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Find the *Acromag BusWorks XT1211-000* at our website: ***Click HERE***

BusWorks® XT Series
10/100MB Industrial EtherNet/IP™ I/O Modules
USB Programmable

Model XT1212-000 & XT1222-000
8-Channel Differential Current Input
8-Channel Differential Voltage Input

USER'S MANUAL



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IMPORTANT SAFETY CONSIDERATIONS

You must consider the possible negative effects of power, wiring, component, sensor, or software failure in the design of any type of control or monitoring system. This is very important where property loss or human life is involved. It is important that you perform satisfactory overall system design and it is agreed between you and Acromag, that this is your responsibility.

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GETTING STARTED

DESCRIPTION

Symbols on equipment:



Means “Refer to User’s Manual (this manual) for additional information”.

The XT1212-000 and XT1222-000 are Ethernet/IP™ network modules for interface with up to eight differential channels of DC current input (XT1212-000), or eight differential channels of DC voltage input (XT1222-000). They provide input isolation from the network and power. These units are conveniently setup and configured for network communication via a USB connection to any Windows-based PC (Windows XP and later versions only).

Key Features

- **CE Approved, UL/cUL Class I, Division 2 Approved.**
- **Designed and Manufactured with High Quality/High Reliability with AS9100 (Aerospace Quality)/ISO9001.**
- **Ethernet/IP™ Protocol Support for up to 10 connected messaging sessions, plus unconnected messaging.**
- **Conveniently setup and configured w/ Windows software via USB.**
- **High-Density 22.5mm wide package with pluggable, front-facing terminals.**
- **Dual Isolated, auto-crossing, 10/100Mbps Ethernet ports w/ Auto-Negotiation offers a convenient “daisy chain” network connection saving switch ports.**
- **Operation & Diagnostic LED indicators aide trouble-shooting.**
- **Bus Power Ready for Clean Wiring along the DIN Rail, and/or for Redundant Power Connections.**
- **High 1500VAC Isolation between input channels (as a group), the network (including port-to-port), and power.**
- **Input, power, network, and USB ports are all transient protected.**
- **Wide-range DC power input from 12-32V.**
- **Wide ambient temperature operation from -40°C to +70°C.**
- **Thoroughly Tested and Hardened For Harsh Environments.**
- **Withstands High Shock (25G) and Vibration (4G).**
- **Model XT-1212/22-000 is ATEX Certified for Explosive Atmospheres.**
  II 3 G Ex nA IIC T4 Gc -40ºC ≤ Ta ≤ +70ºC
  DEMKO 15 ATEX 1561X

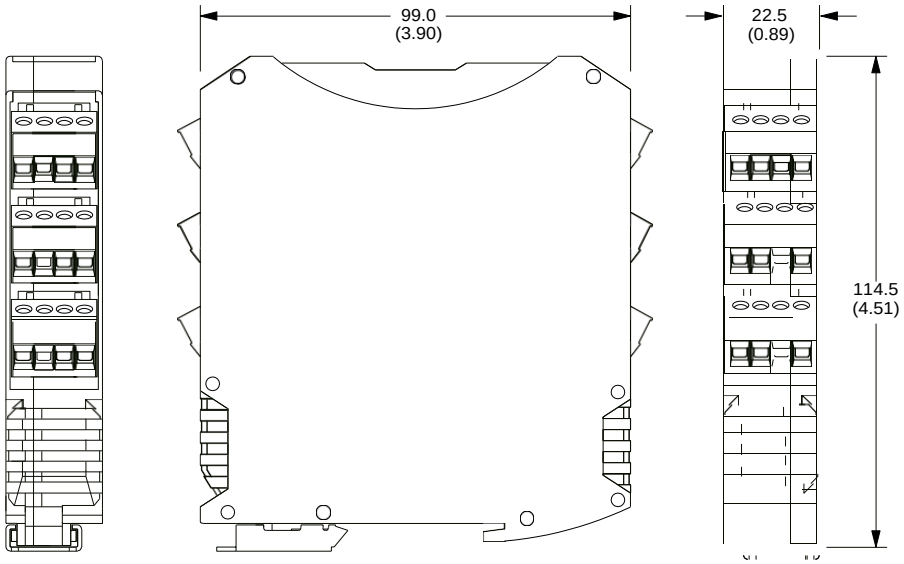
Application

This module is designed for high-density mounting on T-type DIN rails. XT models may be mounted side-by-side on 22.5mm centers and can plug-together for modular expansion with shared power connection along the DIN rail. These models will interface with any mix of up to 8 differential current inputs (Model XT1212-000), or 8 differential voltage inputs (Model XT1222-000), monitored via a 10/100Mbps Ethernet interface using the Ethernet/IP™ application protocol. Units are conveniently setup and configured for network operation via a USB connection to a host computer running Acromag configuration software.

Mechanical Dimensions

Units may be mounted to 35mm "T" type DIN rail (35mm, type EN50022), and side-by-side on 22.5mm (0.9-inch) centers.

WARNING: *IEC Safety Standards may require that this device be mounted within an approved metal enclosure or sub-system, particularly for applications with exposure to voltages greater than or equal to 75VDC or 50VAC.*



DIMENSIONS ARE IN MILLIMETERS (INCHES)

DIN Rail Mounting & Removal

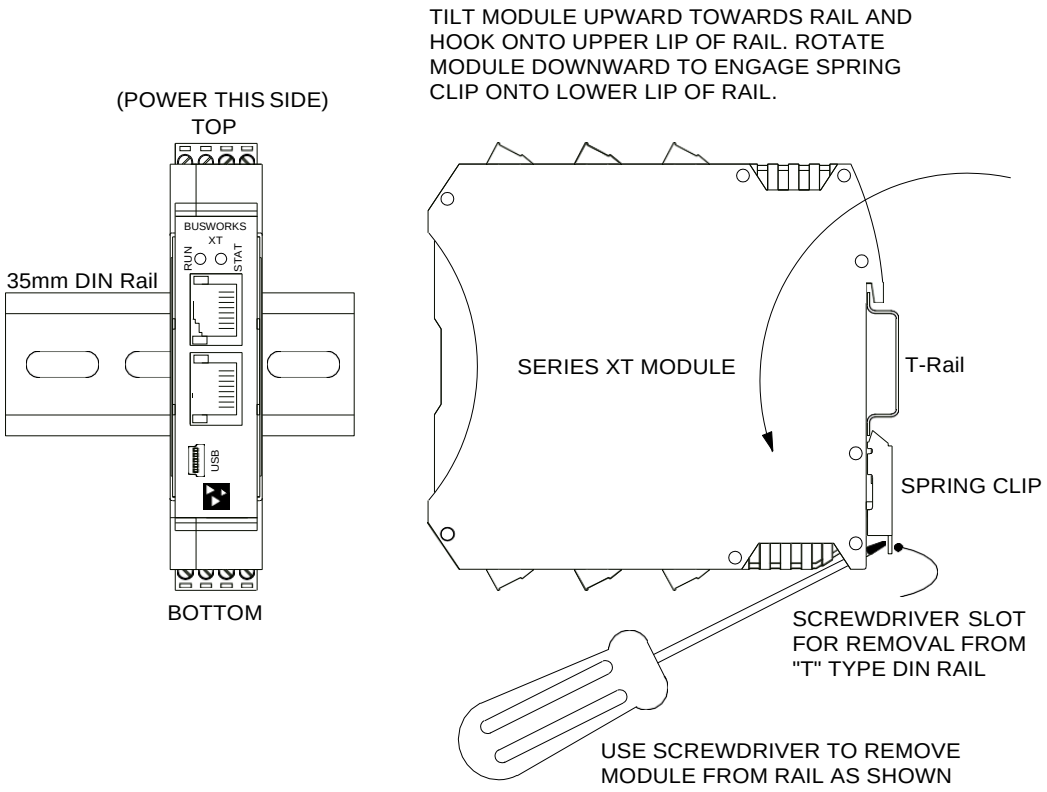
Refer to the following figure for attaching and removing a unit from the DIN rail. A spring loaded DIN clip is located on the bottom side. The opposite rounded edge at the bottom of the top side allows you to tilt the unit upward to lift it from the rail while prying the spring clip back with a screwdriver.

To attach the module to T-type DIN rail, angle the top of the unit towards the rail and place the top groove of the module over the upper lip of the DIN rail. Firmly push the unit downward towards the rail until it snaps into place.

To remove it from the DIN rail, first separate the input terminal blocks from the bottom side of the module to create a clearance to the DIN mounting area. You can use a screwdriver to pry the pluggable terminals out of their sockets. Next, while holding the module in place from above, insert a screwdriver along the bottom side path of the module to the DIN rail clip and use it as a lever to force the DIN rail spring clip down, while pulling the bottom of the module outward until it disengages from the rail. Tilt it upward to lift it from the rail.

IMPORTANT: For ambient operation above 55°C, it is recommended that you space units apart to aide cooling. Module is intended to be mounted upright on a horizontal DIN rail, allowing cool air to enter in through the bottom vents and warm air to exhaust out the top vents. Above 55°C, a space of at least 20mm between modules is recommended to aide cooling in this manner.

SERIES XT MODULE DIN RAIL MOUNTING AND REMOVAL



ELECTRICAL CONNECTIONS

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been removed or the area is known to be non-hazardous.

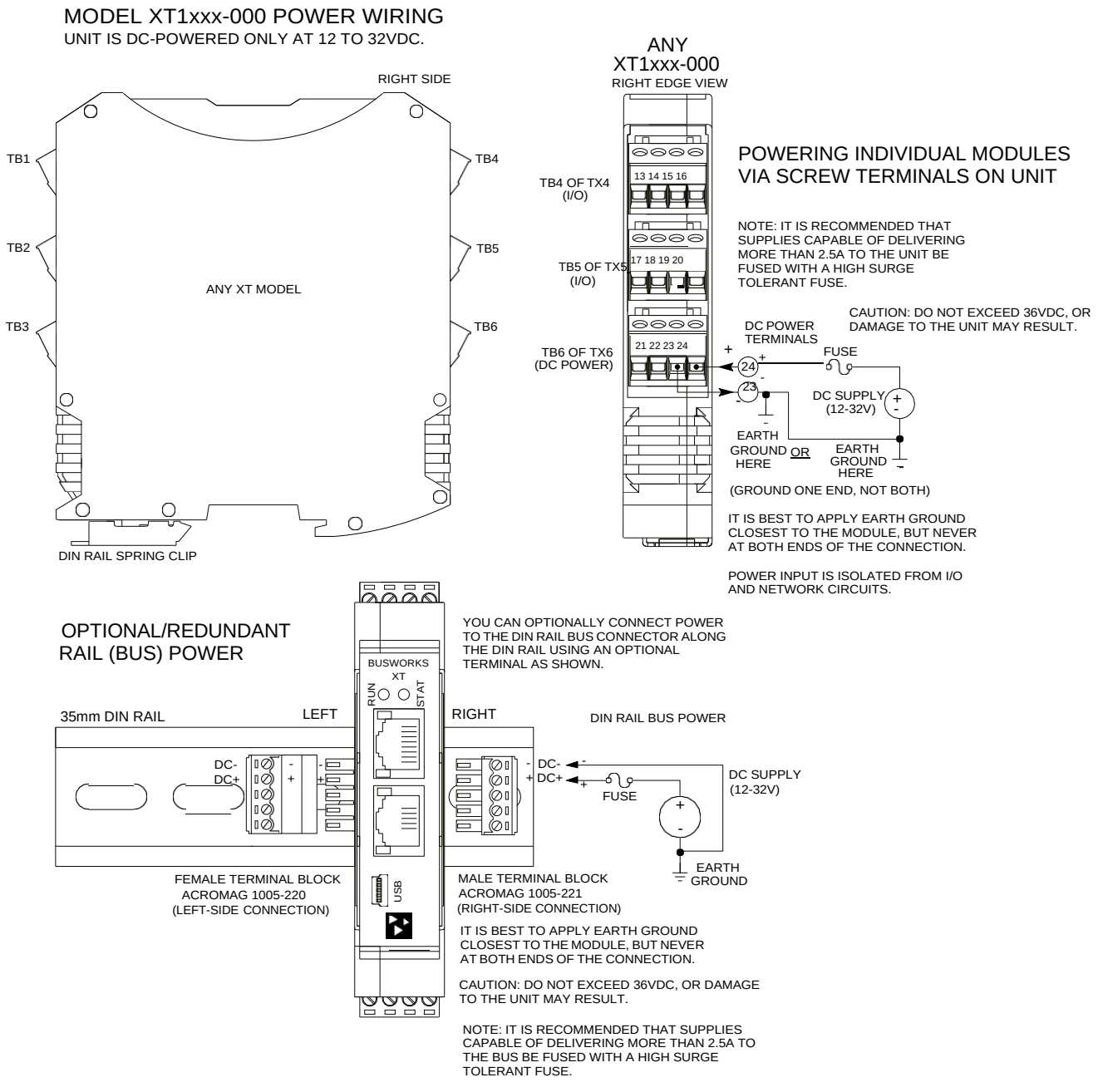
WARNING – EXPLOSION HAZARD – Substitution of any components may impair suitability for Class I, Division 2.

WARNING – EXPLOSION HAZARD – The area must be known to be non-hazardous before servicing/replacing the unit and before installing.

Wire terminals can accommodate 14–26 AWG (2.08–0.13mm^2) solid or stranded wire with a minimum temperature rating of 85^{o}C. Input wiring may be shielded or unshielded type. Twisted pair, or shielded twisted pair, input wiring is recommended. Terminals are pluggable and can be removed from their sockets by prying outward from the top with a flat-head screwdriver blade. Strip back wire insulation 0.25-inch on each lead and insert the wire ends into the cage clamp connector of the terminal block. Use a screwdriver to tighten the screw by turning it in a clockwise direction to secure the wire (use 0.5-0.6nM torque). Since common mode voltages can exist on I/O wiring, adequate wire insulation should be used and proper wiring practices followed. As a rule, input wires are normally separated from power and network wiring for safety, as well as for low noise pickup.

Power Connections

Connect a DC power supply from 12-32V as shown in the drawing below. Observe proper polarity (input power is reverse-polarity protected). Optionally, the unit may be powered (or redundantly powered) via its DIN rail connector (optional terminal required, see bottom figure below). For supply connections, use 14 AWG wire rated for at least 80°C. Do not exceed 36V DC peak.

