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Acromag®

EtherStax™ Stackable Industrial I/O Family
Modbus TCP/UDP/IP 10/100MB Ethernet I/O

Model ES2113 96-Channel Digital Input/Output

USER'S MANUAL



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Symbols on equipment:



Means "Refer to User's Manual (this manual) for additional information".

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For additional information, please visit our web site at www.acromag.com and download our whitepaper 8500-765, Introduction To Modbus TCP/IP, or 8500-648, Introduction to Modbus.

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IMPORTANT SAFETY CONSIDERATIONS

You must consider the possible negative effects of power, component, wiring, sensor, or software failure in the design of any type of monitoring or control 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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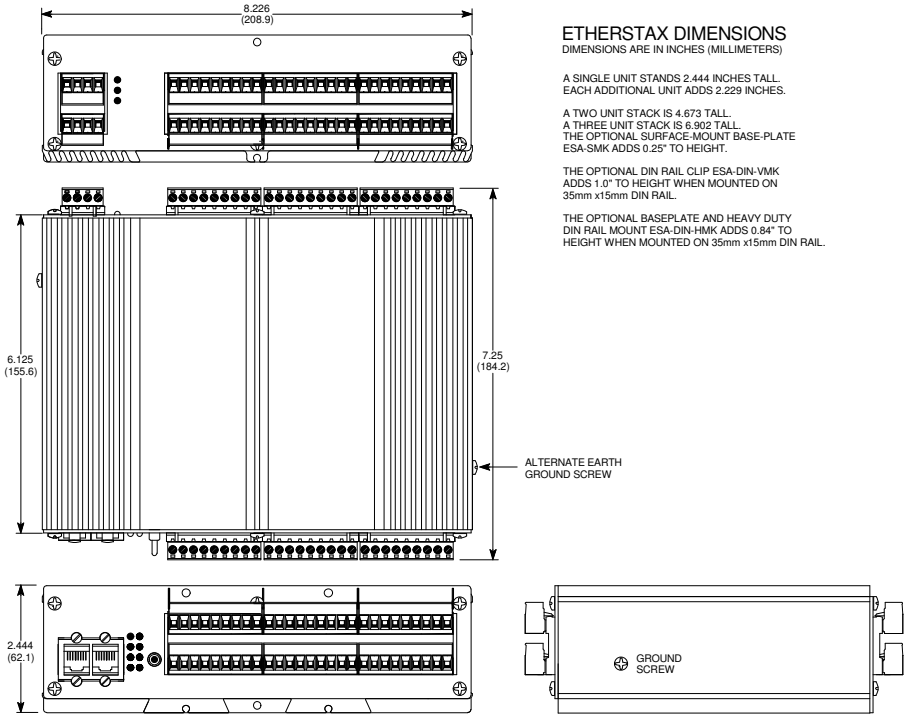
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Units are designed to interlock and stack together up to 3 units high. A stack of units can be bolted to a wall or flat surface, or mounted on deep-channel, "T" type, 35mm x15mm DIN rails (per DIN EN60715 TH35), depending on the optional mounting kit selected. Available mounting kits are shown below.

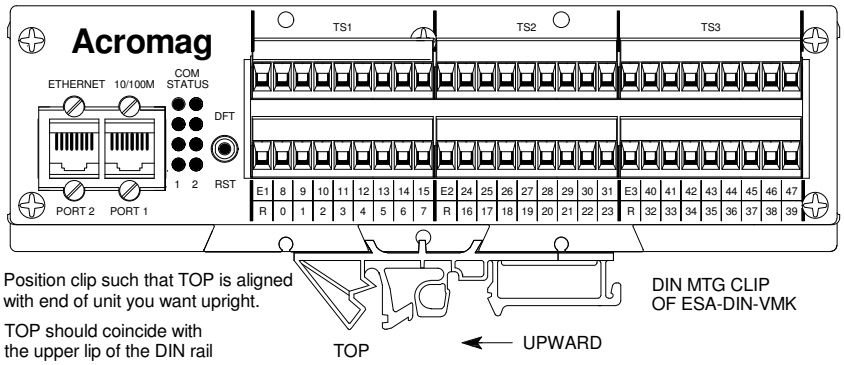


MOUNTING AND DIMENSIONS

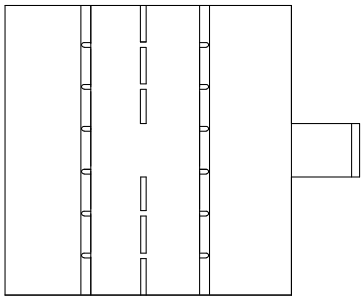
A single unit stands 2.444 inches tall. Each additional unit adds 2.229 inches.

A two-unit stack would be 4.673 inches tall. A three unit stack is 6.902 inches tall. Add any additional height as necessary to account for the mounting plate, DIN clip, and DIN rail, if required.

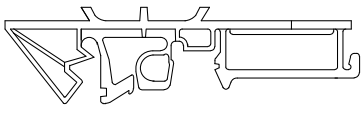
DIN Rail Vertical Mount Kit ESA-DIN-VMK (One or Two Units): This kit includes two plastic DIN clips (Rose Bopla #77003500) that slide into the dove-tail channel of the bottom of the housing. You can use one clip to mount a single unit, or both for added stability when stacking two units. If stacking more than two units on a DIN rail, see ESA-DIN-HMK.



ESA-DIN-VMK TOP VIEW



ESA-DIN-VMK SIDE VIEW



NOTE: ESA-DIN-VMK CONTAINS TWO OF THESE PIECES.

MOUNTING AND DIMENSIONS

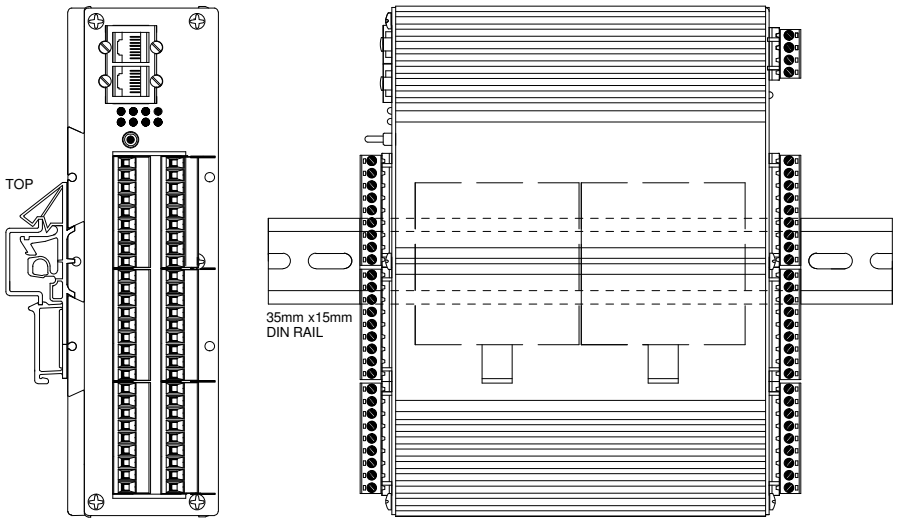
Simply slide the clips of this kit into the dovetail channel at the bottom of the enclosure. You can use one clip, or both (recommended), DIN clips of this kit to mount a single unit. For a stack of two units, both clips must be used. To remove a unit from the DIN rail, you have to lift the assembly upward and tilt the top of the unit back to disengage it from the rail. If you choose to install both DIN clips for added security (recommended), then more pressure will be required to disengage the unit from the rail. To mount a stack of 3 units to a DIN rail, use the heavy-duty DIN kit model ESA-DIN-HMK instead.

The drawing at right shows how to mount a unit with the ESA-DIN-VMK kit.

This kit includes two DIN clips for added stability, or for mounting a stack of two units. Note the orientation of the DIN clips relative to the rail.

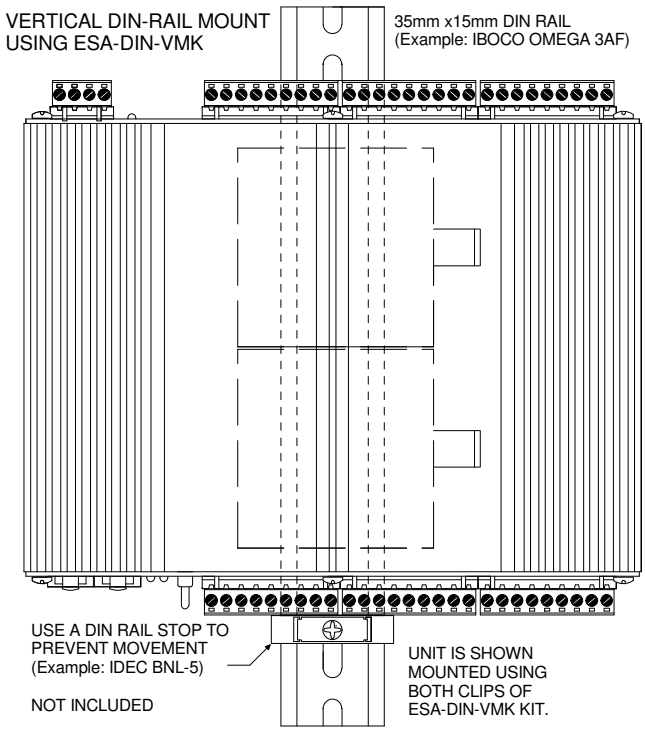
To remove a unit from the rail, grip unit on each side and pull/push upward while tilting the top back to release the unit from the upper lip of the DIN rail.

ETHERSTAX MOUNTING WITH ESA-DIN-VMK

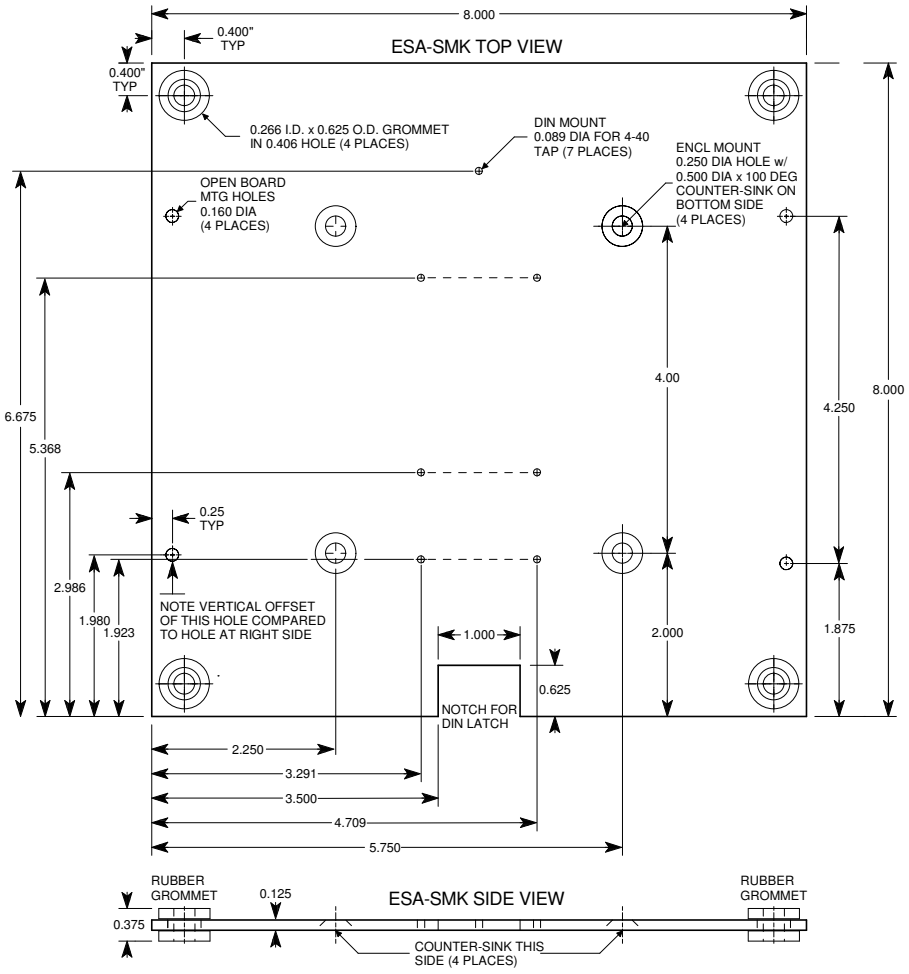


IMPORTANT: Stack no more than 2 units with ESA-DIN-VMK.
Use both clips of this kit with two units stacked together.

You can use the ESA-DIN-VMK to mount a unit horizontally, or vertically as shown at right. Be sure to use a DIN rail stop to prevent the unit from moving along the rail with vertically mounted DIN rail.



Surface-Mount Kit ESA-SMK (One to Three units): This kit includes a shock-mounted aluminum base-plate and bolts that attach to the bottom of the housing. Mounting holes with rubber grommets at each corner support 1/4-inch bolts for mounting to flat surfaces. Up to three units may be stacked on this plate.



This plate also includes the four holes necessary for mounting an open-frame circuit board to it (i.e. no enclosure with hardware of ESA-OMK).

ESA-SMK Kit Contents:

1 Pre-Drilled Aluminum Base-Plate, 8 x 8 x 0.125.
4 1/4-20 x 0.375 Flat-Head, 100° Counter-Sink, Phillips
4 Rubber Grommet, 0.625 O.D. x 0.266 I.D

The 1/4-inch bolts and washers (recommended) to attach this assembly to a flat surface or panel are not provided.

For DIN rail mounting of this plate, see ESA-DIN-HMK

MOUNTING AND DIMENSIONS

Insert the four rubber grommets into the holes at each corner of the base-plate.

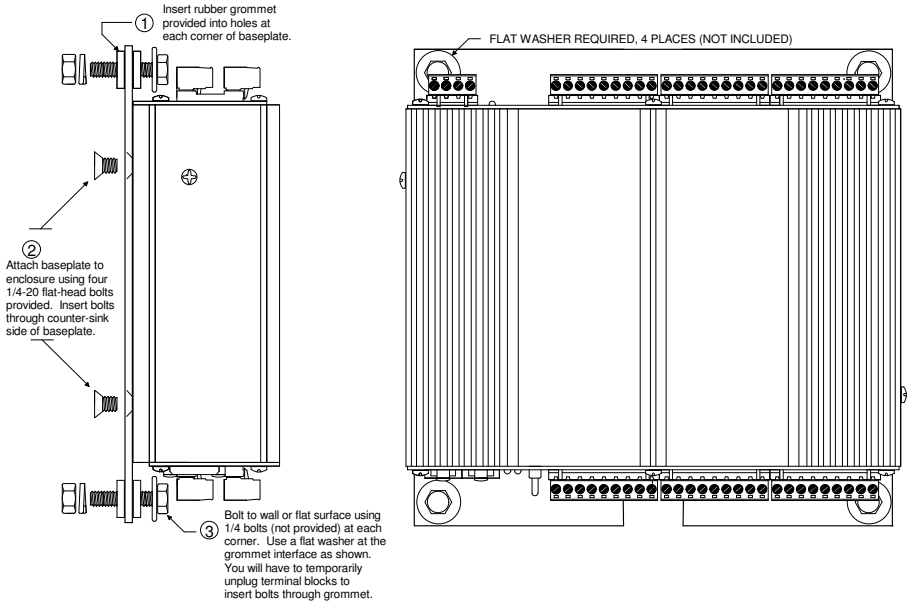
Then use the four 1/4-20x0.375, flat head, counter-sink bolts provided to bolt this plate to the bottom of the enclosure. Be sure to insert the bolts from the counter-sink side of the plate.

Add any additional units to your stack--you can safely stack up to three units on this plate.

Use 1/4-inch bolts (not provided) to bolt this assembly to a wall or flat surface. It is recommended that flat washers (not provided) be used to protect the rubber grommet.

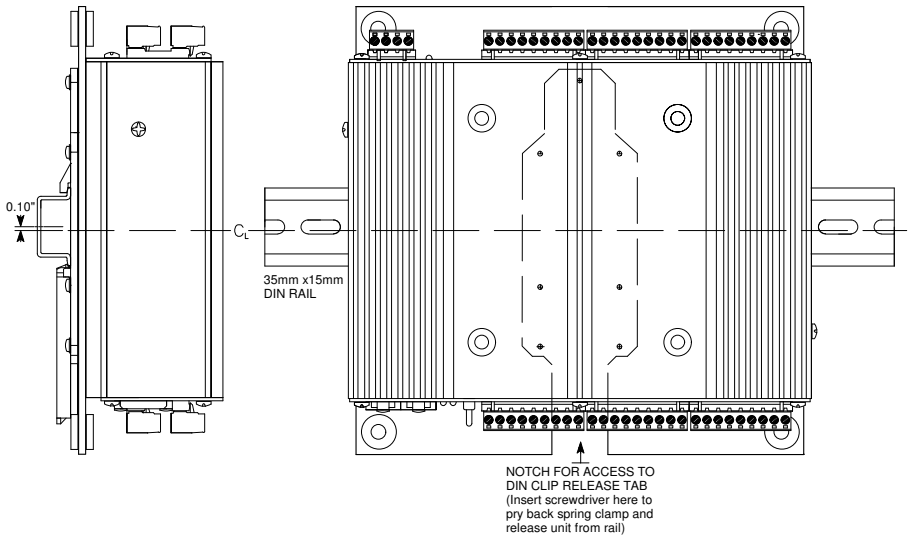
MOUNTING AND DIMENSIONS

ETHERSTAX SURFACE MOUNTING WITH ESA-SMK



DIN Rail Horizontal Mount Kit ESA-DIN-HMK (one to three units): This kit has the same base-plate as ESA-SMK above, but adds a heavy-duty DIN adapter (Phoenix UTA-159) and screws for mounting to 35x15mm T-type DIN rails. Up to three units may be stacked on this plate and mounted to a DIN rail.

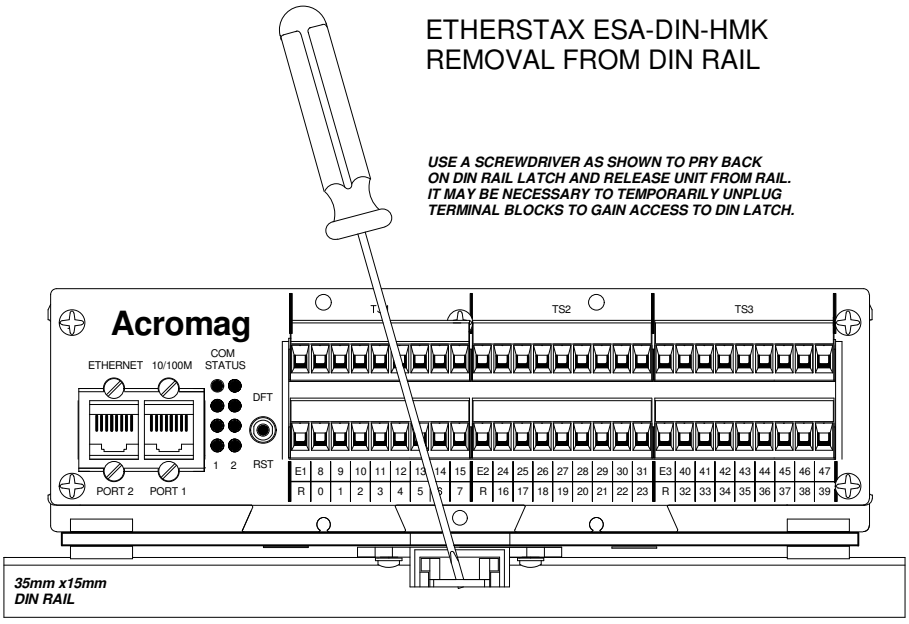
ETHERSTAX MOUNTING WITH ESA-DIN-HMK



ESA-DIN-HMK Kit Contents:

1	Pre-Drilled Aluminum Base-Plate, 8 x 8 x 0.125.
4	1/4-20 x 0.375 Flat-Head, 100° Counter-Sink
4	Rubber Grommet, 0.625 O.D. x 0.266 I.D.
1	Heavy-Duty DIN Adaptor (Phoenix UTA-159)
7	4-40 x 0.25 screw with lock-washer

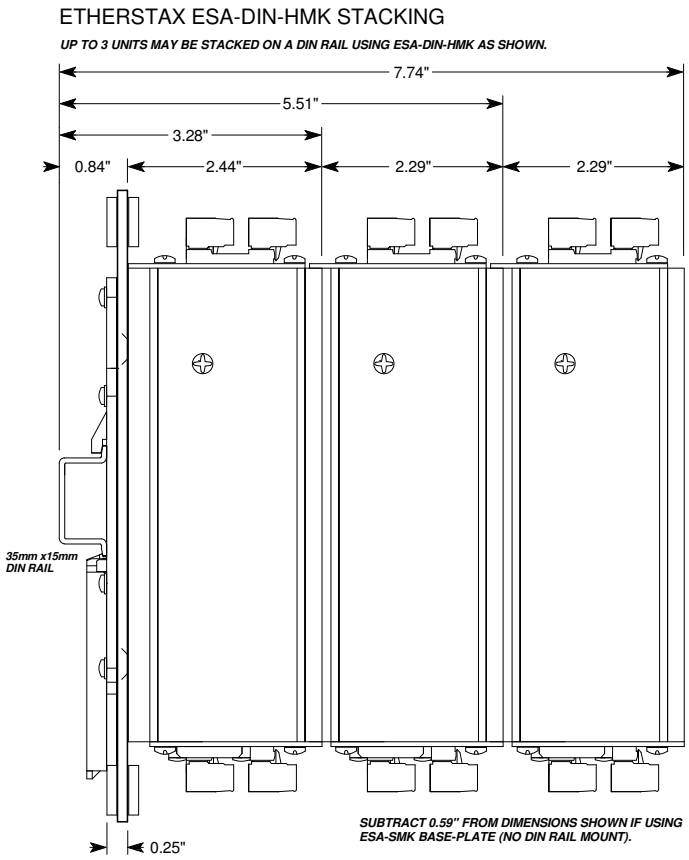
To attach or remove the ESA-DIN-HMK to/from the DIN Rail, use a screwdriver tip inserted into the slot at the end of the DIN clip, in the area of the notch of the base-plate as shown below. Pry back to compress the DIN clip spring and release it from the rail. You may have to temporarily unplug the terminal blocks in the area of this notch to gain access to the DIN clip.



MOUNTING AND DIMENSIONS

IMPORTANT: *Be sure to remove power before attempting to disengage unit from the DIN rail.*

Be sure to grip unit firmly before disengaging unit from rail and avoid dropping it.



Note that you can stack up to 3 units on the ESA-DIN-HMK or ESA-SMK as shown at left.

