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

Model XT1542-000
Combination Analog Voltage Output and Digital I/O
(8 DC Voltage Output Channels and 4 Digital I/O Channels w/ Active-High Inputs and Tandem High-Side Switched Outputs)

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 XT1542-000 is a Ethernet/IP network module for interface and control of up to eight channels of DC Output Voltage and four channels of sourcing digital I/O. It provides output isolation from the network and power and is 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.**
- **Combination of Octal DC Voltage Outputs (±10V, ±5V) and Quad Sourcing Digital I/O.**
- **Ethernet/IP Protocol Support.**
- **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 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 Connection.**
- **High 1500VAC Isolation between output channels (combined as a group), the network, and power.**
- **Outputs & Digital I/O, 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 +65°C.**
- **Thoroughly Tested and Hardened For Harsh Environments.**
- **Withstands High Shock (25G) and Vibration (4G).**
- **Model XT-1542-000 is ATEX Certified for Explosive Atmospheres.**
  Ⓔx II 3 G Ex nA IIC T4 Gc -40°C ≤ Ta ≤ +65°C
  DEMKO 15 ATEX 1561X

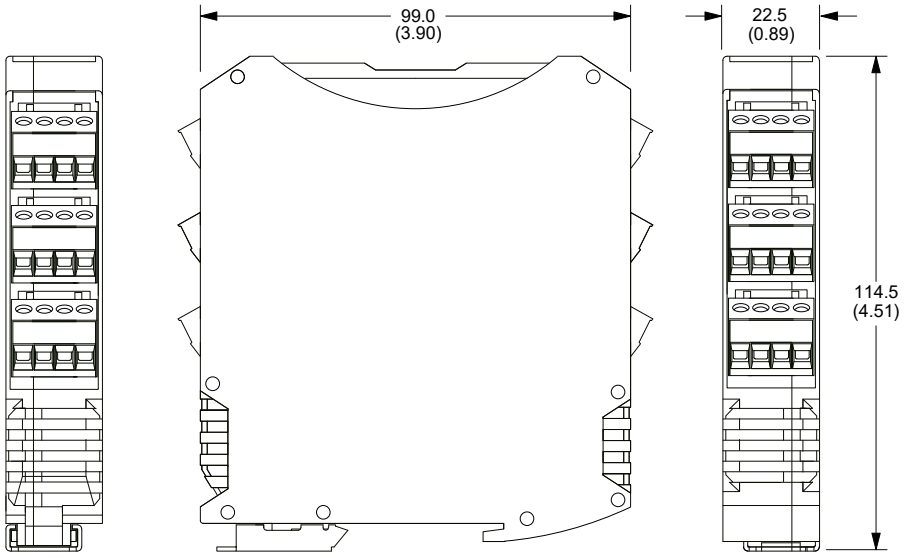
Application

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, expanding modularly with a shared power connection along the DIN rail. This model provides 8 channels of DC Voltage Output and 4 channels of sourcing digital output with tandem active-high digital inputs, all monitored and controlled 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

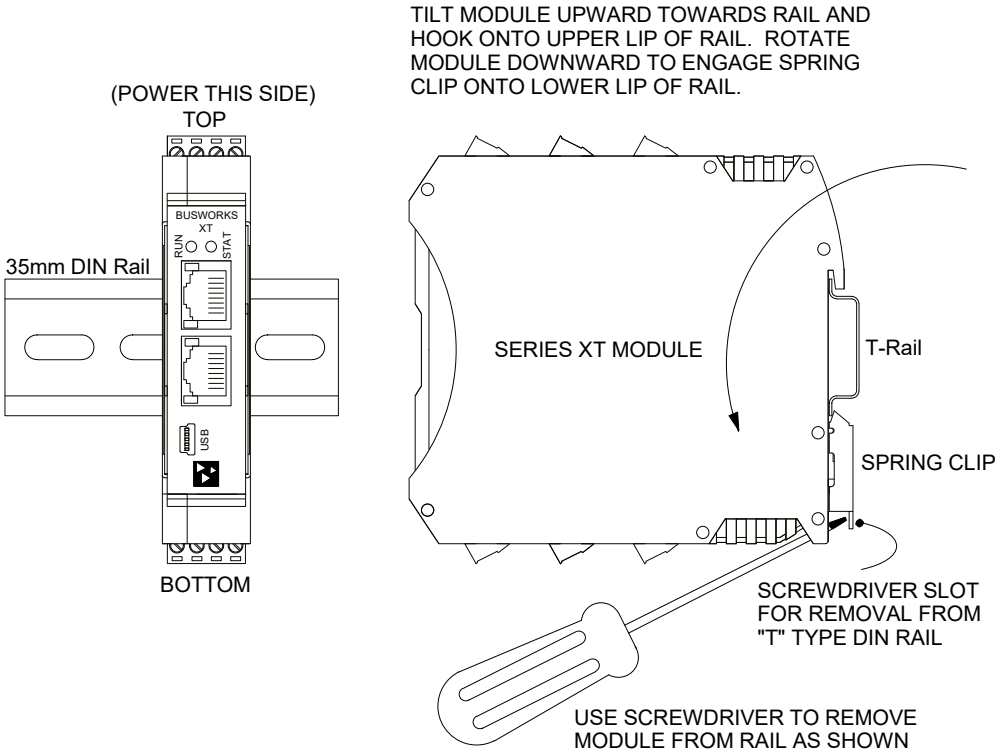
Refer to the following figure for attaching and removing a unit from the DIN rail. A spring loaded DIN clip is located on the bottom side. The opposite rounded edge at the bottom of the top side allows you to tilt the unit upward to lift it from the rail while prying the spring clip back with a screwdriver.

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.

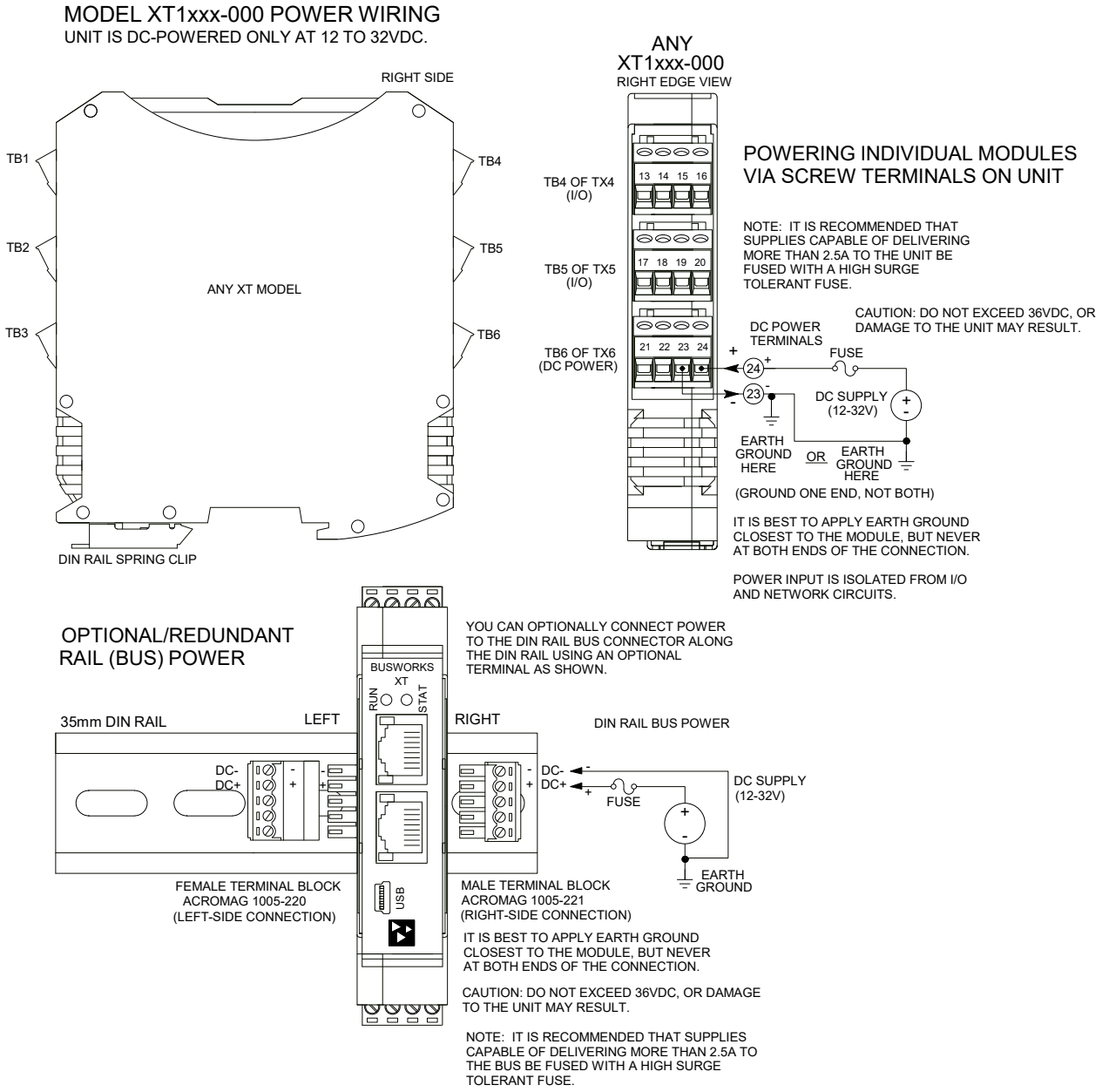
WARNING – EXPLOSION HAZARD – Substitution of any components may impair suitability for Class I, Division 2.

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. Output wiring may be shielded or unshielded type, but twisted-pair, or shielded twisted-pair, 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, output & excitation wires are normally separated from power and network wiring for safety and isolation, as well as for low noise.

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. Be sure to connect earth ground to the DC- terminal, ideally closest to the module, as the other isolated circuits shunt their circuit commons to DC- via high-voltage isolation capacitors. For Excitation connection to power (see Output Connections).

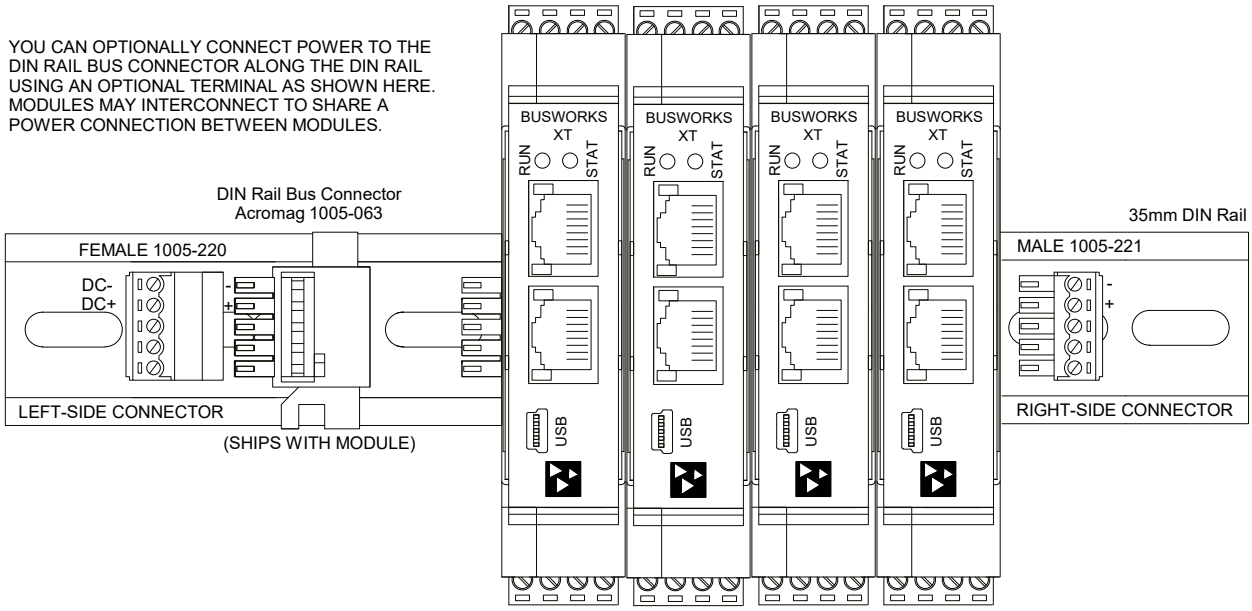


Power Connections…

Note that you can use the bus power connector of the module to interconnect modules to unit power 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. Analog & digital output excitation cannot be connected along the bus of this model.