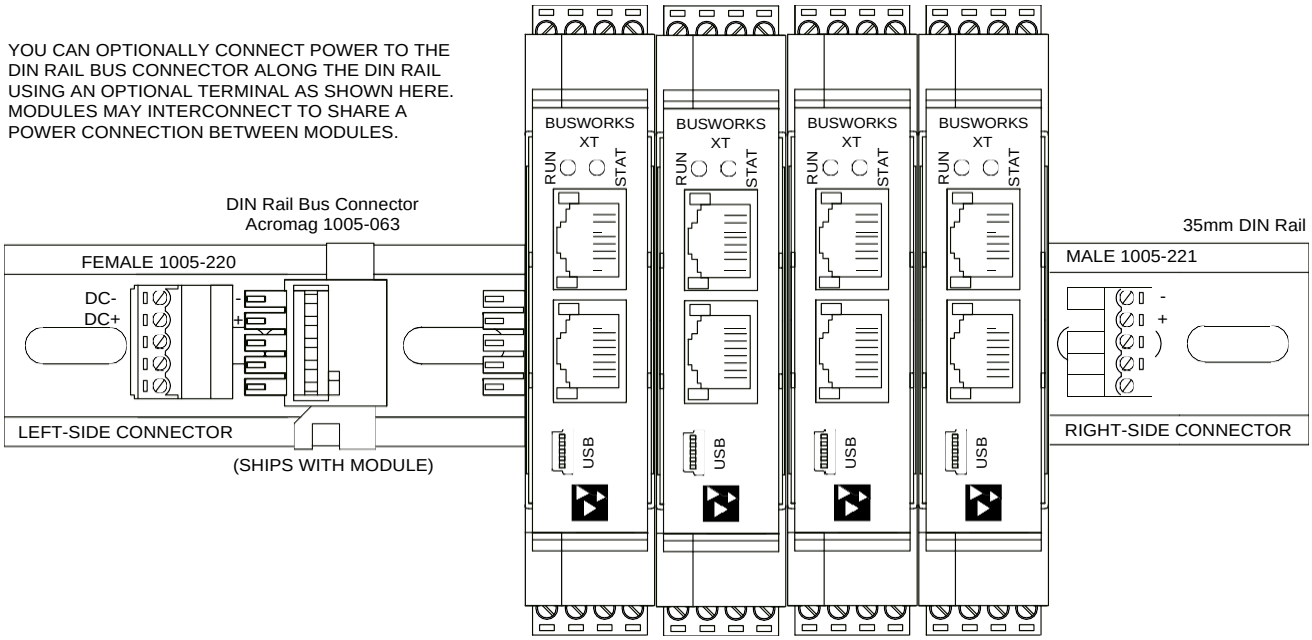


Power Connections…

Note that you can use the bus power connector of the module to interconnect modules by plugging them together and connecting them as a group to a suitable power supply using an optional left or right terminal block, 1005-220 or 1005-221, as shown below.

Important – End Stops: If this module uses the optionally powered (or redundantly powered) via the DIN rail bus for hazardous location installations (Class I, Division 2 or ATEX Zone 2) it must use two end stops (Acromag 1027-222) to secure the terminal block and module (not shown).

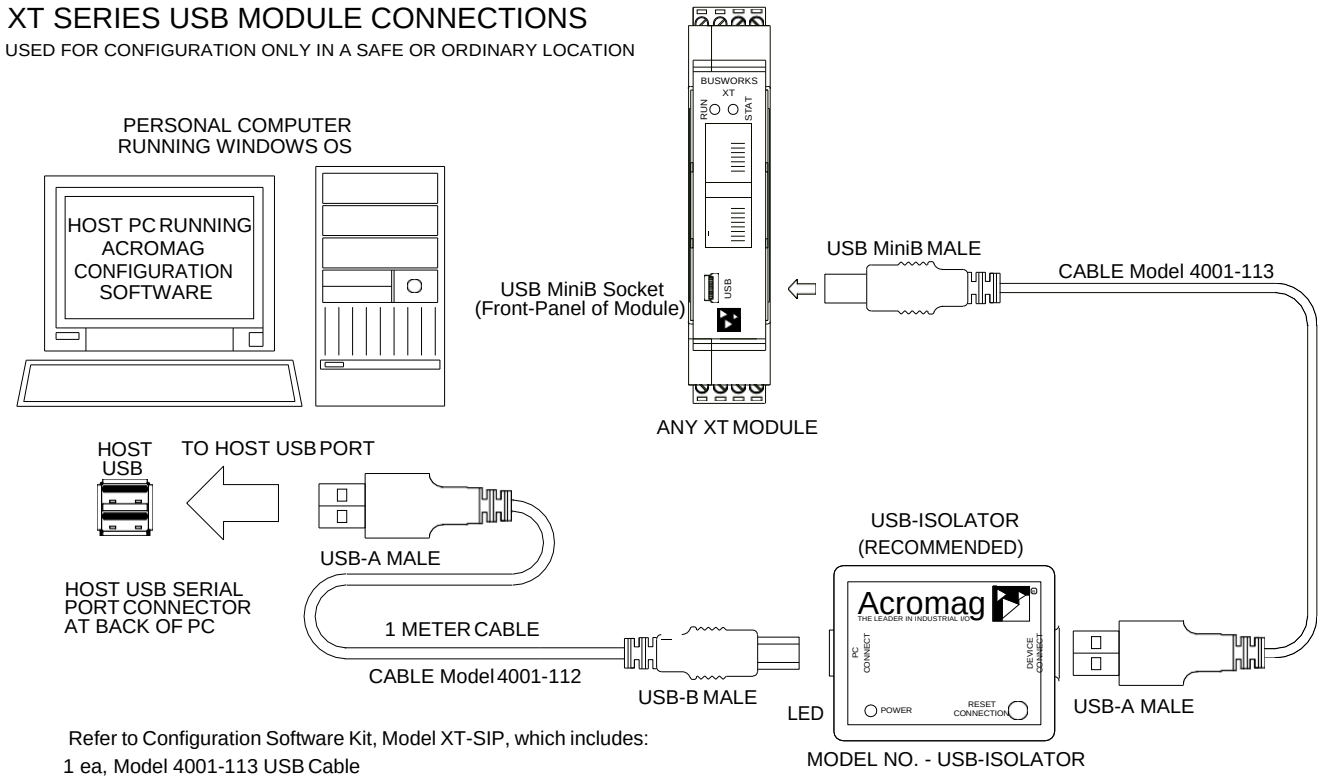
XT MODEL OPTIONAL BUS POWER WIRING



USB Connection

WARNING: The intent of mating USB with this unit is so that it can be conveniently setup and configured in a safe area, then installed in the field which may be in a hazardous area. Do not attempt to connect a PC or laptop to this unit while installed in a hazardous area, as USB energy levels could ignite explosive gases or particles in the air.

- **USB Signal Isolation Recommended -** You may use Acromag model USB-ISOLATOR to isolate your USB port, or you can optionally use another USB signal isolator that supports USB Full Speed operation (12Mbps).
- **Reconfiguration Does Not Require a Network Connection, as the module uses a USB connection to configure the unit**.
- **Connect Unit to Power Before USB**.



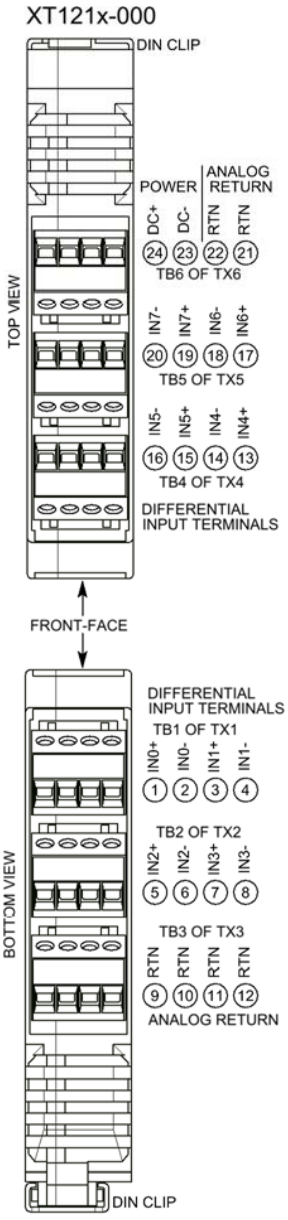
Refer to Configuration Software Kit, Model XT-SIP, which includes:
1 ea, Model 4001-113 USB Cable
1 ea, Model 4001-112 USB Cable
1 ea, Model USB-ISOLATOR
1 ea, Model XT-CONFIG CDROM Software
1 ea, Model 5035-360 Ethernet Cable

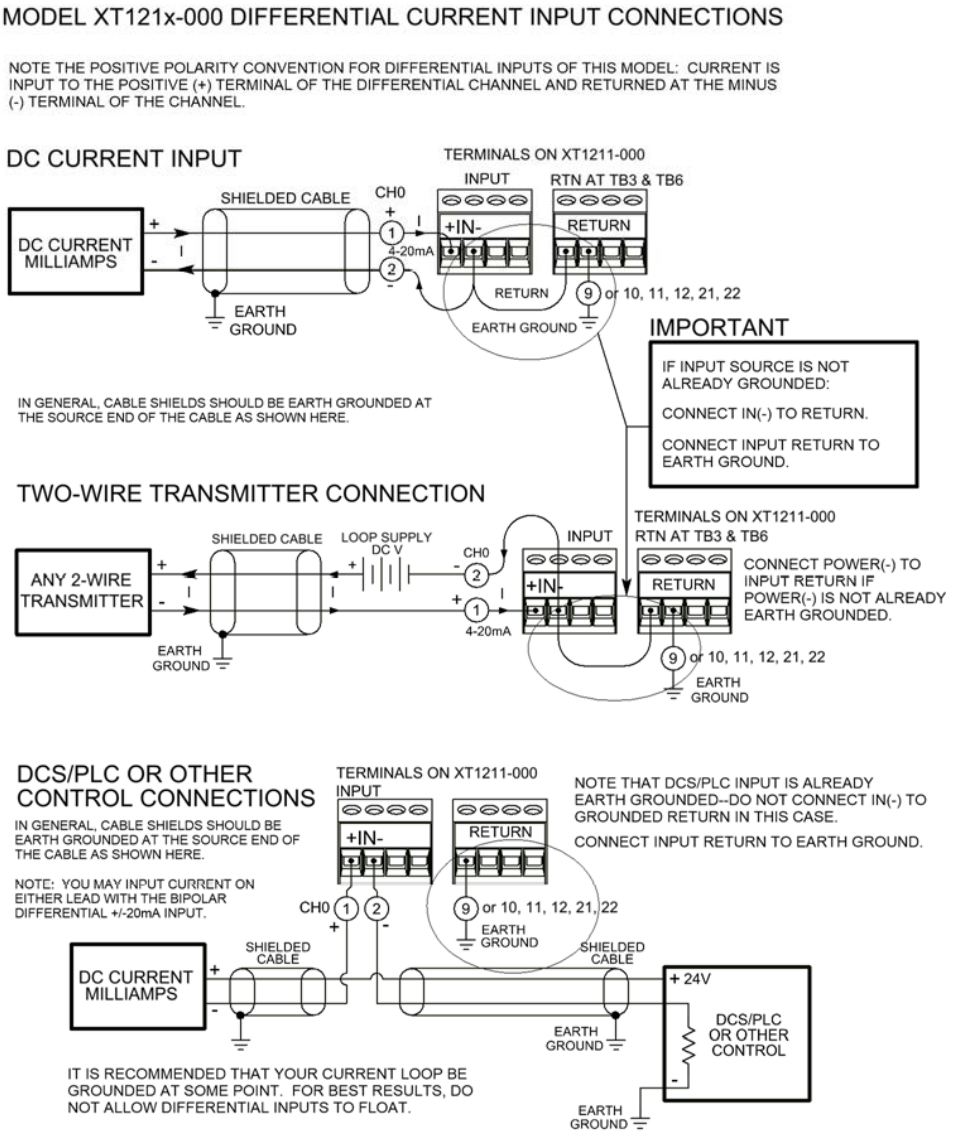
Input Connections

These models monitor DC current inputs and DC voltage inputs. The XT1212-000 model has 8 differential current inputs, while the XT1222-000 model has 8 differential voltage inputs. An optional current sensor (Acromag model 5020-350) may be used with the XT1212-000 model to monitor AC currents. Observe proper polarity when making input connections. Refer to the following figures to wire the DC inputs of these models.

Current Input Connections - Model XT1212-000

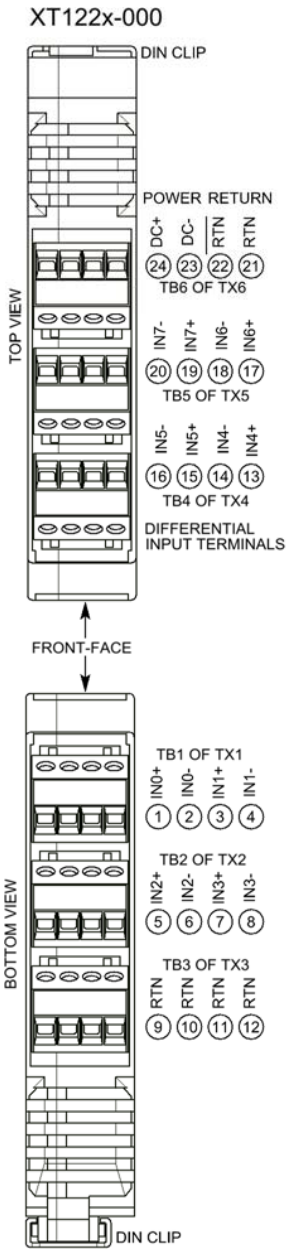
The **XT1212** model supports up to **8 differential DC current inputs**. The input is bipolar, allowing current to be delivered to the positive or negative terminal (±20mA). The ±20mA current input is shunted through a 27.4Ω resistor and drives ±0.548V full-scale to a 16-bit A/D converter with a full-scale bipolar range of ±1.325V. The normal convention is that positive differential current is delivered to the positive terminal, and returned at the negative terminal. Inputs include a bank of six common return terminals at TB3-9..12 & TB6-21..22 (RTN). These are optionally used to reference input channel signals (IN-) to a common return, and to earth ground, if they would otherwise be left floating. Refer to the following figures for example DC current input connections to this model.

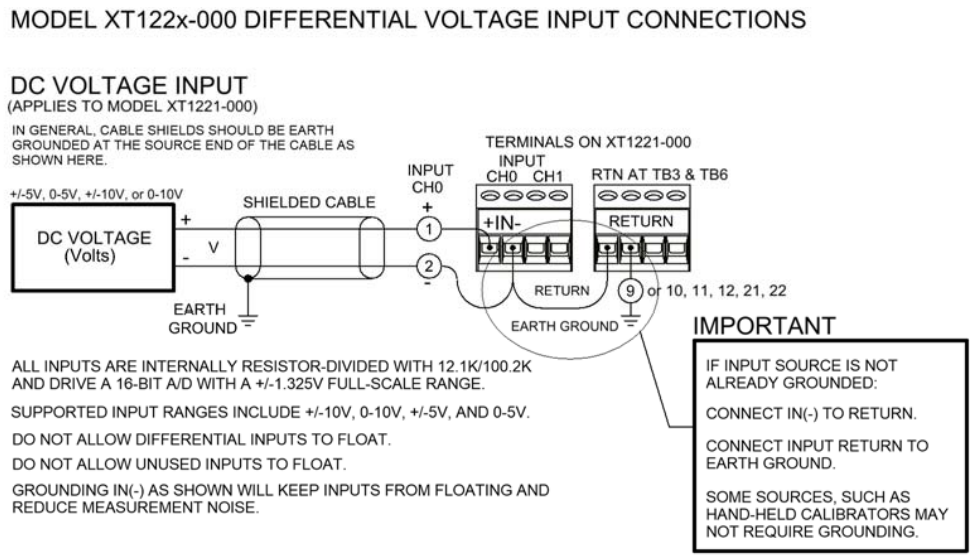




Voltage Input Connections - Model XT1222-000

The **XT1222** model supports up to **8 differential DC voltage** inputs. You can set each channel to an input range of ±10V, 0-10V, ±5V, or 0-5V. This voltage is divided down via a 12.1K/100.2K resistive divider, then driven to a 16-bit A/D converter with a full-scale input range of ±1.325V. Connect your input voltage to input positive (+) and negative (-) while observing proper polarity. If the input signal source is floating (not earth grounded), then it is recommended that you connect the negative input lead to an analog return terminal of the module, and connect earth ground to one return as shown below. Refer to the following figures for example DC voltage input connections.