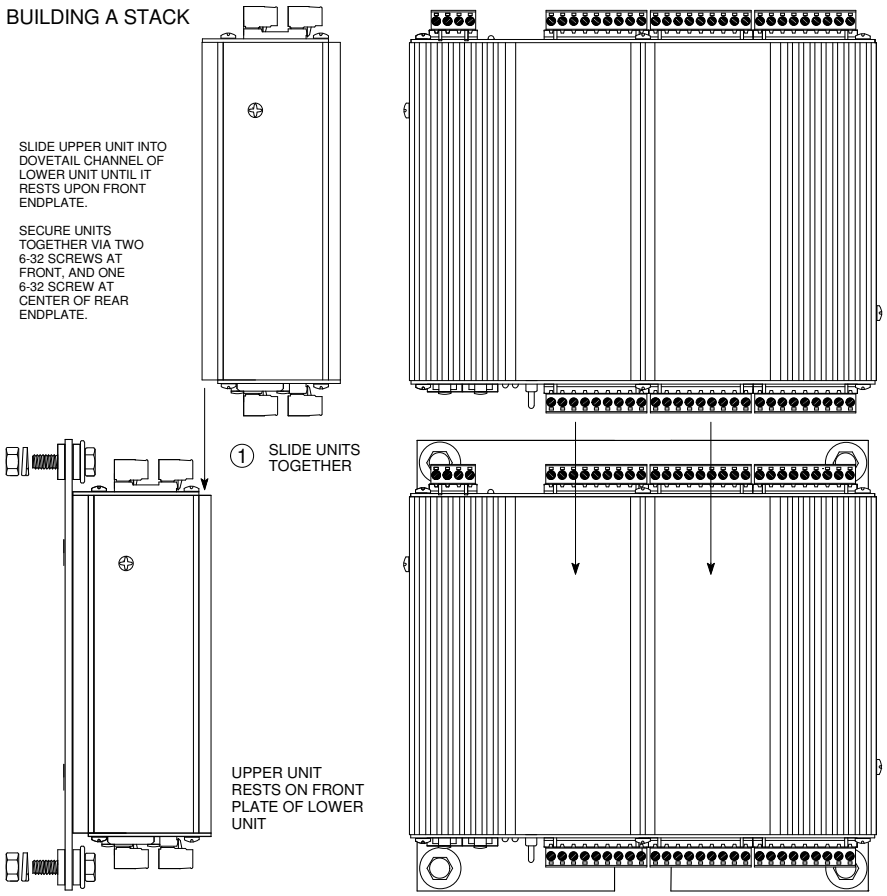
Subtract 0.59 inches from dimensions shown if using ESA-SMK (i.e. no DIN rail mount).

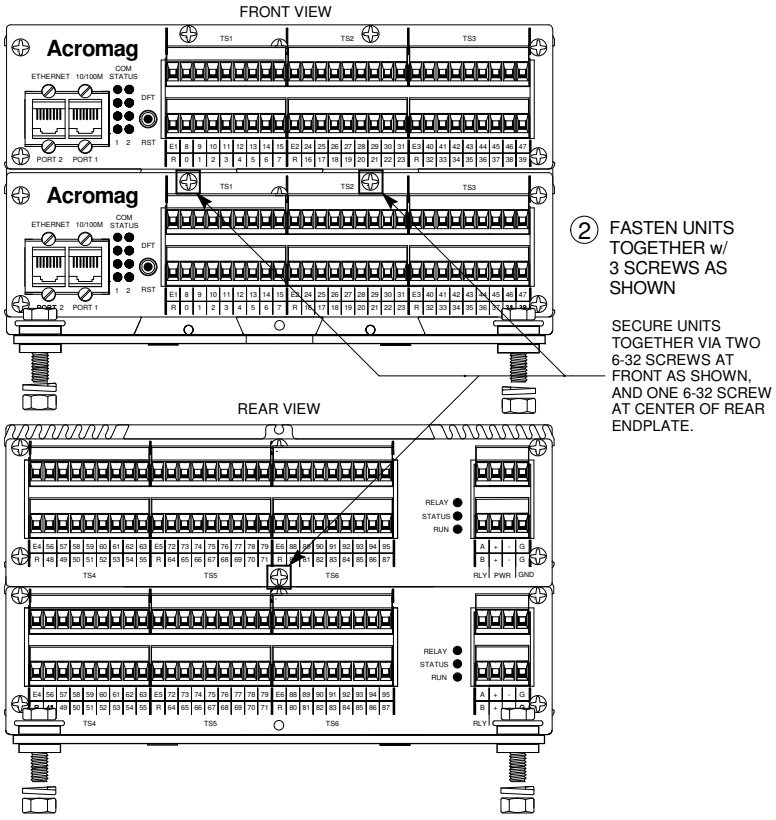
MOUNTING AND DIMENSIONS

The drawing at right shows how to stack units together.

You can stack up to three units together in this manner.

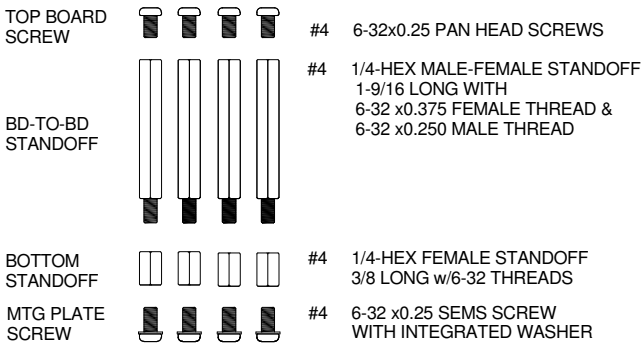
WARNING: *Be sure to grip the edges of unit firmly when stacking units and avoid dropping it.*



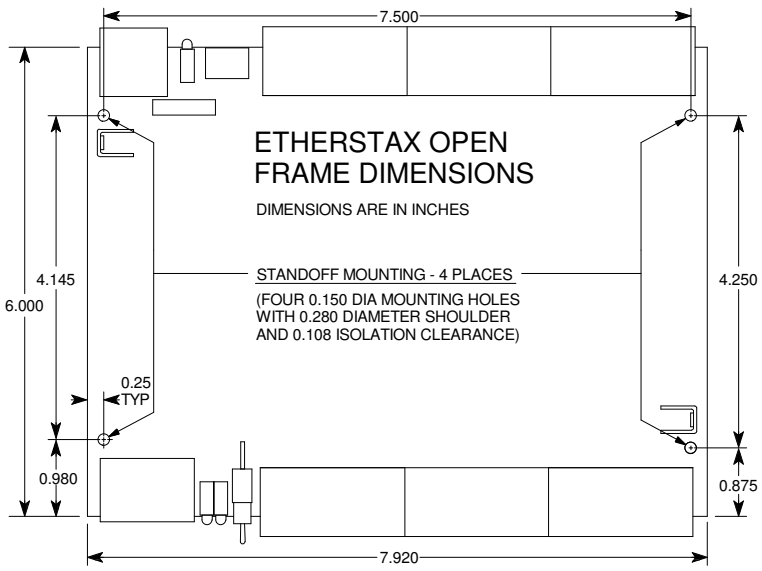


Open-Board Mounting Kit ESA-OMK: EtherStax units can be ordered and mounted without their enclosure. This kit includes the jack-screws, and fasteners necessary to stack two open circuit boards together, plus the standoffs and screws for mounting this assembly to a flat surface. Note that this is a replacement kit, as open-frame units already include these items. Use additional kits as required for stacking more than two boards in this manner.

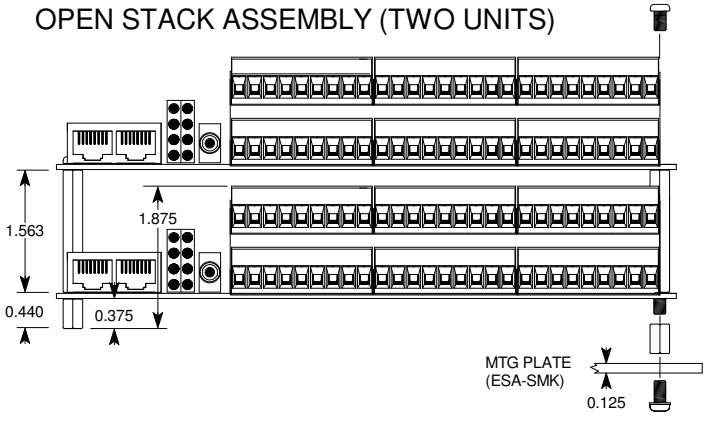
ESA-OMK KIT CONTENTS



ESA-OMK kit items are also included with every open board assembly.



OPEN STACK ASSEMBLY (TWO UNITS)



MOUNTING AND DIMENSIONS

IMPORTANT: *Units ordered without their enclosure do not retain safety agency listing, but are recognized components (see Specifications – Agency Approvals). Open-frame units are also vulnerable with respect to ESD. While the open unit retains all of its built-in transient suppression and filtering, the sensitive electronic circuits are left exposed to ESD damage without the protection of an enclosure.*

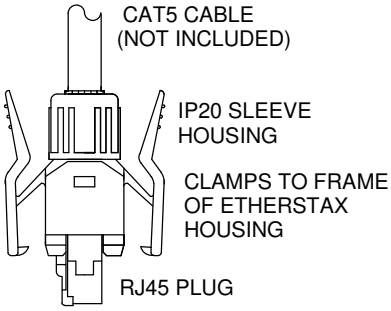
You should take adequate measures to protect open-frame mounted units from dust, debris, and ESD.

Thus, it is recommended that open units be mounted in a protective enclosure or cabinet.

Note: *Open-frame units may also mount to the optional surface-mounted base plate ESA-SMK to facilitate surface or DIN-rail mounting. This plate has mounting holes located as shown to mate with those of the circuit board.*

Be very careful when handling open-frame circuits to avoid ESD damage to the sensitive circuit components.

MOUNTING AND DIMENSIONS



ESA-CTK IP20 CAT5
CABLE TERMINATION KIT

Cable Termination Kit ESA-CTK: The EtherStax enclosure includes a panel mounted frame around the RJ45 network port that accommodates special IP20 clip-type plug connectors that help to secure network connections from shock and vibration. You can still utilize standard RJ45 modular plug connectors, but if you want the added security of this clip frame, then you have to use the compatible cable plug connectors provided by this kit. This kit provides the male plug and sleeve housing for one end of Category 5 Ethernet cable that will mate to this frame. Category 5 cable is not included. You will also require a modular crimping tool for attaching the plug to your cable (most standard RJ45 crimping tools will work).

Units ordered without their enclosure cannot utilize this clip.

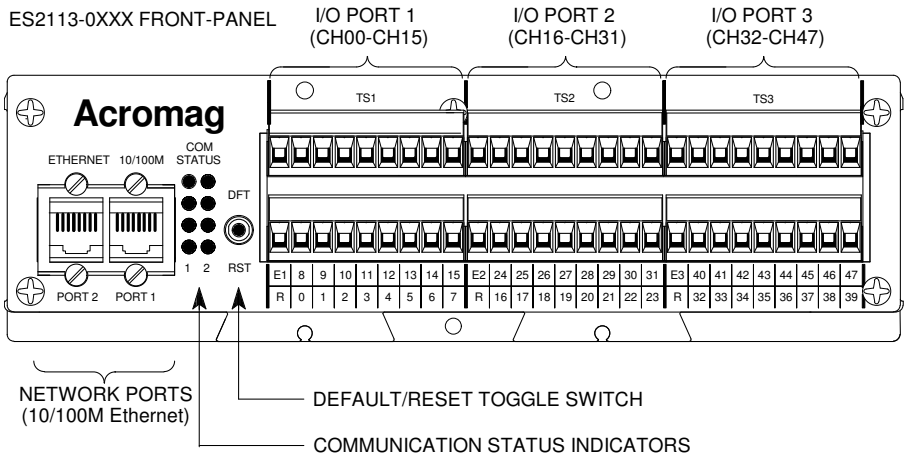
CONTROLS & INDICATORS

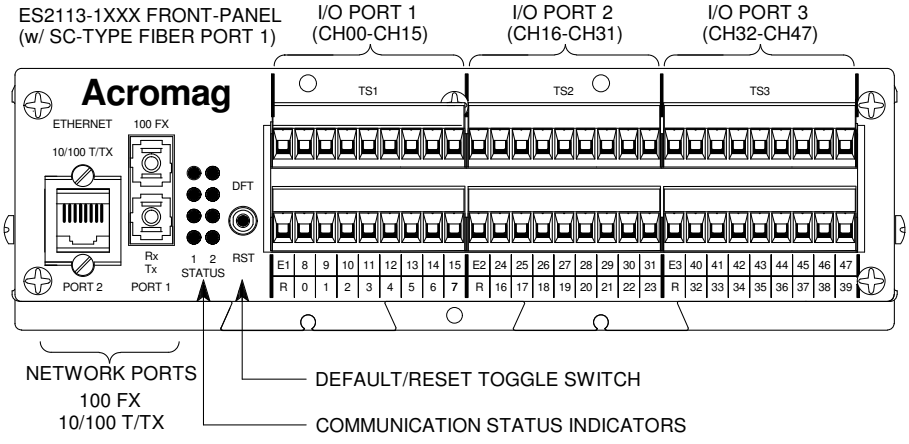
Front Panel

Two columns of status indicators for the network ports are used to indicate different things according to whether the unit is in switch mode, or hub/repeater mode. Refer to Specifications – Controls & Indicators for these definitions.

The toggle switch is used to toggle the unit into or out of Default Mode (toggle up & hold 4 seconds), or to reset the unit (toggle down).

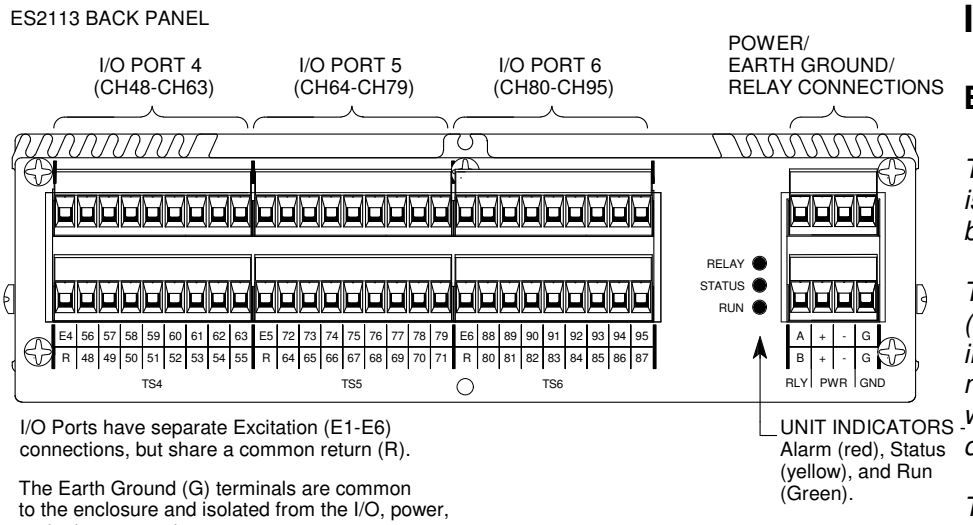
In Default Communication Mode, the yellow STATUS LED on the back of the unit will flash slowly and the unit will assume a fixed static IP address of "128.1.1.100", a default subnet mask of "255.255.255.0", a default username of "User", and a default password of "password".





CONTROLS & INDICATORS

Back Panel



I/O Ports have separate Excitation (E1-E6) connections, but share a common return (R).

The Earth Ground (G) terminals are common to the enclosure and isolated from the I/O, power, and relay connections.

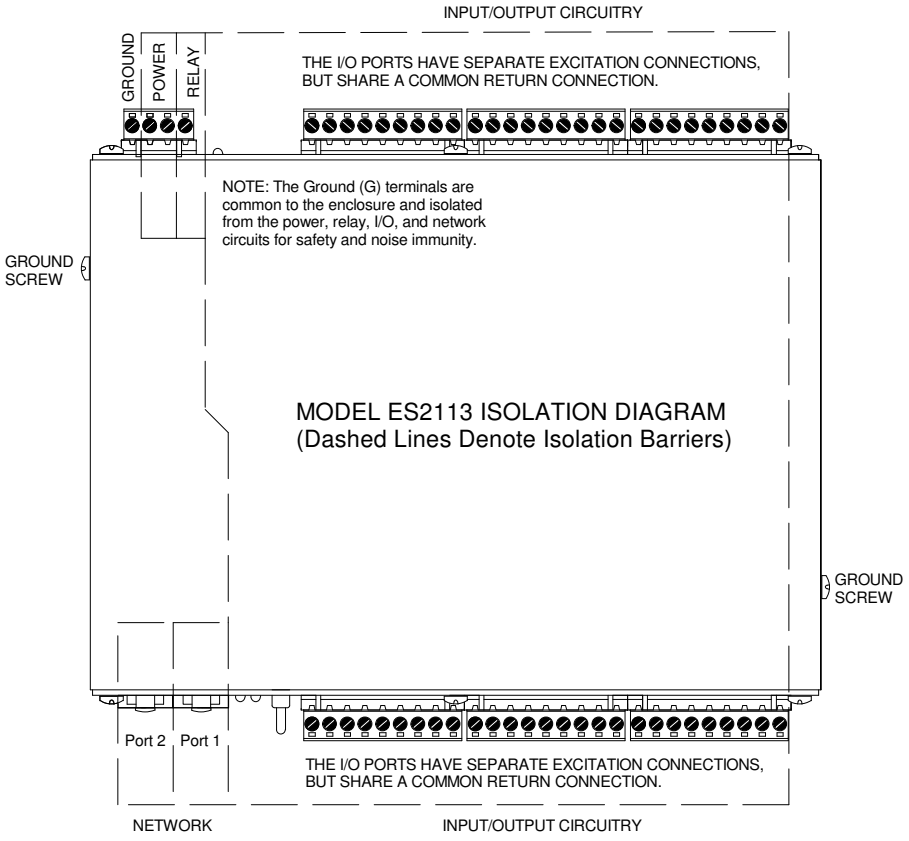
UNIT INDICATORS - Alarm (red), Status (yellow), and Run (Green).

The Green RUN LED (bottom) is ON if power is on and will blink in "wink" ID mode.

The Yellow STATUS LED (middle) blinks ON/OFF slowly in default communication mode and blinks rapidly if a watchdog timeout has occurred.

The Red RELAY LED (top) is ON if relay is energized (relay terminals A & B are closed).

ISOLATION BARRIERS



Dashed Lines denote isolation barriers. Additionally, the enclosure is also isolated.

The I/O circuitry, network ports (each), power circuit, relay, and enclosure (earth ground) are isolated from each other for safety and noise immunity.

Note that the network ports are individually isolated from the rest of the circuit and from each other.

***IMPORTANT:** Transient suppression devices are internally shunted to earth ground, please connect the ground terminal to a suitable earth ground to complete this path and protect the unit. Ground may alternately connect to the ground screw on either side of the unit instead of the ground terminal.*

CONNECTIONS

Network

For 100Base-TX systems, at a minimum, use data grade Unshielded Twisted-Pair (UTP) wiring that has a 100Ω characteristic impedance and meets the EIA/TIA Category 5 wire specifications.

It is recommended that you use a CAT-5 cable to connect this device to your PC.

For 10Base-T systems, you may use Category 3, Category 4, or Category 5/5E UTP/STP cable.

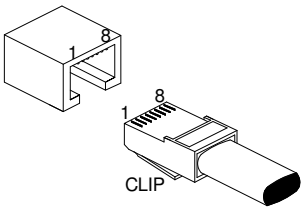
In either case, you are limited to 100 meters between any two devices.

RJ45 MDI AND MDI-X CONNECTIONS

PIN	MDI WIRING	MDI-X WIRING
1	Transmit +	Receive +
2	Transmit -	Receive -
3	Receive +	Transmit +
4	Not Used	Not Used
5	Not Used	Not Used
6	Receive -	Transmit -
7	Not Used	Not Used
8	Not Used	Not Used

Note Crossover Connections

ETHERNET PORT



RJ-45 CONNECTOR

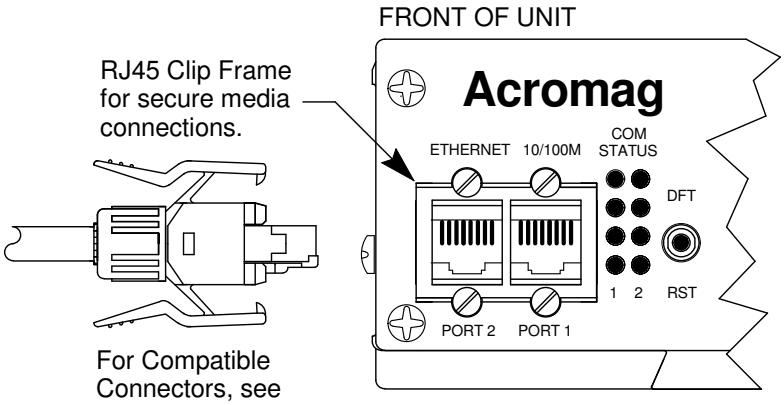
RECOMMENDED CABLE

SPEED	DISTANCE	CABLE
10Base-T	100M	CAT 3, CAT 4, or CAT 5 UTP
100Base-TX	100M	CAT 5/5e UTP/STP

The Ethernet port of this unit is wired MDI-X by default, but includes automatic crossover (the Ethernet port of your PC is typically wired MDI). Thus, you can use either a straight-through or crossover cable to connect this device directly to a PC, Ethernet switch, or another unit.

For compatible male plug connectors, order the Cable Termination Kit, Acromag ESA-CTK.

FRONT OF UNIT



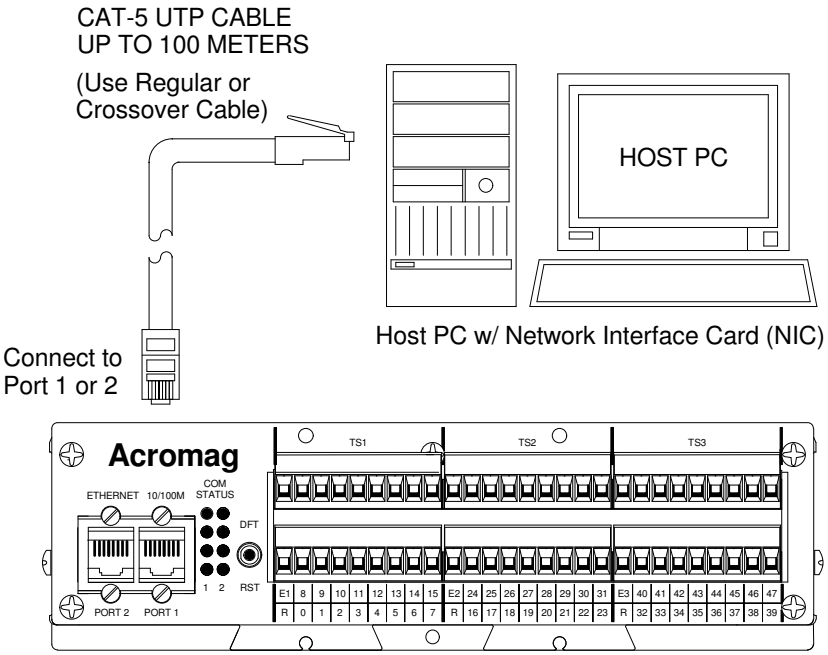
For Compatible Connectors, see ESA-CTK Cable Termination Kit

The RJ45 clip frame mates with the compatible connectors of the ESA-CTK for increased immunity to shock & vibration.

For increased immunity to shock and vibration, the RJ45 network connections include special clip frames that can be used with compatible plug connectors to help secure your network connection from breaking free under shock or vibration. You can still utilize industry standard RJ45 modular plugs, but if you want the extra security provided by this clip frame, then you can order compatible connectors via the Acromag ESA-CTK Cable Termination Kit. This kit includes the male plug and sleeve housing that mate to the RJ45 frame of the enclosure for one end of CAT5 cable (cable not included). You will also need a modular plug crimping tool for attaching the plug provided to your cable.

HOST PC CONNECTED DIRECTLY TO UNIT

Note: This MDI to MDI-X connection does not require a crossover cable.



If your unit is a Model ES2113-1xxx, it includes both a 100FX fiber port and a 10BT/100BTX copper port. To connect directly to the fiber port from your PC, you will need a compatible NIC card installed in your PC, or a media converter. Note that the auto-crossing feature does not apply to fiber connections and the Tx and Rx fiber channels must be mechanically crossed.

Optionally, you may use an external Ethernet switch to connect to your EtherStax unit (recommended). The recommended approach for switched Ethernet is to connect one unit or Ethernet device per switch port. This is the most efficient and deterministic method of communication as it increases network throughput and eliminates data collisions.