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).

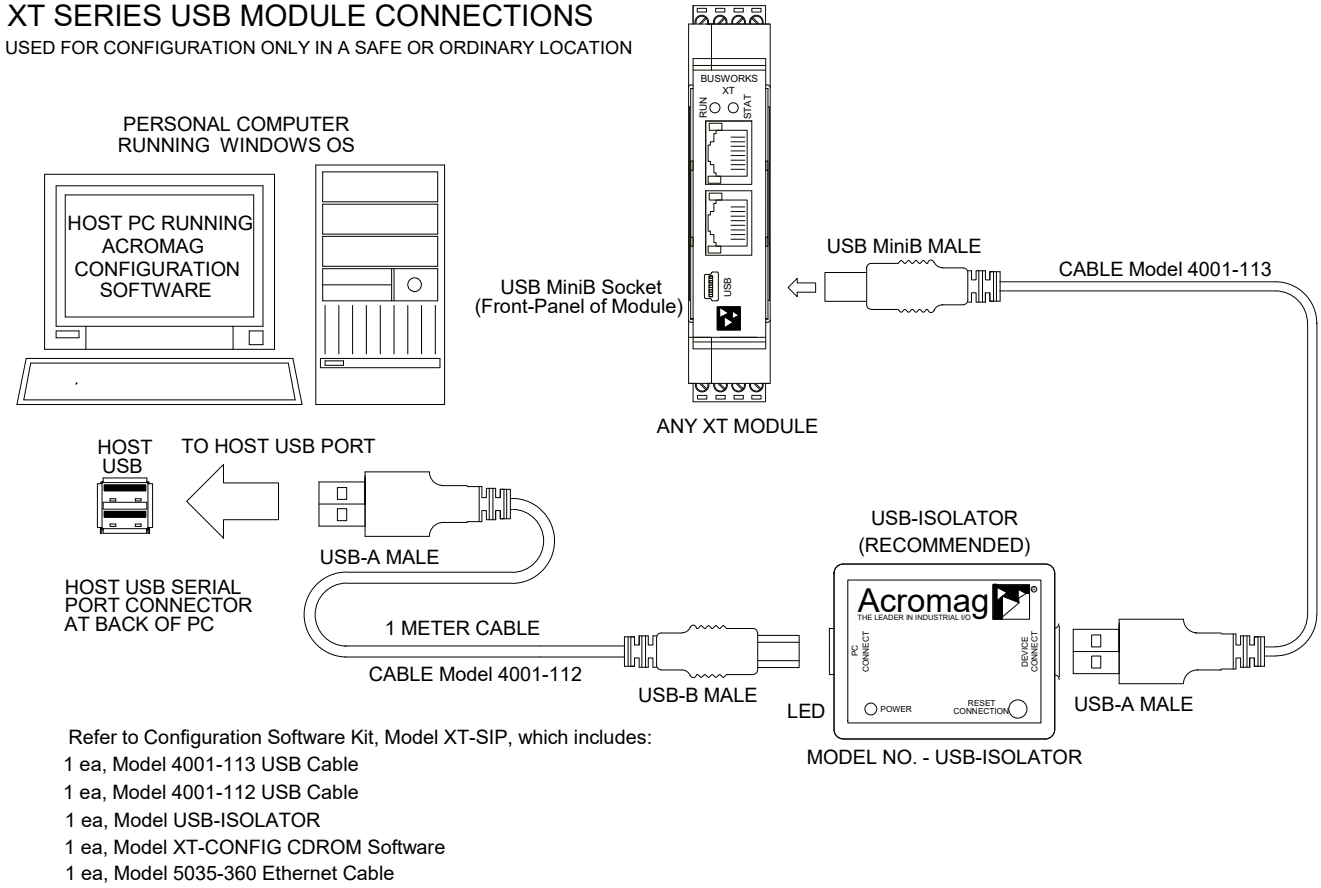
XT MODEL OPTIONAL BUS POWER WIRING



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.

- **Reconfiguration Does Not Require a Network Connection, as the module uses a USB connection to configure the unit**.
- **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). USB isolation is required to break the inadvertent ground loop between the output circuits and earth ground at your PC.
- **Connect Unit to Power Before USB**. This unit does not use USB power, but requires separate connection to DC power.



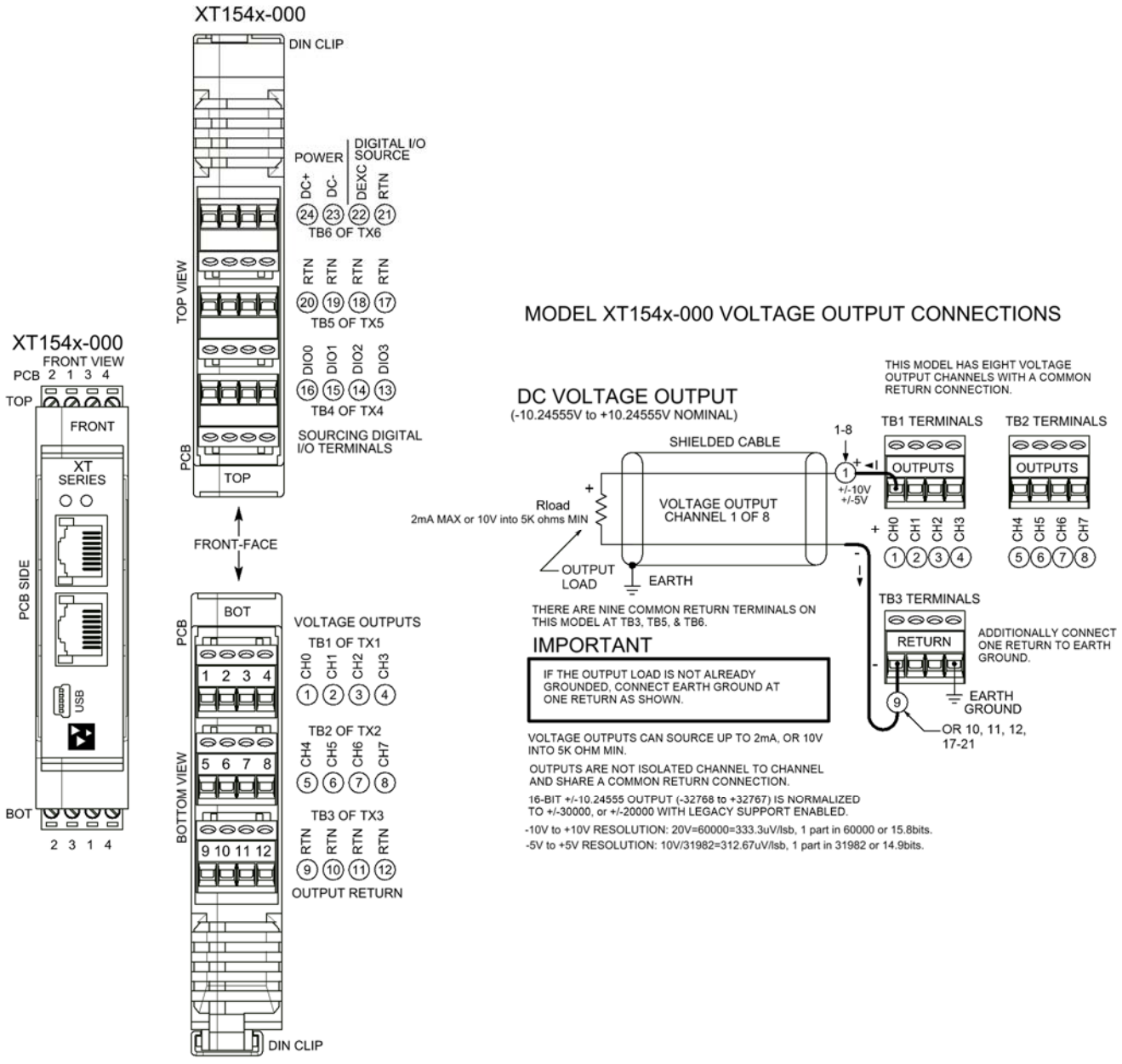
Refer to Configuration Software Kit, Model XT-SIP, which includes:
1 ea, Model 4001-113 USB Cable
1 ea, Model 4001-112 USB Cable
1 ea, Model USB-ISOLATOR
1 ea, Model XT-CONFIG CDROM Software
1 ea, Model 5035-360 Ethernet Cable

Output Connections

This model combines eight analog voltage outputs with four channels of sourcing digital outputs. The Sourcing digital outputs require additional excitation (a separate connection to power). Observe proper polarity when making digital output excitation connections. Refer to the following figures to wire the voltage outputs, digital outputs, and digital output excitation of this model.

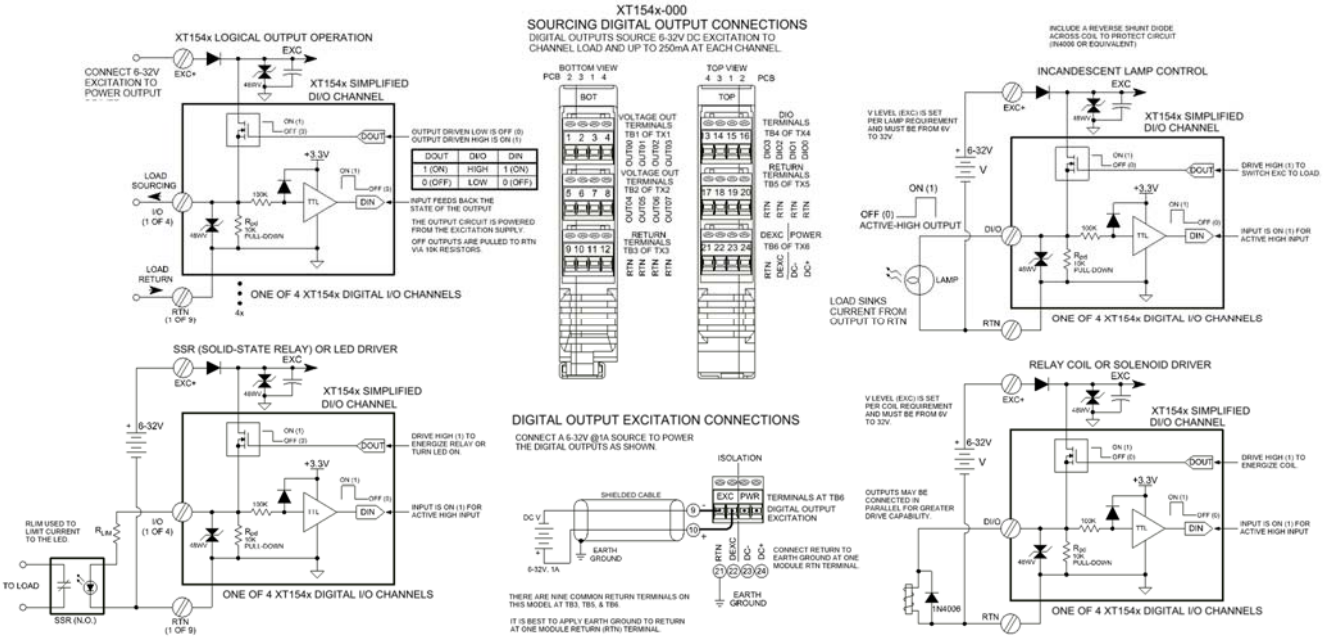
Voltage Output Connections

The **XT1542** model can drive up to **8 DC Voltage Outputs at up to 2mA each** (±5V & ±10V ranges are supported). A 16-bit voltage DAC drives a buffer amplifier at each output channel and sources DC current through the load to output return (RTN). Outputs share a common return connection and are not isolated channel-to-channel. Refer to the following figures for example DC Voltage Output connections from this model.



