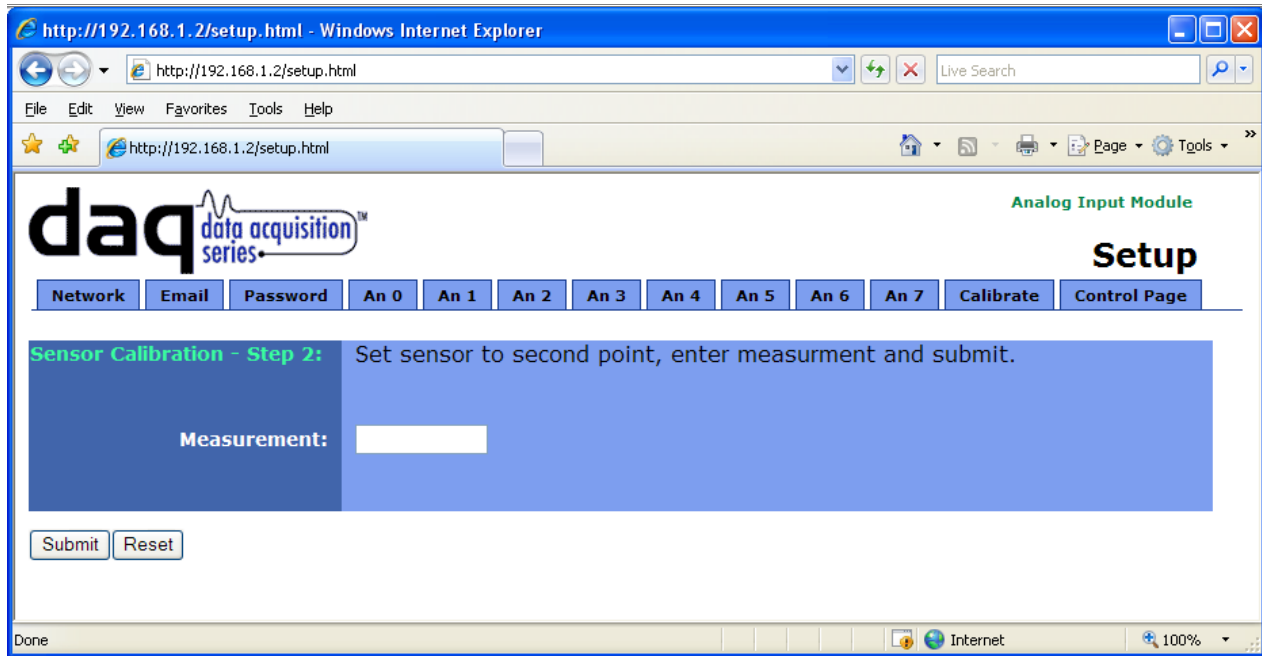
2.5.6 Calibration Page
Each input value can be scaled so the analog readings represent real-world values. The Analog Module scales the inputs using the linear equation below.

$$\text{Scaled Value} = \text{Slope} * \text{Raw Voltage} + \text{Offset}$$

By default, the slope is set to 1 and the offset is set to 0 which which will not scale the input. If the input does need to be scaled, the slope and offset for sensors can be manually entered into the analog setup pages. Alternatively, if the slope and offset information are not readily available, the calibration page can be used to determine the slope and offset. This is done by connecting the sensor to the Analog Module and performing a 2-point calibration.

The calibration process requires that precise measurements be known for two sensor positions (usually on each end of the scale).   Once the sensor is connected, move it to the first calibration point and enter the sensor number (analog input number) and measurement value (scaled analog value) into the calibration page. Press submit. Next, move the sensor to the second calibration point, enter that value into the calibration page and press submit. Once these two points are entered, the Analog Module automatically calculates the slope and offset for that sensor.

An example will be used to illustrate the use of the calibration page. Suppose a potentiometer sensor is used with a float to measure water level of a river. The water level is measured in feet and is reported as elevation (with respect to sea level). In this example, the river bed (no water) measures 5237 feet and the river can move up to 5289 feet. The measurement float can move the full range. Once the sensor is set up and connected to the Analog Module, the float should be physically moved to the bottom of the river and the first measurement (5337) is entered into the Calibrate page and submitted. Next, the float is physically moved to the high position and the second measurement (5289) is entered and submitted.