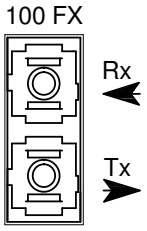
The next section reviews the operation of Ethernet hubs and switches as it relates to the built-in Ethernet switch of this device, which may optionally operate as an Ethernet hub/repeater. You can skip the next two pages if you are already familiar with these terms.

CONNECTIONS

Network – Basic Connections

Your host PC will require that a 10/100M network interface card (NIC) for Ethernet be installed to connect to the EtherStax unit. You may connect to port 1 or port 2 of the EtherStax. The EtherStax unit is auto-crossing, allowing you to use a regular or crossover cable to make connections.

IMPORTANT (Fiber Models): *Some models will substitute an SC-type fiber port connector for port 1. The auto-crossing feature of these units does not apply to the fiber connection and transmit must be manually crossed over to receive, and visa-versa. Facing the front end-plate of the unit, the Transmit (Tx) channel is the bottom half of the SC style connector, while the top half is Receive (Rx).*



COM STATUS		SWITCH MODE LED Column 1 - Port 1 LED Column 2 - Port 2	HUB/REPEATER MODE 1=LED of Column 1 2=LED of Column 2
● ●	GREEN	No Function in Switch Mode.	1=Hub Activity, 2=Hub Collision.
● ●	YELLOW	Link/Activity - ON if Linked/Blinks if Activity.	1=MII/CPU Link/Activity, 2=MII/CPU Error.
● ●	YELLOW	Full-Duplex/Collision - ON for Full-Duplex, Blinks for Half-Duplex Collisions, OFF for Half-Duplex and No Collisions.	1=Port 2 Link/Activity, 2=Error at Port 2.
● ●	YELLOW	Speed - ON for 100Mbps, OFF for 10Mbps.	1=Port 1 Link/Activity, 2=Error at Port 1.
1 2	Refer to Specifications - Controls & Indicators Section for more detail.		

CONNECTIONS

Network - Background

Hubs & Switches

To properly network connect this device, you need to know a little bit about network hubs and switches. Please take a moment to review this material before installing your unit.

Switched Ethernet involves connecting one Ethernet device per switch port. This suppresses CSMA/CD and allows the segment to operate full speed in full duplex. A throughput of 100M at half-duplex effectively doubles with full-duplex. This provides a more reliable and deterministic communication link, as no data collisions are possible.

This device has a built-in Ethernet switch that can alternately operate as an Ethernet hub. To understand which mode to use and how to network connect Ethernet devices, you need to review switch operation and the differences between a switch and a hub. If you are already familiar with these terms, skip over this information and review the various network connections outlined in the following pages.

An Ethernet hub (or repeater) is a device that simply connects Ethernet nodes. Any message at one hub port is repeated on all ports. That is, hubs forward data packets they receive from a single station to all hub ports. As a result, all port devices connected to a single hub will share the same bandwidth. Then as nodes are added to the network hub, they compete for this finite amount of bandwidth (at 10Mbps or 100Mbps). This can cause data collisions to occur and makes network determinism impossible, particularly on busy networks. Determinism is a term that is used to describe the ability to guarantee that a packet is sent or received in a finite and predictable amount of time. In the past, lack of determinism is the main reason that Ethernet has had problems being accepted for use in critical control applications, as most control systems have a defined time requirement for packet transmission, typically less than 100ms.

An Ethernet switch (or switching hub) is an intelligent device that is used to more efficiently connect distributed Ethernet nodes than a hub. Unlike a simple hub, a switch provides *targeted* data transfer, as it will forward a data packet to a specific port or network segment, rather than all ports, thus freeing up bandwidth. The ability to target a packet to a specific port increases network throughput and helps to eliminate the collisions that historically make Ethernet non-deterministic.

- Switches act as intelligent repeaters to increase network distance.
- Switches split networks into separate collision domains at each port.
- Switches provides determinism by reducing collisions.
- Switches increase network bandwidth/throughput.
- Switches can provide supplemental error checking.

With Ethernet, any device can try to send a data frame at any time. The arbitration protocol for carrier transmission access of the Ethernet network is called Carrier Sense Multiple Access with Collision Detect (CSMA/CD). If two devices happen to send a data frame at the same time, then a collision may occur. With CSMA/CD, each device will first sense whether the line is idle and available for use. If it is, the device will begin to transmit its first frame. If another device also tries to send a frame at the same time, then a collision occurs and both frames are discarded. Each device then waits a random amount of time and retries its transmission until it is successfully sent.

Unlike other Ethernet devices, such as an Ethernet host adapter or Network Interface Card (NIC), the port of a switch does not require its own MAC address. During retransmission of a received packet, the switch port will instead look like the originating device by having assumed its source address. This is why the Ethernet collision domain is said to terminate at the switch port. That is, a two-port switch will effectively break a network into two distinct data links or segments (also called *collision domains*). Since all Ethernet nodes are able to recognize the occurrence of a collision, and since the detection of a collision is principal to the way Ethernet arbitrates media access, large domains containing many nodes can become cumbersome.

Thus, using an Ethernet switch to subdivide a large network into separate collision domains will certainly help to increase throughput. Each port of a switch forwards data to another port based on the MAC address contained in the received data packet/frame. In order to know which port to forward a data packet to, the switch will learn and store the MAC addresses of every device it is connected to, along with the associated port number (up to 1024 MAC addresses are stored in high speed SRAM). However, until the switch actually learns the switch port a particular MAC address resides at (after the first packet), it forwards this initial packet traffic to all ports. The switch will use the internal look-up table to quickly determine the location (port) of a node, establish a temporary connection between itself and the node, then terminate the connection once a packet is transferred. In this way, it increases network bandwidth and provides the network determinism required for critical control applications.

Most switches use a *store and forward* algorithm to process Ethernet frames. That is, it first stores the Ethernet frame and examines it for errors before forwarding it to its destination. Although in some case this method may seem to increase the forwarding time (latency) and possibly cause fragmentation, it can also effectively reduce the occurrence of error frames and improve overall throughput for most applications. This is particularly useful where there is heavy network traffic and or greater potential for noise and interference.

The optional hub/repeater mode of this switch provides low-latency network packet transmission that effectively reduces jitter on the network. Ethernet switches have higher inherent latency that varies with packet size due to their store-and-forward behavior. Thus, operation in switch mode adds latency and results in possible latency deviations up to 167us (jitter). In hub-mode, there is a maximum port-to-port latency of only 310ns with a total deviation of only 40ns. This is because hubs immediately repeat the bits arriving on one port at their other ports, rather than storing the entire message first before forwarding it as switches do. This sometimes makes them more useful for transmission of time-critical data, or for reducing latency where there is concentrated link traffic (like the main trunk of cascaded units).

We can also use the hub mode of this switch to implement media redundancy to this device. That is, if you connect the EtherStax to an external switch that happens to support media redundancy via a proprietary ring method, or the Spanning Tree Protocol (STP), or Rapid Spanning Tree Protocol (RSTP), then the EtherStax unit can be placed in "hub mode" and you can connect a cable to both ports. The external redundant switch will sense the redundant path and disable it temporarily. If the primary path should later fail, then the external switch can reactivate the other path, effectively providing media failover protection right to the unit.

Note that Acromag offers several industrial managed and unmanaged Ethernet switch models that can be used to interface to this product (please consult the factory or visit www.acromag.com).

Some examples of various types of network connections using Ethernet switches are included in the following pages.

CONNECTIONS

Network - Background

Hubs & Switches

The current tendency in critical industrial control applications is to connect one Ethernet device per switch port. This will produce the most deterministic mode of operation as the switch can operate full-duplex, with no chance of collisions. This ensures determinism, helping critical control applications to remain predictable and on-time.

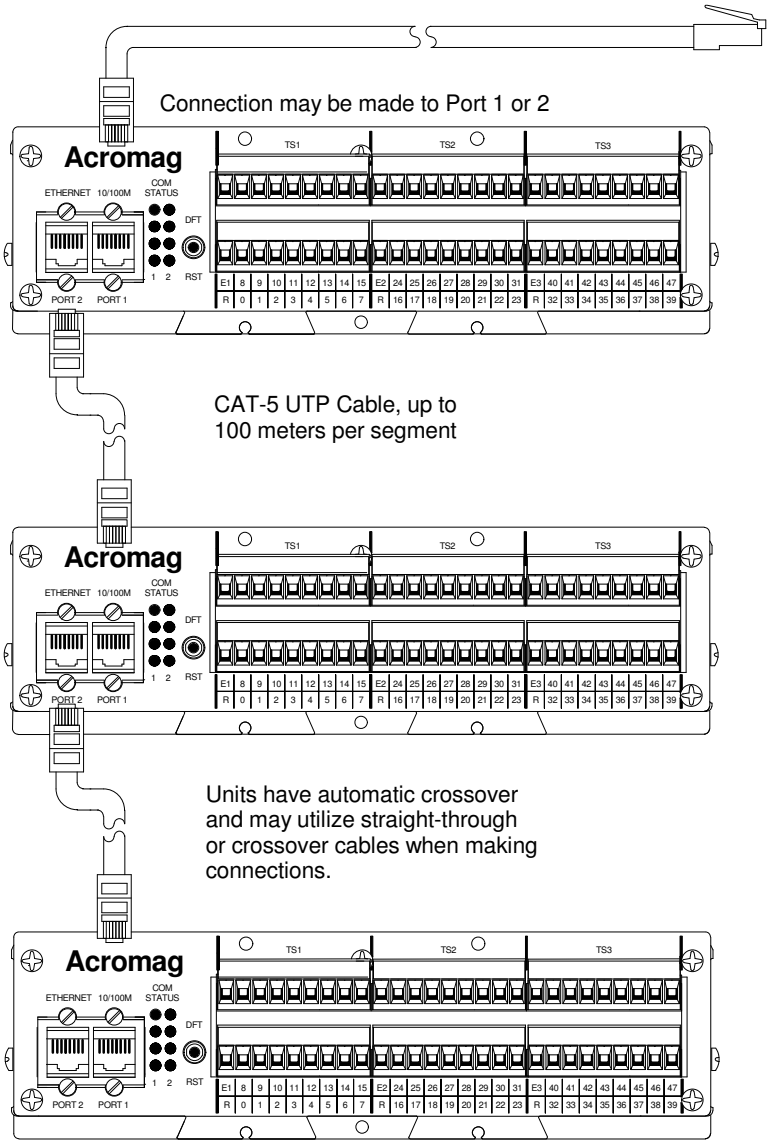
CONNECTIONS

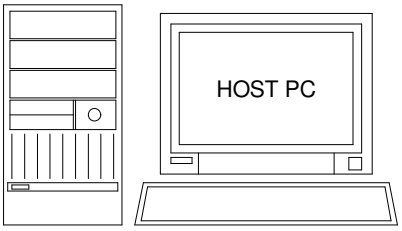
Network

The unit includes two Ethernet ports for convenient cascaded network connections as shown here. This is also useful for extending the network as each segment may extend up to 100 meters.

Note that data collisions are still possible in the first two network segments shown below as these connections carry the data of more than one unit.

You can isolate each segment and prevent collisions using an external Ethernet switch connected as shown in the diagram of the following page (our recommended approach).





You can connect directly to a Host PC with a NIC installed, or via an Ethernet switch.

CASCADING UNITS

Connections may use Port 1 or Port 2.

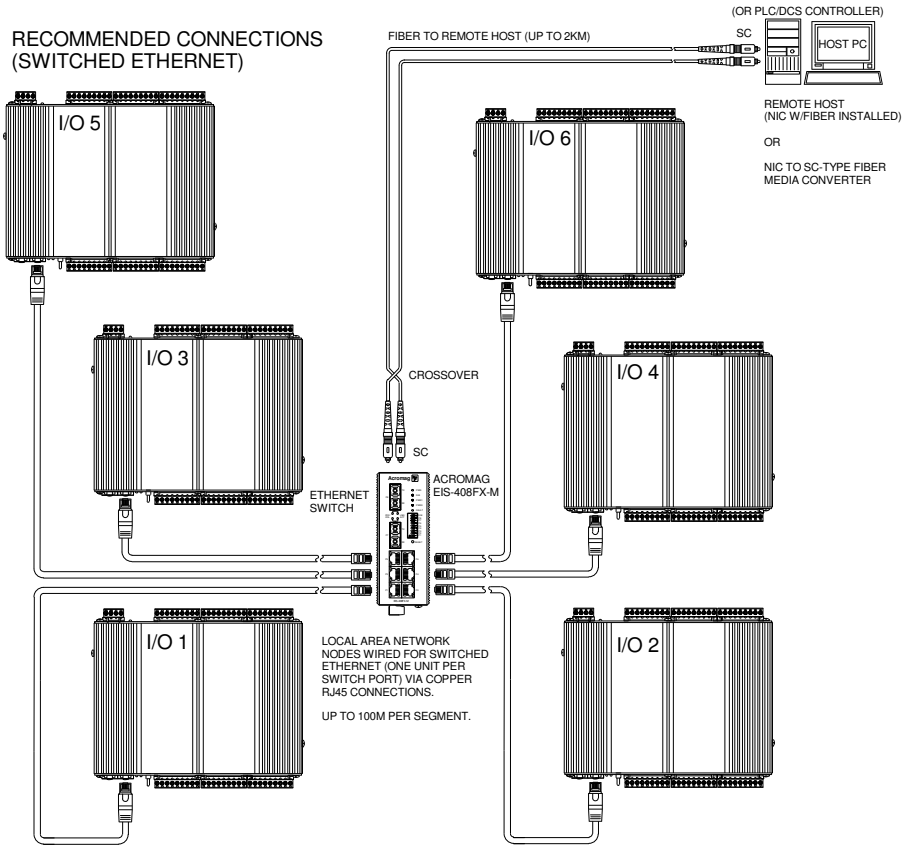
Limit cascaded connections to 4 segments.

Limit cable segments to 100M in length.

You may use straight-through or crossover cables.

TIP: You can significantly enhance the EMI/RFI performance of your network connections by using Category 5E STP cable (Shielded Twisted Pair) cable. The use of shielded cable is strongly recommended for installations in harsh industrial environments and/or in the presence of strong electrical fields. For more information on cable, refer to the Cables & Connectors section at the back of this manual.

You can use an Ethernet switch or switching hub to build a network of Etherstax units, similar to that shown below. The drawing depicts our recommended approach to distributing I/O via switched Ethernet—that is, one EtherStax unit is connected per switch port.



The drawing above shows how to network-connect EtherStax units to an 8-port Ethernet switch (such as Acromag Model EIS-408FX-M). Note that the I/O LAN is distributed locally using copper/RJ45 cable connections (up to 100M per segment), and then connected to a remote (distant) host using fiber cable. The copper connections may use standard or crossover cables, as both the EtherStax unit and the Ethernet switch include automatic crossover, but it is generally not considered good practice to use crossover cables when connecting to an auto-crossing switch.

The switch shown above could be eliminated, if you were connecting to an EtherStax Model ES2113-1000, which includes one fiber port and one standard RJ45 port. For example, you could use the fiber port built into the EtherStax to connect to the distant host using fiber, then add an additional EtherStax locally via its RJ45 port, similar to that shown on the next page. However, the traffic of both units would still be concentrated in the main trunk from the host, and this does not follow the key principle of switched Ethernet, which seeks to suppress CSMA/CD and prevent data collisions by connecting only one device per switch port.

CONNECTIONS

Network

The drawing at left gives our recommended approach to making network connections to the EtherStax via switched Ethernet.

Here we show one EtherStax unit connected per switch port. Thus, each segment is limited to the traffic of only one device and no collisions are possible. This provides the most deterministic method of network communication. Only the segment between the host and the switch carries the traffic of multiple units and collisions are still possible in this segment.

Note that fiber connections must be crossed over, as the auto-crossing feature only applies to copper connections.

***OBSERVATION:** The extra copper port of any of these units can optionally connect to other network devices, but the resulting concentrated traffic in the upstream network segment would violate the goal of switched Ethernet which is to limit the traffic on each segment to the traffic of one device, suppressing CSMA/CD. This is generally not a problem for a small number of cascaded units.*

For many cascaded nodes, it is good practice for the upstream network segment to use a data rate that is 10x the data rate of the downstream nodes, otherwise careful attention must be paid to limiting the number of Ethernet devices that traffic on this segment.

CONNECTIONS

Network

The drawing at right gives an alternate method for connecting to a remote host, while still retaining the benefit of switched Ethernet between two nodes.

This still adheres to the principles of switched Ethernet because the network ports of the EtherStax are provided by an internal 3-port Ethernet switch.

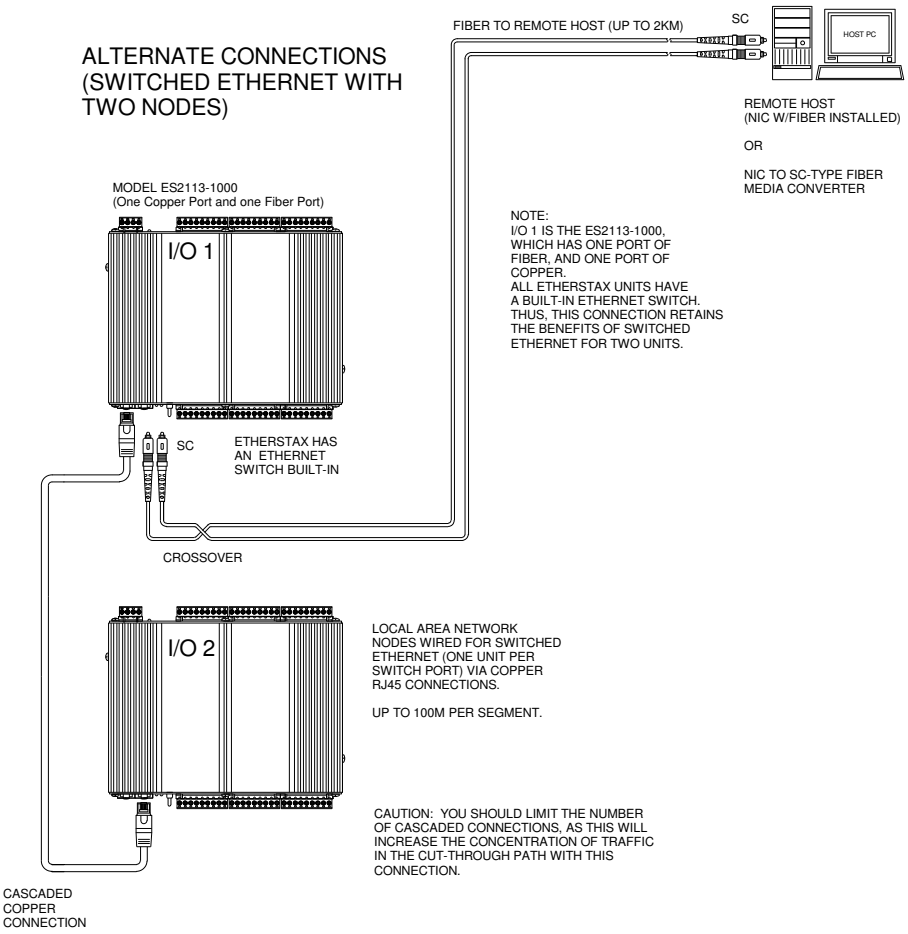
However, note that the fiber connection carries the traffic of both units and this segment is subject to data collisions.

Likewise, if you add a third unit, I/O3, cascaded from I/O 2, then the first copper segment carries the burden of the traffic of I/O 2 and I/O 3. This would not promote the benefit of switched Ethernet in this segment where we attempt to limit the traffic on a switched segment to a single device and suppress the need for CSMA/CD.

***WARNING:** Never use the EtherStax as a bridge device connected in series within your enterprise LAN, as the effect of concentrated traffic in the shared segment could inhibit communication to/from your EtherStax unit.*

Ideally, the shared segment link that carries the concentrated 100Mbps traffic should operate at a higher data rate, like 1Gbps, which this switch does not support

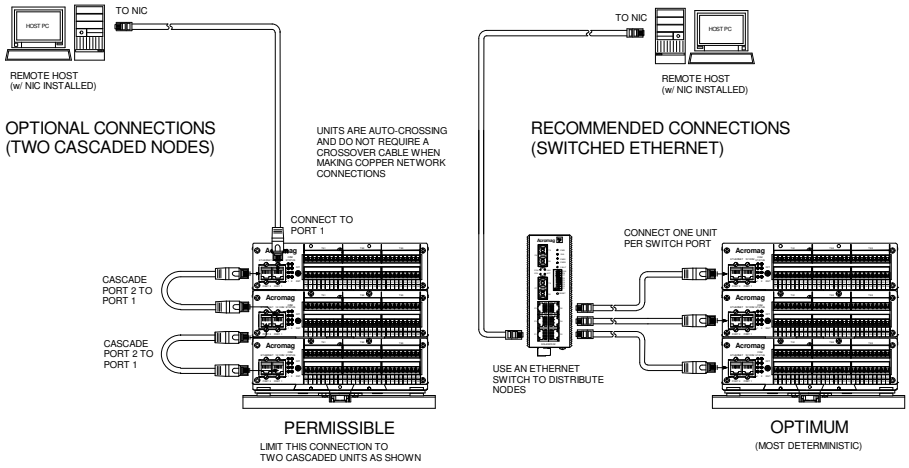
Unfortunately, you cannot avoid concentrated traffic in the main host segment, even with a switch. As such, this aggregate path is usually chosen to operate at a higher data rate than the downstream segments. With the traffic of many Ethernet devices, this would mean that if the main trunk runs at 100MB, then the downstream nodes should operate at 10MB (or 100MB if the main trunk was 1Gbps, which the switch of the EtherStax units does not support). If you cannot easily increase the bandwidth of this segment, then you should be careful to limit the traffic in this shared segment by limiting the total number of Ethernet devices connected downstream.



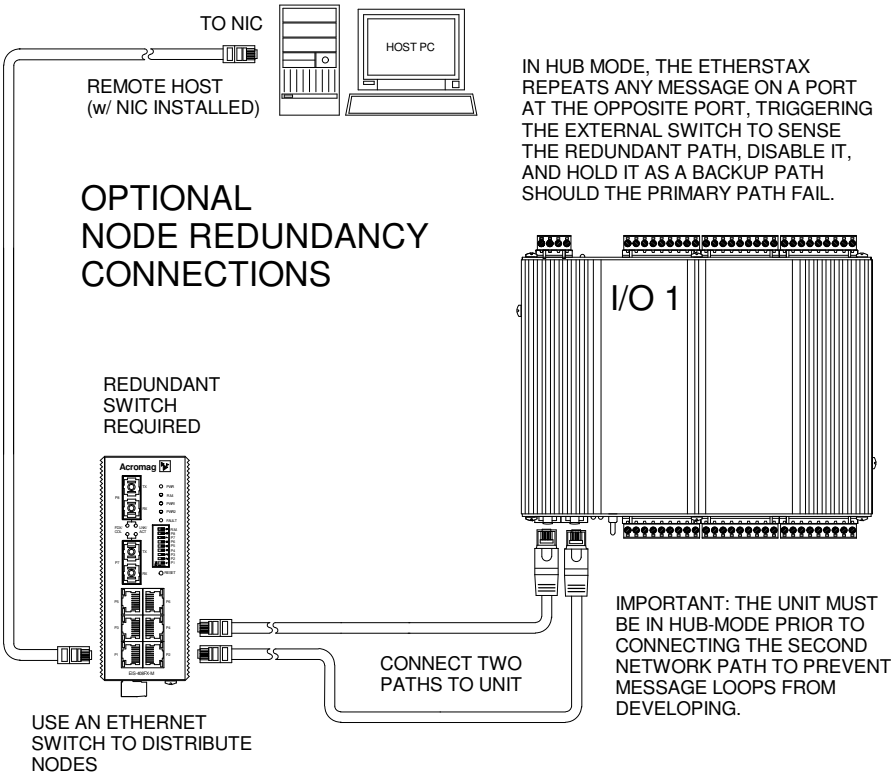
For optimum performance, the ideal recommended approach is to utilize an external Ethernet switch and connect no more than one Ethernet device per switch port—this is what is referred to as switched Ethernet. Connection in this manner avoids the negative effects of concentrated traffic and suppresses the need for collision detection. This effectively allows a segment to operate in full-duplex at the fastest possible speed. Thus, the throughput of 100M at half-duplex, can effectively approach 200MB when operating at full-duplex for switched Ethernet.