Digital Output Connections (Requires Additional Excitation at TB6)

The four digital outputs of this model are open-source, high-side switches, inserted between digital excitation and the load, and include 10K pull-downs to Return (RTN). Outputs will source excitation to loads at up to 32V and 250mA each. You must separately connect Excitation to operate the digital outputs. Observe proper polarity when making I/O connections. Refer to the following figures to wire the digital outputs of this model.



NOTE: You must connect digital EXC to a voltage source from 6 to 32VDC in order to operate the digital outputs, as the sourcing digital output driver is also powered from the excitation supply.

IMPORTANT – Add Protection with Inductive Loads: Outputs do include internal reverse-bias shunt diodes to help protect the output switch from damage due to high reverse-bias voltages generated when switching inductive loads. But you should still add external protection near the inductive load to prevent these transients from being sent along the connection wires. Place a diode (1N4006 or equivalent) across an inductive load with the cathode to (+) and the anode to (-).

For greater drive capability or for switching AC loads, it is common to use an appropriately rated interposing relay. Add protection local to the relay as noted above when driving inductive relay coils.

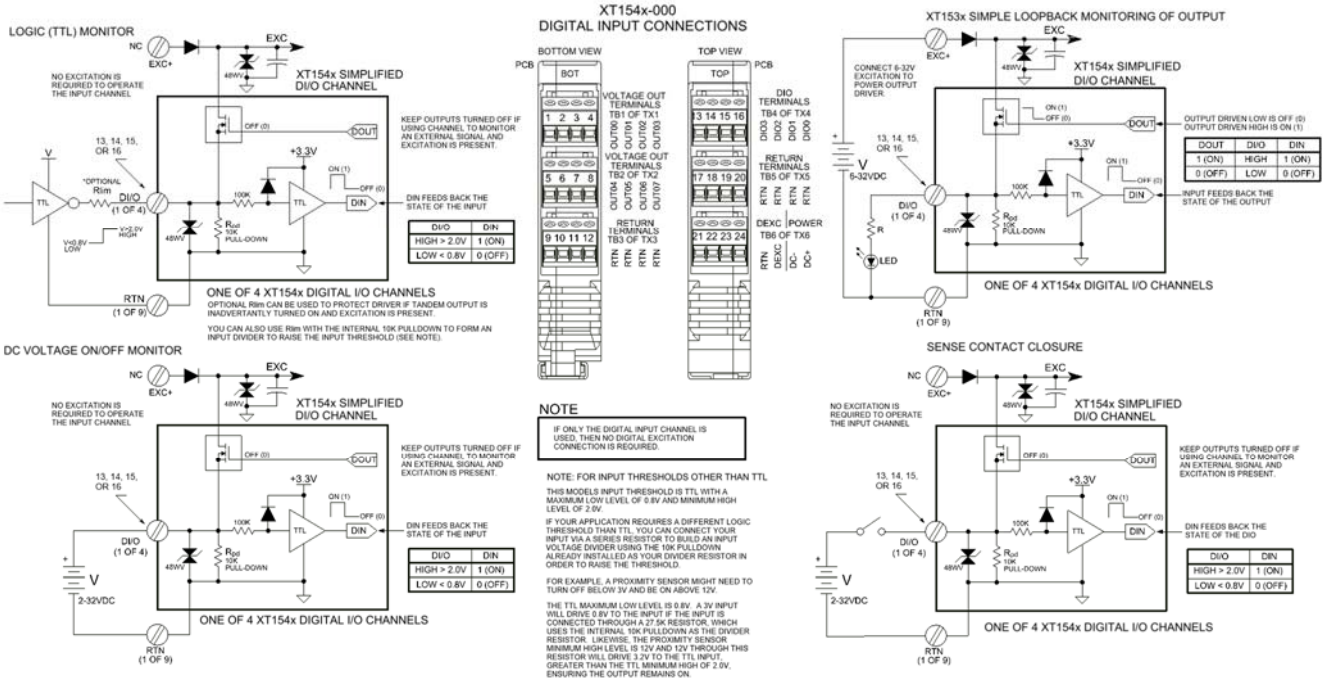
Per UL, when the outputs are used to drive interposing relays for switching AC or DC devices of higher voltage/current, the coil ratings for the interposing relay shall not exceed 24VDC, 100mA.

Digital Input Connections

(Digital Inputs Do Not Require Additional Excitation)

Digital inputs of this model accept voltage signals up to 32V, are active-high, and use TTL thresholds for logic transfer. The digital inputs of this model are connected in tandem with digital outputs and are already wired to accomplish loopback monitoring of their open-source, high-side switched output, but may alternately be used to monitor input levels from the field when their corresponding outputs are switched OFF. Digital inputs are additionally pulled down to Return via a 10K pull-down resistor installed on the board and will never float. Observe proper polarity when making I/O connections. Refer to the following figures to wire the digital inputs of this model.

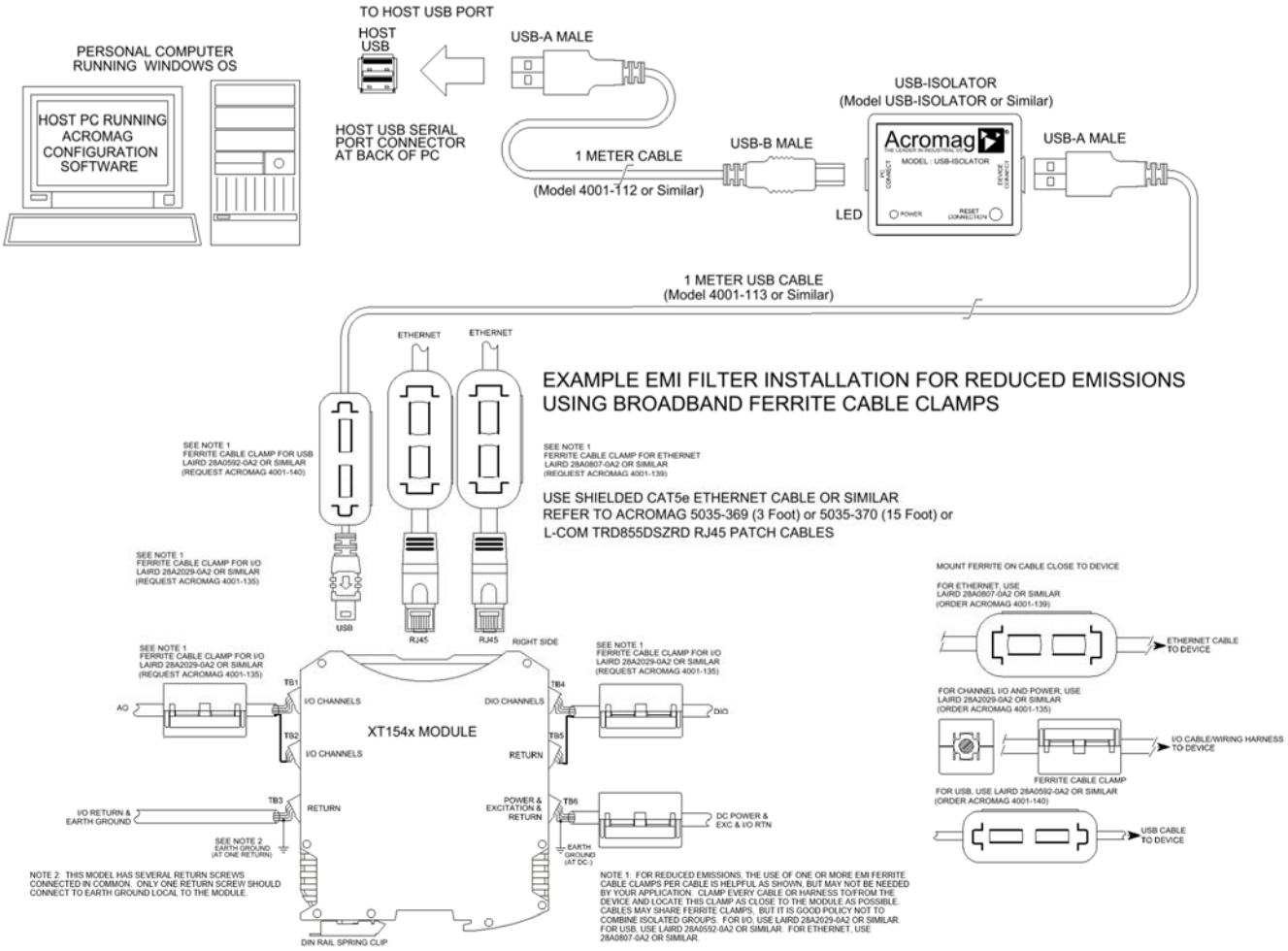
IMPORTANT: You must keep the tandem output turned off when using the input to sense voltage levels from the field to prevent contention between the field signal and the output channel, which may be turned ON. If you inadvertently cause contention, it can trigger the output's protection mechanism to shut it down. In this instance, you would have to cycle excitation OFF/ON to restore operation of the digital output.



NOTE: You do not need to connect digital excitation if you are only using the digital input channel to monitor a field input (tandem output is OFF). Digital excitation is only required to operate the sourcing digital output channels.

EMI Filter Installation

For low CE-rated radiated emissions, the use of one or two 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. These are also helpful for cables connected to Host USB and Ethernet as well. Use Laird 28A2029-0A2 or similar for inputs/outputs and Power (order Acromag 4001-135), Laird 28A0592-0A2 or similar for USB cable (Acromag 4001-140), and Laird 28A0807592-0A2 or similar for Ethernet cable (Acromag 4001-139). Locate ferrites by clamping them outside of all I/O cables or wiring harnesses to/from the module (USB, Ethernet, input/output 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, but rather separate isolated circuits for safety and greater noise immunity.



Earth Ground Connections

(To Protect Your Equipment, Lower System Noise, and Reduce Emissions)

The unit housing is plastic and does not require an earth ground connection itself. 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 outputs/excitation, 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 output, power, and network ground connections.