Section 3: Operation

The Analog Module can be operated using a web browser, by sending text commands to an XML status/control page, or by sending Modbus/TCP requests.

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. The control page displays the final values (raw voltages with the slope and offset applied) for each input at the time of the request. Note, only those inputs who have the 'Display Input Status' setting found on the input setup pages set to **YES** will be displayed on the control page. A control page is shown below. In this example, all the inputs use the default settings accept for input 3. Input three has been configured to convert the raw voltage value from volts to an angle in degrees, 0 degrees corresponding to 0 volts and 360 degrees corresponding to 5 volts. Notice also that the 'Units' option from the input setup page is being used to display the units next to the value.

Note: When the input signal is out of range, meaning it is less than 0 volts or greater than 5, then the control page will indicate this by displaying the text OUT_OF_RANGE instead of a value for the input.
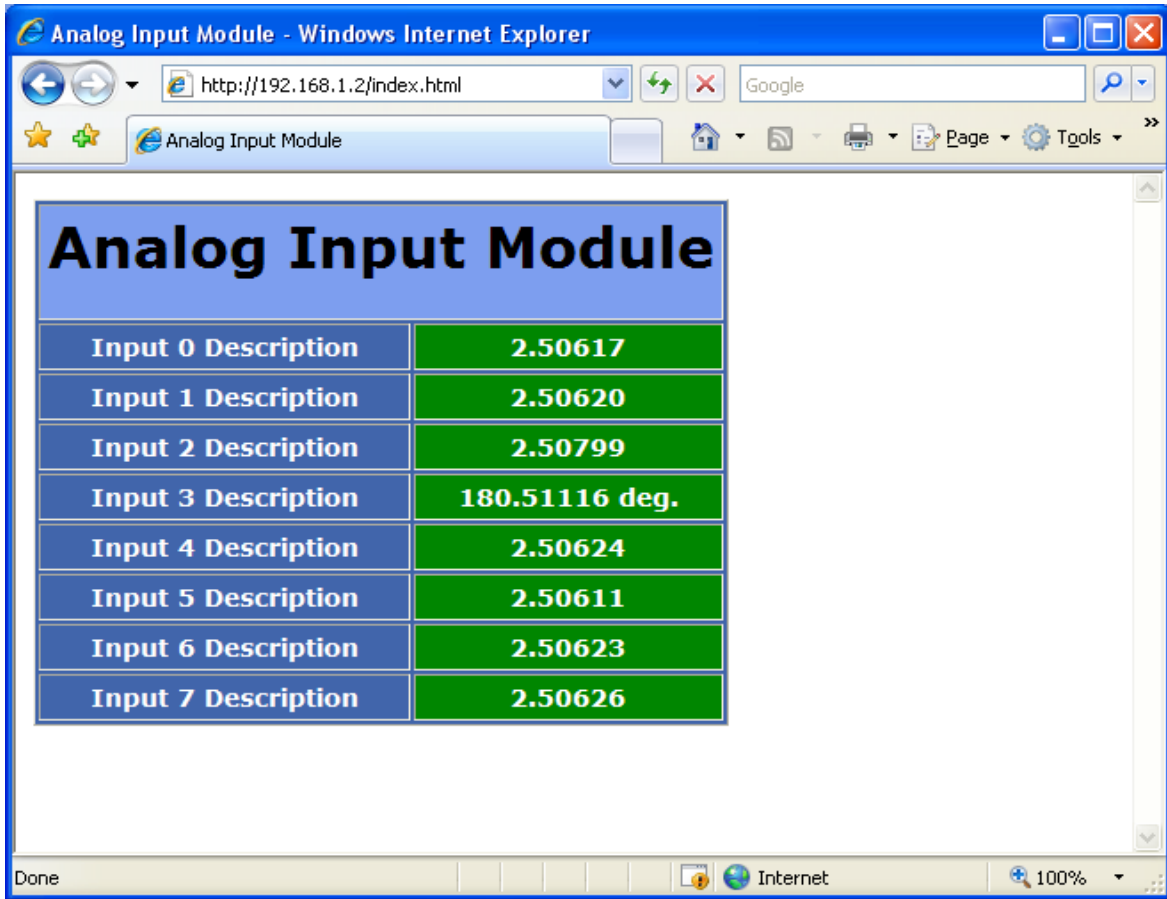
3.2 XML Operation

Custom computer applications may be created to monitor and control the Analog Module without using a web browser. There are two XML pages used for monitoring and controlling the unit. Monitoring the analog readings is done by sending a request to port 80 (or port specified in setup) for the XML page state.xml. Monitoring the analog input modes and resolution can be achieved by requesting the XML page adcstate.xml. The use of these XML pages 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>
      <input0state>2.50487</input0state>
      <input1state>2.50494</input1state>
      <input2state>2.50673</input2state>
      <input3state>180.42037 deg.</input3state>
      <input4state>2.50496</input4state>
      <input5state>2.50494</input5state>
      <input6state>2.50491</input6state>
      <input7state>2.50491</input7state>
      <powerupflag>1</powerupflag>
</datavalues>
```

The tags <inputstate> and <powerupflag> indicate the current state of the Analog Module. Values for each tag are described below.