Although the connection shown above still retains the benefit of switched Ethernet without utilizing an external switch, it really only applies to the first two nodes. If you wanted to connect more than two nodes, but still retain the benefits of switched Ethernet, you would have to utilize an external Ethernet switch and connect one EtherStax unit per switch port.

Although it may be possible to cascade more than two additional EtherStax units (3 units), it is recommended that the number of units connected in this fashion be limited to 3 total (the recommended physical height of a single stack of EtherStax units), as shown in the following drawing.



Again, for the most deterministic approach, utilize an Ethernet switch and distribute connections as one Ethernet device per switch port as shown in the above right drawing.



Note: The EtherStax fiber port does not operate in hub mode and cannot be used in redundant path applications.

CONNECTIONS

Network

Network – Redundant Media Connections (Optional)

Recommended for High-Reliability Applications

When the EtherStax network port is placed in hub/repeater mode, it can support media redundancy right to the node if connected to a redundant switch as shown at left.

CONNECTIONS

Network -

Redundant Media Connections (Optional)

Recommended for High-Reliabilty Applications

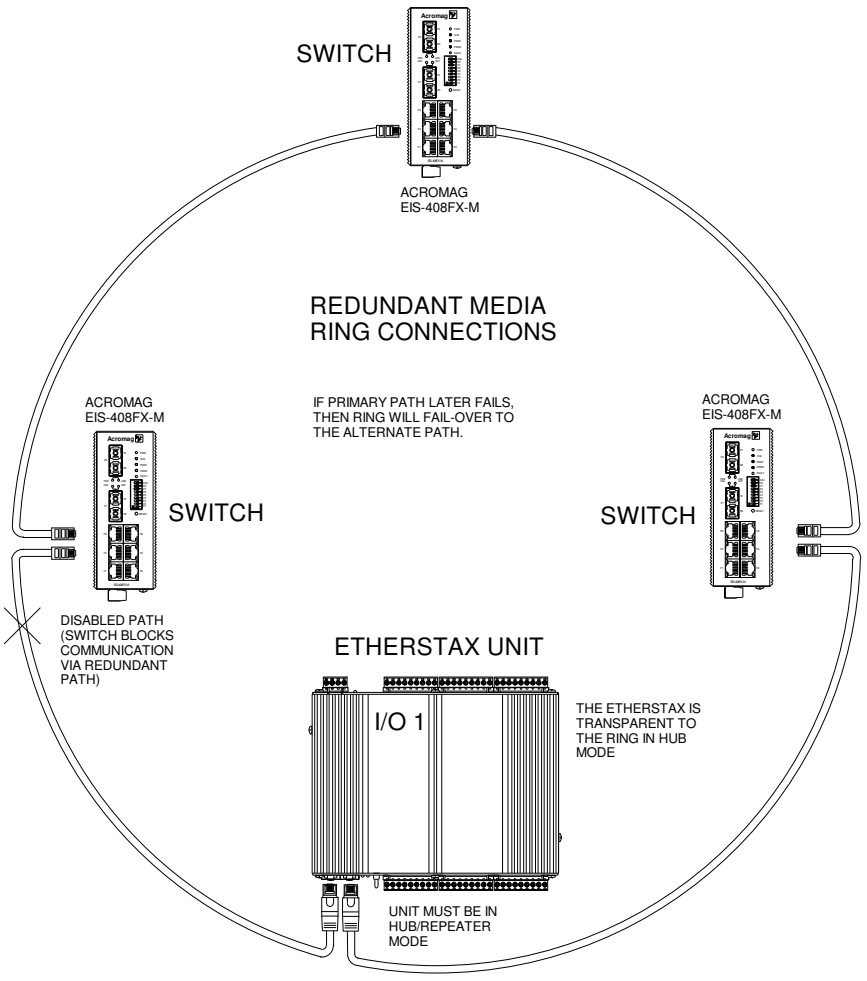
TIP: *If you connect to both ports of this device at the same time from your network, and you notice that the unit is cyclically resetting itself, then this may indicate that your network connections or external network switch(es) are not already setup to handle redundant media connections. Do not connect to both network ports unless your network redundancy status has already been established. Otherwise, message loops may develop that could cause the unit to periodically reset itself.*

Failure to place the EtherStax unit in hub/repeater mode for redundant media connections may prevent the external network switch from detecting the redundant path causing unpredictable results.

Note that all units operate at 100Mbps and half-duplex in hub/repeater mode.

This device has dual Ethernet ports provided by a built-in Ethernet switch. Normally the second port connection provides a convenient cascaded network connection, or is used for extending the network, or to provide media conversion. But this integrated switch also has an alternate operating mode as a hub/repeater. As a hub, anything sent in one port is immediately transmitted out at the other port. This adds much lower latency. Additionally in this mode, if you connect both ports of this device to a redundant switch, or redundant switch network, the external switch will sense the redundant path and automatically disable the second path to this device, holding it as a backup in case of primary path failure. This behavior is completely managed by the redundant switch, making the EtherStax compatible with current proprietary media redundant ring methods, Spanning Tree (STP), or Rapid Spanning Tree (RSTP), but limited to half-duplex operation (hubs are half-duplex devices).

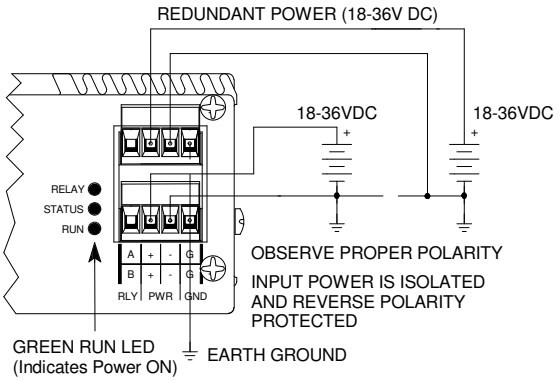
The figure below depicts the EtherStax unit connected to a redundant switch media ring. Here we use an Acromag EIS408FX-M switch to build the ring which supports redundant ring. The EtherStax unit must be placed in hub/repeater mode prior to making these connections. Connected this way, the EtherStax looks just like an Ethernet hub to the ring and operates transparent to the media ring. The redundant path fail-over and recovery are managed entirely by the external switch.



Power

✓ Connect 18-36V DC to the power terminals PWR + and PWR – and observe proper polarity. Optionally connect redundant backup power to the second set of terminals. For supply connections, use No. 14 AWG wires rated for at least 75°C. **CAUTION:** Do not Exceed 36VDC peak.

DC POWER CONNECTIONS



Each of the power inputs is series diode-coupled, providing reverse polarity protection and allowing external redundant drive. You cannot use the second set of power terminals to cascade power to other units because of this diode. With redundant power connections, the higher connected voltage will carry the load, and if that supply later fails, the lower voltage supply will carry the load.

CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize equipment before servicing.

IMPORTANT – External Fuse: If this unit is powered from a supply capable of delivering more than 3A to the unit, it is recommended that current to the unit be limited via a high surge tolerant fuse rated for a maximum current of 4A or less (for example, see Bel Fuse MJS series). Failure to limit peak input current can damage the transient protection (shunt) of the input power terminals for sustained surge or continuous over-voltage conditions.

Input Power ES2113-0

Voltage	Current
18VDC	189mA Typ
24VDC	143mA Typ
36VDC	96mA Typ

Input Power ES2113-1

Voltage	Current
18VDC	249mA Typ
24VDC	187mA Typ
36VDC	127mA Typ

Above is typical power with internal excitation enabled and all outputs ON (sinking ~2mA).

As a rule, your supply should be capable of providing at least twice the maximum current draw of the unit (for inrush). Your series fuse should also be minimum rated for greater than twice this current also.

Additional external I/O port excitation is required for most applications and specific requirements will vary with your load.

Earth Ground

✓ Connect Earth Ground as shown in the connection drawings for best results. Additionally, connect the unit's GND terminal (G) to earth ground as shown above. Alternately, you may utilize the earth ground screw at each side of the enclosure to complete the earth ground path.

In some cases, additional earth grounding is recommended at your I/O. If sensors are already grounded, use caution and avoid adding ground connections which could create ground loops. If your loads happen to be conducting higher currents, or are displaced more than a few feet from the unit, it may be necessary to make these ground connections local to the I/O return terminals for improved transient response.

The enclosure is common to the ground terminals and isolated from the other circuits. Transient energy is shunted to this ground via isolation capacitors and transient voltage suppressors. You must connect earth ground to complete this path and ensure protection. Additional earth grounds may be recommended at the I/O return leads (see connection drawings).

Warning: *To comply with safety and performance standards, use shielded cable and connect earth ground as noted. Failure to use good wiring and grounding practices may be unsafe and hurt performance.*

Alarm Relay

The relay LED indicates the energized state (ON) of these SPST contacts.

You can configure these contacts as failsafe or non-failsafe.

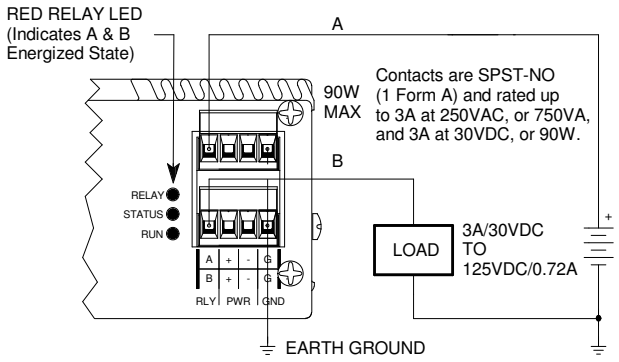
If you select failsafe contacts, then you can also use this relay to signal a power failure (contacts de-energize when power fails).

***IMPORTANT:** External contact protection is required for use with inductive loads. Failure to use adequate protection may reduce the life of the contacts or damage the unit.*

For AC inductive loads, the use of AC-rated capacitors, Metal-Oxide Varistors, or RC-snubbers will help to shunt voltage transients away from relay contacts and extend their life when switching inductive loads. Use a reverse-biased diode at the load for DC inductive loads.

✓ The local alarm relay contacts are located adjacent to power and are labeled A & B. These contacts are switched for conditions of media failure (link loss), watchdog timeout, or power failure (failsafe only). Contacts are normally open type (de-energized), but configurable as failsafe (normally energized), or non-failsafe (normally de-energized)

ALARM RELAY CONNECTIONS - DC LOAD

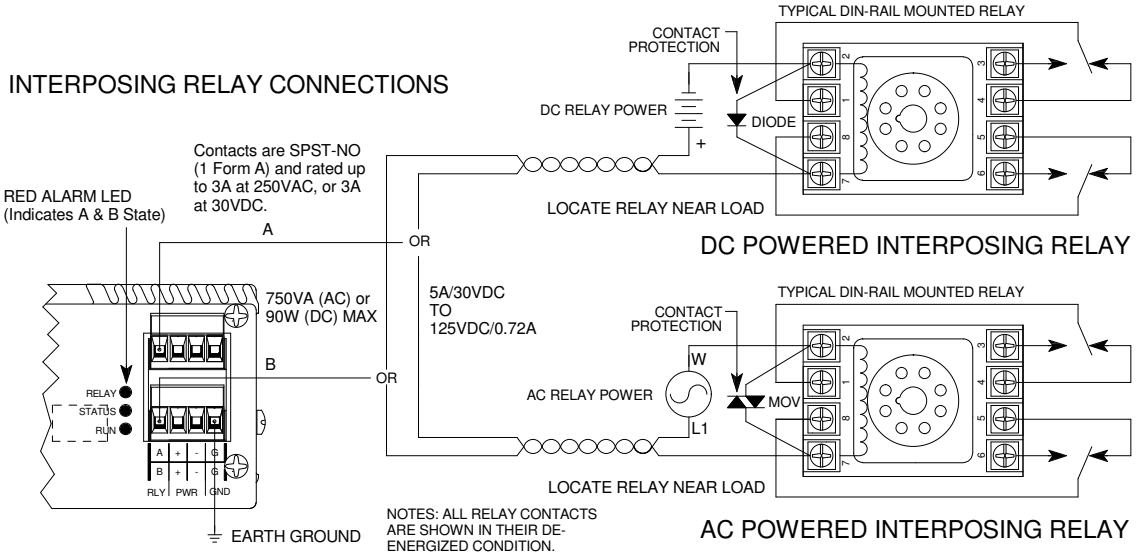


Relay contacts are AC rated to 3A at 250VAC, or 750VA, and DC rated to 3A at 30VDC, or 90W. The maximum switching voltage is 270VAC and 125VDC, and maximum switching current 5A. Your AC application voltage/ current must not exceed 750VA and 250VAC and 5A. Your DC application voltage/current must not exceed 90W and 125VDC and 5A. For control of higher energy devices, use an interposing relay connected as shown below.

IMPORTANT: The relay ratings given apply when switching resistive loads, which are electrically quiet when powered up. For example, an LED lamp is considered a resistive load. On the other hand, inductive loads can be very hard on relay contacts and generally have violent startup voltage and ampere requirements that exceed the steady-state requirements. An electric motor or transformer would be an inductive load.

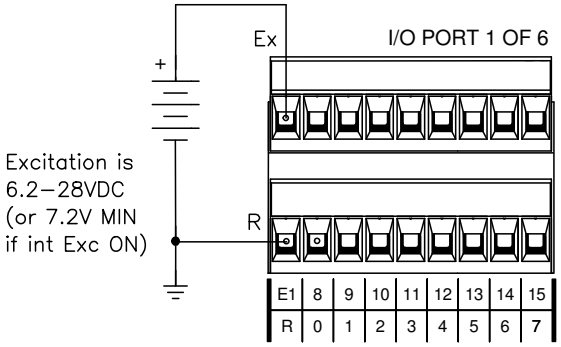
As such, inductive loads typically require 2-3x the runtime voltage or current when power is first applied to the device. Thus, your switch contact voltage and ampere ratings should be selected 2-3x the nominal steady-state requirements of your load. Choosing a relay that is 2-3x more powerful than your rated application is the best way to extend the life of relay contacts.

INTERPOSING RELAY CONNECTIONS



✓ There are six ports of 16 I/O channels each. You must connect external excitation to each port in order to operate the I/O channels. Optionally, you may utilize internal excitation for low current/voltage applications (see below). Connect a 7.2-28V supply to the port excitation (Ex) and Return (R) terminals. This supply should be able to deliver up to 268mApk (with 16mA wetting current ON), plus any output load current, to each port. Outputs may sink up to 0.45A per channel and 3.6A per port from an external excitation supply.

PORT EXCITATION



External excitation over-voltage in range of 28-35V will cause the over-voltage fault flag to be set and the output port to be temporarily shut-down. Normal operation is resumed with return to proper voltage. Upon recovery, all port outputs resume their prior state, or remain OFF, according to the bit settings of the Global Shutdown & Retry Control register.

IMPORTANT – Optional Use of Internal 6.1V excitation
This unit includes an internal, diode-coupled, excitation supply at 6.1V (before diode) that allows the I/O to drive ~2mA/channel (the input wetting current) without connecting excitation. It can also be useful as a redundant backup in some applications. Internal excitation is OK for low current/low voltage applications, but may be turned OFF if you are using external excitation, or if you wish to drive higher currents at low voltages. Note that if internal excitation is left ON, your external supply must connect a voltage at least 0.7V above the internal excitation voltage in order to drive the port, as the port Ex terminal is diode-coupled for reverse polarity protection and redundant supply operation. This diode also blocks the internal excitation supply from sourcing additional current to the load, beyond that provided via the wetting current generators of each input channel. The input wetting currents are reduced to approximately 1.6mA and 12mA typical, if only internal excitation is used and will vary slightly with number of channels ON.

TIP: You can safely connect excitation voltages up to 31V and the unit will not be damaged, if you really need to sense these input levels. This is the I/O transient voltage suppressor working voltage limit. Note that the tandem outputs may temporarily shut down their operation for excitation voltages above 28V (30V typical).

CONNECTIONS

Excitation (Each Port)

You must connect excitation to the port in order to operate I/O.

Internal excitation of 6.1V is enabled by default and only suitable for low current and voltage applications. You can turn this OFF if connecting external excitation, or if you wish to raise the drive capability at low voltage. You will not damage the unit if both internal excitation is enabled and external excitation is connected.

Connect a supply from 7.2-28VDC (or 6.2-28V with internal Ex OFF). The excitation terminal already includes a series connected diode for reverse polarity protection.

The port Return (R) connections are connected in common, but the port excitation connections (E1-E6) are kept separate to allow different ports to operate at different voltage levels. This also means that you have to separately wire an excitation supply to each port, unless you are only utilizing internal excitation.

***Note:** Avoid programming 16mA wetting currents at a port with internal excitation, as internal current drive is limited to a total in the range of 0.5-1.0A.*

CONNECTIONS

Digital Inputs

Inputs are active-low, with 4V thresholds (3.7-4.3V range).

Most input connections do not require an external excitation source and can use internal excitation. Limit input voltages to less than 31VDC maximum.

Inputs include wetting current pull-ups to sense switch closure, which also allows the open-drain output to operate without adding a pull-up.

✓ Connect digital input signals to the input terminals as shown below. The tandem outputs must remain OFF in order to drive inputs externally.

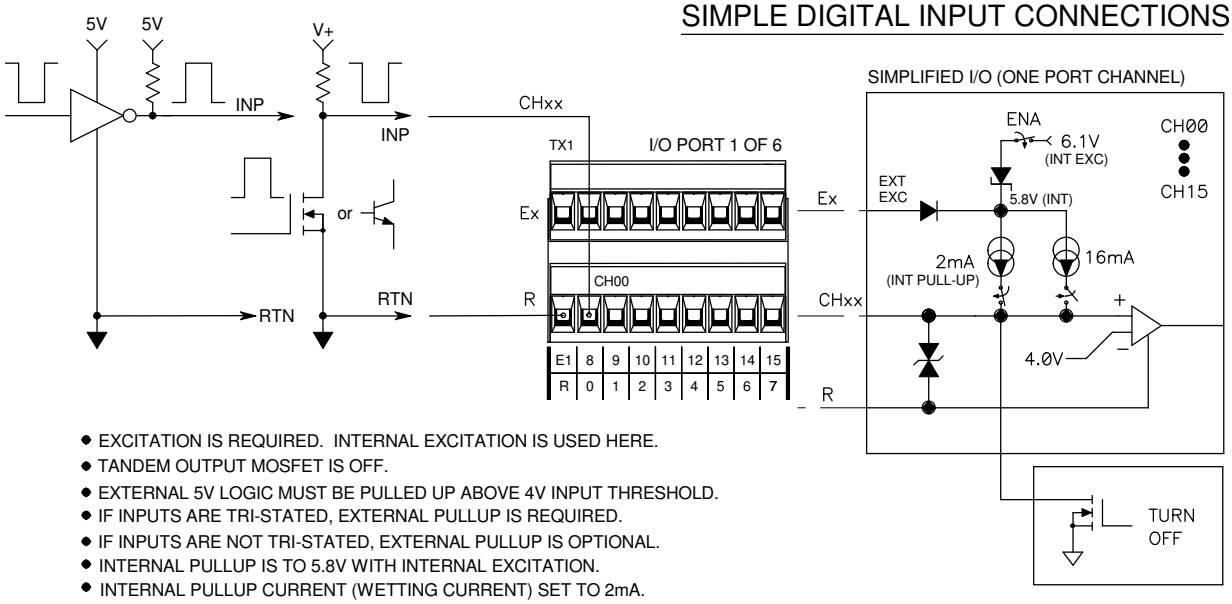
To drive the inputs from an external source, you must turn the corresponding outputs OFF, or the tandem output channel will be in contention with your external signal.

IMPORTANT: You MUST connect an excitation supply to the port excitation (Ex) and Return (R) terminals, or enable internal excitation, in order to operate I/O. External excitation should be from 7.2 to 28V and must provide 44mA (268mA peak), plus any output load current, for each port of 16 I/O channels. Your excitation voltage level will determine the effective input voltage range, as the input wetting current generators (pull-ups) are sourced from the excitation supply.

Inputs source wetting current to sense switch closure. This wetting current is sourced from the excitation supply. As such, your excitation voltage must be greater than your input signal level to effectively pull it up via the internal wetting current pull-ups.

By default, the internal wetting current is set to 2mA continuous, but may optionally be set to switch to 16mA for 20ms after crossing the 4V input threshold, then return to 2mA continuous. This higher level of initial current during transfer will help to prevent oxide buildup on external switch contacts. This current can also be turned OFF by tri-stating the port inputs. You may need to add an external pull-up to your logic driver in order to pull its output above the 4V input threshold (4.3V max), especially if the inputs are tri-stated.

SIMPLE DIGITAL INPUT CONNECTIONS



- EXCITATION IS REQUIRED. INTERNAL EXCITATION IS USED HERE.
- TANDEM OUTPUT MOSFET IS OFF.
- EXTERNAL 5V LOGIC MUST BE PULLED UP ABOVE 4V INPUT THRESHOLD.
- IF INPUTS ARE TRI-STATED, EXTERNAL PULLUP IS REQUIRED.
- IF INPUTS ARE NOT TRI-STATED, EXTERNAL PULLUP IS OPTIONAL.
- INTERNAL PULLUP IS TO 5.8V WITH INTERNAL EXCITATION.
- INTERNAL PULLUP CURRENT (WETTING CURRENT) SET TO 2mA.

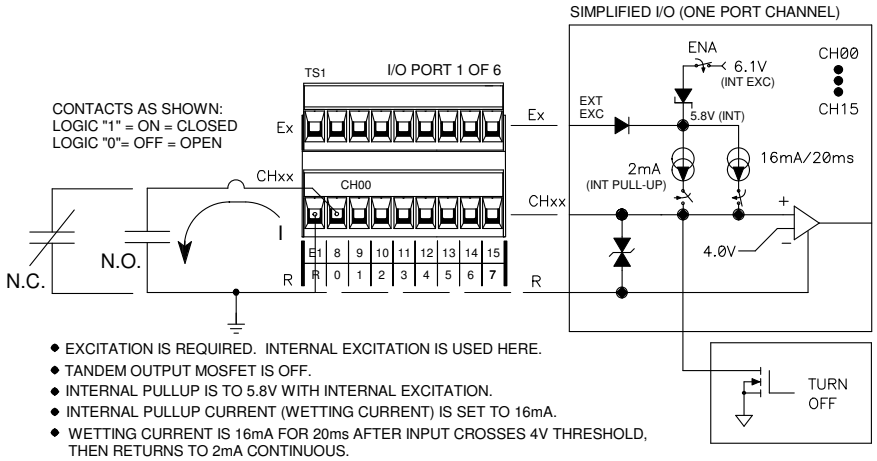
Refer to the examples that follow for other types of input connections.

CONNECTIONS

Digital Inputs

Refer to the examples below for other types of input connections.