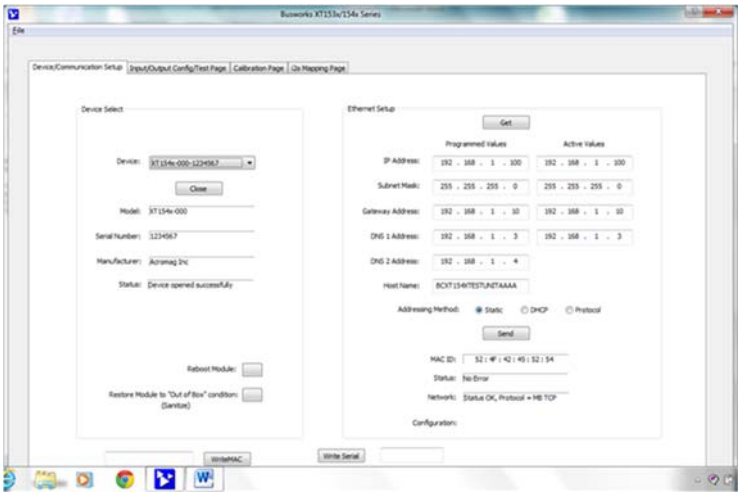
Note: A USB isolator is recommended when connected to a grounded Personal Computer for configuration purposes. This will avoid a inadvertent ground loop that will occur if your input signal is already earth grounded, as a PC commonly earth grounds its USB port and this makes contact with both the USB 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 I/O 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 it from the web will help to ensure that your 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 five other combinational model variations—three models with 8 voltage outputs, plus three models with 4 current outputs, each including 4 sourcing digital I/O channels.

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 an Ethernet network. Once you Select a device and click **"Open"** to connect to an XT1542-000, 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)

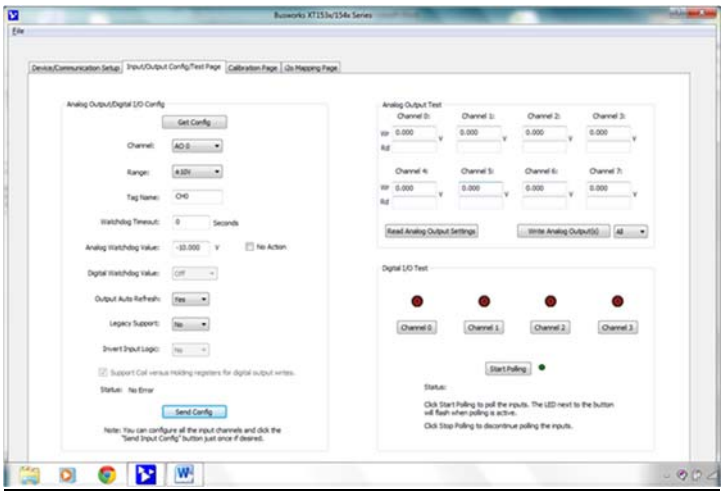
- Retrieve a connected module's current network configuration with [Get].
- Set the Network IP address required for Ethernet communication on your network.
- Set the subnet mask, gateway, and/or domain name server addresses for your network.
- Write your parameters to the connected unit with [Send] and 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…

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.



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.

For a more detailed configuration procedure, see the Configuration Step-by-Step section of Technical Reference on page 18 of this manual.

I/O Configure (Configure I/O Channels Here)

- Use **[Get Config]** to retrieve the connected module's I/O configuration.
- Select the specific channel to configure.
- Set the range for the selected analog output channel.
- Optionally apply a Tag Name to the channel for reference over USB (up to 8 characters).
- Configure a watchdog timer for the output channel and a Timeout value or state. Setup auto-refresh for the outputs to combat digital upset or force a restart following thermal shutdown (digital outputs). You can even choose to invert the logic for the tandem digital input channel.
- Choose Legacy Support="Yes" if you want the output to be scaled from ±20000 for ±100%, versus ±30000 for ±100%.
- Optionally invert the Input Logic of digital input channels.
- Support Coil Register versus Holding Register for digital output writes: This is a Modbus TCP/IP option and has no effect for Ethernet/IP and Profinet models.
- Read the status of your configuration message over USB in the Status field.
- Use **[Send Config]** to send your configuration to the connected unit and read message Status. You only need to click [Send…] one time after setting up each channel, and all channels will be written at once.

Analog Output & Digital Output Test

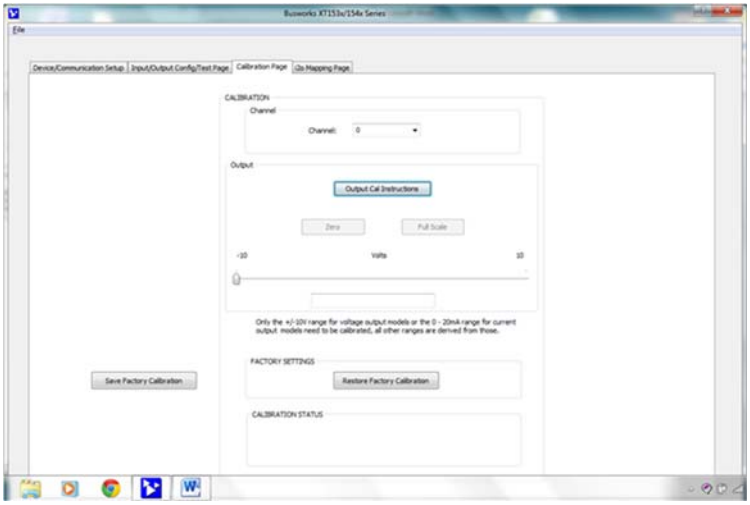
After making I/O configuration changes, you can use the I/O Test controls to verify operation of your I/O.

- Read the current analog output settings by clicking [Read Analog Output Settings].
- Set the output level of analog output channels by entering field values and clicking [Write Analog Outputs].
- Turn digital outputs On/Off with [Channel…].
- Use [Start/Stop Polling] to poll digital inputs.
- Display the current state of the inputs with simulated LED's and "1" or "0" superimposed on the lamps for ON or OFF.

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 Output Calibration 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 18 of this manual.

Calibration Page (Calibrate Your Outputs Here)

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

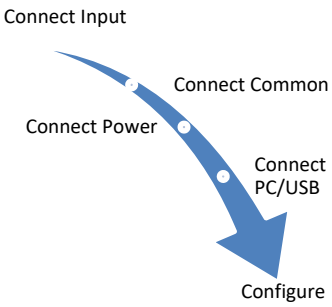
- Click the **[Output Cal Instructions]** button to begin analog output calibration and follow the on-screen prompts to calibrate output Zero and Full-scale of the output channel.
- Use **[Zero]** and **[Full Scale]** and measure the output range zero or full-scale signal and enter the measured value here.

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 Outputs:** Refer to Output Connections at the front of this manual and connect your output(s) as required for your application. Outputs of this model share a common return (RTN) connection. Be sure to additionally connect one return (RTN) terminal to earth ground near the module. Earth ground applied to return allows the input filters to shunt potentially harmful transient energy to ground, helping to protect the output circuits from transient damage.

2. **Connect Digital Output Excitation:** The digital outputs of this model require a separate connection to excitation to operate them. Refer to Output Connections at the front of this manual and connect to output excitation as required. If you are only using the digital input channels (outputs OFF), then no connection to excitation is required.

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 XT15XXConfig.exe software to begin configuration and USB control of your unit (software is compatible with XP or later versions of the Windows operating system). Note that the same software is used for six models, Three version of XT154x-000 with 8 voltage outputs and 4 digital I/O channels, plus three versions of XT153x-000 with 4 current outputs and 4 digital I/O channels.

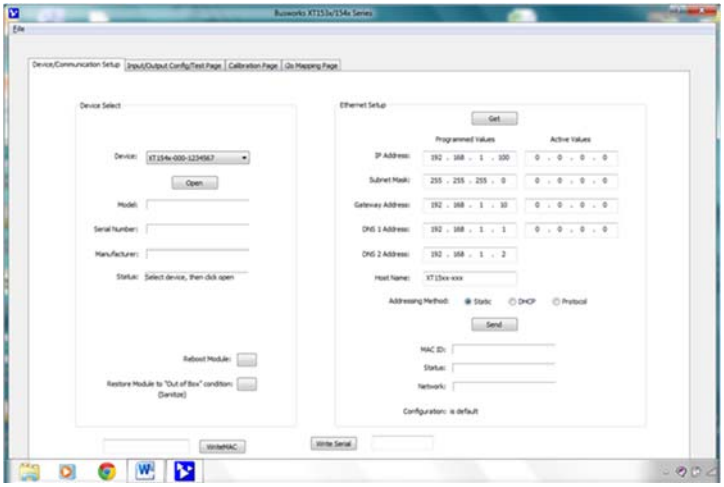
   IMPORTANT: Allow the unit to fully power-up and establish its Ethernet connection before attempting to open USB communications with the unit using the XT15xxconfig.exe software (wait ~30 seconds after powering-it up to give it time to initialize).

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 match the module's subnet address domain in order to talk to it.

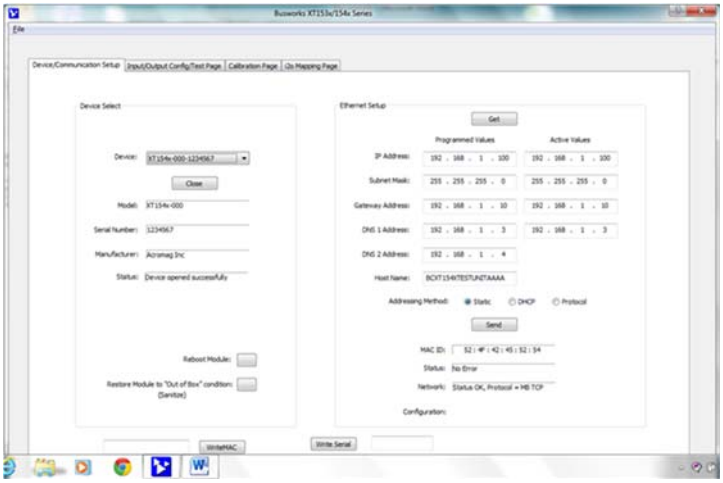
Device/Communication Setup

Note that you should already have power connected to the XT1542 at this point, as this model does not utilize USB power.

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

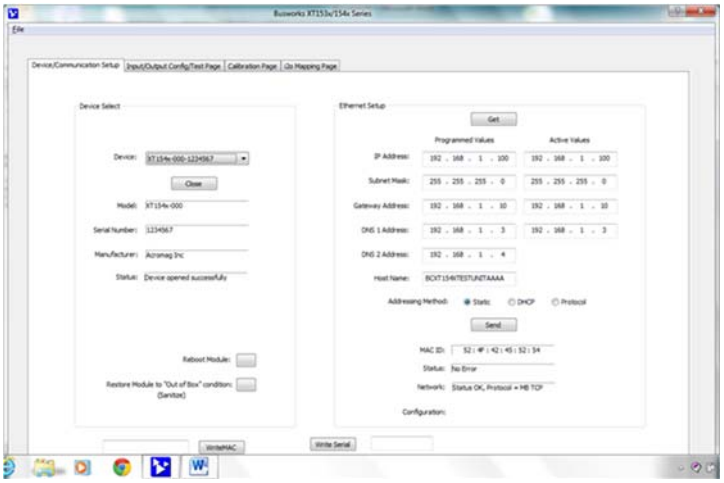
Use the **[Get]** button to retrieve the current Ethernet setup of the connected module (sometimes the Active Values fields will indicate zero's and you must click [Get] to retrieve the actual active values).

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 (however, 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 Ethernet/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.