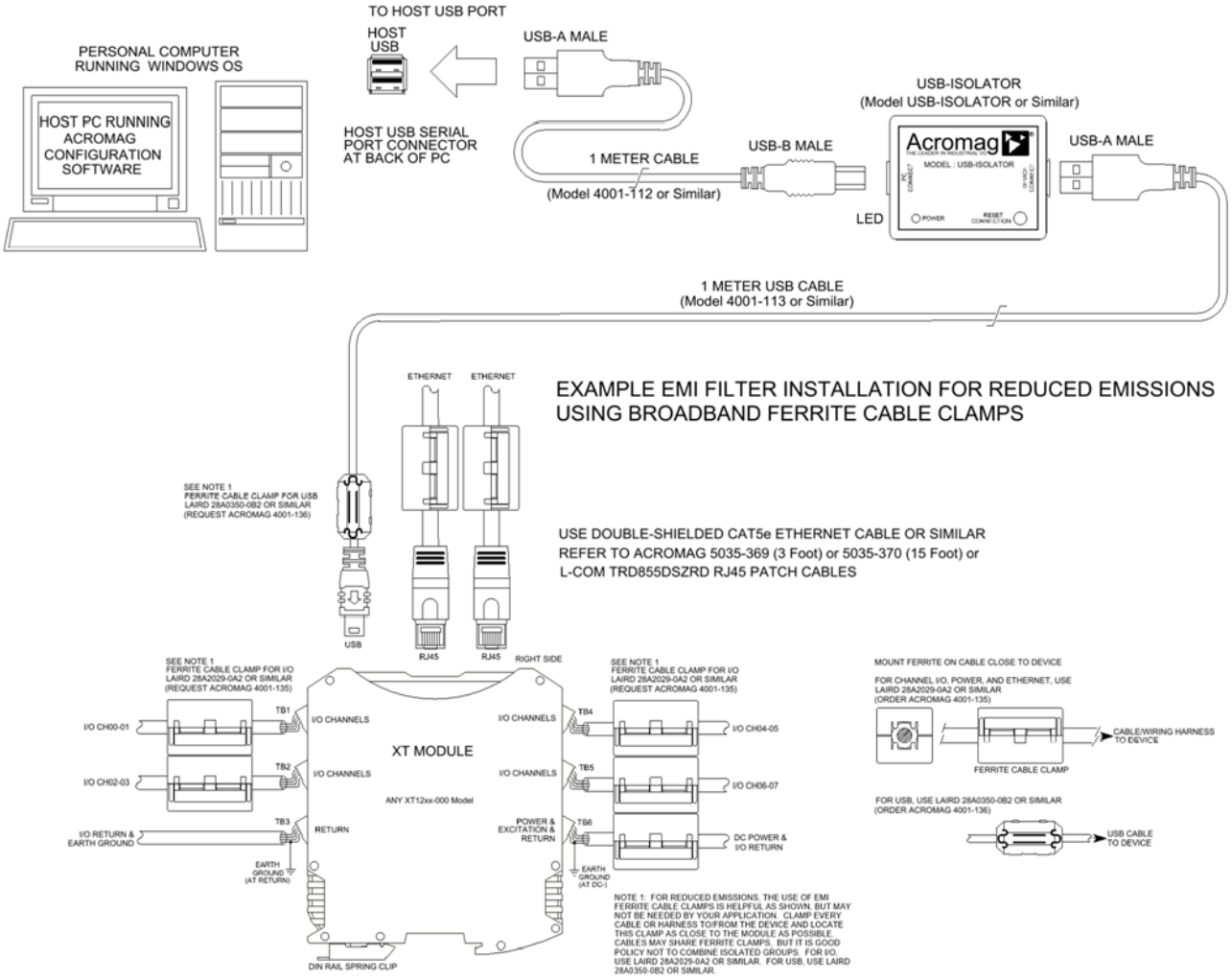


Input Return Connections

The connection diagrams provided show proper ground connections and this is very important for the differential inputs of this model. If your input measurement is over-range clamped, appears noisy, or unstable, please review your grounding practices. Note this module includes six common return terminals (RTN). These connections are provided to reference a differential input signal to a common return, and then reference the return circuit to earth ground, if it would otherwise be left floating. Note also that while there are six return terminals, you only need to earth ground one of these terminals to ground the input circuit, as they are all connected in common.

EMI Filter Installation

For low CE-rated radiated emissions, the use of split/snap-on ferrite cores on all cables or harnesses to/from the device as shown in the drawing on the next page is helpful. Use Laird 28A2029-0A2 or similar for inputs, Ethernet, and Power (order Acromag 4001-135) and Laird 28A0350-0B2 or similar for USB cables (Acromag 4001-136). Locate this ferrite by clamping it outside of all input/output cables or wiring harnesses to/from the module (USB, Ethernet, input group, DC power), and as close to the module as possible. While the use of these ferrites is helpful to obtain low CE-rated emissions, it may not be required for your application. Note also that individual cables may share a ferrite, but it is not good practice to combine isolated circuits inside the same ferrite. It is recommended to separate isolated circuits for safety and greater noise immunity.



Earth Ground Connections

The unit housing is plastic and does not require an earth ground connection. If the module is mounted in a metal housing, an earth ground wire connection to the metal housing's ground terminal (green screw) is usually required using suitable wire per applicable codes. Circuits wired to inputs, power, and the network should be earth grounded as well, as reflected in the connection diagrams. The ground connections noted are recommended for best results and help protect the unit by giving it a low impedance path to ground for shunting destructive transient energy away from the module. See the Electrical Connection Drawings for recommended input, power, and network ground connections.

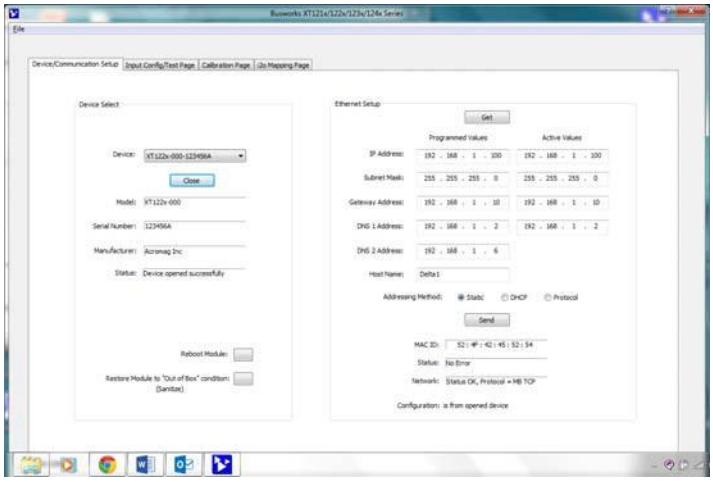
Note: A USB isolator is recommended when connected to a grounded Personal Computer for configuration purposes. This will avoid a potential ground loop that can occur if your input signal is already earth grounded, as a PC commonly earth grounds its USB port and this makes contact with both the USB signal and shield ground which is held in common to the input circuit return of this module.

CONFIGURATION SOFTWARE

While this is an Ethernet network input module, it can only be configured and calibrated via its Configuration Software over a USB connection to a Windows-based PC or laptop. USB saves you the trouble of having to already know its IP address setting, or having to change the address setting of your network interface card to match its address domain in order to communicate with it. USB software is contained in a zip file that can be downloaded free of charge from our web site at www.acromag.com. Look for the software zip file 9500465 in the Documents and Downloads page for your XT product. Initially, you will have to answer a few questions to open a user account and download this file to your computer. This zip file will extract to a *modelconfig.exe* executable file installed in an Acromag subdirectory off the Program Files directory of your PC. Note that you must have administrator rights to download and install this software onto your PC or laptop. Once you have installed the software, be sure to navigate to the *Program Files\Acromag* subdirectory and select the correct *modelconfig.exe* software for your particular module. This same software is also included on a CDROM bundled in the Configuration Kit XT-SIP (see Accessories), but downloading from the web will ensure that the software is the most up-to-date available. This software is compatible with XP or later versions of the Windows operating system. Note that the particular *modelconfig.exe* software for this unit supports eleven other model variations—six models with 8 differential current or voltage inputs, plus six models with 16 single-ended current or voltage inputs.

Quick Overview

After booting the Configuration software for this model, the Device/ Communication Setup page shown below will appear. This screen is used to selectively connect units over USB, and to configure the Ethernet parameters necessary to communicate over the network. Once you Select a device and click **"Open"** to connect to an XT1212-000 or XT1222-00 model, your screen will look similar to the following:



IMPORTANT: Delay clicking [Open] immediately after power up until the unit has established its Ethernet connection (wait ~30 seconds after powering-it up to give it time to initialize), or you may encounter data transfer or timeout errors. To remedy, simply turn power off to the unit, close the software, then turn power back on to the unit and reboot the software after the unit has powered up.

Device Select (First Connect to the Unit Here)

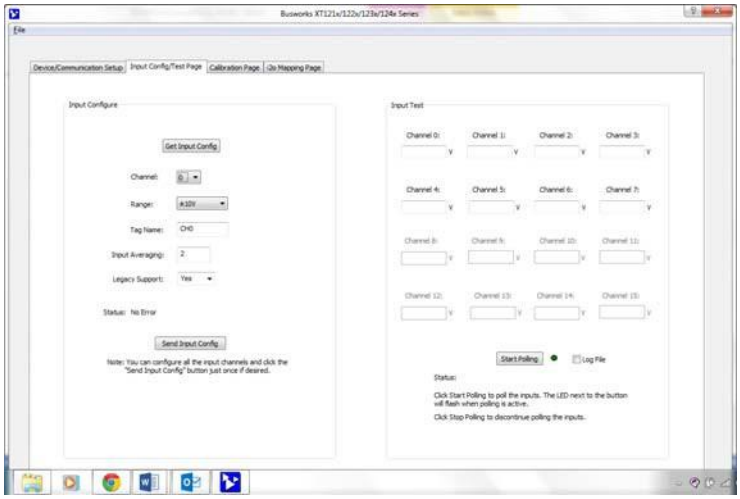
- Select from connected modules and Open or Close communication with them.
- Display the Model, Serial Number, and Manufacturer of the connected module and report the status of the USB connection.
- Reboot a module to force a system reset to the power-up state.
- Restore a module to its initial "out-of-box" state.

Ethernet Setup (Setup your Network Parameters)

- Retrieve a connected modules current network configuration.
- Set the Network IP address required for Ethernet communication on your network.
- Set the subnet mask, gateway, and/or domain name server addresses for your network.
- Write your parameters to the connected unit and read back the USB communication status.

Two other screens can be selected by clicking their tabs, the I/O Config/Test Page, and the Calibration Page. A short description of the controls of each of these pages follows:

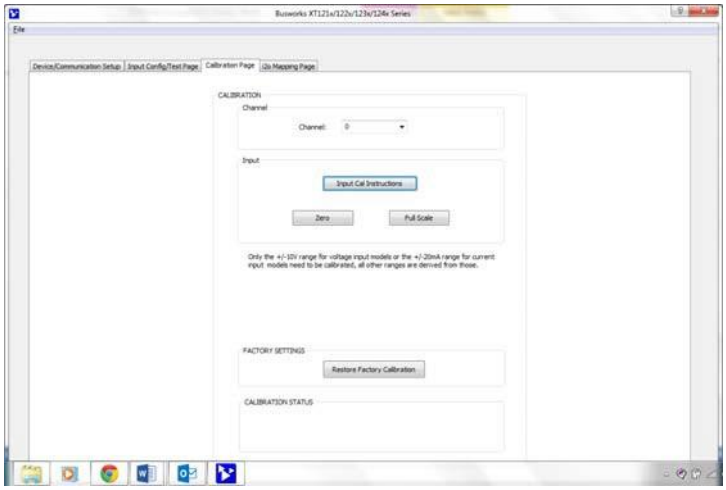
Quick Overview…



Quick Overview…

HELP – You can press F1 for Help on a selected or highlighted field or control. You can also click the [?] button in the upper-right hand corner of the screen and then click to point to a field or control to get a Help message pertaining to the item you pointed to.

After configuring and/or testing your channels, you can click on the Calibration Page tab to display the following screen:



For a more detailed configuration procedure, see the Configuration Step-by-Step section of the Technical Reference on page 16 of this manual.

I/O Config/Test Page (Configure Your Unit Here)

After connecting to your unit and setting up its network parameters, click the I/O Config Test Page tab to display the screen at left.

I/O Configure (Configure Your Inputs Here)

- Use **[Get Input Config]** to retrieve the connected module' configuration.
- Select the specific channel to configure.
- Set the Range for the selected channel.
- Optionally apply a tag name to the selected channel for reference over USB (up to 8 characters).
- Set the number of samples to average the input over (1-200).
- Enable or Disable Legacy Support to set the normalized input resolution to ±20000/0-2000 (legacy support=Yes) or ±30000/0-3000 (legacy support=No).
- Use **[Send Input Config]** to send your configuration to the connected unit and read the message status sent/received to/from the unit over USB. Note that you only need to click [Send…] one time after setting up each channel, and all channels will be written at once.

I/O Test (Check Your Inputs Here)

After making I/O configuration changes, you can use the I/O Test controls to verify operation of your inputs.

- Start/Stop polling the input channels.
- Display the current reading of each input.

Calibration Page (Calibrate Your Inputs Here)

If your inputs exhibit excessive error, you can use the controls of this page to calibrate each channel separately.

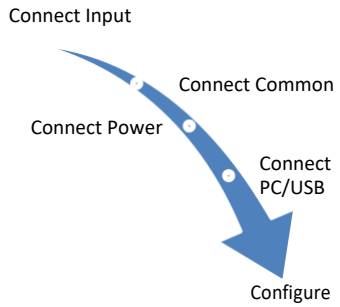
- Click [Input Cal Instructions] button to begin calibration and follow the on-screen prompts to calibrate Zero and Full-scale of any channel.
- Use [Zero] and [Full Scale] to alternately apply a precision zero or full-scale input signal and calibrate your input range.