DRY-CONTACT RELAY CONNECTIONS - NORMALLY OPEN OR CLOSED

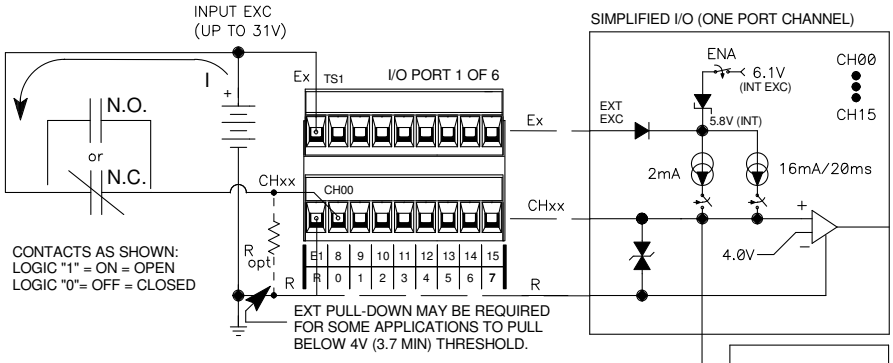


- EXCITATION IS REQUIRED. INTERNAL EXCITATION IS USED HERE.
- TANDEM OUTPUT MOSFET IS OFF.
- INTERNAL PULLUP IS TO 5.8V WITH INTERNAL EXCITATION.
- INTERNAL PULLUP CURRENT (WETTING CURRENT) IS SET TO 16mA.
- WETTING CURRENT IS 16mA FOR 20ms AFTER INPUT CROSSES 4V THRESHOLD, THEN RETURNS TO 2mA CONTINUOUS.

Normally Open (N.O.) or Normally Closed (N.C.) Dry Contact Relay.

Inputs use wetting current to sense the input switch state. This current normally goes to 16mA when the input descends below the 4V threshold, for 20ms, then returns to 2mA continuous.

DRY-CONTACT RELAY CONNECTIONS - NORMALLY OPEN OR CLOSED WITH EXTERNAL SERIES CONTACT EXCITATION



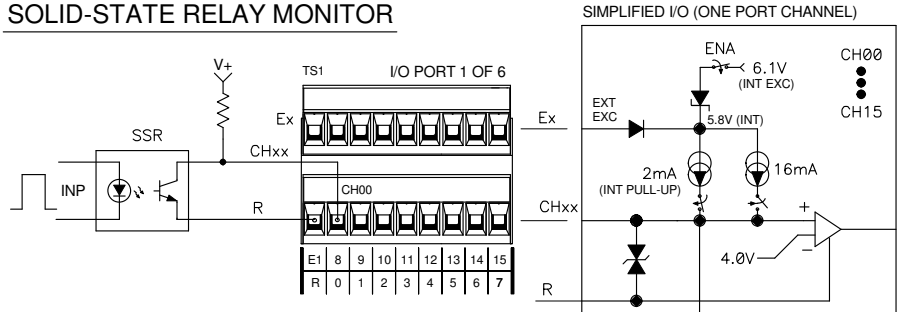
- PORT EXCITATION IS REQUIRED. INTERNAL PORT EXCITATION IS ENABLED HERE.
- TANDEM OUTPUT MOSFET IS OFF.
- PORT INPUTS ARE TRI-STATED TO TURN OFF WETTING CURRENT PULL-UPS.
- DO NOT ALLOW UNUSED TRI-STATED INPUTS TO FLOAT.
- AN EXTERNAL PULL-DOWN RESISTOR MAY BE REQUIRED FOR SOME APPLICATIONS.
- LIMIT EXTERNAL INPUT VOLTAGE TO 31V MAX.

NOTE: IT IS ACCEPTABLE TO UTILIZE THE 24VDC POWER TO THE UNIT TO DRIVE THE EXCITATION TERMINAL AND/OR THE CONTACT EXCITATION.

Normally-Closed Dry Contact Relay with Series Contact excitation

Do not exceed 31V at the inputs.

SOLID-STATE RELAY MONITOR



- PORT EXCITATION IS REQUIRED. INTERNAL EXCITATION IS USED HERE.
- TANDEM OUTPUT MOSFET IS OFF.
- EXTERNAL DRIVER MUST BE PULLED UP ABOVE 4V INPUT THRESHOLD.
- EXTERNAL PULLUP IS ADDED HERE TO INCREASE CURRENT.
- INPUTS MAY OPTIONALLY BE TRI-STATED TO TURN OFF WETTING CURRENT.
- INTERNAL PULLUP IS TO 5.8V WITH INTERNAL EXCITATION.
- IF NOT TRI-STATED, INTERNAL WETTING CURRENT IS SET TO 2mA.

Solid-State Relay (SSR) Monitoring

Tri-stating the inputs will turn off the wetting current pull-ups and the input will then act like a high-impedance comparator with a 4V logic threshold. If tri-stated inputs are left unconnected, the I/O channels float and will need to be tied OFF to properly register the OFF state (you could use output open-load detection to pull-down unused tri-stated inputs—see TIP below).

CONNECTIONS

Digital Inputs

For TTL I/O, verify that your logic drivers are capable of being pulled up above 4V without incurring damage. Enable internal port excitation to power the unit's I/O circuit. Tri-state the port inputs to disable their internal pull-up. Outputs of a port will require external pull-ups to keep them from floating (if unused), or in order to drive TTL inputs, while the port is tri-stated.

Digital Outputs

Outputs are the open-drains of mosfet switches and are intended for DC current-sinking applications only, 450mA maximum with up to 3.6A per port, or 300mA maximum and 4.8A per port.

***Note:** By default, outputs will turn OFF (open) following a software reset, or power interruption to the unit. Optionally, you can configure a post power-on/reset state for port outputs.*

A series blocking diode in the Ex terminal prevents internal excitation from sourcing current to the load, beyond the built-in 2mA I/O wetting current. For greater drive capability, use an external excitation source.

Do NOT connect outputs to voltages greater than 31V or damage to the I/O port may result. The 31V limit is the working voltage limit of the built-in transient voltage suppressors at each I/O channel.

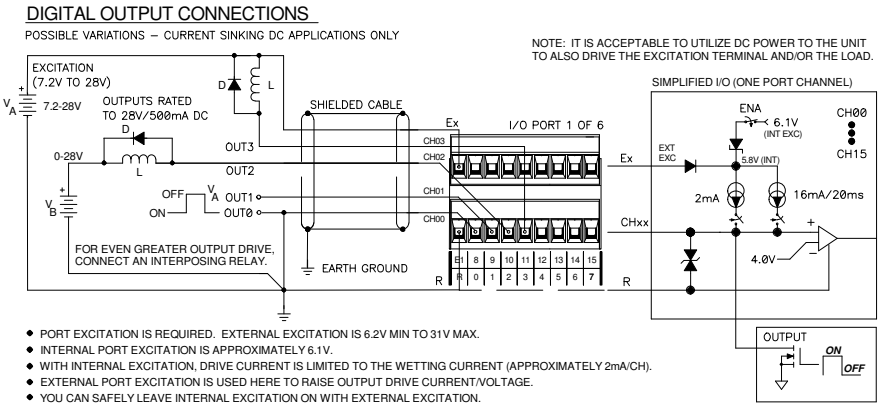
TIP: You can increase wetting currents by paralleling I/O channels, or by adding an external pull-up resistor to an external excitation source.

TIP: Unused tri-stated inputs can be pulled to the ON state if you also enable the tandem output open-load detection (adds 50uA pull-downs in the output OFF state).

Note that wetting currents are slightly lower than 2mA/16mA for excitation voltages below 7.2V. For example, they are approximately 1.6mA/12.2mA with only internal 6.1V excitation enabled. This current will also vary slightly with the number of channels turned ON. Use external excitation above 7.2V to properly regulate this current to the 2mA/16mA levels.

Although inputs will not be damaged by input voltages up to 31V with only internal 6.1V excitation present, the internal wetting current generators (pull-ups) are sourced by the excitation voltage and your excitation voltage should be greater than your input signal voltage for the internal pull-ups to operate properly. These pull-ups are disabled with the inputs tri-stated.

✓ Connect your load to the output terminals as shown below. Limit load current to 450mA, and combined load currents to 3.6A per port, or 300mA per output and 4.8A per port.



Note - You must connect port excitation to operate I/O. Use of internal excitation provides only a limited output drive capability equivalent to the input wetting current. Your excitation voltage should be greater than your load voltage. Outputs may temporarily shut down for excitation voltages over 28V, or load voltages greater than 50V.

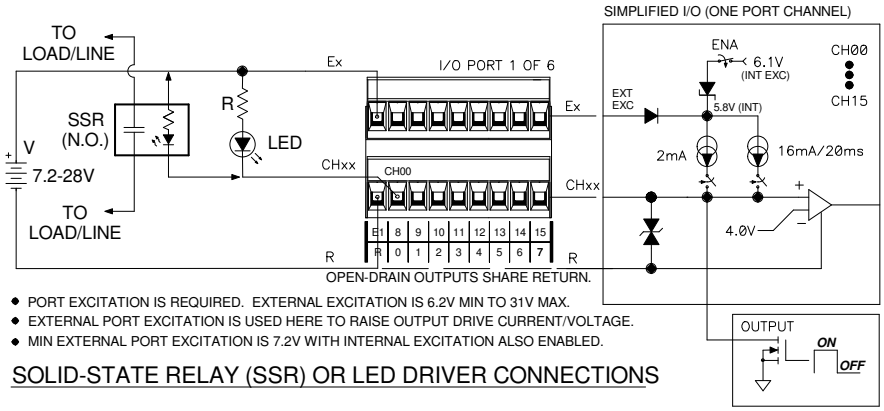
IMPORTANT – Add Protection With Inductive Loads: Outputs should include reverse-bias shunt diodes to help protect the output switch from damage due to the high reverse-bias voltages generated when switching inductive loads. You should add external protection near the inductive load to prevent these transients 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 (-).

LOAD GROUNDING: If your load is connected at some distance from the unit, or your load currents are high, earth grounding the return lead should be done local to the I/O terminals to allow the built-in transient protection to effectively shunt to earth via a low impedance path not affected by IR losses.

CONNECTIONS

Digital Outputs

Refer to the examples below for other types of output connections.



- PORT EXCITATION IS REQUIRED. EXTERNAL EXCITATION IS 6.2V MIN TO 31V MAX.
- EXTERNAL PORT EXCITATION IS USED HERE TO RAISE OUTPUT DRIVE CURRENT/VOLTAGE.
- MIN EXTERNAL PORT EXCITATION IS 7.2V WITH INTERNAL EXCITATION ALSO ENABLED.

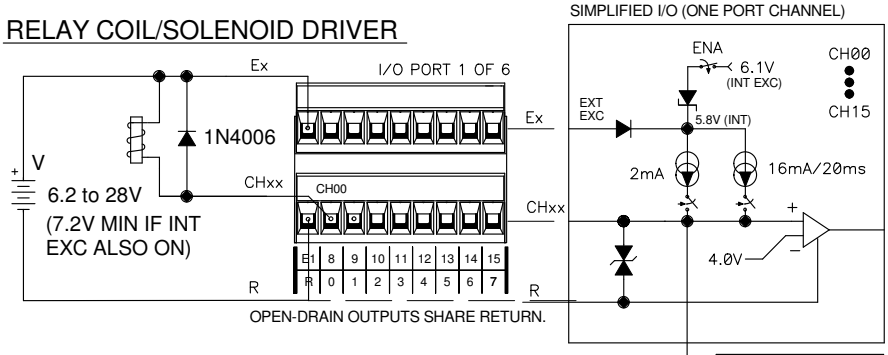
SOLID-STATE RELAY (SSR) OR LED DRIVER CONNECTIONS

Solid-State Relay (SSR) or LED Driver

You should also consider whether the open-load detection feature should be enabled, as this can pull 50uA of drive current through the load in the OFF state.

CAUTION: If Output Open Load Detection is enabled, up to 50uA of current will be pulled through the load with the output in the OFF state. Do not enable open-load detection if you are driving loads that cannot tolerate 50uA of "leakage" current in the OFF state.

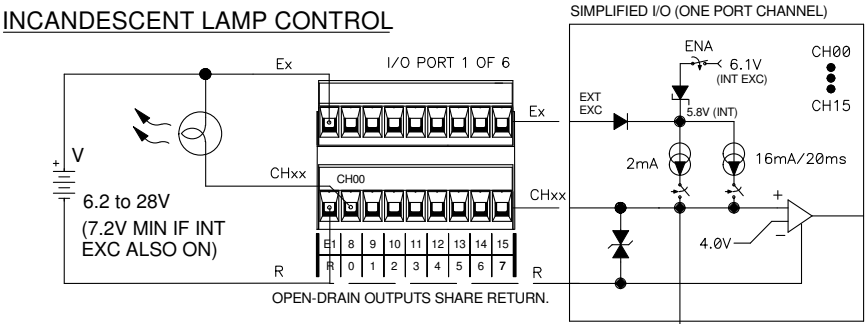
RELAY COIL/SOLENOID DRIVER



- NOTE PROTECTION DIODE REQUIRED WITH INDUCTIVE LOADS.
- PORT EXCITATION IS REQUIRED. EXTERNAL EXCITATION IS 6.2V MIN TO 31V MAX.
- EXTERNAL PORT EXCITATION IS USED HERE TO RAISE OUTPUT DRIVE CURRENT/VOLTAGE.
- MIN EXTERNAL PORT EXCITATION IS 7.2V WITH INTERNAL EXCITATION ALSO ENABLED.
- YOU CAN SAFELY LEAVE INTERNAL EXCITATION ON WITH EXTERNAL EXCITATION.

Relay Coil or Solenoid Driver (Note Protection – External "Snubbing" Diode at Coil)

INCANDESCENT LAMP CONTROL



- PORT EXCITATION IS REQUIRED. EXTERNAL EXCITATION IS 6.2V MIN TO 31V MAX.
- EXTERNAL PORT EXCITATION IS USED HERE TO RAISE OUTPUT DRIVE CURRENT/VOLTAGE.
- MIN EXTERNAL PORT EXCITATION IS 7.2V WITH INTERNAL EXCITATION ALSO ENABLED.
- YOU CAN SAFELY LEAVE INTERNAL EXCITATION ON WITH EXTERNAL EXCITATION.
- AVOID ENABLING FAST SHORT FAULT PROTECTION WITH INCANDESCENT LAMPS TO AVOID NUISANCE TRIPS WITH RESULTANT HIGH INRUSH CURRENTS.

Incandescent Lamp Control

To drive lamps, you may avoid using the fast short-fault protection mode as it might cause nuisance shut-downs as a result of high ON inrush currents.

Although selecting fast shutdown helps limit repeated thermal stress on the output driver, it acts too fast to report it via the output fault flags.

CONNECTIONS

Digital Outputs

Other Considerations For Output Control

- Built-in output protection will automatically shut-down output operation for current-limit, thermal overload, excitation over-voltage, and output drain over-voltage conditions. The outputs can optionally be programmed to automatically retry their control, or remain OFF following a thermal or over-voltage shut-down (default response).
- Do not exceed 450mA of load current per output with 3.6A total current per port, or 300mA per output and 4.8A per port.
- If you enable open-load detection, a 50uA pull-down current will be present with the output in the OFF state. This opposes the input wetting current pull-up, so inputs must be tri-stated for this to work. Consider open-load detection carefully if you happen to be driving loads sensitive to small currents, or you cannot tolerate unused inputs being pulled to the ON state.
- You can select a faster responding 100-450us shutdown mechanism that is triggered based on output Vds measurement (default), as opposed to a thermal shutdown which allows the output to heat-up. Normally if an output drives a shorted load, built-in thermal protection will kick-in to protect the output. This effectively allows output port protection to be tailored to incandescent lamp loads (thermal), or inductive loads (faster). However, the fast shutdown may not trigger the thermal fault flag, as it acts too fast to capture. But fast action does further limit repeated thermal stress which helps preserve the life of the output driver for repeated faults.

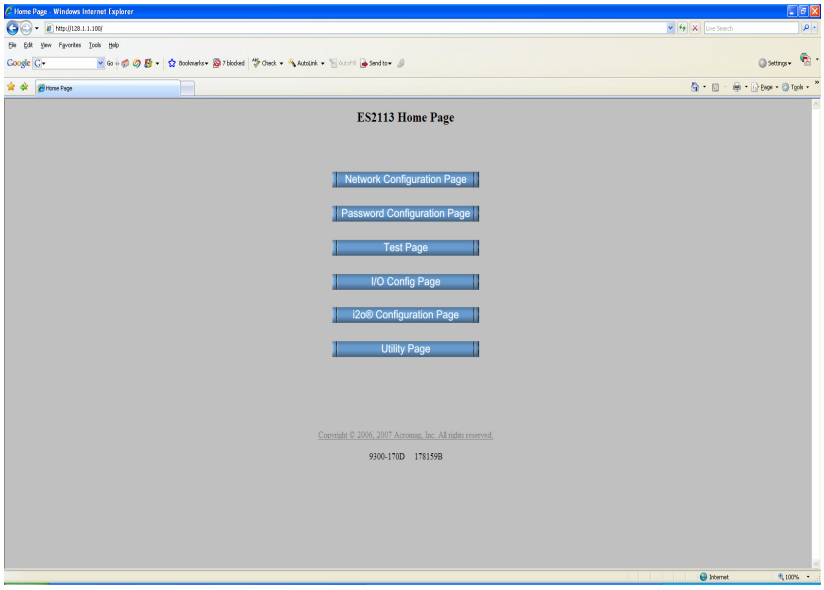
WEB BROWSER

Home Page

This unit supports Modbus over TCP/IP and UDP/IP (a TCP/IP message will get a TCP/IP response, while a UDP/IP message will get a UDP/IP response). You may use your own software to issue Modbus commands to this device (see Modbus Registers), or you may use a standard web browser, as these units have built-in web pages that allow you to setup and control their operation. Simply execute your web browser, type the IP address assigned to your unit in the "Address" window (http://128.1.1.100/ for our example), click [Go], and you will be presented with the Home Page window of the unit similar to that shown below:

The Home Page provides buttons to access the other web pages of this unit that are used to configure the network parameters, change the user name and password, configure the I/O, and operate the unit.

Note that the unit's serial number and firmware number are included at the bottom of the Home Page.

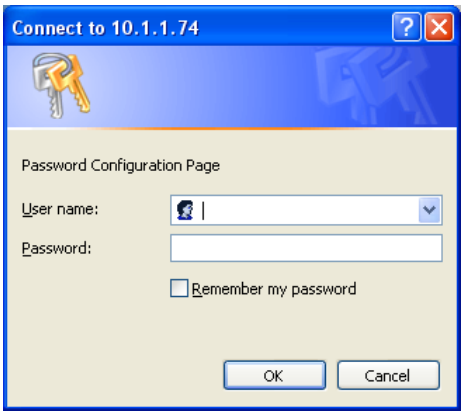


WEB BROWSER

Home Page

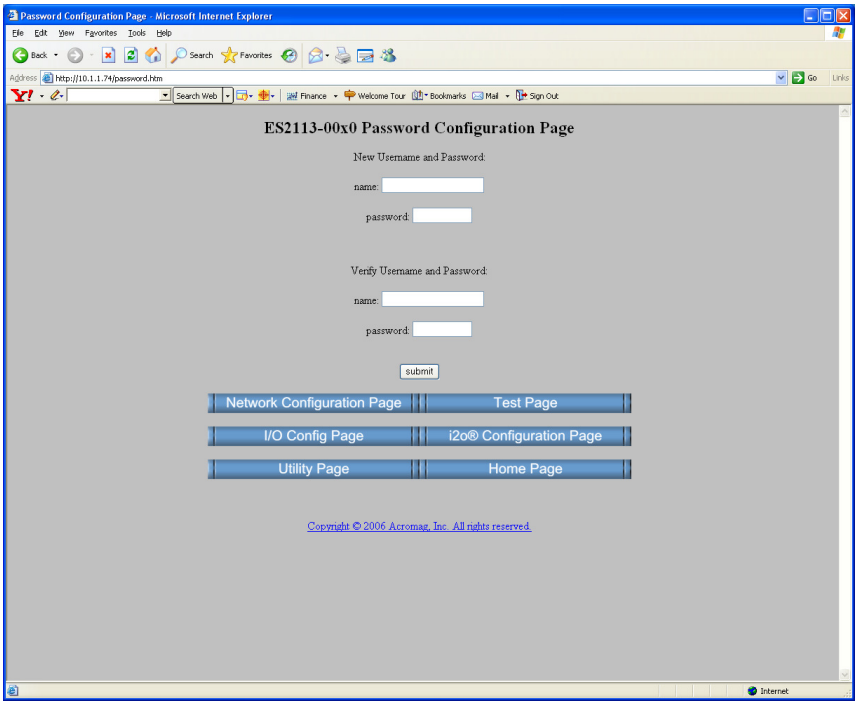
Not all parameters are programmable with Modbus commands issued to Modbus registers. In general, you would still have to use the embedded web pages to complete your configuration (for example, the network configuration parameters do not have Modbus registers). For additional details on various operating modes, please refer to the command descriptions of the Modbus Memory Map.

For each new browser session that accesses the Home Page of this unit, you will be presented with a window prompting you to enter the current User Name and Password as shown on the next page. This information is required before the program will allow you to make any other selections. **The default user name and password is "User" and "password" respectively.** After entering these defaults, you should invoke the Password Configuration Page to change these parameters to something more meaningful for you.



IMPORTANT: If you forget your user name and password, you can always toggle the unit into default mode via the DFT default mode toggle switch at the front of the unit (hold this toggle 4 seconds to invoke default mode). In this mode, the password and username will revert to the original defaults noted above (unit assumes IP address 128.1.1.100), allowing you to re-invoke the Password Configuration Page and change the username and password as required.

Password Configuration Page



Note: *Your password is limited to 10 characters. If you exceed 10 characters, your password will only be set to the first 10 characters you typed. This will become painfully apparent to you when you attempt to gain access later.*

WEB BROWSER

Password Configuration Page

Use up to 20 alphanumeric characters (case sensitive) to specify your username, and 10 alphanumeric characters (case sensitive) to specify a password. You will have to type in these entries twice to help prevent errors.

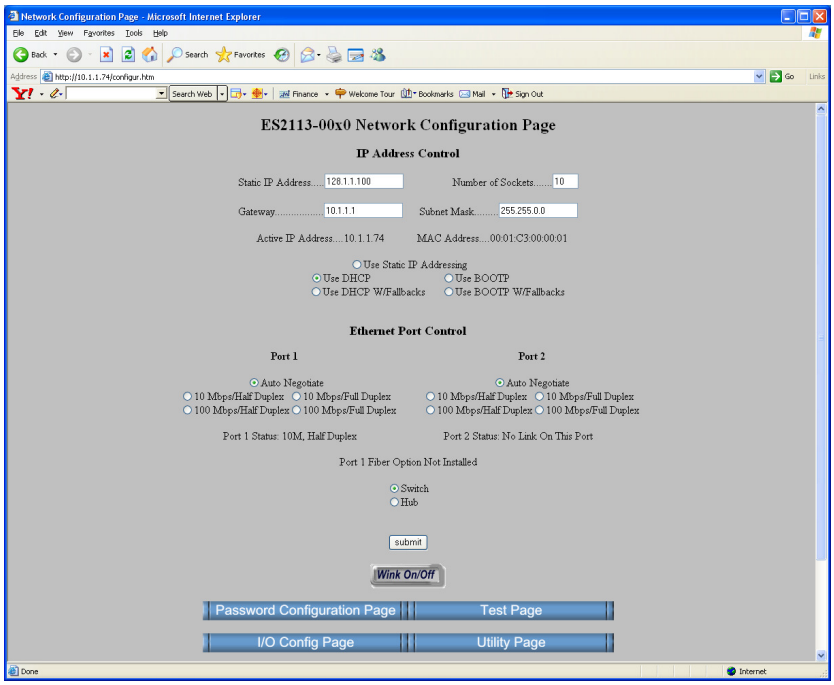
Click the **submit** button to write your changes to the unit.

After completing your username/password changes, click on the appropriate button at the bottom of the page to select another web page. If you happened to have made changes, you may be prompted again to re-enter your new username and password before being permitted to move to the other web pages. Just be sure to use the new values you just set.