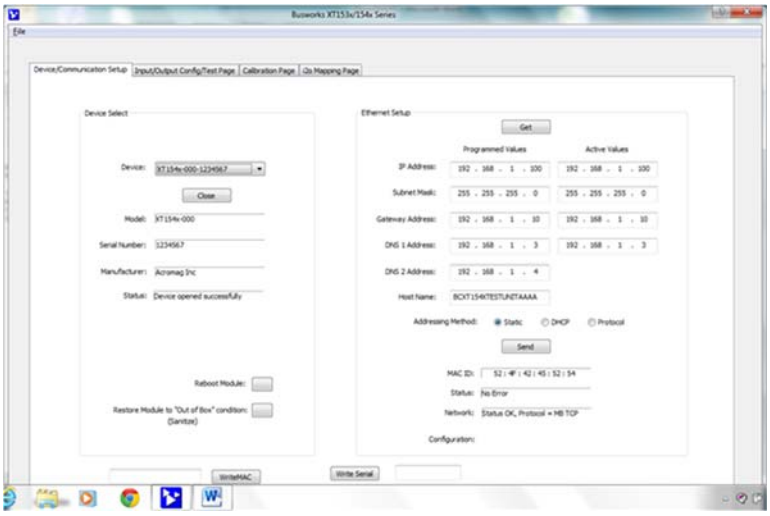
The **Subnet Mask** is used to subdivide the host portion of the IP address into two or more subnets. The subnet mask will flag the bits of the IP address that belong to the network address, and the remaining bits that correspond to the host/node portion of the address. The unique subnet to which an 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 & Profinet models (required), it is not available for Ethernet/IP TCP/IP models. In this 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.

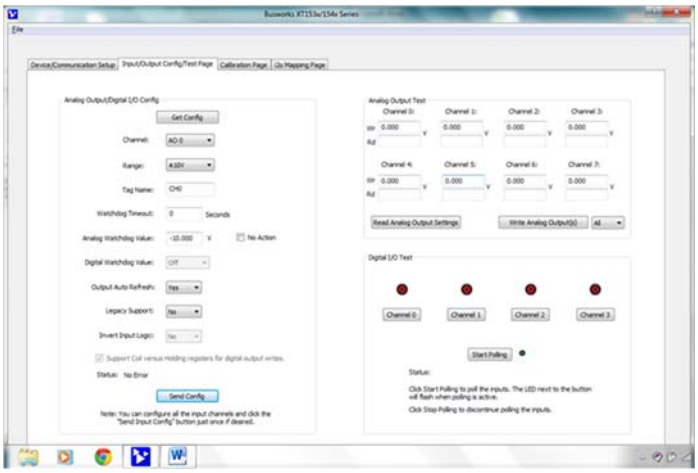
You can click the **[Send]** button to write your Ethernet Setup parameters to the unit once you are done making your selections. This completes any changes made on this page.

The status field will indicate the status of your sent parameters over USB after clicking [Send]. The Network field will indicate 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 Config/Test Page

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:



Input/Output Configure

If you are connected to a module, the initial Input/Output Config/Test Page screen shown at left will display the current I/O configuration of the connected module before making changes.

[Get Config] to Get the Channel 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 **[Get Config]** at the top of the screen to retrieve the connected module's current I/O 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 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 two core models having 4 or 8 analog output channels, plus 4 channels of sourcing digital I/O. You can select the specific channel to address here. You can choose to configure channel's selectively, then click **[Send Config]** to write the channel configuration to the unit, or more simply make changes to many channels and then click **[Send Config]** one time to write all the channel configurations to the unit.

Select the Range: Use the "Range:" field to select your output range (analog channels only). For the XT1542-000 model, you can select a DC Voltage Output range of ±10V or ±5V for each of four analog output channels.

Set a Tag Name (Optional, up to 8 Characters): You can give each 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 channel function or application over USB.

[Get Config] Button: Click this button to retrieve the entire I/O configuration of the module.

Channel: Use the channel scroll bar to select the DIO channel you wish to configure. This model has 4 discrete DIO channels and you can configure each individually.

Watchdog Timeout: Specify a time from 1 to 65534 seconds. A time of 0 or 65535 will disable the channel's watchdog timer. If no channel read or write activity occurs during this period, a watchdog timeout will be triggered and the channel will be written to the watchdog state (On or Off) you specify in the next field.

Watchdog State: This is the state that you want the output to go to following a watchdog timeout (see above).

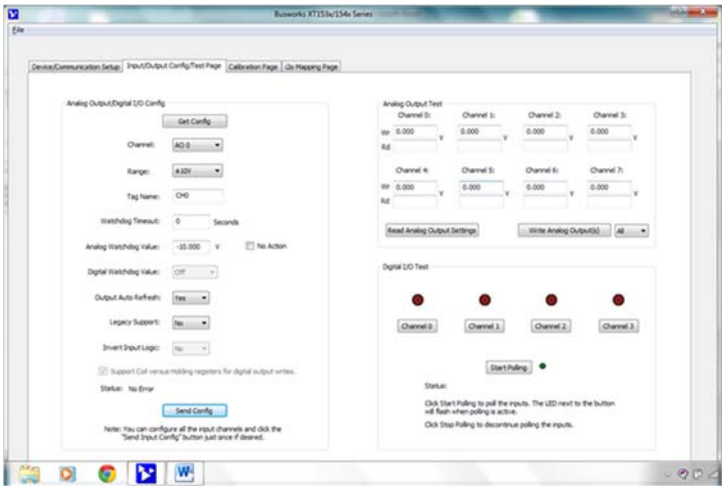
Output Auto-Refresh: You can specify that outputs should be rewritten periodically to ensure they maintain their programmed state following a digital upset, perhaps by some extraordinary transient event. This is also useful to reset an output that may be in a latched thermal shutdown following overload conditions.

I/O Config/Test…

Input/Output Configure…

Invert Input Logic: Note that this model has active-high inputs, but you can choose to apply an inverter to your input channel by selecting "Yes" here. This only applies to input logic of this model, not its output control logic, as setting an output to "1" always turns it ON for this model regardless of this option setting.
Support Coil Versus Holding Registers for Digital Output Writes: This is a Modbus TCP/IP option and it has no effect for Ethernet/IP or Profinet models.
Status field: This field displays status messages relative to sending and receiving I/O parameters over USB to the module.
[Send Config] Button: Click this button to send the entire I/O configuration to the device. You can choose to do this one time after you have setup all the I/O channels individually.

Once you have made your configuration selections, click the **[Send Config]** button to write them to the module. You can read the USB Status of your sent configuration message to the unit in the "Status" field just above the [Send Config] 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/Output Test

You can use this screen to test the operation of your analog and digital outputs.

Analog Output Test

There are 8 or 4 analog output fields that allow you to enter or read output values in volts (XT154x) or mA (XT153x).

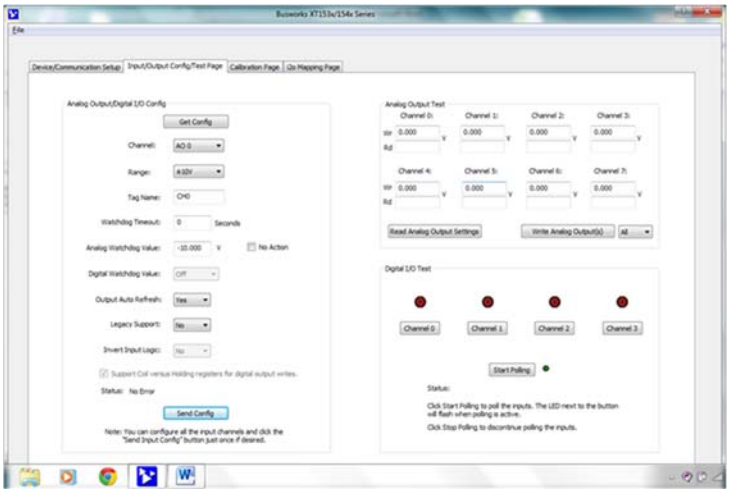
[Read Analog Output]: Click this button to read the current analog output values into the channel fields.
[Write Analog Outputs]: Click this button to write the analog output values that you typed into the channel fields to the output channels.

Digital Input & Output Test

In addition to testing the analog outputs, you can turn digital outputs On/Off by clicking the **[Channel]** toggle button. Optionally, you can click the **[Start Polling]** button to trigger the software to periodically read the digital inputs (it updates about once per second) and display their states via the simulated LED's. Note the simulated lamp next to the **[Start Polling]** button flashes slowly each time it samples the digital input. Click **[Stop Polling]** to stop polling the inputs before moving onto the next page.

[Channel…] Button: Click this button to turn the associated output ON. Note that turning it ON connects the output to the digital excitation source (high-side switch). A "1" is superimposed on the lamp for ON, and "0" for OFF (true regardless of the Invert Input logic Setting).
[Start Polling] Button: This toggles between Start/Stop. Click this button to Start/Stop periodic polling of the input channels. The small green simulated lamp next to this button will flash each time a new sample is taken (channel states are indicated and updated about once per second). Be sure to first stop polling before moving onto another page.
Status: This field displays status messages relative to sending and receiving channel I/O over USB to the module.

I/O Config/Test…



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 digital inputs (updates about once per second) and display their states (0/1) inside their simulated channel LED's. Note the simulated green lamp next to the [Start Polling] 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 digital input channels. The channel states are indicated (via 1/0 and LED color) and updated about once per second. Be sure to first stop polling before moving onto another page.

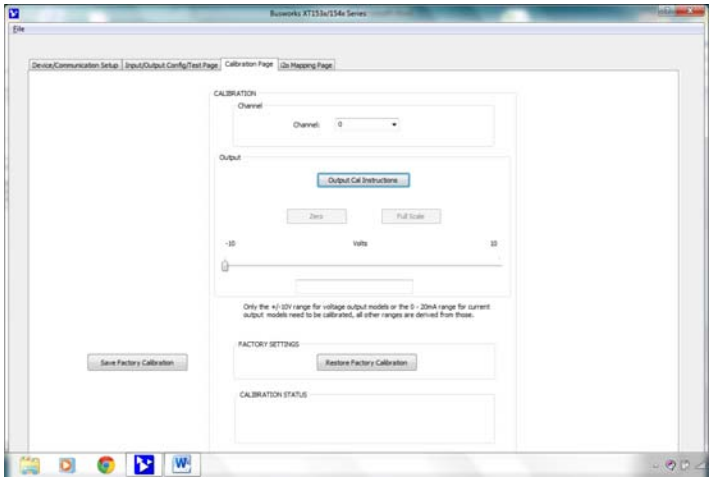
IMPORTANT: If you drive the input high from a field signal and also turn the tandem output ON, this contention will trigger a protection mechanism in the output that will cause it to turn OFF, and you will have to cycle excitation OFF/ON to restore output operation.

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 for field installation, as outputs have already been 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:



*Output Calibration is a simple process initiated by clicking **[Output Cal Instructions]** to begin, then following the prompts. Voltage outputs have a ±10V primary range, and the optional ±5V sub-range is calibrated automatically with ±10V. Before attempting to recalibrate an output, set the ±10V output range from the "I/O Config/Test" page, making sure you write your range selection to the unit by also clicking the **[Send Config]** button of that page.*

CAUTION - Output Calibration: Be sure to accurately set and measure the output zero and full-scale levels during calibration. Setting these endpoints incorrectly will produce output error, as output levels cannot otherwise be validated during calibration.

IMPORTANT: This unit has already had its output channels factory calibrated with a high level of precision. Any attempt to recalibrate the outputs could degrade performance if not done properly, or done using lower grade equipment. Consider your decision to recalibrate the analog outputs carefully.