<inputstate>   180.42037 deg. (raw analog value with slope and offset applied, units are displayed as well)
                   OUT_OF_RANGE (raw analog value lies outside the valid input range of 0 to 5 volts)

<powerupflag>   The power up flag can be used to detect power loss. Whenever the unit is power on, the
                powerupflag will be set to 1. This flag can then be cleared by the user. The only way the
                powerupflag can be set to 1 is if the unit looses power.

Request the current mode of the analog inputs as well as current resolution: http://192.168.1.2/adcstate.xml

This will return the following XML page.:

```
<?xml version="1.0" encoding="utf-8" ?>
-<datavalues>
      <resolution>24.6</resolution>
      <an0_mode>single-ended</an0_mode>
      <an1_mode>single-ended</an1_mode>
      <an2_mode>single-ended</an2_mode>
      <an3_mode>single-ended</an3_mode>
      <an4_mode>single-ended</an4_mode>
      <an5_mode>single-ended</an5_mode>
      <an6_mode>single-ended</an6_mode>
      <an7_mode>single-ended</an7_mode>
</datavalues>
```

The tags <resolution> and <an_mode> indicate the current settings of the analog to digital convert. Values for each tag are described below.

<resolution>   This is the current resolution of the analog to digital converter. This resolution is specified in bits
                and can be changed through the XML page. Higher resolutions slow down the conversion process.
                The highest resolution is the default resolution of 24.6 bits.

<an_mode>   single-ended (The input is being used in single-ended mode)
                differential (The input is being used in differential mode with the adjacent input.)

Commands can be sent to the Analog Module to change the resolution of the analog to digital convert. This allows the Analog Module to be adjusted for precision or speed. The resolution setting applies to all the analog inputs. The following is an example of how to set the resolution.

Set resolution to 22.4 bits: http://192.168.1.2/adcstate.xml?res=22.4

The following table indicates how long it takes to sample all eight inputs 1 time based on the selected resolution. Choosing a lower resolution will result in a faster response time while loosing precision.

Resolution (Effective Number of Bits)	Time Required to Sample All Eight Inputs (Seconds)
24.6	1.6
24.4	0.58
24	0.291
23.4	0.15
22.9	0.072
22.4	0.036

Password :
If the control password is enabled in the Analog 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?noReply=1 HTTP/1.1 (Ends with two \r\n)
Authorization: Basic bm9uZTp3ZWJyZWxheheQ== (Ends with two \r\n)

where bm9uZTp3ZWJyZWxheheQ== 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 Analog Module can read using Modbus/TCP protocol. This provides a standard means of using the Analog Module in conjunction with devices and software from other manufacturers. This section contains the information necessary to communicate with the Analog 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 Analog 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 Analog Module.

The Analog Module functions as a Modbus server (slave).   Client (master) devices open a connection with the Analog Module on port 502 (unless another modbus port is selected) and send commands or requests to read the state of the analog inputs. When the Analog Module receives a command, it will perform the desired function and return a response. The following commands are available:

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

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 Holding Registers (Modbus Function Code 03 (0x03))
This function is used to read the final values (raw values with slope and offset applied) of each input. 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 30 (0x10 and 0x1E). Also, the address must be evenly divisible by 2. In other words, only address 0x10, 0x12, 0x14, 0x16, 0x18, 0x1A, 0x1C, and 0x1E 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. The following table lists the address that correspond to each input.