TECHNICAL REFERENCE

CONFIGURATION STEP-BY-STEP

Getting Connected

This section will walk you through the Connection-Configuration process step-by-step. But before you attempt to reconfigure this module, please make the following electrical connections.



1. **Connect Inputs:** Refer to Input Connections at the front of this manual and connect your input(s) as required for your application. Inputs of this model are differential. Do not allow inputs to float (see #2 below).

2. **Connect Analog Return:** If your input signal is not already grounded, you should connect earth ground to analog input return (RTN) at one point, and your Input(-) to analog return (RTN). Doing this will keep the differential input from floating and within the common mode range of the analog to digital converter of this model. Failure to earth ground input(-) and input return (RTN) will increase measurement noise. Earth ground applied to analog return also allows the input filters to shunt potentially harmful transient energy to ground, helping to protect the input circuit from transient damage.

3. **Connect Power:** You need to connect power from 12-32V to power this module. Current required will vary with voltage level (refer to Specifications). Your supply must be capable of providing at least twice the maximum rated current for your voltage level. You can choose to connect to Power via terminals on the unit, or via optional terminals that connect to the module's bus connector along the DIN rail (See Power Connections).

4. **Connect to PC via USB:** Refer to USB Connections of page 9 and connect the module to your PC or laptop using the USB isolator and cables provided in Configuration Kit XT-SIP.

   Now that you have made your connections and applied power, you can execute the XT12XXConfig.exe software to begin configuration of your unit (software is compatible with XP or later versions of the Windows operating system). Note that the same software is used for eight models, including the XT1212-000 with 8 differential current inputs, and the XT1222-000 with 8 differential voltage inputs.

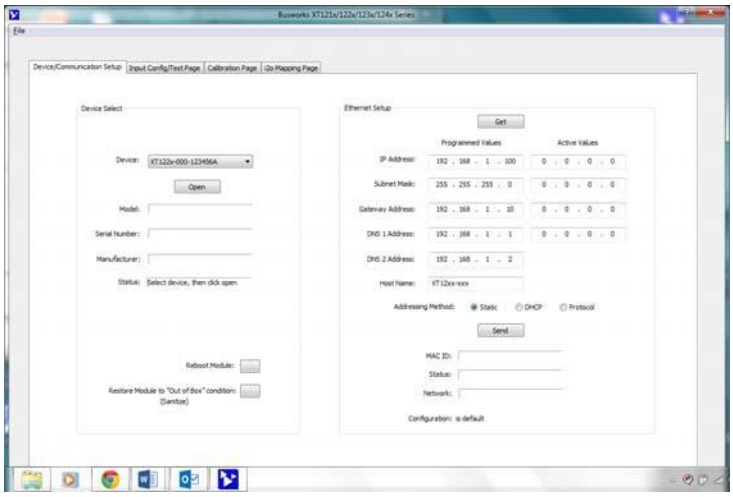
   IMPORTANT: Allow the unit to fully power-up and establish its Ethernet connection before attempting to open USB communications with the unit using the XT12xxconfig.exe software (wait ~30 seconds after powering-it up to give it time to initialize).

Note that you do not connect your module to an Ethernet network in order to configure it. It is configured for network operation by initially connecting to USB with a host PC running model-specific configuration software. This has the advantage of not having to know the module's IP address setting, or having to change the address setting of your network card to an address in the module's subnet address domain in order to talk to it.

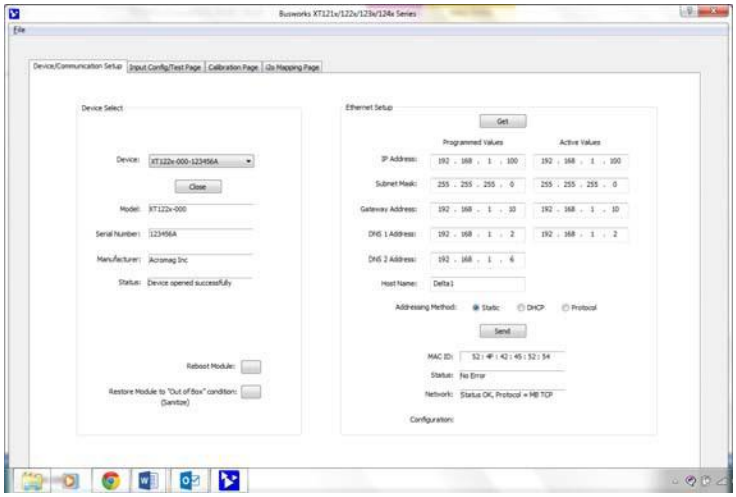
Device/Communication Setup

Note that you should already have power connected to the XT1212 at this point, as this model does not utilize USB power and you will not be able to configure, calibrate, or test the unit without power applied.

After executing the Acromag Configuration software for this model, a screen similar to that shown below will appear, if you have not already connected to your transmitter via USB (note Device Select fields are blank under these conditions).



Once you have selected a device, click the **[Open]** button to open communication with the unit and the screen will fill out similar to the following (the selected unit's Model, Serial Number, Manufacturer, and a USB connection status message will be displayed as shown in the screen below:



The Device Communication Setup screen is split into two parts: Device Select & Ethernet Setup.

Device Select

Connect your PC to the unit via USB, and the unit's model-serial information will appear in the Device field as shown in the second screen at left.

If you happen to be connected to more than one unit via a USB hub, you can use the Device scroll field to select another unit, using the serial information suffix of the Device Model number to discern one unit from another.

Once you have selected a device, click the **[Open]** button to open communication with the unit.

After clicking [Open], the selected unit's Model, Serial Number, Manufacturer, and a connection status message will be displayed as shown in the second screen at left.

TIP: Always Close a connection with one device before selecting another device.

You can use the **[Reboot Module]** button to force a reset of the unit by clicking on it, an effect equivalent to a power-on reset.

You can use the **[Restore Module…]** button to restore a module to its initial "out-of-box" configuration.

Ethernet Setup

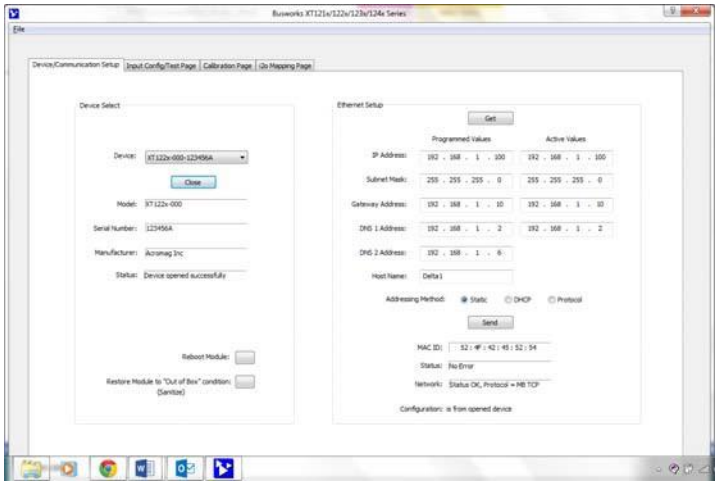
Use the **[Get]** button to retrieve the current Ethernet setup of the connected module (sometimes the Active Values fields will indicate zeros and you must click [Get] to retrieve the actual active values).

Use the Ethernet Setup portion of the Device/ Communication Setup screen shown above to specify network parameters required to communicate with this module (host) over Ethernet. By connecting USB to set these parameters, you do not have to change your PC or network adapter's IP address in order to address this unit, simplifying communication setup (you may still have to consult with your network administrator to complete the contents of this page). The functionality of these network parameters is defined below:

Device/Communication Setup…

The Internet or world-wide web is actually a large network made up of many smaller networks (sub-networks) linked together by gateways or routers. The gateway or router serves as an access point to/from a particular sub-network. For example, your ISP provides DSL modems or cable modems which connect your local hardware to the Internet and often serve as gateways. The gateway address is the address of this gateway or router in the same subnet as the host, and is used as the bridge to connect to various other sub-networks with different sub-network addresses and address masks, that collectively connect together to make up the Internet. Data packets sent over the Internet contain both the sender's Internet address and the receiver's address. A packet is first sent to a gateway computer that understands its own domain or group of host addresses. The gateway reads the destination address of the packet, and if it is outside of its own domain, it forwards the packet on to an adjacent gateway that again reads the destination address. Then that gateway will forward the message on, if the address is not within its domain. Eventually, one gateway recognizes the packet as belonging to a host within its domain. Finding a match, that gateway forwards the packet directly to the host whose address is specified. Rather than continually passing a packet from gateway to gateway, some networks will use a default gateway which is the address of another node on the same network that the software uses when an IP address does not match any other routes in the routing table (address domain) of the primary gateway.

Ethernet Setup…continued



An **IP Address** (Internet Protocol Address) is a unique identification number for any host (this module) on any TCP/IP network (including the internet). It uniquely defines one host from all other computers (hosts) on the Internet. The IP address is made up of four octets (8 bits), each octet having a value between 0-255 (00H-FFH). It is expressed here in decimal form, with a period between octets.

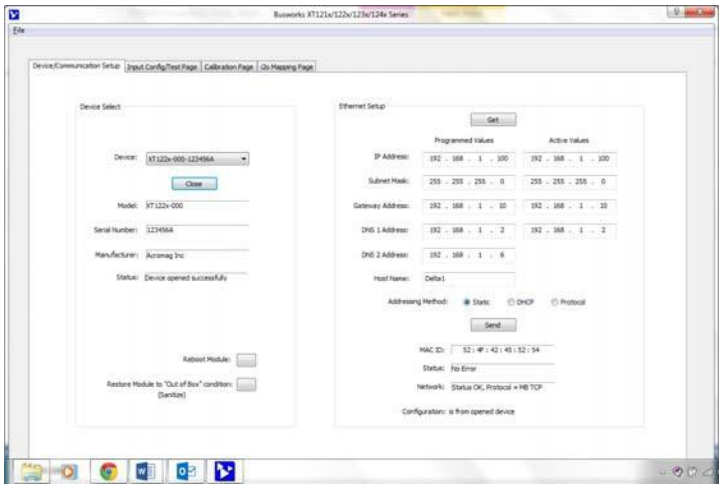
The **Subnet Mask** is used to subdivide the host portion of the IP address into two or more subnets. The subnet mask will flag the bits of the IP address that belong to the network address, and the remaining bits that correspond to the host/node portion of the address. The unique subnet to which an IP address refers to is recovered by performing a bitwise AND operation between the IP address and the mask itself, the result being the subnet address.

Gateway Address refers to the IP Address of the gateway this module is to cross, if your local area network happens to be isolated or segmented by a gateway. Typically, it is assigned the first host address in the subnet address space. If a gateway is not present, then this field should contain an unused address within the host subnet address range.

NOTE: Fortunately, this model uses USB to setup its network configuration parameters, and you can instead change its IP address to an address compatible with your own PC network without having to network connect to it first. This saves you from having to consult with your network administrator to either temporarily change your PC's TCP/IP configuration (see TCP/IP Properties of Network Configuration in Windows), or perhaps having to create a separate private network using a second network adapter installed in your PC. The necessary steps would vary with your operating system, but can get quite involved.

A DNS server relates symbolic names to actual numeric IP addresses, while the DHCP server is responsible for dynamically passing out IP addresses. The **DNS 1 Address** refers to the IP address of the first Domain Name Server used on this network. The **DNS 2 Address** refers to the IP address of the secondary Domain Name Server used on this network.

Device/Communication Setup…



Ethernet Setup…continued

The **Host Name** is the name to be assigned to this host (this module on the network), if its address happens to be assigned dynamically using DHCP.

The **Addressing Method** refers to how this network module will obtain its IP address when connected to its network.

Static addressing is as the name implies—*static*, and represents a unique fixed IP Address generally assigned by your service provider or system administrator. The default address assigned to this module is 192.168.1.100 and static (refer to product side label).

DHCP (Dynamic Host Configuration Protocol) refers to a protocol for assigning dynamic IP addresses to devices on a network. With dynamic addressing, a device can have a different IP address every time it connects to the network. In some systems, it can even change while it is still connected.

The Protocol addressing method refers to allowing the particular application protocol specific to this model to set the IP address. This option only applies to Ethernet/IP and is required for Profinet models. It is not an option for Modbus TCP/IP models. In the Protocol method, the TCP/IP object of the particular protocol (for Ethernet/IP) sets the address. Profinet requires protocol addressing and has its own method for accomplishing address assignment using this method.

By default, the module is setup to use **Static IP Addressing and a default Static IP Address of 192.168.1.100**. You can optionally choose to have the IP address assigned dynamically via DHCP, but this will additionally require that you specify a valid Host Name to retrieve the address from. Choosing Protocol gives the application protocol permission to assign the address and this is required for Profinet models.

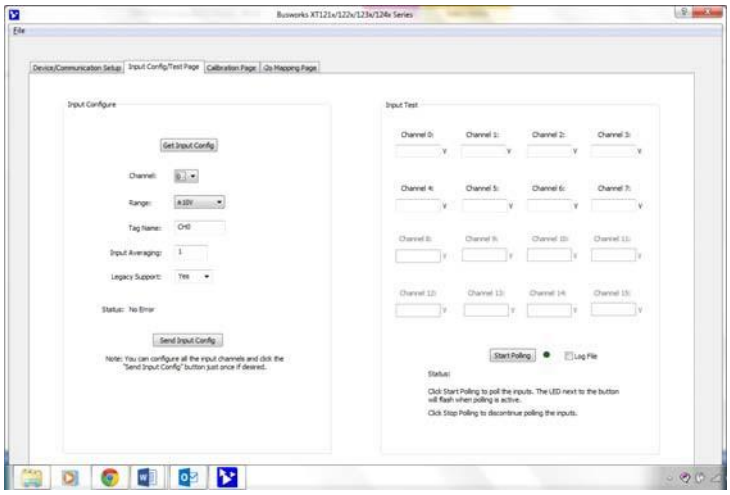
You can click the **[Send]** button to write your Ethernet Setup parameters to the unit once you are done making your selections. This completes any changes made on this page.

The status field will indicate the status of your sent parameters over USB after clicking [Send]. The Network field will the current network connection status, as well as the protocol used for this network. The Configuration field will indicate whether the configuration is from an open device, or a default configuration.

You can click the **[Exit]** button in the lower right hand part of this screen to exit the Configuration Software, or simply click on another tab to access another page before exiting this software.

I/O Configuration/Test

You can click the **"I/O Config/Test Page"** page tab to begin configuring the unit, and/or optionally test its operation. The I/O Config/Test screen is shown below:



I/O Configure

If you are connected to a module, the initial I/O Config/Test screen represents the current configuration of the connected module before making changes.

Get the Input Configuration…
If you have loaded the configuration from a saved file, or if you have made changes to any fields on this page, you can click the **[Get Input Config]** button at the top of the screen to retrieve the connected module's current channel configuration (all channels). Otherwise, the connected module's current configuration was loaded automatically when you selected the tab for this page.

Note that if you make any changes to the selections indicated, the only way to preserve your changes is to write them to the device by clicking the **[Send Input Config]** button after completing your selections, or to save them to a file by clicking **"File"** in the upper left-hand corner of the screen.