During output calibration, you must precisely set the zero and full-scale output signals at the selected channel. This is done separately for each output channel. Outputs can be adjusted in 1 lsb increments/decrements using the mouse and slide control, and the right & left arrow keys of your keyboard. Output adjustments operate with a 30 second timer that will return the output to its previous programmed level after 30 seconds of slide or arrow control inactivity. Simply set the output to precisely -10V using a meter to measure the output, click the [zero] button, then [OK] to set the zero endpoint. Repeat this process at +10V using the [full-scale] button.

CAUTION: The controls of this page will temporarily change the output signal level (slide control uses a 30 second timer). Be sure to disconnect any critical control equipment that may be inadvertently affected by varying the output signal.

CALIBRATION – Channel

Use the Calibration Channel scroll field to select the analog output channel to calibrate. This model has eight Voltage Output channels numbered 0 to 7. For best results, load the voltage output channel similar to your final application, in particular for application load resistance levels less than 10K. Connect a precision voltmeter parallel to your load across your output to measure the output voltage precisely.

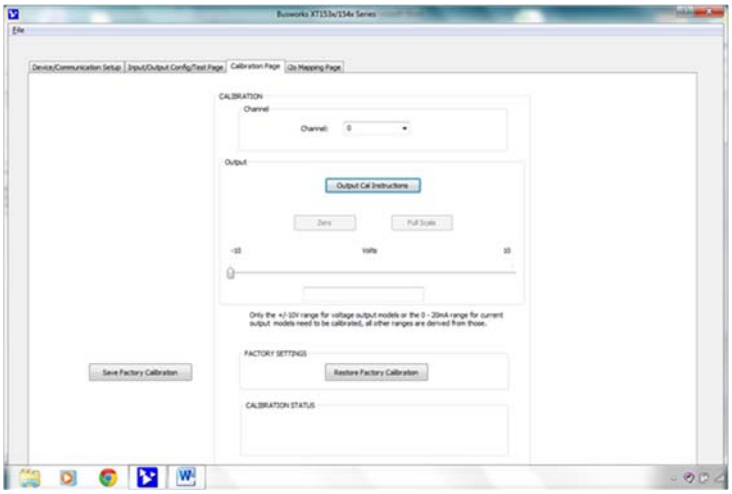
CALIBRATION – Output

Click **[Output Cal Instructions]** to receive calibration instructions and enable the calibration [Zero] & [Full-Scale] buttons.

Use your mouse and the slider control to adjust the output level to precisely -10.000V. You can also use the left and right arrow keys of your keyboard to make fine adjustments in 1 lsb increments. Measure the output voltage to an accuracy of 0.025% or better. Click Output **[Zero]** and then [OK] to set the output zero endpoint and complete zero calibration. The DAC count that produced this value will then be stored and associated with this range level.

Use your mouse and the slider control to adjust the output level to precisely +10.000V. You can also use the left and right arrow keys of your keyboard to make fine adjustments in 1 lsb increments. Measure the output voltage to an accuracy of 0.025% or better. Click Output **[Full-Scale]** and then [OK] to set the output full-scale endpoint and complete full-scale calibration. The DAC count that produced this value will be stored and associated with this range level. The zero and full-scale DAC counts determined here are used to develop a linear relationship between the output voltage and the DAC.

Calibration Page…



Factory Settings

You can use the FACTORY SETTINGS **[Restore Factory Calibration]** button of this page to restore the module's original factory output calibration if you think you made an error and have degraded its performance, or the output 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 calibration over USB. It will display messages like "No Error", "Transfer Error", and "Timeout Error" after clicking [OK] 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.

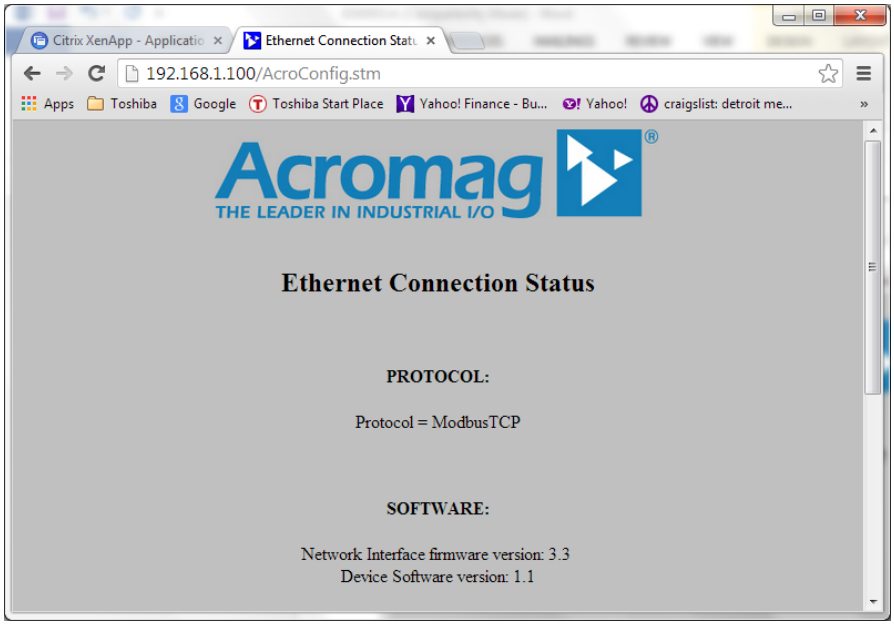
TIP – Calibration TimeSaver: When calibrating output channels, and moving from one channel to the next, you can save lots of time adjusting the outputs of successive channels by simply changing the channel number following your initial zero or full-scale calibration, then clicking on the slide control, which retains its last position. This sends the new output selected to the same place you had adjusted the previous output. You will find that output channel endpoints only differ by a few counts channel-to-channel, and you can simply use the arrow keys to make any fine adjustments as necessary. Calibration of all outputs is further streamlined by doing all output channel zero endpoints first, followed by doing all the channel full-scale endpoints next, each in succession.

Network Home Page

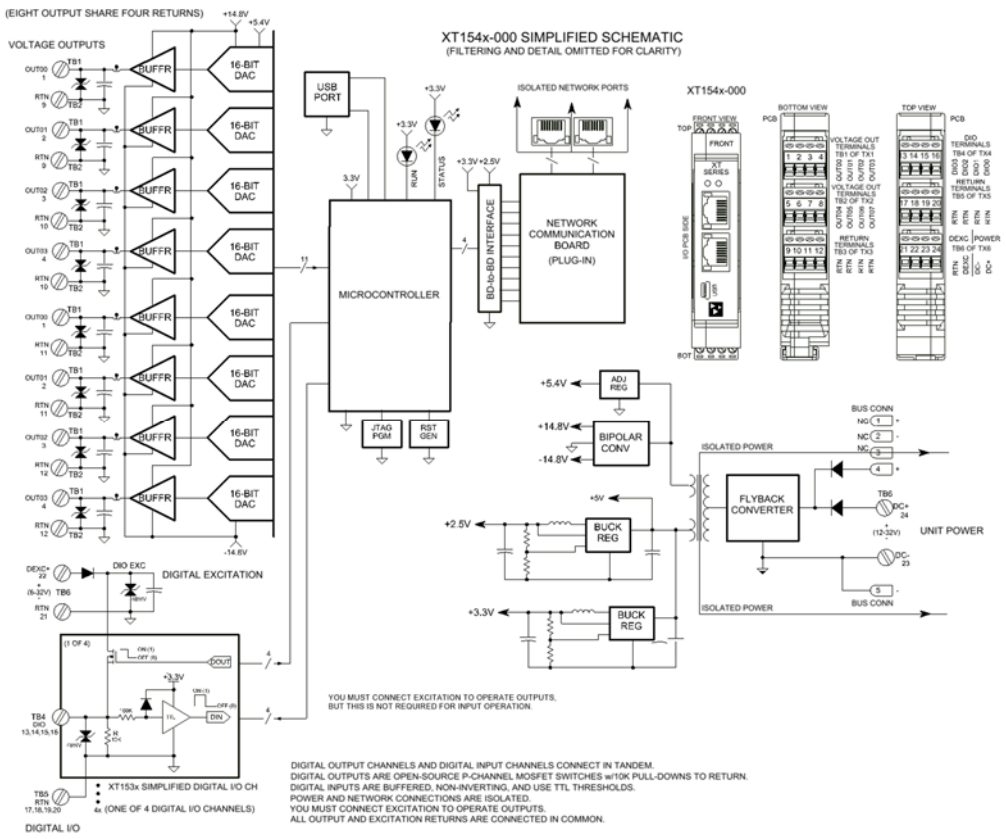
After you have configured your unit for network communication via USB, you can identify the unit on the Ethernet network using a web browser directed to its IP address (you set this address on the Device/Communication Setup page of the USB Configuration Software for the unit, the default IP address is 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.
- You must separately connect excitation to operate digital outputs.
- Outputs & USB are Isolated from the network and power.
- Outputs & Excitation share a common Return.
- Output Return is common to USB return/ground.
- Analog outputs are buffered and driven via 16-bit DAC's.
- Digital Outputs source excitation to the load and are powered from the digital excitation.

This model has eight individual voltage output channels & four digital I/O channels. Outputs are driven through a unity gain buffer from a 16-bit voltage DAC at each output channel. This combinational model includes four smart high-side power switches (open-source P-channel mosfets) that switch (source) excitation to a load under digital control of a 32-bit microcontroller. Each output source is pulled down to return via a 10KΩ resistor, and is fed back to the controller through a 100KΩ series resistor which drives non-inverting input buffers with input diodes clamped to its +3.3V rail, allowing input voltages well above the rail (up to 32V). Digital input channels use TTL logic thresholds and feed back the actual state of the tandem output source, or optionally an input state from the field, with its tandem output turned OFF. Network communication specific to Ethernet/IP is handled by a separate communication controller on a mating board, serial-UART linked to the I/O board. Power for the output 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 USB connection to its I/O board microcontroller from a host PC. The host PC runs model specific configuration software. 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.

How it Works…

The outputs and excitation and USB, the network, and power circuits are isolated from each other. The USB port ground is common to the output circuit return. The USB port ground of most PC's is also common to the USB cable shield and earth ground. I/O could otherwise 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 I/O signal, which could have the negative effect of driving digital upset or noise 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 that follows below form the object model for the XT1532-000 (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	A Double-Word or 32-bit String

Model XT1542-000 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

(04_{HEX} – 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 the digital I/O channels of this model are indicated by a single bit of a 16-bit word for discrete on/off control or indication.

Data values for the analog output channels are indicated by a 16-bit word containing an unsigned-integer that represents the normalized data value for the channel.

The data value for the heartbeat counter uses an unsigned 16-bit integer value with 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[]	2 0	GET
4	Data Size (Tot # of Analog & Digital Input Words)	UINT[]	2	GET
Instance 64H Attributes (Output Instance 1)				
3	Discrete Output Data-array of words Analog Output Data-array of words	UINT[] UNIT[]	1 4	GET/SET
4	Data Size (Tot # of Analog & Digital Output Words)	UINT[]	5	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 CODE	**IMPLEMENTED FOR: CLASS LEVEL**	**INSTANCE LEVEL**	**SERVICE NAME**	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single	
10_{HEX}	No	Yes	Set_Attribute_Single	

When using the Assembly Object for discrete I/O data transfer, the 4 digital channels of this model use the lower 4 bits of a 16-bit data word to denote the state of the channels with the lsb of the data word aligned to the lowest channel number of the group (see below). The upper 12-bits of the discrete data word are not used and can be ignored. Unless otherwise defined for outputs, a 1 bit means the corresponding output is closed or ON, a 0 bit means the output is open or OFF. For tandem inputs of this model, a value of 1 means the input is ON (low < 0.8V), while a value of 0 specifies the input is OFF or in its high state (high > 2.0V). This assumes the Invert Input Logic function is set to "No" or disabled.