Input	Address
0	0x10
1	0x12
2	0x14
3	0x16
4	0x18
5	0x1A
6	0x1C
7	0x1E

Note: When the input value is outside the valid range (0 to 5 volts) then a really large value will be returned, usually a hex value such as 4F80 XXXX will be returned which is roughly 4294967295 when converted to a float using the IEEE 754 format..

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};

3.4 Special Functions

3.4.1 Email Alerts

Each of the eight inputs on the Analog Module can be configured to send an email message to up to three users when alarm conditions occur. For each input, up to three email addresses can be configured to receive email messages. The header, descriptions and units are taken from the entries in the setup pages.

The message shown below uses default text settings accept for where the units VDC are shown for input 3. The text shown in bold indicates that it can be changed by the user.

Analog Input Module - Email Notification

Email alert triggered by high alarm from **Input 3 Description**: 2.50587 **VDC.**

Input 0 Description: 2.50405
Input 1 Description: 2.50410
Input 2 Description: 2.50585
Input 3 Description: 2.50573 **VDC.**
Input 4 Description: 2.50408
Input 5 Description: 2.50402
Input 6 Description: 2.50406
Input 7 Description: 2.50406

Much 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.

Analog Input Module – This text is set in the 'Main Header Text' field under the An 0 tab.
VDC. – The units are set through the 'Units' field under the analog input setup tabs.
Input 0 Description – This text is set in the 'Input Description' field under the An 0 tab.
Input 1 Description – This text is set in the 'Input Description' field under the An 1 tab.
Input 2 Description – This text is set in the 'Input Description' field under the An 2 tab.
Input 3 Description – This text is set in the 'Input Description' field under the An 3 tab.
Input 4 Description – This text is set in the 'Input Description' field under the An 4 tab.
Input 5 Description – This text is set in the 'Input Description' field under the An 5 tab.
Input 6 Description – This text is set in the 'Input Description' field under the An 6 tab.
Input 7 Description – This text is set in the 'Input Description' field under the An 7 tab.

*Note: The email message will only contain the values for inputs that have the 'Display Input Status' field set to **Yes** on the input setup pages.

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

<u>Network Page:</u>
IP Address
Netmask
Broadcast
Gateway

<u>Email Page</u>
DNS Address
Mail Server (SMTP)
Domain
Return Email
Email 1 Address (Email 2,3 Address is optional)

<u>An 0 Through An 7 Pages:</u>
Message Options
Use Email Address (At least one email address should be selected for email to work)

3.4.2 Alarm Conditions

The diagram below shows a visualization of the upper and lower trigger options when one of the analog inputs is configured to send out emails or remote messages based on the triggers. When the input goes above the upper trigger level a high alarm occurs. This high alarm condition remains until the input drops below the dead band. The same is true when the input falls below the lower trigger. In this situation the low alarm condition remains until the input rises past the dead band. Red dots indicate high and low alarms while the green dots indicate a return to the normal operating condition.