Select the Channel…
This software supports models having 8 and 16 channels, channels 0-7, and/or 0-15, according to their model. You can select the specific channel to address here. You could choose to configure channel's selectively, then click [Send Input Config] to write the channel configuration to the unit, or more simply make changes to many channels and then click [Send Input Config] one time to write all the channel configurations to the unit.

Select the Range…
Use the "Range" field to select your input range. For the XT1212-000 model, you can select DC current ranges of ±20mA, 0-20mA, 4-20mA, and 0-11.17mA. For the XT1222-000 model, you can select DC voltage ranges of ±10V, ±5V, 0-10V, and 0-5V.

Set a Tag Name (Optional, up to 8 Characters)….
You can give this input channel a name to document its purpose if desired. This is not used by the firmware or software and just serves as a convenient label for discerning the input function or application over USB.

***Set Input Averaging* (Global Setting, Not Per Channel)…**

Use this field to set the integer number of input samples to average over before updating the input value/reading. Set this number from 1 to 200. Note that higher averaging levels result in lower average noise, but with slower I/O response times. Selecting 1 designates that no averaging will be performed.

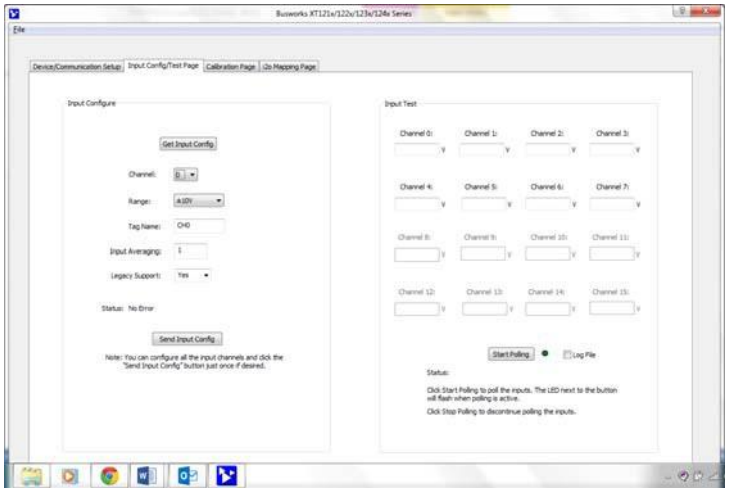
Status…

This field displays status messages relative to sending and receiving configuration parameters to/from the module via USB.

I/O Configuration/Test…

Send Input Configuration and Read Status…

Once you have made your configuration selections, click the **[Send Input Config]** button to write them to the module. You can read the USB Status of your sent message to the unit in the "Status" field just above this button. Alternately, you could click **"File"** in the upper left hand corner of the screen to save the settings you made to a file on your PC, for later reference.



Input Test

At this point, you can test the module's operation by clicking on the **[Start Polling]** button of the Input Test section of the I/O Config/Test page to trigger the software to periodically read the inputs (updates about once per second) and display their values in the fields below their channel designators. Note the simulated lamp next to the button flashes slowly each time it samples the input. Click **[Stop Polling]** to stop polling the inputs before moving onto the next page.

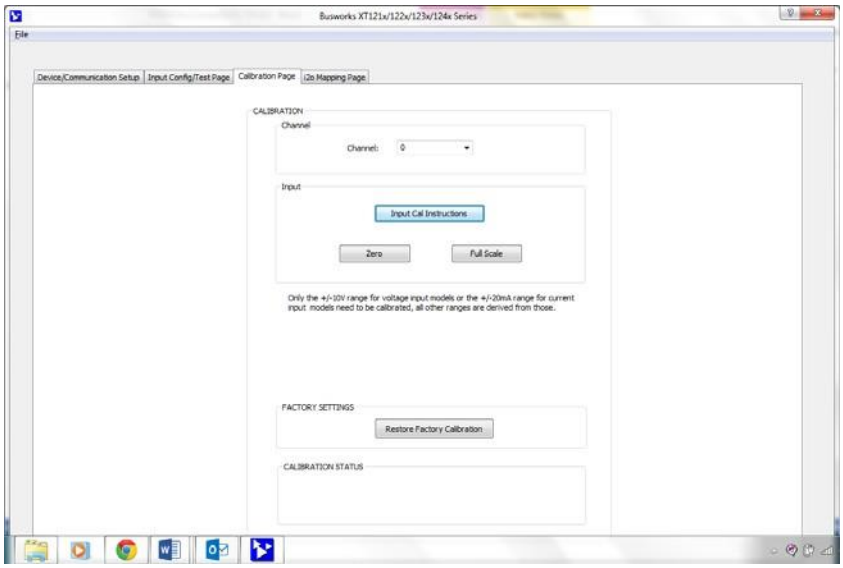
Start Polling Button (Toggle Start/Stop): Click this button to Start/Stop periodic polling of the input channels. The channel values are indicated and updated about once per second. Be sure to first stop polling before moving onto another page.

TIP: Be sure to Stop polling a module before moving onto another page. Note that you will always have to restart polling if you come back to this page and want to poll the inputs.

HELP – You can press **[F1]** for Help on a selected or highlighted field or control. You can also click the **[?]** button in the upper-right hand corner of the screen and click to point to a field or control to get a Help message pertaining to the item you pointed to.

Calibration Page

Once you've configured your unit, you are ready to install it in the field, as the unit has already been factory calibrated. If you later encounter error that is out of specification, you can choose to click the **Calibration Page** tab to display the Calibration control page shown below:



IMPORTANT: This unit has already had its input channels factory calibrated with a high level of precision. Attempts to recalibrate the input channels could degrade their performance if it's not done properly, or done using lower grade equipment. Consider your decision to recalibrate carefully.

CAUTION-Input Calibration: Driving input levels outside of the nominal input range of the unit will not be acceptable for calibration of zero or full-scale. Since input levels cannot be validated during field calibration, incorrect signal levels will produce an undesired output response.

Calibration of this model is a simple process initiated by clicking the **[Input Cal Instructions]** button to begin, then following the on-screen prompts.

CALIBRATION – Input

*Before attempting to recalibrate an input channel, first set the Input Range to calibrate from the "I/O Config/Test" page. Additionally, make sure you write your range selection to the unit by clicking the **[Send Input Config]** button of that page.*

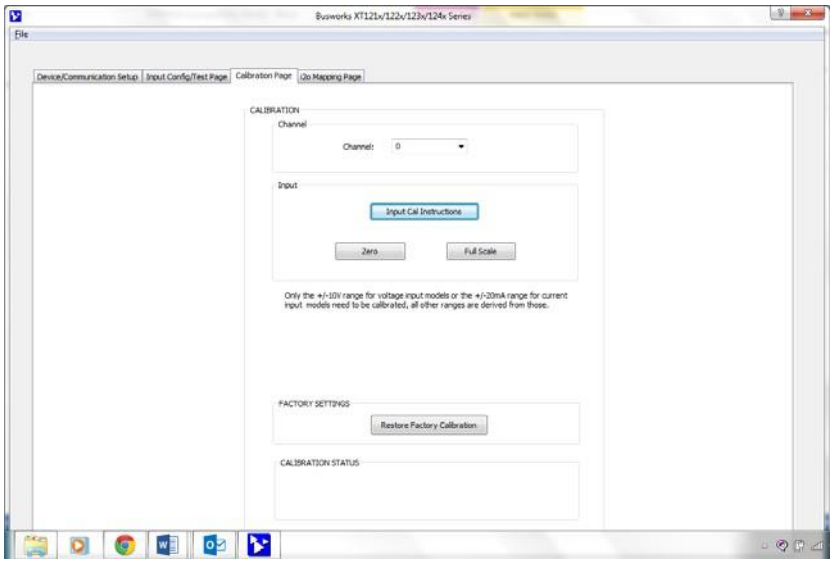
Use the Calibration Channel scroll field to select the particular channel to calibrate. This model has eight differential input channels numbered 0 to 7.

After setting your input parameters, and selecting a channel to calibrate on the I/O Config/Test Page, click the "Input Cal Instructions" button to begin input calibration and enable the Input [Zero] and [Full-Scale] buttons of the Calibration Page shown above.

Click Input **[Zero]** and you will be prompted to input the minimum value of your selected input range at the input channel. If you have a voltage input model, this will be 0, -5V or -10V. Current input models may choose -20mA, 0mA, or 4mA. Once you input zero precisely, click the **[OK]** button and follow the prompts to complete zero calibration.

Click Input **[Full-Scale]** and you will be prompted to input the full-scale value of your selected input range at the channel. For voltage models, this will be 5V or 10V, depending on input range. For current input models, this will be 11.17mA or 20mA, depending on the input range. Once you input full-scale precisely, click **[OK]** and follow the on-screen prompts to complete full-scale calibration.

Calibration Page…



Factory Settings

You can use the FACTORY SETTINGS **[Restore Factory Calibration]** button of this page to restore the module's original factory calibration if you think you made an error during recalibration, degraded its performance, or the input reading appears erratic.

In addition to the Restore Factory Calibration function of this page, you could optionally use the **[Restore to "Out of Box" Condition]** button of the Device/Communication Setup Page to return the unit to its original factory configuration settings. This other function does not restore calibration, but only configuration. Alternatively, that button can be used as a sanitation tool to restore a unit to its initial configuration when decommissioning it.

Calibration Status

This field displays calibration status messages relative to USB like "No Error", "Transfer Error", and "Timeout Error" during calibration. If you encounter a Transfer or Timeout Error, you may have to repeat the calibration process.

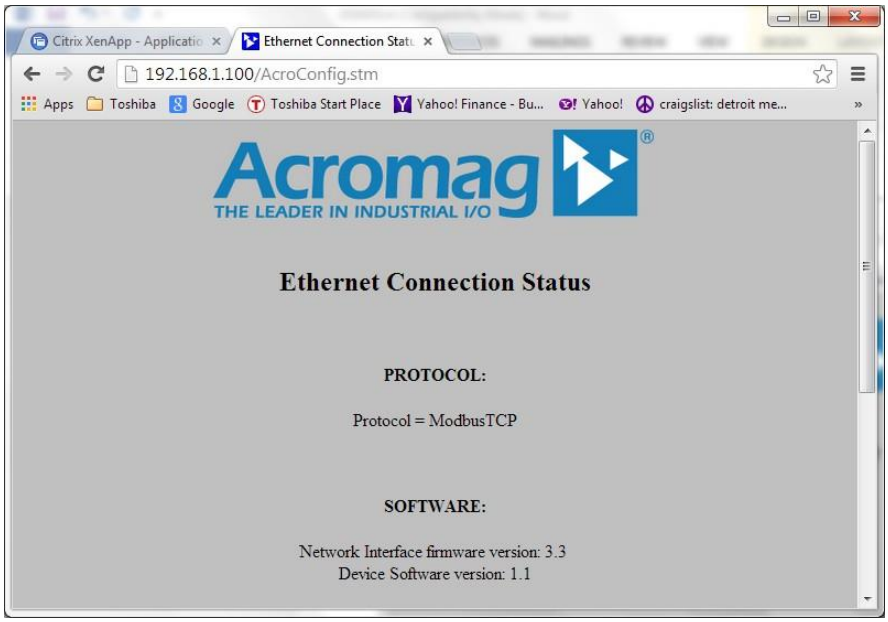
HELP – You can press **[F1]** for Help on a selected or highlighted field or control. You can also click the **[?]** button in the upper-right hand corner of the screen and click to point to a field or control to get a Help message pertaining to the item you pointed to.

Network Home Page

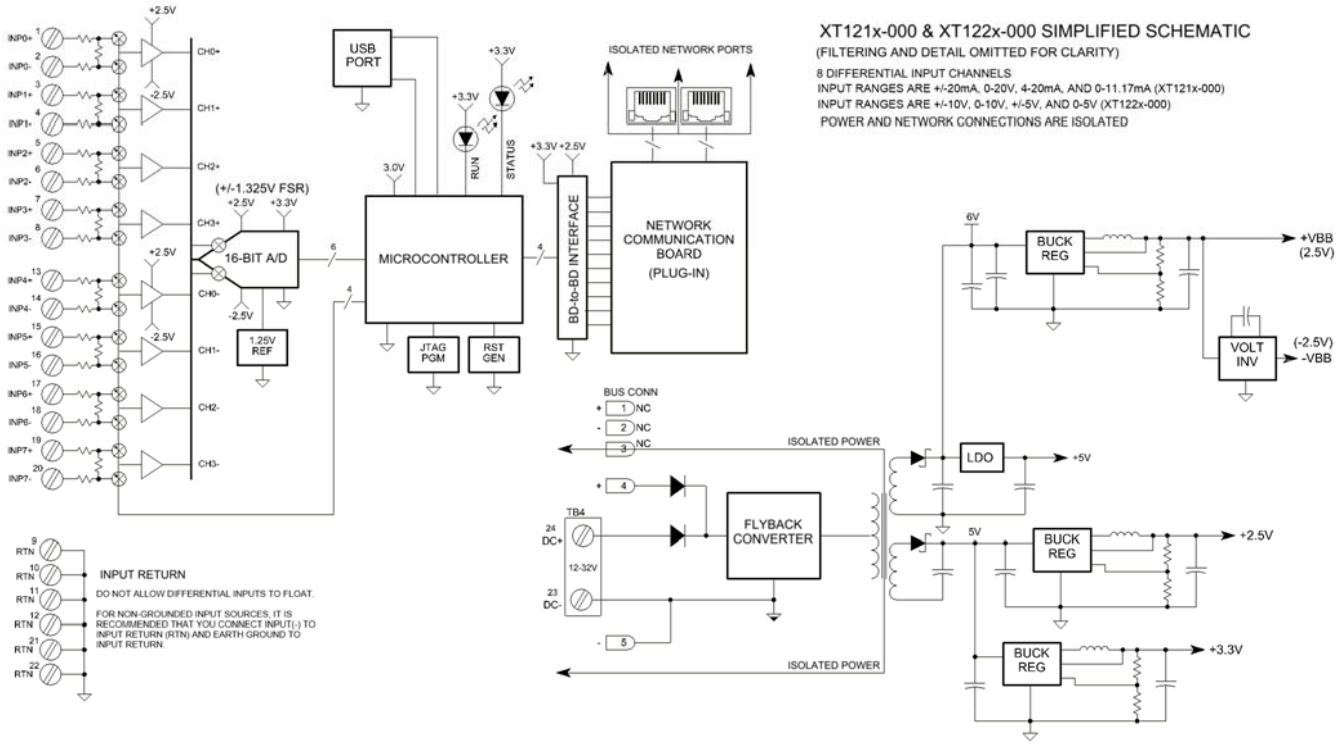
After you have configured your unit for network communication via its USB connection, you can identify the unit on the Ethernet network using a web browser directed to its IP address (you set this address on the Device/Communication Setup page of the USB Configuration Software for the unit, the default is 192.168.1.100). This will access the home page of the unit similar to the first screen shown on the following page.