Assembly Object…

Data Word (2 Bytes)	Applicable Channel	Assignment/Function
Input Word[0] least 4 bits (Produced)	DI Channels 0-3	Bits [3…0], b3b2b1b0 = CH3CH2CH1CH0, 1=Output ON, 0=Output open/OFF, Bits [15…4] Not Used.
Input Word[1], 16-bit Heartbeat Counter (Produced)	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.	
Output Word[0] least 4 bits (Consumed)	DO Channels 0-3	Bits [3…0], b3b2b1b0 = CH3CH2CH1CH0, 1=Turn Output ON, 0=Turn Output open/OFF, Bits [15…4] Not Used.
Output Word[1] (Consumed)	AO Channel 0	16-bit signed integer representing the normalized data value for voltage output channel 0[1].
Output Word[2] (Consumed)	AO Channel 1	16-bit signed integer representing the normalized data value for voltage output channel 1[1].
Output Word[3] (Consumed)	AO Channel 2	16-bit signed integer representing the normalized data value for voltage output channel 2[1].
Output Word[4] (Consumed)	AO Channel 3	16-bit signed integer representing the normalized data value for voltage output channel 3[1].
Output Word[5] (Consumed)	AO Channel 4	16-bit signed integer representing the normalized data value for voltage output channel 4[1].
Output Word[6] (Consumed)	AO Channel 5	16-bit signed integer representing the normalized data value for voltage output channel 5[1].
Output Word[7] (Consumed)	AO Channel 6	16-bit signed integer representing the normalized data value for voltage output channel 6[1].
Output Word[8] (Consumed)	AO Channel 7	16-bit signed integer representing the normalized data value for voltage output channel 7[1].

[1]**Note:** Internally, the ±5V output range is a sub-range of the ±10V range and calibrated automatically with ±10V. To simplify operation, all ranges use a normalized ±30000 output count with -30000 driving -10V/-5V, 0 driving 0V, and +30000 driving +10V/+5V. Or, with legacy support enabled, a normalized ±20000 count is used with -20000 driving -10V/-5V, 0 driving 0V, and +20000 driving +10V/+5V.

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 file of the XT1542-000 is Acromag_XT1542.eds and it is 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 (e.g. to every address within its domain).

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 the 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 denotes *Domain Name System* or *Domain Name Server* and refers to the system or server 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, including output excitation. Verify that 12-32V power is applied to the unit. If using output channels, verify that output excitation has also been provided.

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 allow it to complete its initialization and stop the blinking. Note, this only occurs for the 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 to handle inrush current (select a current capacity at least 2x the maximum current draw of the unit).
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 (DC-).

Diagnostics Table…

POSSIBLE CAUSE	POSSIBLE FIX
USB Communication To This Unit is Lost…	
Was communication interrupted by severe interference or shock?	Reset the unit by cycling power to it.
Adding another unit to network slows network interaction considerably…	
Does each unit have a unique MAC address? U*nits are shipped with a unique factory MAC address assigned, but a rare 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 each unit has a unique MAC address--This should always be the case. If you have 2 units with the 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 of 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.	The USB isolator breaks the ground loop 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 USB via a USB isolator. Use an isolator like Acromag USB-ISOLATOR. Otherwise, a battery powered laptop may configure the module, as it cannot earth ground its USB port.
Output 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.	Even though the I/O is isolated from the network and power, if your output signal is already earth grounded, then connecting non-isolated USB to the module may drive a ground loop between your output 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.
Enabled watchdog timer never times out, or only times out initially…	
There is an established client-server connection (socket) over the network with this module.	Timer will time out if a client-server network connection has not been established (i.e. you are only connected via USB), or has been severed by a network cable break.

Diagnostics Table…

POSSIBLE CAUSE	POSSIBLE FIX
Outputs Appear Noisy or Unstable…	
Have you grounded your output return? One output Return terminal should include a connection to earth ground.	Connect one I/O Return (RTN) terminal to earth ground if any output is not already earth grounded (all outputs share return).
Software Status says "Data Transfer", "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 the unit has completed power-on initialization and established its network connection.
Cannot Get an i2o Source to Write Digital Outputs on this Module…	
i2o is not supported by this model.	i2o is only supported on Modbus TCP/IP models.
Digital Outputs Not Working…	
Missing digital excitation connection to power which powers the output driver.	You must connect an excitation supply from 6-32V to operate the digital outputs (not required for digital input-only operation).
Digital Outputs Stopped Working…	
Your digital output shut down due to contention with a field input signal.	Contention at the I/O channel triggers a protection mechanism that causes the output to turn OFF and you must cycle excitation OFF/ON to the output to restore output operation.
Digital Inputs Appear to Register Incorrect State…	
There is contention between a field input signal and the tandem open-source output which may be ON, or the Invert Input Logic function is enabled.	If you are monitoring a field-wired digital input, you must turn the channel's corresponding output OFF. Check the state of the Invert Input Logic function. Note that the output will turn OFF if contention with a field input signal occurs and you will have to cycle excitation OFF/ON to restore output operation.
Digital I/O Channels Change States when you connect USB…	
Indicative of a ground fault between earth ground at the PC and earth ground applied at an I/O channel, when you have not isolated your USB signals.	Only connect to the unit via isolated USB if your I/O signal is already earth grounded. You could connect without USB isolation if the I/O signal is not already grounded (not recommended).
Unit Does Not Power-On with 12V Supply…	
Your 12V supply is outputting a voltage below 11.5V.	Most 12V supplies are ±10%. This unit does not operate below 11.5V. Check your actual supply voltage under load and make sure it is at least 11.5V.

Diagnostics Table…

POSSIBLE CAUSE	POSSIBLE FIX
Continuous blinking yellow status LED…	
Watchdog timer has timed out.	In the absence of a client-server relationship over the network, such as that formed with i2o (Modbus TCP/IP models), or between a Ethernet/IP master/client and slave/server, a PLC or HMI and a server module, the watchdog will timeout when enabled. Also, timeout will occur if a client-server relationship has been severed by a network cable break, or power disruption at the client.
Writing a digital output causes adjacent channels to change their state…	
Digital outputs are written four channels at a time using an input register with coil registers disabled.	Because all four outputs are addressed at one time in this mode, it is necessary to retrieve or store all current output states before writing specific outputs in order to implement a masking strategy and prevent adjacent channel's from potentially changing their states (i.e. if an adjacent channel is currently ON or OFF, you need to reinforce the ON/OFF state in your output write to keep it ON/OFF).
Network Status Field of Device Setup Page Indicates "Failed" Error…	
A connection to the unit's network card was lost (Device Setup page Network Status field indicates "Failed", its voltage outputs go to 0V).	If your Network status message indicates "Failed", try cycling power to the module to force a re-initialization (The Restore to Out-of-Box condition or "sanitize" may also recover unit operation). One scenario that can drive this error condition is if you are using two different software interfaces to communicate with a unit at the same time (like the USB configuration software and a Ethernet/IP utility).

Service & Repair Assistance

This unit contains solid-state components and requires no maintenance, except for periodic cleaning and module configuration parameter verification. It may additionally require output zero and full-scale endpoint verification (calibration), to correct for long-term component aging. 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 XT-SIP and also with the isolator model USB-ISOLATOR.

USB A-mini B Cable



USB A-mini B Cable – Order 4001-113

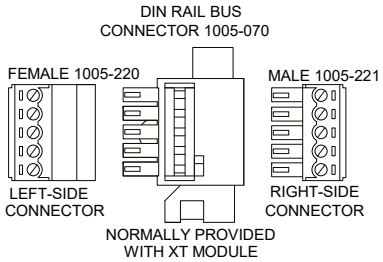
- USB A-mini B Cable 4001-113

This is a 1 meter, USB A-miniB replacement cable for connection between the USB isolator and any ST, 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.

Accessories…

DIN Rail Bus Connector Kit



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

- 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 potentially lower emissions and increased RFI resistance. 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

XT1542-000 (Eight Voltage Output Channels combined w/ Four Sourcing Digital I/O Channels)

8 AO & 4 DIO Output Channels (Combination Voltage Output Module with Sourcing Digital I/O)
Ethernet/IP Support
DC Powered
CE Approved
Includes UL/cUL Class I, Division 2 approvals

The XT1542-000 is a member of the Acromag DIN-Rail mounted, "Busworks" family of network I/O modules in the XT Series. The XT1542-000 model provides eight channels of DC Voltage Output, plus four sourcing digital I/O channels. This model operates over Ethernet using Ethernet/IP, but is setup and calibrated for network operation using USB. The trailing "-000" model suffix denotes DC power with CE & UL/cUL Class I, Division 2 Approvals.

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). Digital outputs of this model require a separate connection to power in order to operate them. Reconfiguration of any XT model will require use of the XT-SIP configuration kit, ordered separately (see Accessories section).

Analog Outputs

This model has eight separate DC Voltage Outputs for ±10V or ±5V which share Return and include transient voltage suppression. Unit must be wired and configured for the intended output (see Connections section for details). The following paragraphs summarize this model's output type, ranges, and applicable specifications:

Analog Output Ranges: Select ±10V (calibrated range), or ±5V (sub-range). A 16-bit voltage DAC drives each output through a unity-gain, non-inverting buffer.
Analog Output Accuracy: Each output is calibrated from the factory to better than ±0.1%. Manual calibration of the outputs can be done to improve accuracy to better than 0.05% with accurate equipment. Note that the ±5V sub-range is calibrated from its ±10V calibration.
Analog Output Ambient Temperature Drift: Better than ±50ppm/°C (±0.0050%/°C).
Analog Output Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS) with a clamp level above 14V typical.
Analog Output Max Voltage: The 16-bit DAC output is limited to a bipolar voltage range 2x its reference with ±2*5.1228V=±10.2455V. This corresponds to an internal signed integer count of -32768 to +32767 (or ±5.1228V and ±16384 for the ±5V sub-range). Thus, ±10V corresponds to ±31982 and ±5V corresponds to ±15991. However, to simplify output control, the selected output range will use a normalized DAC count of ±30000 corresponding to ±100% of the range (or ±20000 correspond to ±100% of the range with Legacy Support enabled). The normalized count is limited to a 16-bit signed integer up to 32767, but the DAC output voltage is capped at ±10.2455, and this corresponds to a normalized count of 30000*10.2455/10= 30736.
Analog Output Load Resistance: Voltage Output load must be greater than or equal to 5KΩ. As such, the output can source up to ±2mA maximum at ±10V into 5KΩ.
Analog Output Update Rate: Output levels are updated when written, and continuously refreshed every 5 seconds.
Analog Output Calibration: Outputs can be calibrated manually by driving the channel to its ±10V output range zero and full-scale endpoints, precisely measuring its output signal, then storing the measured value and the corresponding DAC program count, to build the equation of a straight-line for any output value within the linear digital range. The ±5V is a sub-range and calibrated from ±10V data.

Voltage Outputs…

Analog Output Resolution: The maximum output swing of the 16-bit bipolar DAC is twice the DAC reference voltage of 5.12277V, or ±10.24555V (-32768 to +32767). The DAC drives unity-gain buffers at each output. The effective resolution of the DAC output is dominated by the lower resolution of its normalized value. That is, ±10V is normalized to ±30000 (333.33uV/bit), or ±20000 (1000uV/bit). The ±5V range is treated as a sub-range of the ±10V range. The raw DAC count that corresponds to ±10V is calculated via the expressions -32768*10/10.24555= -31983, and +32767*10/10.24555= +31982. The normalized counts that correspond to ±10.24555V are calculated via the expressions ±30000*10.24555/10=±30737, or ±20000*10.24555/10=±20491 with legacy support. The raw DAC counts that correspond to ±5.12277V is calculated via the expression ±32768/2= ±16384. The raw DAC counts that correspond to ±5V occur ±16384*5/5.1227= ±15991. From a programmer's perspective, the output ranges are set using the normalized values of ±30000 for ±100% of range, or ±20000 with legacy support enabled.