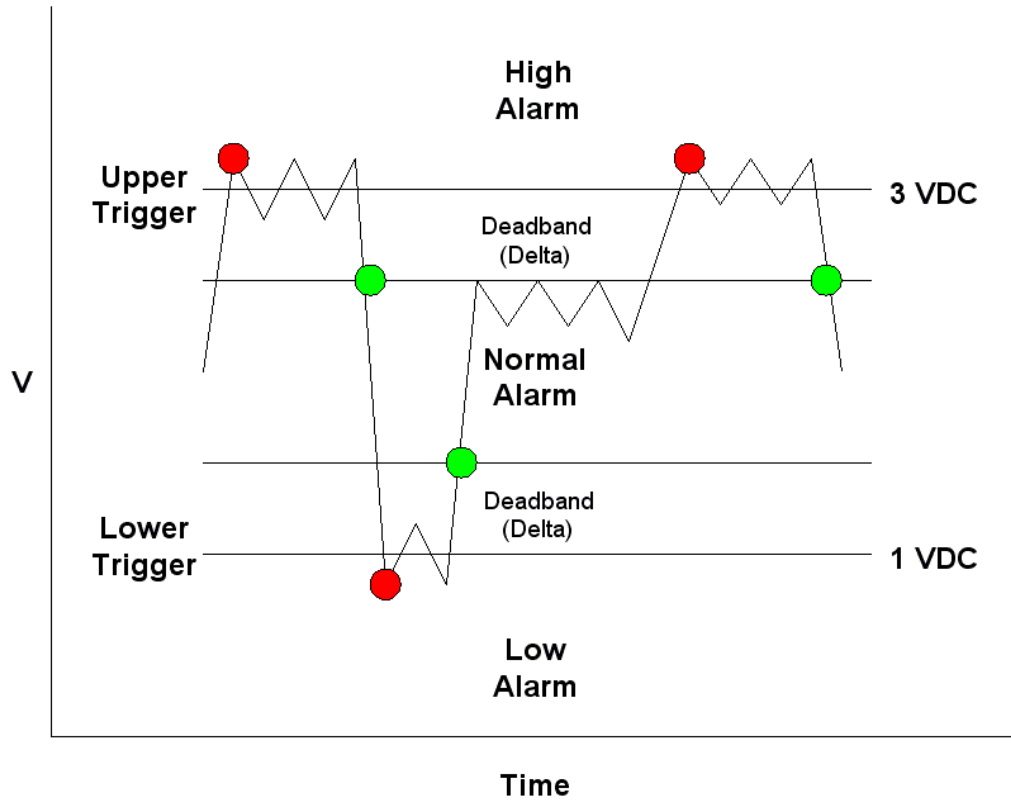
Appendix A: Restoring Factory Default Settings

In the event that the IP address or passwords are forgotten, the Analog 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.
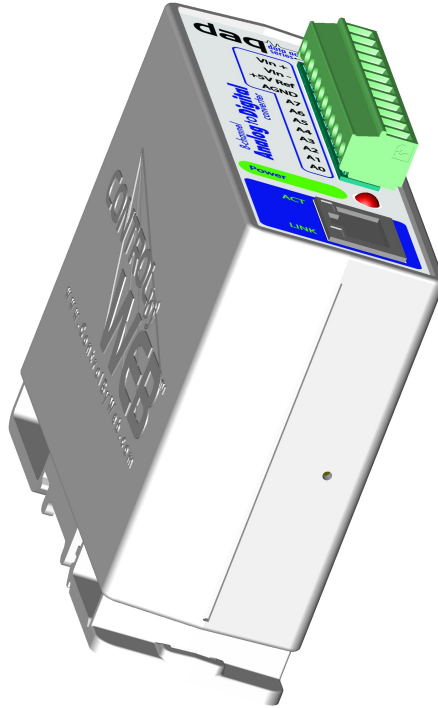
Appendix B: Specifications

Analog Inputs: 8 Channels (can be configured as 8 single-ended, 4 differential, or a combination)
Accuracy: ±0.075% Full Scale
Resolution: 10µV (24 bit ∑∆ ADC)
Input Range: 0 to 5 Volts (all channels)

Power Requirements:
Model X-DAQ-8A5-6
Voltage: 6VDC ± 5%
Current: See table below for typical values

10 Mbps Network	100 Mbps Network
155 mA	300 mA

Model X-DAQ-8A5-I
Voltage: 9~28VDC
Current: See table below for typical values

10 Mbps Network	100 Mbps Network