You can click the "Communication Parameters" link of the Home Page to access the Ethernet Connection Status page shown in the second screen on the following page, which reviews the unit's network communication parameters that were set over a USB connection to the device (scroll down this page to view all applicable parameter settings).





BLOCK DIAGRAM



How It Works

Key Points of Operation

- Unit is DC Powered
- Inputs & USB are Isolated from the network and power.
- Inputs are fully differential.
- Inputs use 16-bit conversion.
- Input circuit common is common to USB ground.

This model has eight differential input channels that are multiplexed to the differential input channel of a 16-bit ΣΔ A/D converter under control of a 32-bit microcontroller. Input common screws are provided to reference input(-) to analog common for channels that would otherwise be floating, and to conveniently connect earth ground to this isolated input. Network communication specific to Ethernet/IP™ is handled by a separate controller on a mating communication board, serial-UART linked to the I/O board. Power for the I/O and network circuits is provided via an isolated flyback converter on the I/O board that operates from 12-32V. The unit is setup for network operation via a USB connection between a host PC and the microcontroller of the I/O board. The host PC runs model specific configuration software designed for the particular XT model. By using USB to configure the unit for network communication, it is not necessary to know the IP address of the unit in order to communicate with it, nor to change the IP address of your network card to match the module's subnet address domain. Refer to the block diagram above to gain a better understanding of how this model works.

The inputs & USB, network, and power circuits are isolated from each other. The USB port ground is common to the input circuit common. The USB port ground of most PC's is also common to the USB cable shield and earth ground. Inputs could be grounded or ungrounded. For this reason, it is recommended that USB signals be isolated when connected to a PC to prevent a ground loop from occurring between the PC earth ground and a grounded input signal, which could have the negative effect of driving digital a upset for severe ground loop currents.

About Ethernet/IP™

EtherNet/IP™ (Ethernet Industrial Protocol) is traditional Ethernet combined with an industrial application layer protocol targeted to industrial automation. This application layer protocol is the Control and Information Protocol (CIP™).

For more information on EtherNet/IP™, please refer to our whitepaper "Introduction to EtherNet/IP™", 8500-747. This document is included on the CDROM that is bundled with the XT-SIP configuration kit (purchased separately) and may also be downloaded from our web site at www.acromag.com. You may also obtain a copy of the EtherNet/IP™ standard from the Open deviceNet Vendor association (ODVA) web site for EtherNet/IP™ at www.ethernet-ip.org.

Object Models

All CIP™ devices are modeled as a *collection of objects.* An object represents a particular component of a device. This collection of related data values and common elements of the device make up its *object model*. We use the term c*lass* to refer to a specific type or set of objects (same kind of system components), and *instance* to refer to one implementation of a *class*. The term *attribute* refers to a characteristic of an instance, an object, or an object class. *Attributes* provide status information and govern the operation of an object. *Services* are used to trigger the object/class to perform a task. And the object's response is referred to as its *behavior*. Note that the term *object* and *class* are often used interchangeably, even though a class is really a specific type of object.

To illustrate, if our object is fruit, we can say that an apple is a *class* of fruit. A Macintosh apple is an *instance* of this class, and red skin is one *attribute* of this particular instance.

In general, there are three types of objects or classes defined by CIP™—*required* objects, application or *device-specific* objects, and *vendor-specific* objects. Required objects must be included in every CIP™ device. Device-specific objects are the objects that define the data encapsulated by the device and are specific to the type of device and its function. Objects not found in the profile for a device class are vendor-specific objects and these vendor extensions are usually included as *additional features* of the device.

With CIP™, a class exists simply to combine data for I/O messaging among common elements and the CIP™ library already contains many commonly defined objects or classes. The confusion that surrounds this topic usually arises from the nesting of objects and classes that occurs in defining other objects and classes, and in linking together these various objects to build larger device *profiles*. The objects shown in the table below form the object model for the XT1212-000 (any object ID from 64H to C7H is a vendor-specific object type). Note that these objects make use of the following data types:

Object Models…

DATA TYPE	DESCRIPTION
USINT	Unsigned Short Integer (8-bits)
UINT	Unsigned Integer (16-bits)
UDINT	Unsigned Double Integer (32-bits)
STRING	Character String w/ 1-byte per character
BYTE	8-bit String
WORD	16-bit String
DWORD	32-bit String

Model XT1212-000 & XT1222-000 Supported Ethernet/IP™ Object Models

Object	Class Attributes	Class Services	Instance Attributes	Instance Services
Identity	1,2,3,6,7 (get)	GAA, GAS	1,2,3,4,5,6,7 (get)	GAA, Reset (type 0 and 1), GAS
Message Router	1,2,3,4,5,6,7 (get)	GAA, GAS	1,2 (get)	GAA, GAS, Multiple Service Packet
Assembly	1,2,3,46,7 (get)	GAS	Data (3, get/set), Size (4, get)	GAS, SAS
Connection Mgr	1,2,3,4,6,7 (get)	GAA, GAS	1,2,3,4,5,6,7,8 (get/set)	GAA, SAA, GAS, SAS, Forward Close, Unconnected Send, Forward Open, Get Connection Owner, Large Forward Open
Port	1,2,3,6,7,8,9 (get)	GAA, GAS	1,2,3,4,7 (get)	GAA, GAS
TCP/IP	1,2,3,4,6,7 (get)	GAA, GAS	1,2,4 (get), 3,5,6,8,9,10,11 (get/set)	GAA, GAS, SAA, SAS
Ethernet Link	1,2,3,4,6,7 (get)	GAA, GAS	1,2,3,7,8,10 (get) 6,9 (get/set)	GAA, GAS, SAS
QOS	1,2,3,6,7 (get)	GAS	1,2,3,4,5,6,7,8 (get/set)	GAS, SAS

Details for the Assembly Object are included below, because this object is needed to establish a connection. Details for the remaining objects will not be included here, as these details can be obtained by module query once a connection has been established.

Assembly Object

(04HEX – 3 Instances)

The Assembly Object binds attributes of multiple objects, allowing data to or from each object to be sent or received over a single connection.

Assembly objects can be used to bind input data or output data—note that "input" and "output" are taken from the network's perspective. An input will produce data on the network while an output will consume data from the network.

Produced/Consumed=Input/Output

Data values for analog I/O models are generally indicated by a 16-bit word containing a signed-integer that represents the normalized input data value, except for the heartbeat counter, which uses an unsigned 16-bit integer value (a range of 0-65535).

ATTR ID	NAME	DATA TYPE	DEF DATA VALUE	ACCESS RULE
Class Attributes				
1	Revision	UINT[]	1	GET
2	Max Instance	UINT[]	81	GET
Instance 65H Attributes (Input Instance 1)				
3	Discrete Input Data (array of words), Analog Input Data (array of words)	UINT[] UINT[]	0 18	GET
4	Data Size (Tot # of Analog & Digital Input Words)	UINT[]	18	GET
Instance 64H Attributes (Output Instance 1)				
3	Discrete Output Data-array of words Analog Output Data-array of words	UINT[] UNIT[]	0 0	GET/SET
4	Data Size (Tot # of Analog & Digital Output Words)	UINT[]	0	GET
Instance 80H Attributes (Configuration Instance)				
	Most I/O clients include a Configuration path when opening an I/O connection to a server. There is no Configuration data needed.			
Common Services				
SVC	**IMPLEMENTED FOR:**			
CODE	**CLASS LEVEL**	**INSTANCE LEVEL**		**SERVICE NAME**
0EHEX	Yes	Yes		Get_Attribute_Single
10HEX	No	Yes		Set_Attribute_Single

Data Word (2 Bytes)	Applicable Channel	Assignment/Function
Word[0] Produced	AI Channel 0	16-bit signed integer representing the normalized data value for input channel 0
Word[1] Produced	AI Channel 1	16-bit signed integer representing the normalized data value for input channel 1
Word[2] Produced	AI Channel 2	16-bit signed integer representing the normalized data value for input channel 2
Word[3] Produced	AI Channel 3	16-bit signed integer representing the normalized data value for input channel 3
Word[4] Produced	AI Channel 4	16-bit signed integer representing the normalized data value for input channel 4
Word[5] Produced	AI Channel 5	16-bit signed integer representing the normalized data value for input channel 5
Word[6] Produced	AI Channel 6	16-bit signed integer representing the normalized data value for input channel 6
Word[7] Produced	AI Channel 7	16-bit signed integer representing the normalized data value for input channel 7
Word[8] = 16-bit Heartbeat Counter (Produced Data Only = Input Data Only)	This 16-bit integer counts from 0 to 65535 and wraps back around to 0. It increments by 1 for every host to network data transfer to help indicate if fresh data is present relative to the last data transfer, or if the unit has halted for some reason.	

EDS File (Electronic Data Sheet)

The EDS file is an ASCII text file that describes a product's device type, product revision, and its configurable parameters on a network. EDS files contain file revision information (File), identity object information (Device), device type information - DeviceNet, EtherNet/IP™ or ControlNet (Device Classification), physical connection information (Port), and connection information (Connection Manager). EDS files may optionally contain parameteric information used to configure specific attributes (Parameter), group information used to logically group parameters together (Group), or enumeration information used to assign meaningful names to values (Enum), plus other information as necessary.

All EtherNet/IP™ devices include an Electronic Data Sheet (EDS) file for device configuration. The purpose of this file is for use by various control software, network configuration tools, and application programs to help identify and understand the capabilities of the EtherNet/IP™ device, usually in order to commission it on an EtherNet/IP™ network. The EDS files of the XT1212-000 (Acromag_XT1212.eds) and XT1222-000 (Acromag _XT1222.eds) are included on the CDROM of the XT-SIP kit (purchased separately). You can open the EDS file with any ASCII Text Editor if you wish to examine its contents.

IP Addressing

The IP address (Internet Protocol Address) uniquely defines a network host on the Internet, from all other hosts on the Internet, while the Internet Protocol (IP) is the method by which the data is exchanged between different hosts on the Internet.

A *Static IP Address* is as the name implies—static. That is, it is a unique IP Address that is assigned by a service provider and never changes.

A *Dynamic IP Address* is an address that is temporarily assigned to a user by a service provider each time a user connects.

A *Subnet* is a contiguous string of IP addresses. The first IP address in a subnet is used to identify the subnet, while the last IP address in a subnet is always used as a broadcast address. Addresses between the first and last subnet address make up the address domain of the subnet. Anything sent to the last IP address of a subnet is generally sent to every host on that particular subnet.

Subnets are further broken down into three size classes based on the 4 octets that make up the IP address. A Class A subnet is any subnet that shares the first octet of the IP address. The remaining 3 octets of a Class A subnet will define up to 16,777,214 possible IP addresses ($2^{24} - 2$). A Class B subnet shares the first two octets of an IP address (providing $2^{16} - 2$, or 65534 possible IP addresses). Class C subnets share the first 3 octets of an IP address, giving 254 possible IP addresses. Recall that the first and last IP addresses are always used as a network number and broadcast address respectively, and this is why we subtract 2 from the total possible unique addresses that are defined via the remaining octet(s).

TIP: The first node (0), node 10, and the last node (255 for our example) are typically reserved for servers and may yield poor results if used.

IP Addressing…

For our example, the default IP address of this module is 192.168.1.100. If we assume that this is a Class C network address (based on a default Class C subnet mask of 255.255.255.0), then the first three numbers represent this Class C network (or subnet) at address 192.168.1.0, the last number identifies a unique host/node on this network (node 100) at address 192.168.1.100.

The *Subnet Mask* is used to determine which subnet an IP address belongs to. The use of a subnet mask allows the network administrator to further divide the host part of this address into two or more subnets. The subnet mask flags the network address portion of the IP address, plus the bits of the host part that are used for identifying the sub-network. By convention, the bits of the mask that correspond to the sub-network address are all set to 1's (it would also work if the bits were set exactly as in the network address). It's called a mask because it can be used to identify the unique subnet to which an IP address belongs to by performing a bitwise AND operation between the mask itself, and the IP address, with the result being the subnetwork address, and the remaining bits the host or node address.

For our Example, if we wish to further divide this network into 14 subnets, then the first 4 bits of the host address will be required to identify the subnetwork (0110), then we would use "11111111.11111111.11111111. 11110000" as our subnet mask. This would effectively subdivide our Class C network into 14 subnetworks of up to 14 possible nodes each.

With respect to the default settings of this module:
Subnet Mask 255.255.255.0 (11111111.11111111.11111111.00000000)
IP Address: 192.168.1.100 (10000000.00000001.00000001.01100100)
Subnet Address: 128.1.1.0 (1000000.00000001.00000001.00000000)

The subnetwork address of 128.1.1.0 has 254 possible unique node addresses (we are using node 100 of 254 possible as our default). Nodes 0, 10, and 255 are typically reserved for servers and may yield poor results if used.

Dynamic Host Configuration Protocol (DHCP)

DHCP refers to Dynamic Host Configuration Protocol and is a method used to assign unique temporary numeric IP addresses as required. A DHCP server maintains a pool of shared IP addresses which are dynamically assigned and recycled. When a DHCP device wants to use a TCP/IP application, it must request an IP address from the DHCP server. The DHCP server will check the shared supply addresses, and if all addresses are in use, the server will send a busy signal to the client which signals it to try again later. Only static IP addresses will ensure a connection every time, while dynamic addresses do not.

Domain Name System (DNS)

DNS refers to the Domain Name System or Domain Name Server and refers to the system used to associate an alphanumeric character string with a numeric IP address. The DNS is actually a distributed database of domain names and corresponding IP addresses. These servers contain information on some segment of the domain name space and make this information available to clients called *resolvers*. For example, the DNS allows us to use "Acromag.com" as an IP address rather than a more complicated number string.

TROUBLESHOOTING

Diagnostics Table

Before attempting repair or replacement, be sure that all installation and configuration procedures have been followed and that the unit is wired properly. Verify that 12-32V power is applied to the unit.

If your problem still exists after checking your wiring and reviewing this information, or if other evidence points to another problem with the unit, an effective and convenient fault diagnosis method is to exchange the questionable unit with a known good unit.

Acromag's Application Engineers can provide further technical assistance if required. Repair services are also available from Acromag.

POSSIBLE CAUSE	POSSIBLE FIX
Green RUN LED does not light…	
Internal +3.3V rail has failed.	Return module for repair.
Green RUN LED flashes continuously…	
A network link has not been established.	Check your cable and switch/hub connections. Once a link is established, the green Run LED should not continue to blink but remain ON. If it continues to blink, then the cable/connection is bad, or the firmware may have been corrupted.
Unit was not connected to network upon power-up, or network cable is bad.	The RUN LED will continue to blink as the unit initially hunts for a network link. Connect a network cable to the unit to complete its initialization and stop the blinking. Note, this only occurs for initial network communication following power-up.
Unit failed to boot firmware (Internal Firmware Failure).	A continuously flashing green Run LED can signify the unit has failed to initialize and may require repair if you are sure you have a good network connection and proper power voltage. Return module to Acromag for repair/reprogramming.
Unit Fails to Start-up or Initialize…	
Input power voltage below 12V, or input supply is current-limited below twice the unit's current draw?	Check your power voltage and make sure that it is at least 12V and of sufficient capacity (select a current capacity at least 2x the maximum current draw of the unit).
Communication To Unit is Lost…	
Was communication interrupted by severe interference or shock?	Reset the unit by cycling power to it.