IDEAL RANGE LIMITS WRT RAW DAC COUNT AND SIGNED 16-BIT INTEGERS

Range Limit	16-Bit Raw DAC Count[1]	Output Voltage	Normalized Pgm Count Std	Normalized Pgm Count w/Legacy
±10V Output Range				
-UNR	-32768	-10.24555V	-30737	-20491
-FS	-31983	-10.0000V	-30000	-20000
ZERO	0	0.0000V	0	0
+FS	+31982	+10.0000V	+30000	+20000
+OVR	+32767	+10.24555V	+30737	20491
±5V Output Range (a Sub-Range of ±10V)				
-UNR	-16384	-5.12277V	-30737	-20491
-FS	-15991	-5.0000V	-30000	-20000
ZERO	0	0.0000V	0	0
+FS	+15991	+5.000V	+30000	+20000
+OVR	+16384	+5.12277V	+30737	20491

[1]Note: This is the ideal internal count used by the firmware to control the DAC, not the count that operators use to set the output level. Operators use the Normalized count to set the output level and that count will differ around the ideal values shown above according to their channel-specific calibration.

[2]Note: The ±10V Cal Lo & Cal HI raw DAC counts can be calculated via the expressions -32768*10/Vomax=Cal Lo and +32767*10/Vomax=Cal HI, with Vomax=maximum output voltage=2*Vref and Vref=5.12277.

Analog Output Digital-to-Analog Converter (DAC): A 16-bit octal DAC, Analog Devices AD5362BSTZ, operating in bipolar mode with a 5.12277V reference, yielding a 16-bit D/A output voltage range of ±2*5.12277=±10.24555V, corresponding to a raw signed integer DAC count of -32768 to +32767, and a normalized DAC program count of ±30736 (with ±10V at ±30000).

Analog Output Cable Length: Output interface cables should not exceed 30m in length for rated performance.

Reference Test Conditions: ±10V output into 10KΩ; ambient temperature = 25°C; 24VDC supply.

Digital Outputs & Excitation

This model has four tandem digital input and output channels.

Excitation for the sourcing digital outputs is required at TB6 to operate them.

To control higher voltages and/or currents, or for controlling AC, an interposing relay may be used (see Note).

This model has four open-source, smart, p-channel mosfet switches with a common drain connection to the digital excitation source at TB6-22. It provides high-side switching between the digital excitation and the load connected between the output channel at TB4 and return at TB5. It is intended for DC voltage sourcing applications only. The outputs will drive any rated load up to 250mA each with one side connected to return. Outputs have tandem inputs which provide true loopback monitoring of the output state, or the inputs can be used to monitor field inputs with the output OFF. Individual I/O channels are pulled down to I/O Return (connected at RTN terminal) with 10KΩ resistors and do not float. External excitation is required for digital output operation and this is connected between the EXC and RTN terminals of TB6 (terminal numbers 22 and 21 respectively).

Digital Output "OFF" Voltage Range: 0 to 32V DC. Limit voltage to less than 36V peak, or damage to the unit may result. Use protection when switching inductive loads (for example, use a reverse shunt diode at the inductive load).
Output Active Current Limitation: The unit limits load current to a shorted load to 0.6A typical, 0.4A-0.9A range (EXC=13V and 0.01Ω load resistance). This limit works with a latched thermal shutdown to help protect the output channel from damage due to overload (cycle excitation OFF/ON to restore output operation after a shutdown).
Output Thermal Shutdown: Individual outputs will shutdown and latch off for thermal overload conditions that drive the junction temperature into the region from 150° to 200°C. If your outputs stop working, the I/O pin is pulled low and the output must be cycled OFF/ON to restore operation.
Output Under-voltage Shutdown: Outputs will shut-down if their excitation voltage is less than 6.0V (3V-6V threshold).
Output Overvoltage Shutdown: Outputs will shut-down if their excitation voltage exceeds 36V minimum.
Output Ground Loss Protection: The output automatically turns off if the ground lead is disconnected (RTN).
Output "OFF" Leakage Current: 50uA maximum per channel (mosfet only). Does not include the input bias current for the tandem digital input (see Note below).
Note: The 100KΩ series input buffer resistors in combination with the +3.3V voltage diode clamps at the input buffer will tend to increase the off-state current with increasing output voltage (up to 3.5mA at 32V). This is a consequence of the input buffer circuitry being connected in tandem to the output mosfet source lead at every I/O channel, and the presence of a 10KΩ pull-down on the input.
Output "ON" Current Range: 0 to 250mA DC, continuous (up to 1A total for all 4 channels combined). No deration is required at elevated ambient. Match one TB5 return (RTN) to each of 4 output loads.
Output R_{ds} ON Resistance: 0.5Ω typical at 0.25A and 25°C, 1.0Ω Maximum.
Output Response Time: 10ms typical. Does not include network time. The actual output switch time will vary with network traffic, interrupts, and output load.
Note: Per UL, when the outputs are used to control interposing relays for switching AC and DC devices of higher voltage/current, the coil ratings for the interposing relay shall not exceed 24VDC, 100mA.

Digital Outputs & Excitation…

Note: *You must connect digital excitation to operate digital outputs. Input only operation does not require Excitation.*

Digital Output Excitation (Required for Digital Output Operation): External excitation from 6-32V (14mA minimum at 32V) is required at TB6 between EXC and return for digital output operation. Reverse voltage protection is included. The current capacity of your excitation supply will depend on your load requirements and the number of channels being loaded. For 4 channels at a maximum rated load of 250mA each, your excitation supply must be able to source 1A. Outputs cannot operate without excitation. Outputs will source the excitation voltage to the load when turned ON, and are powered from it. The Excitation terminal is tied in common to the drains of each output channel mosfet. The source leads of each mosfet drive the output load and are pulled down to Return via a 10KΩ pull-down resistor. You do not need excitation to operate the digital inputs of this model, only the outputs.

Digital I/O Pull-Downs: Individual digital I/O channels have 10KΩ pull-down resistors to return and will never float. The installed resistor is one element of a four element isolated SIP resistor (8 pins) and rated to 0.3W per element up to 70°C (refer to Bourns 4308M-102-103LF parts). If your application requires a stronger pull-down (lower resistance), you will have to wire it externally in parallel with your load, being careful that you do not exceed 250mA of source current per output (load plus pull-down current).

IMPORTANT: If you trigger the output's protection mechanism, perhaps via accidental contention between the channel and a field input signal, it shuts OFF and you must cycle output excitation OFF/ON to restore output operation.

Digital Inputs

This model includes four active-high, buffered inputs, with a common return connection (RTN) for DC voltage applications only and these are used to read back the output or field inputs. Inputs are tied in tandem to the output source leads and provide loopback monitoring of the output state. With the tandem output turned off, they may be used to monitor voltage levels up to 32V from the field. Inputs include transient suppression and series connected 100KΩ resistors, plus diode over-voltage clamps to the internal +3.3V supply rail. Individual I/O channels are pulled down to the return (RTN terminal) with 10KΩ resistors. External excitation at TB6 (the source to the load) is required for output operation and is connected between the EXC and RTN terminals of TB6 (terminal numbers 22 and 21 respectively).

Input Signal Voltage Range: 0 to +32VDC with high-level inputs diode-clamped to a +3.3V logic rail via an internal 100KΩ series resistor to limit the diode current.

Input Signal Logic Threshold: Inputs use TTL logic thresholds with a 0.8V maximum Low Level signal and a 2.0V minimum High Level Signal. You may optionally utilize a series connected resistor at the input to raise its thresholds for your application, utilizing the internal 10KΩ input pull-down as a divider resistor. For example a 27.5K input series resistor would cause a 3V input from a proximity sensor to drive the maximum low level of 0.8V to the input.

Input Current: 280uA, typical at 32VDC. Computed as the max applied input voltage minus 4V (3.3V rail and diode clamp), divided by the series 100KΩ input resistance.

Input Signal Threshold: TTL compatible w/100mV of hysteresis, typical. Low-to-High threshold is 1.7VDC, typical, High-to-Low threshold is 1.6VDC, typical. Logic limits are TTL with 0.8VDC Max LOW level, and 2.0VDC Min HIGH level.

Input Resistance: 10KΩ, typical (inputs include 10KΩ pull-downs to return).

Digital Outputs…

Input Hysteresis: 100mVDC typical.
Input Response Time: 10ms typical, not including network time. The actual input response time will vary with network traffic and interrupts.
Input TVS (Transient Voltage Suppressor): Installed at every digital I/O channel, the rated working voltage is 38V, breakdown voltage is 47V, and its clamping level varies up to 72V.

Power

Power Supply (Connect at TB6 terminals 24 & 23, and/or via the DIN Rail Bus): 12-32V DC SELV (Safety Extra Low Voltage), 3.2W 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 the DIN rail bus at TB7 (these power inputs are diode-coupled to the same point in the circuit). Current draw varies with power voltage as follows and values below assume that all eight voltage outputs are driving +10V into 5KΩ (2mA each):

SUPPLY	XT154x-000 CURRENT
12V	242mA Typical / 266mA Max
15V	187mA Typical / 206mA Max
24V	116mA Typical / 128mA Max
32V	88mA Typical / 97mA 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. Most supplies are ±10%, but this module will not operate below 11.5V.
Excitation: This model requires a separate power connection for its digital output excitation source. Refer to Digital Outputs for excitation requirements.
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.
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, and this will drive ground loop errors when your I/O is also grounded.

USB Interface…

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 outputs of these modules are isolated from each network port and DC power, but the output 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 an output, 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

To communicate with any network device over Ethernet, you must either set your network interface to a valid IP address in the address domain of the device, or set the address of the device to an unused address in the address domain of your network interface. This model allows you to easily set its network IP address via a USB connection to avoid this hassle.

Connector: Dual, shielded RJ-45 sockets, 8-pin, 10BaseT/100BaseTX. The metal shield circuit of the network connectors is isolated and capacitively 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 Configuration.
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.
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's 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, IP20.
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

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.

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 +65°C (-40°F to +149°F).
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95%, non-condensing.
Isolation: I/O channels (analog and digital channels, excitation, and USB as a group), the network (each of two ports), and input 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 the 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).
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.

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 XT1542-000 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.

Ⓔx II 3 G Ex nA IIC T4 Gc -40°C ≤ Ta ≤ +65°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,* $G_B G_C$

XT1542-000	MTBF (Hours)	MTBF (Years)	Failure Rate (FIT)
25°C	457,517 hrs	52.2 years	2,186
40°C	339,622 hrs	38.8 years	2,944

Configuration Controls

Software Configuration Only via USB
Although this module normally operates using Ethernet/IP TCP/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 4 channel analog output and 4 channel digital I/O module is 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
26-AUG-14	A	BC/ARP	Updated Initial Release.
13-OCT-14	B	BC/ARP	Added UL approvals (removed pending) per 14K010, added MTBF data.
15-OCT-2015	C	CAP/ARP	Added ATEX symbols / statements.
22-AUG-2016	D	CAP/MJO	Corrected “Circuit Board” specification.
14 NOV 2017	E	FJM/ARP	Reference Configuration Software without the revision.

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