Network Configuration

After setting your username and password, you can click the "Network Configuration Page" button and a screen similar to that shown on the following page will appear. Use this screen to set the network configuration parameters for your unit (these parameters cannot be set via Modbus registers). These parameters are described below. You may have to consult your network administrator for help in completing the contents of this page.

Note that Acromag Series ES2100 Ethernet I/O devices may take from 3 to 30 seconds to boot upon power-up, depending on your network configuration and whether a DHCP server is present.



An **IP Address** is a unique identification number for any host (this unit) on any TCP/IP network (including 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 placed between octets.

A **Static IP Address** is as the name implies—*static*, and represents a unique fixed IP Address that is generally assigned by your service provider or system administrator. The Default Mode static IP address assigned to this unit is 128.1.1.100 (refer to the product side label).

WEB BROWSER

Network Configuration

Every Ethernet network device (including the network adapter installed in your PC) must have a unique IP address in order to differentiate itself from other devices on the network. The IP address not only identifies the device on the network, but it also determines which other devices may communicate with it. Acromag Ethernet devices have a default IP address setting that defines an address domain that is likely outside of your own, and this prevents direct communication right out of the box. However, once you establish initial communication, you can change the IP address setting to a value compatible with your own network.

This device can be placed into a default communication mode via the DFT toggle switch at the front of the unit.

Default Mode uses a static IP address of "128.1.1.100", a default subnet mask of "255.255.255.0", a default username "User", and a default password "password".

NOTE: In order to network your PC with an EtherStax unit, you may have to consult with your network administrator and either temporarily change the IP address in your TCP/IP configuration (see TCP/IP Properties of Network Configuration in Windows), or create a separate private network using a second network adapter installed in your PC (recommended). The necessary steps will vary with your operating system. Refer to Acromag Application Note 8500-734, or document 8500-815, for help accomplishing this (located on the CDROM shipped with your unit or via download from our web site at www.acromag.com).

Note that the Number of Sockets limitation does not restrict access via Modbus UDP/IP, only TCP/IP, as UDP is a connectionless protocol.

The **Number of Sockets** refers to the number (1-10) of Modbus TCP/IP access points to allow for this host (via port 502 reserved for Modbus). You can restrict access by reducing this number. If this unit is a target i2o device (i2o output), do not set this number below 2, as i2o will consume one TCP/IP socket.

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

A **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 correspond to the host 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, with the result being the sub-network address.

This unit uses a default IP address of 128.1.1.100 and a subnet mask of 255.255.255.0. This setting is also used for units in their default communication mode. These settings define a Class C sub network address for the device, and only IP addresses with a prefix of "128.1.1" and a suffix from 1 to 255, except 100, can communicate with it. Once you establish initial communication with an Acromag device, you can easily change the units IP address setting to something compatible with your own network.

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

The **Host Name** is the name to be assigned to this host if its address happens to be assigned dynamically using DHCP.

The **Active IP Address** refers to the current IP Address being used by this host, as opposed to any new assignments being made via this page.

The **MAC Address** refers to the Media Access Control address that uniquely identifies the MAC hardware of this device. This is a unique fixed address assigned to the MAC at its manufacture. It is not to be confused with the dynamically assigned 32-bit IP Address, commonly denoted as four 8-bit numbers separated by periods (e.g. 128.1.1.100). Every manufacturer producing Ethernet hardware, has by assignment, a series of 48-bit addresses to use. They are restricted to use only the addresses in their series, and only one time, thus ensuring that no two computers in the world will ever have the same MAC address.

WEB BROWSER

Network Configuration

Any Ethernet packet will have two 48-bit address fields appended to it that represent the MAC addresses of the sending computer, and the destination computer. In IEEE 802 networks, the Data Link Control (DLC) layer of the OSI Reference Model is divided into two sub-layers: the Logical Link Control (LLC) layer, and the Media Access Control (MAC) layer. It is the MAC layer that interfaces directly with the network media (each different type of network media requires a different MAC layer) & where address distinction is applied.

If you are using i2o, then i2o target units (output units) must use static IP addresses. Bi-directional i2o implementations will require static IP addressing at both units.

By default, the unit is setup to use **Static IP Addressing and a Static IP Address of 128.1.1.100**. You can optionally choose to have the IP address assigned dynamically via DHCP/BOOTP, or DHCP/BOOTP w/Fallbacks. This will also require that you specify a valid Host Name. Note that DHCP/BOOTP w/Fallback will revert to the static IP address if your DHCP or BOOTP server cannot be found at the address specified.

In general, BOOTP (BOOTstrap Protocol) refers to an internet protocol that enables a diskless workstation to discover its own IP address, the address of a BOOTP server on the network, and a file to be loaded into memory to boot the machine. This enables the workstation or device server to boot without requiring a hard or floppy disk drive. BOOTP works similar to DHCP, but is usually found in older systems. This protocol is defined by RFC 951.

The Default Communication Mode uses a static IP address of "128.1.1.100", a default subnet mask of "255.255.255.0", a default username of "User", and a default password of "password".

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. DHCP also supports a combination of static and dynamic IP addresses. DHCP/BOOTP with fallback will revert to static IP addressing if the DHCP or BOOTP server cannot be found.

The unit includes a default address toggle switch to cause the unit to assume a fixed default static IP address (128.1.1.100). This switch is at the front of the unit and used to toggle the unit into, or out of Default Mode. If the unit is already in default mode, then "Default Communications Mode" will be indicated at the bottom of this screen.

Important (ES2113-1): *Fiber ports are forced to 100MB only, and auto-negotiation and auto-crossing do not apply. Half or full duplex may be selected, but restricted to half duplex only in repeater mode.*

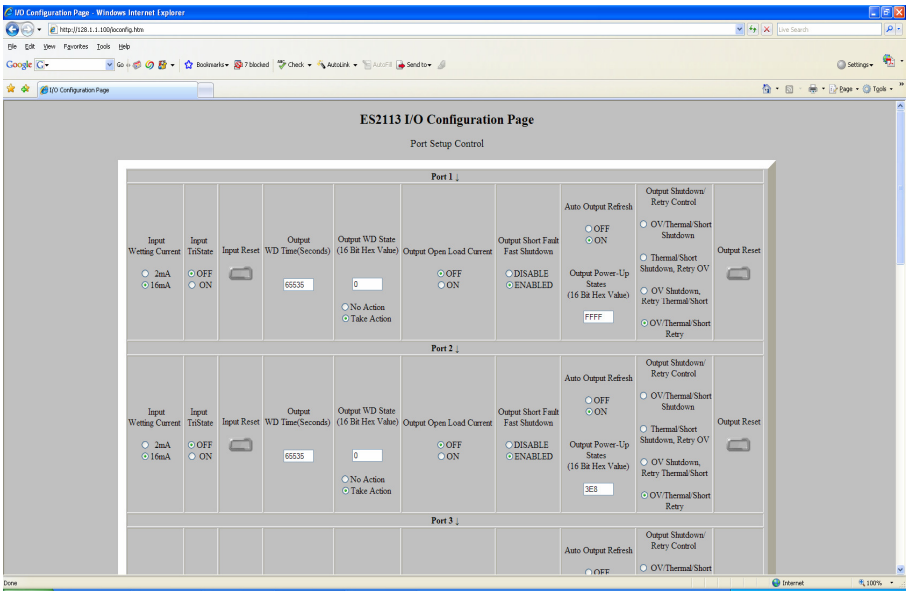
For the Ethernet port controls, you can select that speed and duplex be auto-negotiated (recommended), or you may force the speed to 10Mbps or 100Mbps, and the duplex to half or full. However, full duplex communication will not be possible unless CSMA/CD is suppressed via a switched Ethernet connection at the port. Further, on units that have a fiber-optic SC type connector for port 1, only 100Mbps operation at full-duplex is possible. Note that the port status is displayed just below these fields.

Note: *Hub mode is 100MB at half-duplex only and auto-negotiation does not apply.*

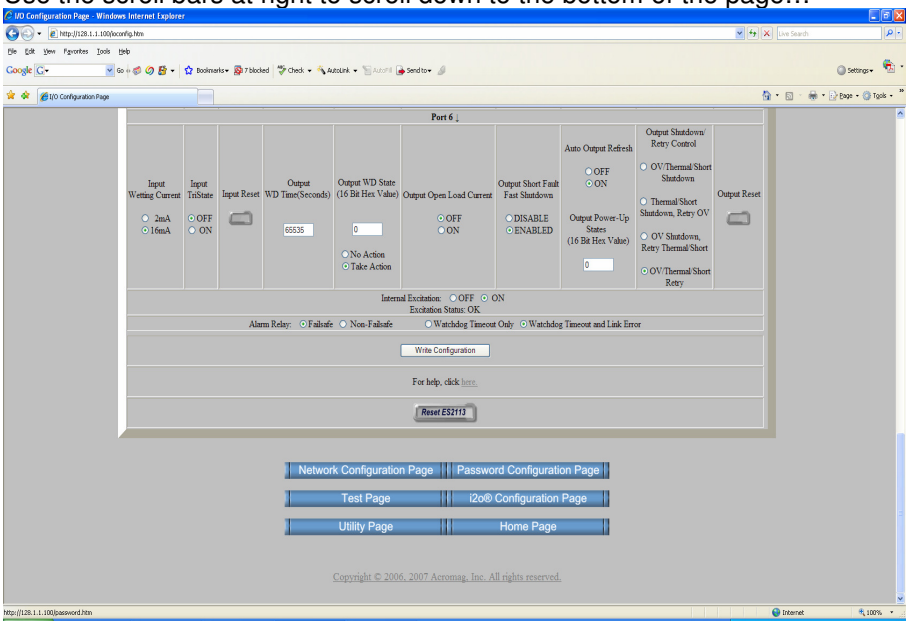
For the mode control, this unit is set to "Switch" by default, but may optionally be set to "Hub". Hub mode is useful to reduce latency on the network, or to setup redundant media connections to this device. You should review the information regarding hubs and switches in the Network Connections section of this manual for help discerning the difference between a switch and a hub, and for information on redundant media connections. Refer to the Technical Reference section of this manual to learn more about Modbus, TCP, UDP, and IP Addressing terms and concepts.

Click the **Submit** button to complete any changes made on this page. Review the port status message to check your settings.

Click the **Wink On/Off** button to toggle the unit in/out of "wink" ID mode. In this mode, the unit's green RUN LED will blink to confirm identification and address setting.



Use the scroll bars at right to scroll down to the bottom of the page…



Configuration information is set for 6 ports of 16 channels each. At the bottom of the page you can enable/disable internal excitation, select failsafe/non-failsafe alarm action, and specify the conditions for alarm. You can also access a help page for information on setting configuration parameters. A system reset button is included (Reset ES2113), which will drive the all outputs to the specified power-up/reset state. Clicking the port Output Reset button will turn the port outputs OFF.

WEB BROWSER

I/O Configuration

After completing the username/password assignment, plus the network configuration parameters, you can use the I/O configuration page to setup your I/O. I/O configuration is done on a per-port basis (port 1 through port 6) and there are 6 ports of 16 channels on this model.

***Note:** When you first enter a page that includes controls like the input and output reset buttons of this page, you may note that your first click on a control is ignored. This is because the first click activates the control.*

You can select from various modes of operation for the input and output channels of each port. Once you have carefully made your selections, click the "Write Configuration" button at the bottom of the page to activate your configuration (reconfiguration takes effect immediately following "Write Configuration").

Note that the Output Reset button resets the port output circuit, but does not honor the output power-up/reset state. Outputs will turn OFF momentarily in response to clicking the Output Reset button. Use the Reset ES2113 button instead to send the outputs to a specified Output post Power-Up/Reset state.

WEB BROWSER

I/O Configuration

The built-in input wetting current generators do not operate without either internal or external excitation, or with the inputs tri-stated.

Without a driver, load, or pull-up connected to the I/O, the tri-stated I/O is essentially floating and may not register the OFF state correctly. In this state, you will have to use I/O pull-ups to pull the OFF state signal above 4.3V in order to be able to read back the correct I/O state.

Note that wetting currents are reduced slightly (~1.6mA) for internal excitation, or low external excitation voltages below 7.2V.

***TIP:** Unused tri-stated inputs may utilize the built-in open-load detection pull-downs to pull to the ON state.*

***TIP:** You can increase wetting currents by paralleling inputs, or connecting to an external excitation supply and adding an I/O pullup to the excitation voltage rail.*

Refer to the following definitions and the Modbus Memory Map for information on optional modes of operation:

Input Functions

Input Wetting Current 2mA/16mA – Wetting current is used by the inputs to sense switch contact closure and attempts to seek a return path. These currents also act like pull-ups for the tandem open-drain outputs, which enables the I/O to be tested without actually wiring to terminals. If this control is set to 2mA (default), the wetting current will be 2mA continuously (~1.6mA with internal Ex). If this control is set to 16mA, then the wetting current is initially set to 16mA as the input crosses the threshold (12mA with internal excitation), and folds back to 2mA continuous (~1.6mA w/internal excitation), 20ms after crossing the ON threshold. The purpose of the higher initial current is to help prevent oxide build-up on the switch contacts. Note that the wetting currents do not actually reach 2mA/16mA settings until the excitation voltage is greater than or equal to 7.2V (external).

Metallic switch contacts can develop higher contact resistance over time due to corrosion induced by humidity, salt, and other elements that exist in harsh environments. Use of the 16mA setting provides higher initial wetting current during contact transfer to reduce or eliminate potential oxide build-up. However, elastomeric switch contacts are made of carbon material and have a high contact resistance, with common resistance up to 1KΩ. With these types of contacts, the pull-up/wetting current must be reduced to prevent excessive power dissipation in the contact. High currents through these switches can produce an IR voltage that can cause the input signal to rise back above the 4.0V threshold. Thus, you should select 2mA for those applications where 16mA cannot be tolerated.

If Input Tri-State is ON, this field will have no effect, as the wetting current generators are disabled in tri-state mode.

CAUTION: The internal excitation supply is not capable of sourcing 16mA of wetting current for 96 channels at one time. If you are switching all channels simultaneously, or making use of the Output Power-Up/Reset states to turn all outputs ON after a reset, and you do not have an external excitation supply connected that can source 1.536A (96channelsx0.016A), then you may experience unpredictable results. Be sure to provide adequate external excitation to each port if you are utilizing 16mA wetting over many channels.

Input Tri-State OFF (Default)/ON – Inputs may be tri-stated and then act as a high-impedance comparator input with a 4.0V threshold (3.7-4.3V range). Wetting current generators are disabled with inputs tri-stated, or without excitation connected. Note that tri-stated inputs will also leave the tandem open-drain output floating if no load is connected. You may optionally utilize the open-load detection pull-downs to pull these inputs to the ON state.
IMPORTANT: If inputs are tri-stated and only internal excitation is present, the output drains will float unless loaded and/or pulled up externally. If the I/O is not pulled up above the 4.0V input threshold, the output OFF state may not register properly, or indicate ON.
Input Reset – Click this button to reset the inputs of the port without invoking a power-on, output, or system reset of the unit. You do not normally need to use this control, but it is may be useful for trouble-shooting and isolating I/O problems between input & output circuitry.

Output Functions

Output WD Time (seconds) – Enter 1-65534 seconds to set a watchdog time period for port outputs, or 65535 to disable the watchdog timer. If no write activity occurs to any channels of the port over this period, a watchdog timeout occurs and the watchdog flag for the port is set in the unit's Status Register. Additionally, you can direct the unit to set its port outputs to a pre-defined state upon watchdog timeout, or do nothing (see below).

Output WD State (16 bit Hex Value) – Upon watchdog timeout, you can direct the unit to set its port outputs to this pre-defined state with "Take Action" also selected, or do nothing with the outputs with "No Action" selected. Enter four hex digits that represent the bit settings for the 16 channels of the port with the lsb corresponding to the lowest numbered channel of the port, and the msb to the highest numbered channel. For example, enter "FFFF" to turn all port outputs ON following timeout.

Output Open-Load Current (OFF/Default or ON) – Set this ON to add a 50uA pull-down to the source to be used to detect open load faults when the inputs are tri-stated. If ON, an open output load fault is flagged by a fault bit in the port's I/O status register. This pull-down current is separate from the wetting current generators (pull-ups) of the tandem inputs. If you are driving loads sensitive to low current in the OFF state, leave this feature OFF.

Output Short-Fault Protection (Thermal or Fast Shutdown) – Outputs include over-current protection normally triggered thermally, causing the output driver to heat up for a shorted load before shutting down the output. The long-term effect of this is that it may induce thermal stress in the output IC which can shorten its life for repeated faults. This protection is also slower, as it requires the part to heat up before shutting down. Short-Fault Fast Shutdown provides a faster method to trigger a thermal fault that relies on output Vds measurement, not self-heating. A fast shutdown of the output will occur within 100-450us after a turn on into a short-circuit with this protection enabled. This feature is generally used to provide protection for loads that experience higher than average currents and require a fast shutdown, or to preserve an external series fuse. But a fast shutdown could become bothersome if the output happens to be driving loads that have higher "inrush" currents (as opposed to inductive loads with a slower current response). A fast shutdown also acts too quickly to be captured and reported via the "Any Output Fault" and Output "Thermal Fault" bits of the port I/O Status register.

Auto Output Refresh – By default, outputs are refreshed every 5 seconds to help ensure that outputs retain their programmed states if EMI or ESD should cause an inadvertent state change. This refresh can optionally be turned OFF to allow an output to remain OFF following a fault condition (see Global Shutdown & Retry Control register).

Output Power-Up/Reset States (16 bit Hex value) – Outputs normally power-up or are reset to the OFF state, but you can use this field to set the post power-up/reset states of the port outputs ON (1) or OFF (0). The lsb corresponds to the lowest numbered channel of the port, the msb to the highest numbered channel.

WARNING: Internal excitation is not capable of sourcing 16mA of wetting current for 96 channels at one time. If you make use of the Output Power-Up/Reset states to turn all outputs ON after a reset, and you do not have external excitation that can source 1.536A (96channelsx0.016A), then you may experience unpredictable results. Always provide adequate external excitation to each port if you are utilizing 16mA wetting over many channels.

WEB BROWSER

I/O Configuration

For help configuring items of this page, click the Help link at the bottom of this web page.

Hex-to-Binary Conversion: "0" = 0000, "1"= 0001, "2" = 0010, "3" = 0011, "4" = 0100, "5" = 0101, "6" = 0110, "7" = 0111, "8" = 1000, "9" = 1001, "A" =1010, "B" = 1011, "C" = 1100, "D" = 1101, "E" = 1110, "F" = 1111.

The Open-Load Detect feature is only useful with inputs tri-stated, as it adds a pull-down that opposes the pull-up of the input wetting current generators. Note that with inputs tri-stated, it also pulls to the ON state.

Outputs that utilize fast shutdown, as opposed to thermal shutdown, are not subject to the automatic retry control. That is, faulted outputs that are shutdown fast do not retry their control until reset, or optionally via the Auto-Output Refresh cycle.

WEB BROWSER

I/O Configuration

The over-voltage shutdown may retry output control after the drain-to-source voltage has returned to normal (below its 50V internal limit), and/or the excitation is below 28V. Note that this shutdown/retry control only applies to the internal output driver, not the coincident input channel circuit (inputs still operate normally).

Output Reset clears the outputs and does not send the outputs to their defined power-on/reset state like a system reset does—click the "Reset ES2113" button at the bottom of the page to do that.

***Note:** The input wetting current is reduced from 2mA to about ~1.6mA with internal excitation, or external excitation voltages below 7.2V.*

The use of internal excitation only provides limited I/O drive capability of about 5.8V at 1.6mA/channel. The drive current is limited to the input wetting current, and the OFF state voltage is pulled to the internal 6.1V rail. You must connect an external excitation supply for greater voltage and current drive capability.

Internal excitation cannot drive 96 channels with 16mA wetting currents selected at one time—use external excitation for this.

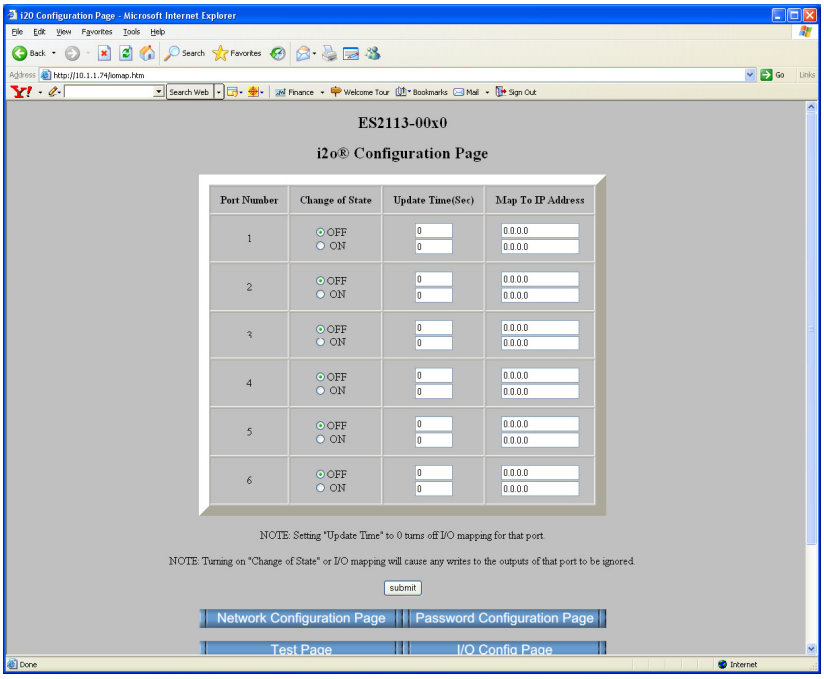
***TIP:** Selecting "Failsafe" will allow the unit to additionally signal a power-loss condition as the contacts will open when power is lost.*

Output Shutdown/Retry Control – Use these controls to select how the port outputs are to react following a thermal, or output or excitation over-voltage fault. Outputs have built-in over-current limiting with thermally-triggered shutdown, and over-voltage triggered shutdown, allowing an output channel to shut-down operation for output faults that occur either as a "thermal fault", or "over-voltage fault". You can elect to keep the output shut-down (only if auto-refresh is also OFF), or automatically retry its control following a shutdown. If the fault has been removed, normal operation can be automatically recovered, as a thermal shutdown may retry the output once the part has cooled sufficiently, or the short-fault has been removed. Note that each output includes a transient voltage suppressor that will clamp short-duration transient voltages above 31V without failure. However, sustained drain-to-source voltages above 31V will eventually destroy the TVS if no method of limiting peak current is employed. The built-in over-voltage protection only shuts-down the output driver circuit and does not affect the parallel transient voltage suppressor.
Output Reset - Click this to reset only the output circuitry of the port without invoking a power-on, input, or system reset of the entire unit. Outputs will turn OFF following an Output Reset. Note that any faulted (shut-down) outputs will attempt to recover operation following a reset of the port. This control is not normally needed, but is sometimes useful for trouble-shooting and isolating I/O problems between input & output circuitry. It is also helpful to restore operation to an output or port that was shutdown fast, or by an output or excitation fault, without having to reset the entire system.