Diagnostics Table…

POSSIBLE CAUSE	POSSIBLE FIX
Cannot Communicate With Module Over Network…	
Power ON at Module?	*Check power. Is Green Run LED ON?*
Using Wrong IP Address	You could either change the IP address of the module, or your host PC network card so that they both match subnet address domains. The easiest solution is to connect to the unit via USB and change the IP address setting of the module.
Many Communication Errors…	
Is Cable segment longer than 100M?	The maximum distance between two nodes on an Ethernet network is limited to 100 meters using approved cable.
Correct Cable Type	Shielded CAT-5/5E cable, equivalent or better, is recommended.
Missing Earth Ground Connection?	Connect earth ground to power minus terminal at TB6-23.
Adding another unit to network slows web page interaction considerably…	
Does each unit have a unique MAC address? *All units are normally shipped with a unique MAC address assigned from the factory. An error in shipment could release a unit with a default MAC address of 52:4F:42:45:52:54.*	Go to the Network Configuration Page of the USB Configuration Software and verify that each unit has a unique MAC address installed. This should always be the case. If you have 2 units with same MAC address, this will slow down communications considerably and you must contact the factory for MAC reassignment.
USB Software Fails to Detect Module…	
Bad USB Connection	Recheck USB Cable Connection
USB has not enumerated the device.	Use the reset button on the Acromag USB isolator to trigger renumeration of the module, or simply unplug and replug the USB cable to the module.
Communication or power was lost while USB was connected and the configuration software was running.	Close the current connection with the software, then select and re-open the module for communication (or simply exit the Configuration software and reboot it).
Cannot Communicate with Module via USB…	
A missing USB Isolator could cause a ground loop between a grounded input signal and earth ground at the connected Personal Computer's USB port.	Without a USB isolator, a ground loop is created between a grounded input signal source and earth ground of the PC USB port. For this reason, and for increased safety and noise immunity, it's best to connect to USB via a USB isolator. Use an isolator like the Acromag USB-ISOLATOR. Otherwise, use a battery powered laptop to configure the module which does not normally earth ground its USB port.

Diagnostics Table…

POSSIBLE CAUSE	POSSIBLE FIX
Input reading Erratic, Not operational, or Intermittent when Connected to USB…	
Unit fails to operate or exhibits an output shift…	
Missing USB isolation with grounded I/O signal source.	Even though the I/O is isolated from the network and power, if your input signal is already earth grounded, then connecting non-isolated USB to the module may drive a ground loop between your input and earth ground at the PC. Use USB signal isolation, or alternatively, you can connect to a battery-powered laptop/PC, which does not earth ground its USB connection.
Input Polarity is Wrong…	
Are your input terminals reversed?	Observe proper polarity for voltage inputs. Current cab be input to the input (+) or input (-) terminals if a non-polarized current range is selected (the ±20mA range).
Inputs Appear Noisy or Unstable…	
Have you grounded your inputs? Un-grounded inputs and the Port return terminal both require an earth-ground connection.	Connect one port return (RTN) terminal to earth ground. If the input signal source is not already grounded, then connect the IN- lead to a port return (RTN) terminal.
Have you tried averaging? Is averaging set to 1?	You can use the configuration controls to set input averaging from 1-200 samples. A value of 1 is equivalent to no averaging. Higher averaging will help to minimize noise, but will increase the response time.
Status field of software screen indicates "Data Transfer Error", "Unknown Protocol" or "Timeout Error"…	
USB connection was opened before unit had completed its power-on initialization and established its network connection.	Wait ~30 seconds after powering-up unit before opening a USB connection via the configuration software. Turn power off to the unit, close the USB configuration software, repower the unit, then reboot the USB configuration software after unit has completed power-on initialization and established its network connection.

Service & Repair Assistance

This unit contains solid-state components and requires no maintenance, except for periodic cleaning and module configuration parameter (zero and full-scale) verification. The enclosure is not meant to be opened for access and can be damaged easily if snapped apart. Thus, it is highly recommended that a non-functioning module be returned to Acromag for repair or replacement. Acromag has automated test equipment that thoroughly checks and calibrates the performance of each module, and can restore firmware. Please refer to Acromag's Service Policy and Warranty Bulletins, or contact Acromag for complete details on how to obtain repair or replacement.

ACCESSORIES

Software Interface Package



Software Interface Package/Configuration Kit – Order XT-SIP

- USB Signal Isolator
- USB A-B Cable 4001-112
- USB A-mini B Cable 4001-113
- Configuration Software CDROM 5041-094

This kit contains all the essential elements for configuring XT network modules. Isolation is recommended for USB port connections to these models and will block potential ground loops between your PC and grounded input signals. A software CDROM is included that contains the Windows software used to program the unit.

USB Isolator



USB Isolator – Order USB-ISOLATOR

- USB Signal Isolator
- USB A-B Cable 4001-112
- Instructions 8500-900

This kit contains a USB isolator and a 1M USB A-B cable for connection to a PC. This isolator and cable are also included in XT-SIP (see above).

USB A-B Cable



USB A-B Cable – Order 4001-112

USB A-B Cable 4001-112

This is a 1 meter, USB A-B replacement cable for connection between your PC and the USB isolator. It is normally included with the XT-SIP Software Interface Package and also with the isolator model USB-ISOLATOR.

USB A-mini B Cable



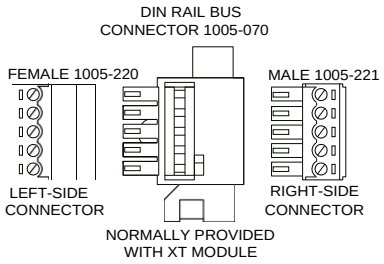
USB A-mini B Cable – Order 4001-113

- USB A-mini B Cable 4001-113

This is a 1 meter, USB A-miniB replacement cable for connection between the USB isolator and any TT or XT module. It is normally included in XT-SIP.

Note that software for all XT Series models is available free of charge, online at www.acromag.com.

DIN Rail Bus Connector Kit



Bus Connector Kit for DIN Rail Bus Connection to Power, Model XTBUS-KIT

This kit contains one each of the following terminals

- DIN Rail Bus Connector 1005-070 for 22.5mm XT Modules.
- Left Side terminal block, female connector 1005-220.
- Right Side terminal block, male connector 1005-221.
- Two End Stops for 35 mm DIN Rails 1027-222 (not shown).

This module was shipped with the first item included in this kit, DIN Rail Bus Connector 1005-070, and this kit offers a spare. Left and right side terminal blocks that mate directly to the bus connector are included in this kit. These terminals are used to optionally (or redundantly) drive power to the modules via their DIN rail bus connector. This allows modules to neatly and conveniently share connections to Power. Two end stops 1027-222, used to secure the terminal block and module for hazardous location installations.

Low EMI Double-Shielded Patch Cable



Ethernet Patch Cable, 3 feet long, Model 5035-369
Ethernet Patch Cable, 15 feet long, Model 5035-370

This cable is used to connect a module to your network switch (like an Acromag 900EN-S005 or equivalent Ethernet switch), and is double-shielded for lower emissions and increased RFI resistance. It has been tested to lower radiated emissions of this product. It has a red, low-smoke, zero halogen jacket and bundles four pairs of 26AWG stranded cable. It uses a 100% foil shield beneath a 60% braided outer shield and includes an RJ45 plug at each end. It is electrically equivalent to L-Com TRD855DSZRD cable and can be obtained in other lengths directly from L-Com (http://www.l-com.com).

Double-shielded CAT5e or better cable is recommended for very noisy environments or in the presence of strong electrical fields. You may obtain shielded CAT-5e cable in other lengths and colors as required for your application from other vendors including L-com Connectivity Products, www.L-com.com, Pro-Link, www.prolink-cables.com, Regal, www.regalusa.com, and Lumberg, www.lumbergusa.com. The recommended L-com cable was used for CE Testing of this model.

SPECIFICATIONS

Model Number

XT1212-000 (Current Input)
XT1222-000 (Voltage Input)

Analog Input Module
Ethernet/IP™ Support
8 Differential Input Channels
DC Powered
CE Approved
Includes UL/cUL Class I, Division 2 approvals

The XT1212-000 and XT1222-000 represent additional members of the Acromag DIN-Rail mounted, "Busworks" family of network I/O modules in the XT Series. The XT1212-000 model denotes an 8 differential channel input model for DC current input, and XT1222 is an 8 differential channel input model for DC voltage input. These models operate over Ethernet using Ethernet/IP™, but they are setup and calibrated for network operation using USB. The trailing "-000" model suffix denotes DC powered w/ CE & UL/cUL Class I, Division 2 Approvals.

Reconfiguration of any XT model will require use of the XT-SIP configuration kit, ordered separately (see Accessories section).

Models are mounted on standard "T" Type DIN rail and include plug-in terminals. Power can be optionally (or redundantly) bussed along the DIN rail (see Power Connections).

Analog Inputs

This model differentially multiplexes eight input channels of DC current (XT1212), or eight channels of DC voltage (XT1222), to a 16-bit ΣΔ A/D through unity-gain buffers. The A/D has a full-scale bipolar input range of ±1.325V (±32768). Current inputs use precision 27.4Ω shunt resistors to convert input current to voltage, such that ±20mA will drive ±0.558V full-scale to the A/D. Voltage inputs drive the A/D through resistive-dividers (0.12076x factor). All inputs include transient voltage suppression, plus current-limited diode over-voltage clamps to the ±2.5V rails. Positive current or voltage is delivered to the (+) input terminal and returned on the negative (-) input terminal.

Unit must be wired and configured for the intended input type and range (see Connections section for details). The following paragraphs summarize this model's input types, ranges, and applicable specifications:

DC Input Range: All input ranges are based on a nominal bipolar and differential full-scale 16-bit A/D range of ±1.325V (for ±32768). XT1222 voltage inputs are resistive-divided and unity-gain buffered prior to the A/D (divider factor is 0.12076x). Current inputs drive 27.4Ω shunt resistors to convert input current to a voltage, and are then unity-gain buffered to the A/D. For XT1222 models, you may select DC voltage ranges of ±5V, ±10V, 0-5V, or 0-10V, on a per channel basis. XT1212 models allow current sub-ranges of ±20mA, 0-20mA, 0-11.17mA, and 4-20mA and use 27.4Ω precision shunt resistors at the inputs to convert input current to voltage such that ±20mA DC (±21.6mA Max) drives ±0.548V full-scale to the A/D. All selectable input ranges are normalized to ±30000 for ±100% of range, or optionally to ±20000 for ±100% of range (w/ legacy support).
Reference Test Conditions: ±20mA (XT1212) or ±5V (XT1222) input; ambient temperature = 25°C; 24VDC supply.
Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS), 5.6V clamp level typical (XT1231), or 18V clamp level typical (XT1241). Inputs also include current-limited (series resistance) diode clamps to the ±2.5V rails.

Analog Inputs…

Input Resolution: A fundamental A/D input range of ±1.325V defines 1 lsb equal to 2.65V/65536, or 40.436uV/bit. The A/D of this model divides the input signal range into a number of parts that can be calculated by subtraction using the expression for A/D counts as (Vin_eff/1.325)*32768 for its bipolar ±1.325V A/D full-scale input range (16 bit w/±32768). Vin is the effective DC input voltage of this model after the input voltage divider (0.12076x on voltage units), or via the current input shunt through 27.4Ω (0.548V @20mA into 27.4Ω for XT1212 Models). The resultant A/D count is then normalized using a bipolar conversion scheme of ±30000 (bipolar ranges) or ±20000 (bipolar ranges w/legacy support enabled), each corresponding to ±100% of input range. That is, -100%, 0% and +100% are represented by decimal values –30000, 0, and 30000, respectively, or -20000, 0, 20000 respectively. The effective input resolution for a given range is normally the lowest resolution of either the A/D conversion, or its normalized value. For this model, the effective resolution is dominated by the A/D converter. An indication of nominal input resolution is expressed as the number of parts between the input range low and high endpoints shown in the Table below. The shaded value is the effective resolution of the input for the selected range, and is equivalent to the A/D resolution for each range of this model.

Input Resolution for XT121x-000 Input Ranges[1]

RANGE Into 27.4Ω	±20mA (±0.548V)	0-20mA (0-0.548V)	4-20mA (0.1096-0.548V)	0-11.17mA (0-0.30606V)
Raw A/D	±13552 (1 part in 27104)	0-13552	2710-13552 (1 part in 10842)	0-7569
Resolution	1.476uA/bit			
PPM	36.9ppm	73.8ppm	92.2ppm	132.1ppm
Normalized	±30000	0-30000	0-30000	0-30000

Input Resolution for XT122x Input Ranges[1]

RANGE	±10V	±5V	0-10V	0-5V
Raw A/D	±29864 (1 part in 59728)	±14932 (1 part in 29864)	0-29864	0-14932
Resolution	334.85uV/bit			
PPM	16.7ppm	33.5ppm	33.5ppm	67ppm
Normalized	±30000	±30000	0-30000	0-30000

[1]XT121x current inputs use a 27.4Ω shunt driving a bipolar ±1.325V (16-bit) A/D Range. XT122x voltage ranges are coupled to the A/D after a 12.1K/100.2K resistive voltage divider (0.120758x). All input ranges are normalized to ±30000 for ±100%, and 0-30000 for 0-100% (or ±20000 for ±100%, and 0-20000 for 0-100% with legacy support enabled).

Input Impedance: 100.2KΩ (XT1222), 27.4Ω (XT1212 current shunt resistor).

Optional AC Current Sensor (Model 5020-350, for AC Current Input to XT121x): The 5020-350 sensor can be connected to any of the input terminals of this model for AC current sensing, and is a toroidal instrument transformer that converts the sinusoidal 50-60Hz AC current signal into a low level DC milliampere signal of 0 to 11.17mA. The input AC current range is a function of the number of turns placed through the toroid as shown in Table 2 below. This sensor is isolated and requires no calibration or adjustment. When used with the XT1212 module, it also facilitates current input isolation channel-to-channel, and redundant current input isolation with respect to the network and power of this transmitter.