Network: 10/100 Base-T Ethernet
Network Setup: static IP address assignment, TCP port selectable

Connectors:
Power/8-Analog Inputs: 12-position, removable terminal strip, 3.81 mm terminal spacing
        (Replacement part number, Phoenix Contact 1803691)

Network: 8-pin RJ-45 socket

LED Indicators: 3
        -Power on
        -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:
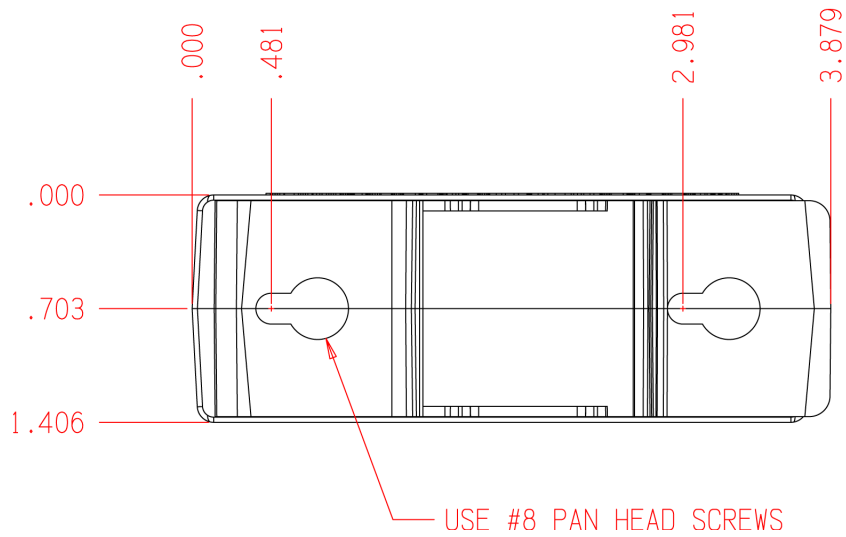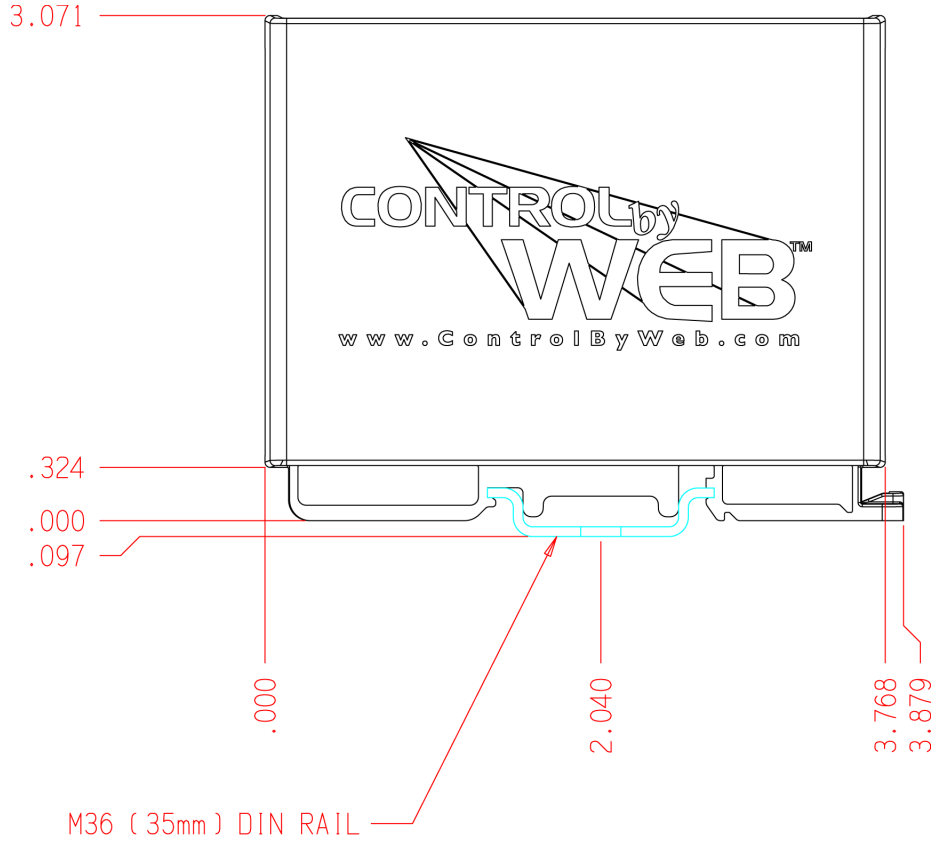Electromagnetic Compliance:
IEC CISPR 22, CISPR 24
FCC 47CFR15 (class B)

EU EN55024, EN55022

Product Safety:
IEC 60950-1 / EN 60950-1

Appendix C: 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

Appendix D: Open TCP Legal Notice

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