Excitation Control
I/O will not operate without port excitation. Limited internal excitation is enabled by default, but may be optionally disabled via this control. Select ON, or leave it ON if you do not have external excitation supply connected at each port, or if you wish the internal excitation to back-up an external excitation supply. Also select ON if you wish to utilize the I/O self test utility, which allows I/O to be controlled/monitored without actually wiring the port. If left ON, you will have to connect external excitation greater than the 6.1V of internal excitation in order to drive the I/O via the external supply. Connect external excitation from 7.2-28V with internal excitation ON, or from 6.2-28V with it OFF. Internal excitation is separately diode-coupled to each port, allowing ports to operate at different levels, even with internal excitation enabled. Select OFF if you are using external excitation for greater voltage and/or current drive capability, or if you wish to simply drive higher currents at the 6V level. Input power is reduced with internal excitation turned OFF. With excitation turned OFF, and no external excitation connected, the I/O will not operate. Further, with internal excitation OFF, you will have to connect external excitation separately to every I/O port. This unit allows separate ports to be connected to different voltage levels at the same time

Alarm Relay (For Output Watchdog Timeout & Link Loss)
Unit includes SPST contacts near the input power terminals labeled A & B. With "Failsafe", the contacts are normally energized (closed), and de-energize (open) on alarm. With "Non-Failsafe", the contacts will normally be de-energized (open), and energize upon alarm (close). Relay is triggered only upon watchdog timeout if "Watchdog Timeout Only" is selected, or additionally upon link loss at the network ports if "Watchdog Timeout & Link Error" is selected. Disable the watchdog timer if you want this alarm to only be triggered by a link loss condition (both ports must be inactive to generate a link-loss error--i.e. no communication possible).

This unit includes special remote messaging functionality called i2o, input-to-output communication. This allows the unit to send its digital input information to an output channel on another ES2113 digital output unit. The I/O Mapping page shown below is used to specify the static IP address of the remote ES2113 unit to send this units input channel data to, either upon change-of-state, or cyclically at the update rate specified.



IMPORTANT: This module is designed to function as a Modbus TCP/IP slave/server. Normally, Modbus servers are not allowed to initiate messages on their own and may only respond to client/master requests. The i2o functionality of this unit is a special application that may cause confusion for some master/client devices linked to the same network. To avoid problems, other master devices on the network should be restricted from attempting to control i2o target devices. You can also make use of the "Number of Sockets" parameter to limit access to an i2o target device.

These units have six ports of 16 digital I/O channels. Each port of the unit represents a pluggable, duplex terminal block pair (two blocks of 9 screws). Port Number 1 refers to I/O channels 0-15, port number 2 refers to channels 16-31, port number 3 to channels 32-47, port number 4 to channels 48-63, port number 5 to channels 64-79, and port number 6 to channels 80-95. Each input port of this unit may be mapped to the corresponding output port of another ES2113 unit. The digital inputs may be written cyclically, or upon change of state. However, if you select change-of-state, you will still need to specify a cyclic update rate in order to keep the communication socket open and prevent a timeout if your change of state transitions happen to occur at intervals greater than 90 seconds apart. If you select a time of 0 with change-of-state enabled, a default value of 30 seconds will be used to ensure the connection remains open. You may want to make the update time longer to conserve network bandwidth while still preventing a timeout. If you disable change of state, then your output control messages will occur at every interval of your update time (a time of 0 disables cyclical messaging).

WEB BROWSER

I/O Mapping Page (Optional i2o Function)

The i2o mapping feature may only be configured via the built-in web browser page as there are no Modbus registers for specifying these parameters.

While this unit supports Modbus TCP/IP and UDP/IP, i2o messages are only sent via Modbus TCP/IP.

The i2o messaging will consume one TCP/IP socket on the target device.

***Note:** The Test Page of this browser interface will not allow you to control any outputs of any source port that is setup for i2o transmission. This is to protect target processes from having separate controls outside of the i2o input signal.*

If you are using i2o, then i2o target units (output units) must use static IP addresses. Bi-directional i2o implementations will require static IP addressing at both units.

WEB BROWSER

I/O Mapping Page (Optional i2o Function)

This messaging function works best if the target unit(s) are already online and ready to receive messages. It will still work if the target output units come online after the input units, but may take several minutes to "discover" the network targets and begin transmitting to them.

If the input unit or the target unit(s) go offline, remote messaging will resume on its own when the connection is re-established, but this "healing" function may take several minutes depending on which device(s) went offline, why, and for how long.

Note that the digital inputs only map externally, and always control the exact same channels of target units (same port-to-port), but individual ports can be mapped to output ports of two different units (at different IP addresses).

Each input port of this device may be mapped to the same port of another Acromag ES2113 unit, or two units at different IP addresses. Subsequent messages will be sent at a periodic rate specified via the update time. Note that the target output port channels may still be controlled independently, but their state will be overwritten by subsequent mapped i2o messages when this feature is enabled. To avoid problems, it is recommended that you do not attempt to separately control the mapped output ports directly.

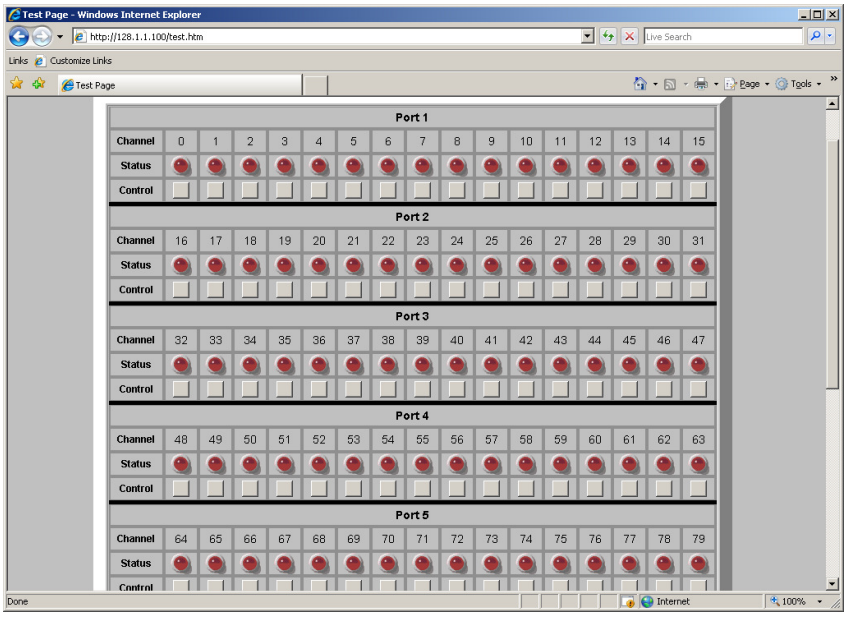
Change-of-State: Set ON to enable remote updates on change of input state, and OFF to update cyclically. With change-of-state enabled, you will still have to specify an update time less than or equal to 90 seconds in order to keep the communication socket open and prevent a timeout of the connection. If you select 0 seconds with change-of-state enabled, a default value of 30 seconds will be used to ensure the connection remains open.
Update Time: Specify a time from 0-90 seconds between messages. Specify 0 to turn i2o messaging OFF (cyclical). If change-of-state is set to ON, a default time of 30 seconds will be used to keep the connection open.
Map To IP Address: This is the Static IP Address of the target output device (another ES2113 unit on the network). Each digital input port may only be mapped to the same port at one or two IP addresses.

Note that if you happen to perform the procedure for restoring a unit to its original configuration as outlined in the "Getting Out Of Trouble" section of this manual, all of the mapping variables are returned to their default values and mapping may have to be reconfigured.

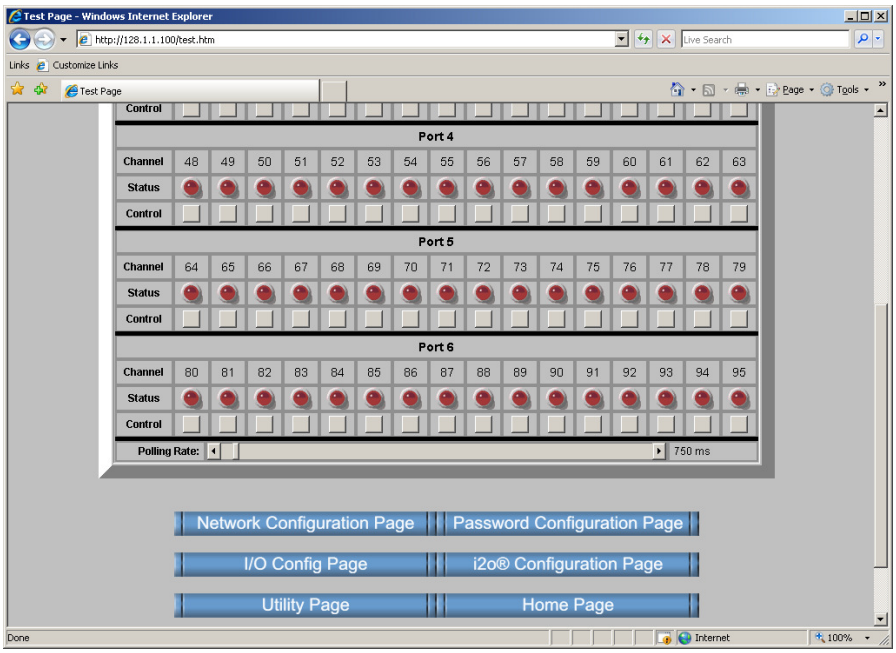
Test Page

When you first enter a page that includes controls like this, you may note that your first click on a control is ignored. This is because the first click activates the control.

After completing the username/password assignments, plus the network and I/O configuration parameters, you can click the Test Page button to access the Test Page and operate your EtherStax unit. Here you are able to read inputs, turn outputs on and off, and even set a polling rate.



Use the scroll bar on the right to scroll down the page as shown below:



Note that the 96 channels of this unit are divided into 6 groups (ports) of 16 channels each. On the unit, each port represents a pluggable, duplex terminal block pair (two blocks of 9 screws). Port Number 1 refers to I/O channels 0-15, port number 2 refers to channels 16-31, port number 3 to channels 32-47, port number 4 to channels 48-63, port number 5 to channels 64-79, and port number 6 to channels 80-95. The state of an I/O channel is indicated by a simulated LED (bright red for "ON") below the channel number. Simply click the white control button below the LED to toggle the corresponding channel ON or OFF, as required.

You can speed-up or slow-down the polling rate of the I/O by clicking and dragging the polling rate slide control at the bottom of the Test Page screen (rate varies from 500ms to 10000ms, rightmost setting disables polling).

TIP: If you ever notice that an output has shut-down its operation unexpectedly, you should review the information given on the I/O configuration page and note that an output can shut-down for conditions induced by over-current, over-heating, a short-circuit, and output over-voltage. Outputs can also shutdown temporarily for excitation over-voltages greater than 28V. However, outputs can also be directed to automatically retry their control once a fault condition has been removed.

A watchdog timeout is triggered at the port if no output channel write occurs for one or more channels of a port within the time period specified. You can use the Port watchdog Timer Control to specify Time from 0001H to FFFEH seconds (1 to 65534s). A time value of 0000H or FFFFH (0 or 65535) will disable the timer for the port I/O. You can also define the state the outputs are to assume following a timeout. For example, enter a state value of "0" (0000H) to turn OFF (open) all port outputs (failsafe state) upon watchdog timeout. You would enter "1" (FFFFH) to turn all port outputs ON upon watchdog timeout.

WEB BROWSER

Test Page

The LED's of this page reflect the input level relative to a 4V threshold, not necessarily the ON/OFF status of the tandem output mosfet.

***TIP:** You can use the mouse to point and click on a control to toggle the corresponding output on/off, or you can use the spacebar to toggle the last output control you pointed to.*

As a safety mechanism, you cannot control outputs of ports that are setup as i2o input ports.

***WARNING:** For correct I/O state feedback, do not allow tri-stated inputs to float. Tri-stated I/O must be pulled to a voltage above the 4V threshold to properly indicate the OFF state.*

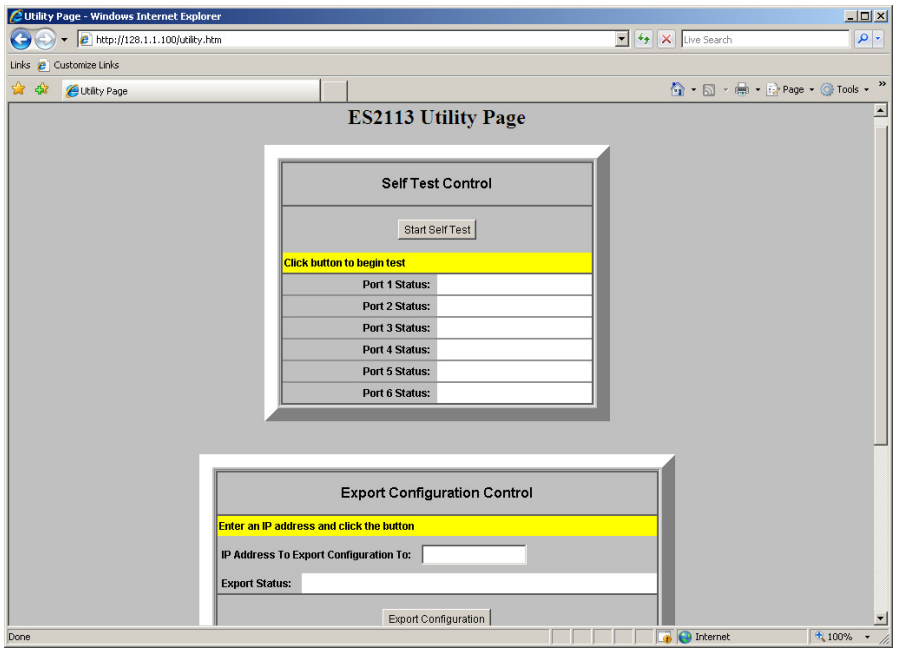
***Note:** The Test Page of this browser interface will not allow you to control any outputs of any source port that is setup for i2o transmission. This is to protect target processes from having separate controls outside of the i2o input signal. That is, inputs control remote outputs, but tandem outputs are blocked from also controlling remote outputs.*

WEB BROWSER

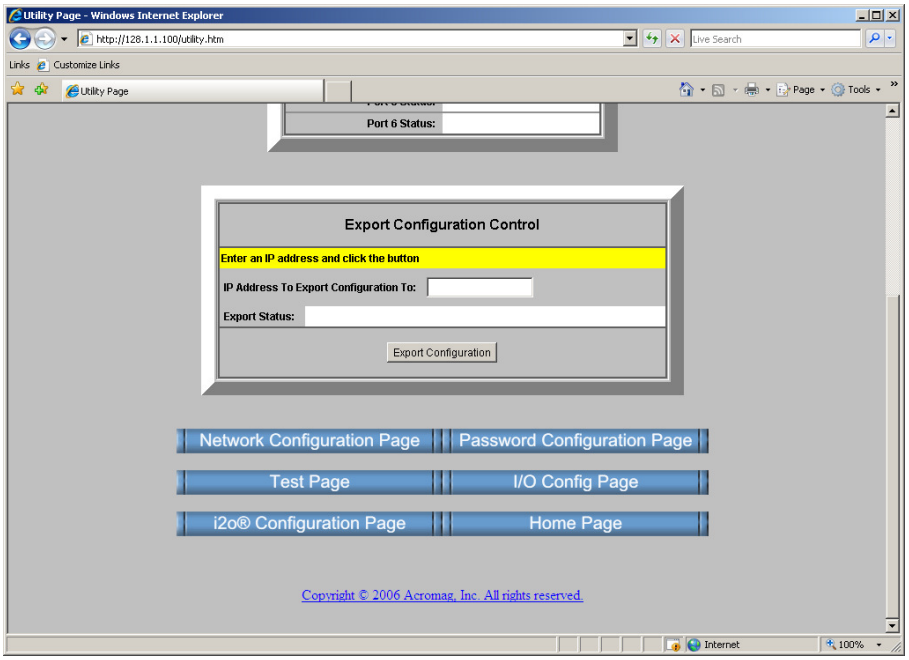
Utility Page

When you first enter a page that includes controls like this, you may note that your first click on a control is ignored. This is because the first click only activates the control.

You may also access a Utility Page that includes a couple of built-in utilities that allow you to verify I/O operation without wiring to the I/O (self-test control), and allow you to export your current configuration to another unit (export configuration control). You can select the Utility Page button from the Test Page screen to display a screen similar to that shown here:



Use the scroll bar on the right to continue scrolling down the page as shown below:



I/O Self Test Control

CAUTION: If you have I/O wiring present, then you should disconnect this wiring to avoid potential signal contention during the I/O test, as this test controls the outputs to drive the input channels using internal excitation. You must turn all outputs OFF and disable any tri-stated input ports prior to test.

The I/O self-test feature of this page takes advantage of the separate input and output channels of this device, its built-in wetting current sources at each input, and the internal excitation supply, to test I/O operation right up to the field screw without having to do any wiring. This is a useful trouble-shooting aide if you are experiencing problems. Make sure that all outputs are OFF and disconnect I/O port field wiring to the unit. Then click the Start Self Test button to check I/O operation. Note that this test temporarily enables internal excitation even if you have turned it OFF, as I/O cannot operate without port excitation. This represents a true test of the I/O and the internal excitation, as the input comparator is tied directly to the output mosfet drain terminal of the channel.

Export Configuration Control

Enter the IP address of the destination unit you are trying to replicate this configuration at. This unit must be already connected to the network. Refer to Network Connections for examples of how to network connect units.

The export function is a real time-saver when commissioning multiple units in similar fashion. Simply enter the IP address of the unit you wish to send your I/O configuration to (it is assumed that you have already communicated with it and setup its network parameters). Click the Export Configuration button to transmit your I/O configuration. With reference to the Modbus Memory Map for this device, this function sends the contents of all Holding Registers (4xxxx registers), right up to the wink register, to the IP address indicated (it does not send network configuration parameters which must be preset via the web browser). The Export Status window will let you know if the configuration was received correctly or not at the remote I/O station.

WEB BROWSER

Utility Page

Floating I/O (i.e. inputs tri-stated) may cause the I/O to improperly read the OFF state, as the input threshold is 4V and inputs must be pulled above this value in order to register as OFF.

Do not use the self-test with the inputs tri-stated and be sure to turn all outputs OFF prior to test.

TROUBLE-SHOOTING

Diagnostics Table

SYMPTOM…	
POSSIBLE CAUSE	**POSSIBLE FIX**
Green RUN LED Does Not Light…	
Bad connections.	Recheck Power Connections
Try a system reset.	Use the RST toggle to reset the unit.
Internal +3.3V power has failed or a fatal processor (firmware) error has occurred.	Return unit for repair.
Input Power TVS has failed. This could occur for a sustained voltage surge or continuous over-voltage at the power terminals.	Return unit for repair. Power should be fused externally or current-limited to a safe operating level no less than twice the maximum input current.
Input Wetting Currents are Low, or Not 2mA/16mA…	
You are using Internal EXC or less than 7.2V of external excitation.	This is normal for excitation voltages below 7.2V.
Repeated System Resets Occur with Redundant Port Connections…	
Your external network or switch is not setup to handle redundant media connections.	Use an external redundant switch to connect to both ports of this device at the same time.

TROUBLE-SHOOTING

Diagnostics Table …continued

Upon power-up, after blinking momentarily the green "Run" LED should remain ON. This indicates the unit is properly powered and operating normally. If RUN continues to blink, then the unit may not be connected to the network or the cable is bad. Otherwise, a continuous blinking RUN LED can indicate unit is in "wink" ID mode, or it may be indicative of a firmware initialization error.

SYMPTOM…	
POSSIBLE CAUSE	**POSSIBLE FIX**
Continuous Flashing Green RUN LED…	
Unit was not connected to network upon power-up, or network cable is bad.	The RUN LED will continue to blink as the unit hunts for a network link. Connect a network cable to the unit to complete its initialization.
Unit in "wink" mode.	Read Unit Status register to verify "wink" status. Write 5555H to Wink Mode Toggle Register to toggle wink mode off/on.
Unit failed to boot firmware.	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.
Cannot Communicate…	
Power ON to the unit?	Check if green RUN LED is ON?
Fiber Connections not crossed over.	The auto-crossing feature does not apply to the fiber port. These connections must physically cross transmit to receive and visa-versa.
Wrong IP Address	Change IP address of the unit or host PC so they both match. Try the default unit address of 128.1.1.100.
Many Communication Errors…	
Is cable segment longer than 100M?	Distance between two Ethernet nodes is limited to 100 meters with approved cable.
Correct Cable?	Shielded CAT-5/5E cable or equivalent is recommended.
Missing earth ground connection.	Connect earth ground to TB6 GND terminal adjacent to power terminal.
Inputs Not Reading Back Correct OFF State…	
Excitation is below 6.2V, or inputs are tri-stated and floating.	The built-in wetting current sources that function as input pull-ups are not operable without proper excitation, or with the inputs tri-stated. Connect an excitation voltage, or pull the input signal up above the 4.3V maximum input threshold as required.
Unit Fails I/O Self Test…	
Internal excitation supply has failed, field wiring has been left connected, one or more outputs are turned ON, or inputs are tri-stated?	Do not float I/O as inputs must pull above the 4V threshold in the OFF state to read as OFF. Tri-stated inputs float without an external connection or with open-load detection OFF—do not tri-state inputs prior to this test. Otherwise, try connecting external excitation.
Outputs Don't Stay Shutdown After Fault with GSRC Register Bit Clear…	
Internal refresh cycle is enabled? (see also Global Shutdown & Retry Control Register)	Also disable the Auto Output Refresh cycle if you want outputs to stay shutdown after a fault.

SYMPTOM…	
POSSIBLE CAUSE	**POSSIBLE FIX**
Outputs Not Working…	
Missing external excitation connection and internal excitation is OFF?	You must connect an excitation supply between the port Ex & Return (R) terminals to power the output circuit if internal excitation is OFF.
Internal excitation turned OFF? (You can enable/disable internal excitation via the I/O Configuration web page or the Internal Excitation Control register)	I/O will not operate without excitation. If you're not using external excitation, you may have disabled the internal excitation supply. Return to the I/O Configuration Page and enable internal excitation if you have not connected external excitation.
Have you checked I/O operation via self-test feature?	To verify I/O is operational and has not been damaged, use the Self Test feature (see Utility Page). Be sure to unplug the terminals to avoid signal contention with external I/O signals.
Output Fault has occurred. (Outputs may shutdown in response to a fault—see the Global Shutdown & Retry Control register)	Review the info of the I/O Config Page and note outputs may shut-down for over-current/-temperature, and voltage faults. Identify any potential faults or shorts and correct them. Remove output field wiring to see if operation is restored.
Output TVS has failed? (Note – The TVS working voltage limit is 31V)	Outputs include transient voltage suppressors that will squelch over-voltage of short duration, but may fail for sustained over-voltage fault conditions without current-limiting. In this case, the unit must be returned to the factory to replace this TVS.
Cannot Browse Unit…	
Your browser may be setup to use a proxy server for LAN communications.	Temporarily disable the use of a proxy server by your browser (see procedure of next page).
Fiber Port Not Communicating…	
Is fiber cable crossed over? Have you selected 100MB and Full-Duplex for fiber port 1? Note the Tx channel of the unit is the bottom half of the SC fiber connector, while the Rx channel is the top half (facing front of unit).	The auto-crossing feature does not apply to fiber connections, which must physically crossover the transmit and receive channels. Further, the fiber port communicates at full-duplex and 100M only and auto-negotiation is not possible.
Redundancy Failover Protection Not Occurring…	
Your unit's network configuration is not in hub/repeater mode.	Set the unit to hub/repeater mode (not switch mode) for redundant media applications.
I/O Status Flags Appear Intermittent…	
Your unit is periodically retrying its control while a fault is present.	Auto-refresh should be OFF if you wish faulted outputs to stay OFF. See the Global Shutdown & Retry Control register to affect this behavior.

TROUBLE-SHOOTING

Diagnostics Table …continued

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 unit with a known good unit. Acromag's Application Engineers can provide further technical assistance if required. Complete repair services are also available from Acromag.