Analog Inputs…

The output wires of this sensor are polarized with red as plus (+) and black as minus (-). Normally these output wires are attached to one end of a user supplied cable, while the other end connects to the current input terminals of this module, connected similar to that shown below:

MODEL XT121x-000 WIRING TO AC CURRENT SENSOR 5020-350

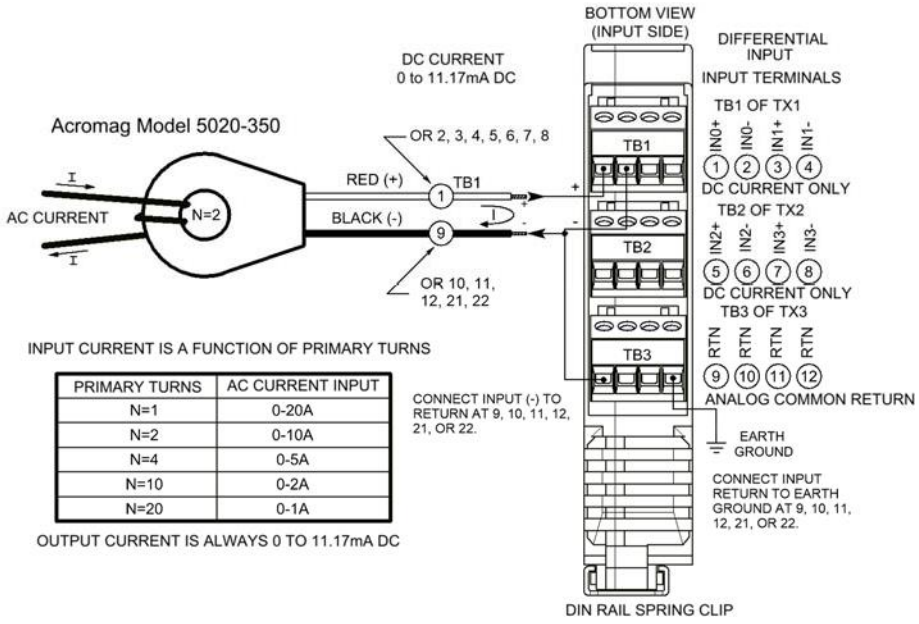


Table 2: Optional AC Current Sensor Turns & Range		
AC Current Input Range	**Primary Turns**	**Sensor Output (Red/Black Wires)**
0 to 20A AC	1	0 to 11.17mA DC
0 to 10A AC	2	"
0 to 5A AC	4	"
0 to 2A AC	10	"
0 to 1A AC	20	"

AC Input Burden: A function of the wire gauge resistance used for primary turns (the current carrying wire being monitored).
AC Current Sensor to Transmitter Wiring Distance: 400 feet maximum for 18 gauge wire. Other wire gauges can be used as long as the resistance of both wires is less than 5Ω.
AC Input Overload: The AC current sensor will withstand overload conditions as follows:

- 20 times full scale for 0.01 seconds.
- 10 times full scale for 0.1 seconds.
- 5 times full scale for 1.0 second.

General

Input Accuracy: Better than ±0.05% of span typical, ±0.1% maximum. This includes the effects of repeatability, terminal point conformity, and linearization, but does not include sensor error.
Input Measurement Temperature Drift: Better than ±50ppm/°C (±0.0050%/°C).
Input Update/Conversion Rate: Fresh Input data is available to the network every 10mS. Raising the number of samples for averaging could increase this time.
Response Time from an Ethernet command: Typically less than 5mS.
Input Calibration: Inputs can be calibrated manually by driving the input channel with a precision reference current or voltage signal source.
Input Analog to Digital Converter (A/D): A 16-bit delta-sigma converter, Texas Instruments ADS1158IRTC, connected in bipolar mode with a 1.25V reference, yielding a 16-bit A/D input range of ±1.325V corresponding to a count of ±32768.
Input Filter: Normal mode filtering fixed per input type.
Input Filter Bandwidth: -3dB at 25KHz, typical, no averaging.
Input Noise Rejection (Common Mode): Better than -110dB @ 60Hz, typical with 100Ω input unbalance.
Input Cable Length: I/O port interface cables should not exceed 30m in length for rated performance.

Power

Power Supply (Connect at TB6 terminals 24 & 23, and/or via the DIN Rail Bus): 12-32V DC SELV (Safety Extra Low Voltage), 2.8W max. Observe proper polarity. Reverse voltage protection is included. Unit can be redundantly powered by connecting power to both the power terminals on the unit at TB6 and DIN rail bus at TB7 (these inputs are diode-coupled to the same point in the circuit). Current draw varies with power voltage as follows.

SUPPLY	XT12x2-000 CURRENT
12V	212mA Typical / 233mA Max
15V	172mA Typical / 187mA Max
24V	103mA Typical / 116mA Max
32V	77mA Typical / 87mA Max

CAUTION: Do not exceed 36VDC peak to avoid damage to the unit. Terminal voltage at or above 12V minimum must be maintained to the unit during operation.
Power Supply Effect: Less than ±0.001% of output span effect per volt DC change.

USB Interface

Unit includes a USB socket for temporary connection to a PC or laptop for the purpose of setup, reconfiguration, and trouble-shooting. USB isolation is recommended when connecting to a unit that may also be connected to grounded I/O signals. The unit does not receive power from USB and must already have DC power connected to it when connecting to USB.
CAUTION: Do not attempt to connect USB in a hazardous environment. Module should be setup and configured in a safe environment only.
Data Rate: USB 2.0 compatible, up to full-speed at 12Mbps.
Transient Protection: Unit adds transient voltage protection to USB power and data lines when connected, but the unit does not use USB power.

USB Interface…

Cable Length/Connection Distance: 5.0 meters maximum.
Driver: No special drivers required. Uses the built-in USB Human Interface Device (HID) drivers of the Windows Operating System (Windows XP or later versions only).
USB Connector: 5-pin, Mini USB B-type socket, Hirose UX60-MB-5S8.

PIN	DEFINITION
1	+5V Power (Transient protected, but not used by this model)
2	Differential Data (+)
3	Differential Data (-)
4	NC – Not Connected
5[1]	Power Ground (Connects to Signal Ground via ferrite bead)
SHLD[1]	Signal Ground (Connects directly to Signal Ground)

[1]**Note:** Most Host Personal Computers (except battery powered laptops) will connect earth ground to the USB shield and signal ground.
Transient Protection: Unit adds transient voltage protection to USB power and data lines when connected, but the unit does not use USB power.
USB Cable Length/Connection Distance: 5.0 meters maximum.

IMPORTANT – USB Isolation is recommended: The inputs of these modules are isolated from each network port and DC power, but the input ground is also common to its USB connection. Most Personal computers (except DC powered laptops) connect their USB signal and shield ground to earth ground. Without a USB isolator, an earth grounded USB connection could drive a ground loop with any earth ground also applied at its input, which might interfere with operation. For this reason, we recommend that you always use a USB isolator when making a USB connection to prevent a potential ground loop from affecting performance. Otherwise, in the absence of USB isolation, a battery powered laptop could be used to connect to the unit, as the laptop does not normally connect to earth ground.

Ethernet Interface

Connector: Dual, shielded RJ-45 sockets, 8-pin, 10BaseT/100BaseTX. The metal shield circuit of the network connectors is isolated and capacitive-coupled to the input power minus terminal via an isolation capacitor.
Network-to-Network Isolation: Network ports are additionally isolated from each other and will withstand a 1000VAC dielectric strength test for 1 minute without breakdown.
Wiring: Unit includes auto-crossover for MDI or MDI-X cables.
Protocol: Ethernet/IP™ w/USB reconfiguration.
IP Address: Default mode static IP address is 192.168.1.100.
Data Rate: Auto-sensed, 10Mbps or 100Mbps.
Duplex: Auto-negotiated, Full or Half Duplex.
Compliance: IEEE 802.3, 802.3u, 802.3x.
Ethernet/IP™ Protocol Support: Up to 10 connected message sessions, plus unconnected messaging. The unit includes a built-in web page for ID on the network using a standard web-browser, but configuration of the unit is only possible using configuration software running on a Windows PC and connected via USB.

Ethernet Interface…

Communication Distance: The distance between two devices on an Ethernet network is generally limited to 100 meters using recommended copper cable. Distances may be extended using hubs, switches, or fiber optic transmission. However, the total round trip delay time must not exceed 512 bit times for Ethernet collision detection to work properly.
Port Status Indicator: Yellow LED of the network connector indicates network activity--Ethernet connection is busy and traffic is present.
Address: The module IP address can be preset (static) by the user via USB. At startup, it can be loaded from internal non-volatile memory, or it can be automatically acquired via a network server using DHCP (Dynamic Host Configuration Protocol).

Before you can communicate with any module over Ethernet, you must set your network interface to a valid IP address in the address domain of the module. Refer to Acromag Application Note 8500-734 for example instructions on how to change the IP address of your PC network interface card in order to talk to an Acromag module.

Enclosure & Physical

General purpose plastic enclosure for mounting on 35mm "T-type" DIN rail.
Dimensions: Width = 22.5mm (0.9 inches), Length = 114.5mm (4.51 inches), Depth = 99.0mm (3.90 inches). Refer to Mechanical Dimensions drawing.
I/O Connectors: Removable plug-in type terminal blocks rated for 12A/250V; AWG #26-12, stranded or solid copper wire.
Program Connector: 5-pin, Mini USB B-type socket, Hirose UX60-MB-5S8.
Case Material: Self-extinguishing polyamide, UL94 V-0 rated, color light gray. General purpose NEMA Type 1 enclosure.
Circuit Board: Military grade fire-retardant epoxy glass per IPC-4101/98.
DIN-Rail Mounting: Unit is normally mounted to 35x15mm, T-type DIN rails. Refer to the DIN Rail Mounting & Removal section for more details.
Shipping Weight: 0.5 pounds (0.22 Kg) packed.
IMPORTANT: For ambient operation above 55°C, space units apart to aide cooling. Module is intended to be mounted upright on a horizontal DIN rail, allowing cool air to enter in through the bottom vents and warm air to exhaust out the top vents. Above 55°C, a space of at least 20mm between modules is recommended to aide cooling in this manner.

Environmental

These limits represent the minimum requirements of the applicable standard, but this product has typically been tested to comply with higher standards in some cases.
Operating Temperature: -40°C to +70°C (-40°F to +158°F).
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95%, non-condensing.
Isolation: Input channels and USB (as a group), network (two ports), and power circuits are all isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). This complies with test requirements of ANSI/ISA-82.01-1988 for voltage rating specified. The network ports will withstand a 1000VAC dielectric strength test port-to-port for one minute without breakdown.
Installation Category: Suitable for installation in a Pollution Degree 2 environment with an Installation Category (Over-voltage Category) II rating per IEC 1010-1 (1990).

Environmental…

Shock & Vibration Immunity: Conforms to: IEC 60068-2-6: 10-500 Hz, 4G, 2 Hours/axis, for sinusoidal vibration; IEC 60068-2-64: 10-500 Hz, 4G-rms, 2 Hours/axis , for random vibration, and IEC 60068-2-27: 25G, 11ms half-sine, 18 shocks at 6 orientations, for mechanical shock.

Electromagnetic Compatibility (EMC)

Minimum Immunity per BS EN 61000-6-2:

1) Electrostatic Discharge Immunity (ESD), per IEC 61000-4-2.
2) Radiated Field Immunity (RFI), per IEC 61000-4-4.
3) Electrical Fast Transient Immunity (EFT), per IEC 61000-4-4.
4) Surge Immunity, per IEC 61000-4-5.
5) Conducted RF Immunity (CRFI), per IEC 61000-4-6.

This is a Class A Product with Emissions per BS EN 61000-6-4:

1) Enclosure Port, per CISPR 16.
2) Low Voltage AC Mains Port, per CISPR 16.
3) Telecom / Network Port, per CISPR 22.

WARNING: This is a Class A product. In a domestic environment, this product may cause radio interference in which the user may be required to take adequate measures. Refer to the EMI Filter Installation drawing in the Electrical Connections section of this manual to install ferrite cable clamps that help to reduce radiated emissions. The use of low EMI double-shielded Ethernet cable is also helpful in curbing emissions.

Agency Approvals

Electromagnetic Compatibility (EMC): CE marked, per EMC Directive 2004/108/EC. Consult Factory.

Safety Approvals: UL Listed (USA & Canada). Hazardous Locations – Class I, Division 2, Groups A, B, C, D Hazardous Location or Nonhazardous Locations only. These devices are open-type devices that are to be installed in an enclosure suitable for the environment. Consult Factory.

ATEX Certified: Model XT1212/22-000 is ATEX Certified for Explosive Atmospheres per ATEX Directive 94/9/EC which complies with standards BS EN 60079-0:2012 & BS EN 60079-15:2010.

Ex II 3 G Ex nA IIC T4 Gc -40°C ≤ Ta ≤ +70°C

DEMKO 15 ATEX 1561X

X = Special Conditions

1) The equipment shall only be used in an area of not more than pollution degree 2, as defined in EN 60664-1.
2) The equipment shall be installed in an enclosure that provides a degree of protection not less than IP 54 and only accessible with the use of a tool in accordance with EN 60079-15.
3) Transient protection shall be provided that is set at a level not exceeding 140 % of the peak rated voltage value at the supply terminals to the equipment.

Reliability Prediction

Reliability Prediction
MTBF (Mean Time Between Failure): MTBF in hours using MIL-HDBK-217F, FN2. *Per MIL-HDBK-217, Ground Benign, Controlled,* $G_B G_C$

XT1212-000	MTBF (Hours)	MTBF (Years)	Failure Rate (FIT)
25°C	478,854 hrs	54.7 years	2,088
40°C	359,078 hrs	41.0 years	2,785
XT1222-000	**MTBF (Hours)**	**MTBF (Years)**	**Failure Rate (FIT)**
25°C	486,024 hrs	55.5 years	2,058
40°C	365,543 hrs	41.7 years	2,736

Configuration Controls

Software Configuration Only via USB
Although this module normally operates using Ethernet/IP™ over Ethernet, it can only be setup, calibrated, and configured via USB. This is convenient since you do not have to already know its IP address setting, or set your IP address to a compatible domain address, in order to talk to it. Its behavior as an 8 channel analog input module is determined via program registers set using a temporary USB connection to a host computer or laptop running a Windows-compatible configuration software program specific to the model. This software provides the framework for digital control of all configuration & calibration parameters, and this information is stored in non-volatile memory.

LED Indicators:
RUN (Green) – Located at front panel. Constant ON if power is on and unit is OK. Flashes ON/OFF during initialization, or if flashing continuously, it may indicate a firmware issue.
ST (Yellow) – Located at front panel. Turns ON if any input signal is over/under range.
ACT (Yellow) – Located on the RJ45 port connector itself. Indicates Ethernet activity--the Ethernet connection is busy and traffic is present.

Refer to Configuration Step-by-Step in the Technical Reference section of this manual for detailed information on available software control of this model.

REVISION HISTORY

The following table shows the revision history for this document:

Release Date	Version	EGR/DOC	Description of Revision
22-JAN-14	A	BC/KLK	Initial Acromag release.
05-AUG-14	B	BC/AP	Updated Release, remove i2o logos (Modbus only), added module spacing recommendations.
10-SEP-14	C	CAP/ARP	Added UL Mark (removed pending) per ECO #14H030.
13-OCT-14	D	BC/ARP	Added MTBF Data.
26 JUN 15	E	RH/ARP	Updated Input Update/Conversion Rate.
15-OCT-2015	F	CAP/ARP	Added ATEX symbols / statements.
19-AUG-2016	G	CAP/MJO	Corrected “Circuit Board” specification.
13 NOV 2017	H	FJM/ARP	Reference Configuration Software without the revision.

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