TROUBLE-SHOOTING

Diagnostics Table …continued

POSSIBLE CAUSE	POSSIBLE FIX
Unit Fails to Start-up or Initialize…	
Input power voltage below 18V minimum?	Check your power supply voltage and make sure that it is at least 18V.
Communication To Unit is Lost…	
Was communication interrupted by severe interference or shock?	Reset the unit via the RST toggle or by cycling power.
Outputs Do Not Go to Their Reset State for an Output Reset…	
Clicking the Output Reset button does not honor the power-on/reset state?	The reset states are only applicable to a power-on, system, or software reset via the Wink/Reset register.

Trouble Browsing Your Unit?

Refer to Acromag Application Note 8500-734 for help in setting up network communication with your unit (see CDROM shipped with unit or down-load it from www.acromag.com). This document gives details for changing your PC's TCP/IP configuration in order to communicate with similar hardware to your unit (see TCP/IP Properties of Network Configuration in Windows). If you have carefully followed this procedure and you still cannot browse your unit, you may have the web browser of your laptop or PC setup to use a proxy server when browsing the web. If you are using Internet Explorer, refer to the "Tools" pull-down menu, select "Internet options…", click the "Connections" tab, then click the "LAN Settings" button. Locate the Proxy server information and uncheck the box next to the statement "Use a proxy server for your LAN". Then click [OK] to return to the "Connections" screen, and click [OK] again to save your settings. This should allow you to use Internet Explorer to browse the unit as required. However, to later restore your PC's connection to your company network, you may have to re-enable the use of a proxy server for your LAN.

Getting Out Of Trouble



So, your EtherStax has apparently "gone wild", and resetting the unit did not correct your problem, then follow this procedure to restore it to its initial configuration and regain control.

There is limited error checking to keep you from writing invalid values to a configuration register and operation may become unpredictable if you do this under certain conditions. If resetting the unit fails to restore order, then to regain control of the unit, the unit can either be re-downloaded at the factory, or you can try restoring its initial configuration by following this procedure:

Procedure For Restoring any EtherStax Unit to its Initial Configuration

IMPORTANT: Use this only as a last resort, as this procedure will reset everything to its default state--all holding registers, network settings, and i2o settings (the permanently coded MAC ID does not change).

1. With unit power OFF, press and hold the front-panel toggle switch in the default (DFT upward) position.
2. Holding the toggle switch in the default position and apply power.
3. Note the green RUN LED will turn ON. Continue to hold the toggle at the DFT position for about 10 seconds until the green RUN LED turns OFF. Release the toggle switch at this point and the RUN LED will blink for 1-10 seconds as the unit acquires its address, then remains ON for normal operation. At this point, the unit is not in the default communication mode, but all registers are reset back to their default factory state.
4. If the green RUN LED never turned OFF while you held the DFT toggle during power-up, then reinitializing the unit has failed and you should try it again. This time, make sure that the DFT toggle switch is completely depressed and held until RUN turns OFF while powering the unit. Also make sure that you are holding the DFT toggle in the DFT direction (upward), rather than the RST direction (downward).

TECHNICAL REFERENCE

KEY FEATURESKEY FEATURES

- **High Density Flexible Industrial I/O** – Unit provides 96 channels of discrete I/O with high voltage/current open-drain outputs for low-side control of external devices. Tandem buffered inputs allow outputs to be read back, or input levels monitored, and facilitate a built-in I/O self test.
- **Web-Page Reconfiguration –** The unit may be configured, controlled, and monitored using a standard web browser over Ethernet.
- **I/O Mapping (i2o) Feature** – Allows inputs of an ES2113 unit to remotely control the outputs of another ES2113 unit on the network.
- **Achieves End-Node Redundancy** – Dual Ethernet ports can be used to accomplish media redundancy right to the unit when connected to redundant switches that support STP, RSTP, or most other proprietary ring redundancy methods.
- **Fully Isolated** – I/O channels, network ports, enclosure, and power are all isolated from each other for safety and increased noise immunity.
- **Safety Agency Approvals** – CE marked, UL Listed (USA & Canada) suitable for use in Class I, Division 2, Groups A, B, C, D Hazardous Locations, or Nonhazardous Locations only.
- **Selectable Modbus TCP/IP or UDP/IP Protocol Support –** Up to 10 sockets of support for Modbus using TCP/IP. Also supports UDP/IP.
- **Flexible IP Addressing** – Supports static, DHCP, or BOOTP.
- **10Base-T and 100Base-TX Support** – Auto-negotiated 10/100Mbps, Half or Full Duplex.
- **100BaseFX Support** – Optional models support a 100M FX fiber-optic connection at one of two ports.
- **Dual Ethernet Ports Make Network Connections Easy** – A built-in switch allows units to be connected in cascaded "daisy-chain" fashion without consuming another (external) switch port. The second port also allows the network distance to be extended an additional 100 meters (copper), or 2km (fiber).
- **Network Ports are Individually Isolated & Transient Protected –** The dual network ports of this device are safety-isolated from each other and have built-in transient protection from ESD, EFT, and other transients.
- **Auto MDI/MDI-X Crossover** – No special up/down link port or crossover cables are required to connect this device to your PC, external Ethernet switches, or hubs.
- **Low-Latency, Cut-Through Repeater Mode** – Reduces port-to-port latency jitter of switch mode from about 167us, to 40ns, for time critical applications or concentrated traffic links.
- **Tandem Input/Output Circuitry for Loopback Monitoring** - Input buffers are connected in tandem with open-drain outputs for convenient loop-back monitoring of the output states.
- **Configurable Power-Up/Reset State** – Outputs can be set to turn ON or OFF following power-up, system reset, or software reset.
- **Built-In Self-Test for Port I/O Read/Write –** Useful for troubleshooting I/O and internal communications for diagnostic purposes.
- **Inputs Have Programmable "Wetting" Current Sources Built-In –** Inputs have built-in current sources that eliminate the need to add pull-ups. This also facilitates I/O self-test without adding wiring. Wetting current is used to sense switch closure at an input and can be set to 16mA or 2mA. Normally, it automatically folds back from 16mA to 2mA, 20ms after the input crosses the 4V threshold. This is to provide higher levels of current during switch closure, which helps to reduce oxide buildup on switch contacts.

KEY FEATURES
…continued

- **Inputs May Be Optionally Tri-Stated** – The inputs may be tri-stated to a high-impedance state (disables wetting current). Tri-stated inputs act as simple comparators with a 4.0V threshold.
- **Built-in Output Thermal, Over-Current, & Over-Voltage Protection -** Inputs also include thermal protection. Status flags report these faults.
- **Outputs Include Selectable Fast Short-Fault Protection –** By default, if an output drives a shorted load, built-in thermal protection will kick-in to protect the output. Optionally, this device allows you to specify whether a port is to rely on the internal thermal protection mechanism, or implement a faster responding 100-450us shutdown mechanism based on the output drain-to-source voltage. This effectively allows output port protection to be tailored to incandescent lamp loads, or inductive loads. Limiting thermal stresses also helps preserve the life of the output driver.
- **Output Open-Load Detect** – Outputs include 50uA current sinks (pull-downs) that can be enabled to flag an open load with inputs tri-stated.
- **Failsafe Mode Support w/Watchdog Time Control** – Outputs can be sent to a failsafe state if the host fails and a watchdog timeout occurs.
- **Separate Port Excitation Terminals –** An excitation supply connection is provided for every 16 channels (ports) which allows individual ports to operate at different voltage levels. The excitation terminals also include transient and reverse-polarity protection.
- **Built-In Port Excitation** – I/O will not operate without excitation, but limited internal excitation allows the I/O to operate without an external excitation supply for low voltage and current applications.
- **Nonvolatile Reprogrammable Memory** – Allows the functionality of this device to be reliably reprogrammed thousands of times.
- **Extensive Operating & Diagnostic LED's Aide Troubleshooting** – Three LED's indicate power, operating mode, wink status, and relay state. Eight communication LED's indicate per-port activity, including: communication errors, link status, collision, speed, and duplex.
- **Internal Watchdog** - A hardware watchdog timer is built into the DSP that causes it to initiate a self reset if the controller ever "locks up" or fails to return from an operation in a timely manner.
- **Convenient "Wink" ID Mode Support** – Blinks green RUN LED in wink mode as a tool to help identify specific remote units.
- **Local Alarm Function** – Unit includes a set of SPST-NO relay contacts.
- **Wide Ambient Operation** – Reliable operation from -40°C to +75°C.
- **Hardened For Harsh Environments** - For protection from RFI, EMI, ESD, EFT, & surges. Has low radiated emissions per CE requirements.
- **Shock & Vibration Immunity** – To 5g random vibration per IEC60068-2-64, to 50g mechanical shock per IEC60068-2-27 (see Specifications).
- **Rugged and Stackable Aluminum Enclosure** – The anodized aluminum enclosure also allows units to be stacked and locked together.
- **"Plug-In" Terminal Blocks -** Make wiring removal, & replacement easy.
- **Enclosure Supports Surface or DIN-Rail Mount** – Optional surface or DIN-rail mounting, even when units are stacked together.
- **Open (No Enclosure) Option** – Units can be purchased without their enclosure and stacked together via threaded standoffs & 6-32 screws.
- **Wide-Range DC-Power w/ Redundant Power Connection -** Diode-coupled for use with redundant supplies and/or battery back-up. An extra power terminal is provided for optional standby backup power.

HOW IT WORKS

This unit will interface with any mix of up to 96 digital input and/or output signals, and provide an isolated 10/100Mbps Ethernet interface for configuration, monitoring, and control of the I/O. Inputs and outputs are connected in tandem with each other. An internal DSP will switch outputs ON/OFF and sample the digital inputs. Embedded configuration parameters are stored in non-volatile memory. With outputs turned OFF, channels operate as active-low, wide-range voltage inputs. Otherwise, inputs monitor the state of the corresponding open-drain output for independent "loop-back" monitoring of the output.

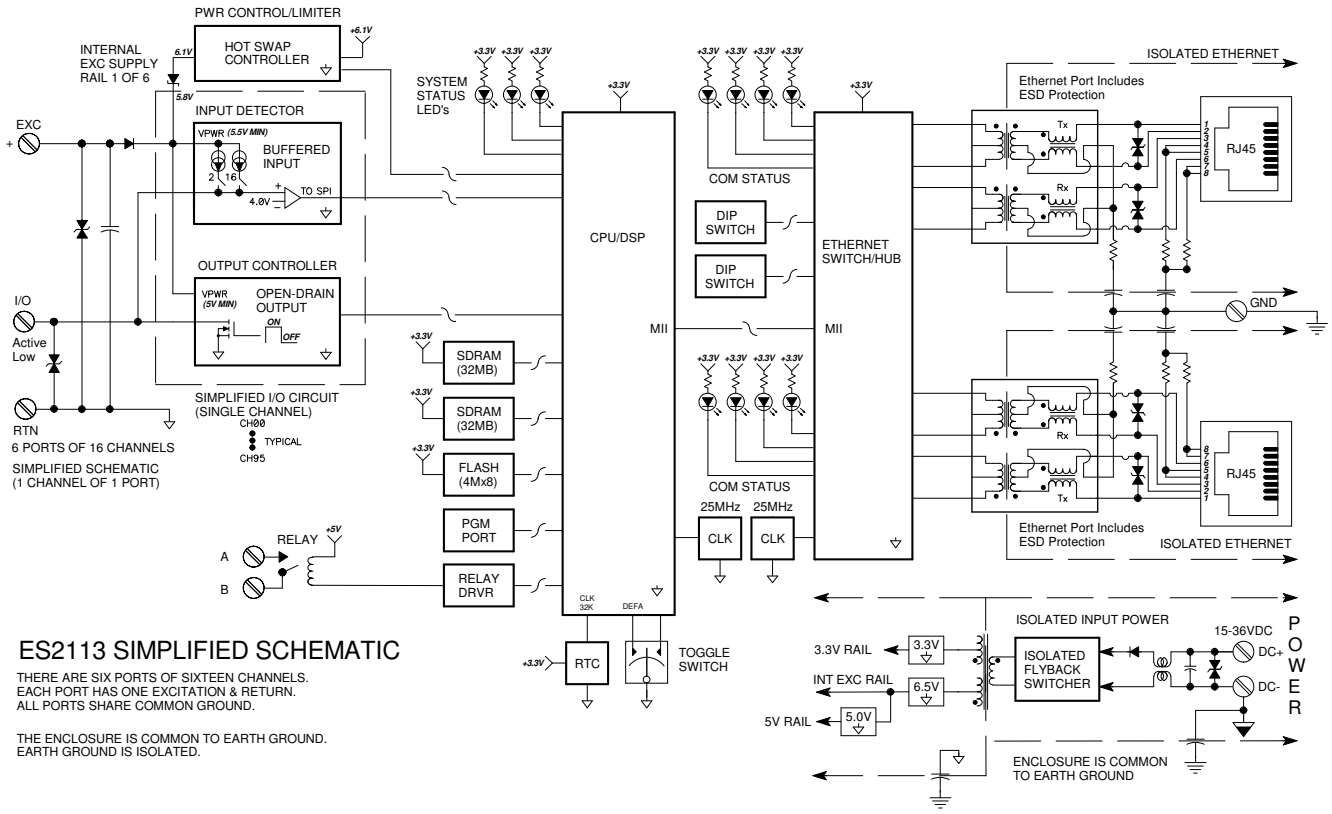
I/O channels are organized as 6 ports of 16 channels each. All I/O terminals include transient suppression. The I/O circuitry has built in thermal, over-voltage, and over-current protection. Separate port Excitation (Ex) terminals allow individual ports to operate at different voltage levels. The excitation terminals also have built-in transient and reverse polarity protection. Optionally, the internal 6.1V excitation supply can provide limited I/O drive capability equivalent to the wetting current without an external excitation supply connected.

Outputs of these models are the open-drains of n-channel mosfets (low-side switches). Inputs are active-low. A buffered input comparator is connected in tandem with each drain circuit and compares this signal to a 4.0V reference voltage. Inputs sense switch closure via built-in wetting current generators (2mA). These current sources initially provide a higher level of current during switch closure (16mA). This helps to minimize oxide buildup on external switch contacts. These sources also eliminate the need to pull-up the tandem open-drain mosfets of the output circuitry. Optionally, these current sources can be disabled and the input will operate as a simple high-impedance comparator with a 4.0V threshold.

The network interface utilizes a dedicated, 3-port, Ethernet switch to provide two external network ports to the internal CPU/MAC (third port). Both network ports are fully isolated and include transient protection. The embedded switch may also operate as an Ethernet hub, allowing automatic end-node media redundancy when both ports are connected to an external redundant switch (copper only). This also makes the node redundancy compatible with most proprietary ring redundancy methods, Spanning Tree (STP), or Rapid Spanning Tree (RSTP).

This device is packaged in a rugged aluminum enclosure. The enclosure is common to the earth ground terminal and fully isolated from the internal circuitry for increased safety and noise immunity. The internal transient suppression devices are shunted to earth ground via safety rated isolation capacitors.

A wide-input, high-efficiency, switching regulator (isolated flyback converter) provides isolated power to the unit, and optionally port excitation. Most I/O power is actually derived from the port excitation supply, requiring that excitation must be present to operate I/O. Refer to the simplified schematic on the following page to help gain a better understanding of circuit operation.



ES2113 SIMPLIFIED SCHEMATIC

THERE ARE SIX PORTS OF SIXTEEN CHANNELS.
EACH PORT HAS ONE EXCITATION & RETURN.
ALL PORTS SHARE COMMON GROUND.

THE ENCLOSURE IS COMMON TO EARTH GROUND.
EARTH GROUND IS ISOLATED.

Key Observations

- Ethernet ports are individually isolated from power, I/O, and each other, and include transient suppression.
- Inputs are active-low and operate like comparators with 4.0V thresholds.
- Inputs include built-in wetting current sources to sense contact closure or output ON (no pull-ups are required).
- Outputs are open-drain, low-side switches, and are pulled high by the built-in wetting current generators of the tandem inputs.
- I/O Ports require excitation to operate, but include an internal series Schottky diode-coupled 6.1V supply, for simple low-current and low voltage applications without having to wire an external supply. This supply is separately diode-coupled to each port and can be optionally turned off.
- All I/O channels share a common return connection, but each I/O port has a separate port excitation connection to allow individual ports to operate at different voltage levels.
- The input power and external excitation terminals are series-diode coupled for reverse polarity protection and to facilitate redundant power connections.
- The aluminum enclosure is common to the earth ground terminal and transient suppression devices are shunted to this ground via isolation capacitors, maintaining isolation from earth ground. If an ungrounded enclosure should come in contact with high-voltage, the connected circuits will be isolated from this fault condition.

ABOUT MODBUS TCP/IP & UDP/IP

Modbus TCP/IP and Modbus UDP/IP actually refer to a set of complimentary protocols that operate on your data. Modbus itself, is the *application protocol* and it defines the rules for organizing and interpreting the data. TCP and UDP are *transport protocols*, responsible for transmitting and receiving the data (a message received via TCP, will get a response via TCP, and a message received via UDP will get a response via UDP). IP is a *network protocol*, responsible for addressing and delivering the data.

Referring to the OSI Network Model (a simplified model is shown at left), we see that these protocols reside at different layers, with the application layer at the top. As data is transmitted, each lower layer adds its own header information to the front of the packet that it receives from the next higher layer. The higher layer data is essentially encapsulated by the lower layers, according to the different protocols that operate at these levels and whose service is requested. With respect to Modbus TCP/IP or UDP/IP, the application layer data of Modbus is encapsulated by the transport layer data of TCP (or UDP), which is then encapsulated by the network layer data of IP. This process of wrapping outgoing messages with layer frames as the message is passed down the stack changes to a process of peeling back the layer frames at each layer for a received message as it is subsequently passed up the stack to the application layer.

SIMPLIFIED TCP/IP STACK LAYER REFERENCE MODEL

TX	LAYER	RX
5 ↓	Application	↑ 5
4 ↓	Transport	↑ 4
3 ↓	Internet/Network	↑ 3
2 ↓	Data Link	↑ 2
1→	Physical	→1

A transmitted message is wrapped at each layer as it passes down the stack, while the received message is unwrapped at each layer as it passes up the stack.

For the EtherStax units, Modbus serves as the *application protocol* and it defines the rules for organizing and interpreting the data. It is essentially a messaging structure that is independent of an underlying physical layer. The transport layer resides just below this application layer and is responsible for the transmission, reception, and error checking of the data. While there are a number of transport layer protocols that may operate at this layer, the primary ones of interest to us are TCP and UDP. Which one applies in the EtherStax response will depend on which one was used in passing the message to the EtherStax.

TCP is a connection-oriented transport layer protocol. By connection-oriented, we mean that TCP establishes a secure connection between two network stations for the duration of the data transmission. TCP works via the Client-Server communication model. That is, whichever network station takes the initiative and establishes the connection is referred to as the *TCP Client*. The station to which the connection is made is called the *TCP Server.* The server does nothing on its own, but just waits for the client to make contact with it. The client then makes use of the service offered by the server (depending on the service, one server may accommodate several clients at one time).

TCP verifies the sent user data with a checksum and assigns a sequential number to each packet sent. The receiver of a TCP packet will use the checksum to verify having received the data correctly. Once the TCP server has correctly received the packet, it uses a predetermined algorithm to calculate an acknowledgement number from the sequential number. The acknowledgement number is returned to the client with the next packet it sends as an acknowledgement. The server also assigns a sequential number to the packet it sends, which is then subsequently acknowledged by the client with an acknowledgement number. This process helps to ensure that any loss of TCP packets will be noticed and that if needed, they can then be re-sent in the correct sequence.

ABOUT MODBUS TCP/IP & UDP/IP

Note that with TCP, the transmitter expects the receiver to acknowledge receipt of the data packets. Failure to acknowledge receipt of the packet will cause the transmitter to send the packet again, or the communication link to be broken. Because each packet is numbered, the receiver can also determine if a data packet is missing data, or it can reorder packets not received in the correct order. If any data is detected as missing, all subsequent received data will be buffered. Complete data will be passed up the protocol stack to the application, but only when it is complete and in the correct order.

TCP/IP refers to Transmission Control Protocol and Internet Protocol, and serves as the foundation for the world-wide web. TCP/IP allows blocks of binary data to be reliably exchanged between computers. The primary function of TCP is to ensure that all packets of data are received correctly, while IP makes sure that messages are correctly addressed and routed. We see that the TCP/IP combination does not define what the data means or how the data is to be interpreted, it is only concerned with transporting and delivering the data.

Like TCP, the User Datagram Protocol (UDP) resides above IP and is another protocol for transporting data, but with the emphasis being to transport it on-time, rather than to guaranty delivery. Unlike TCP, UDP is a connectionless protocol that simply allows one device to send a datagram to another device without guaranteed delivery, a retry mechanism, or any acknowledgement.

As UDP is a connectionless transport layer protocol, when a transmitter sends out a data packet, it does not expect to receive confirmation that the packet has arrived at its destination. Further, the receiver accepts the incoming packets, but cannot tell if any packets are missing or in the wrong order. Uncorrupted data packets are simply passed up the protocol stack as they are received. The lack of built-in overhead error checking makes this protocol faster, though somewhat less reliable (error checking in UDP is left to the application protocol). Some implementations of Modbus UDP/IP will recover the Modbus CRC error checking mechanism, while others do not.

We see that UDP packets are treated like separate mailings, with no confirmation of packet receipt, and UDP does not require connections to be established or broken off, thus no timeout situations occur. If a packet is lost, data transmission will continue unabated, and a higher protocol will usually be responsible for repetition. That is, data integrity under UDP is generally handled by the application program itself. These characteristics effectively allow UDP to communicate much faster than TCP.

Some messages are considered time-critical, and if the data is delayed, it loses its value. In this sense, if the data is lost there is no point in retransmitting it. This type of data exchange is commonly used for real-time or control data and sent using UDP (User Datagram Protocol), as opposed to TCP (Transport Control Protocol). UDP is faster than TCP and provides the quick, efficient data transport necessary for real-time data exchange. The EtherStax can use UDP to reduce traffic overhead and achieve higher throughput where appropriate.

ABOUT MODBUS TCP/IP & UDP/IP

To contrast, sending a message via TCP makes sense where continuous data streams or large quantities of data must be exchanged, or where a high degree of data integrity is required (the emphasis here is on *secure data).* Of course the error checking mechanism of the connection-oriented TCP protocol takes time and will cause it to operate more slowly than a connectionless protocol like UDP. Thus, sending a message via UDP makes sense where transmission parameters are changing frequently and when data integrity can instead be assured by a higher order protocol (the emphasis here is on *time-critical data).*

Again, referring to the OSI Network Model, the Network Layer or Internet Layer resides just below the Transport Layer and is responsible for routing the packets to the network. There are many network layer protocols such as ICMP, IGMP, ARP, RARP, but our focus here is on IP.

An IP packet is a chunk of data transferred over the Internet using standard Internet Protocol (IP). The Internet Protocol (IP) is responsible for the actual addressing and delivery of the data packets. IP packets vary in length depending on the data being transmitted, but each packet begins with a header containing addressing and system control information. Similar to UDP, IP is also a connectionless and unacknowledged method for sending data packets between two devices on a network. IP does not guarantee delivery of the data packet, but relies on a transport layer protocol (like TCP), or application layer protocol (like Modbus) to do that. The IP addressing scheme also makes it possible to assemble an indefinite number of individual networks into a larger overall network, without regard to the physical implementation of the sub networks. The data can then be sent from one network station to another, regardless of these differences.

The IP specific header (MBAP of the Modbus TCP/IP specification) is the same for Modbus/UDP as for Modbus/TCP, and is 7 bytes long and comprised of the following fields:

- Invocation Identification/Transaction Identifier (2 bytes).
- Protocol Identifier (2 bytes) - Set to 0 for Modbus by default and other settings are reserved for future extensions.
- Length (2 bytes) - Represents a byte count of all following bytes.
- Unit Identifier (1 byte) - Used to identify a remote unit located on a non-TCP/IP network.

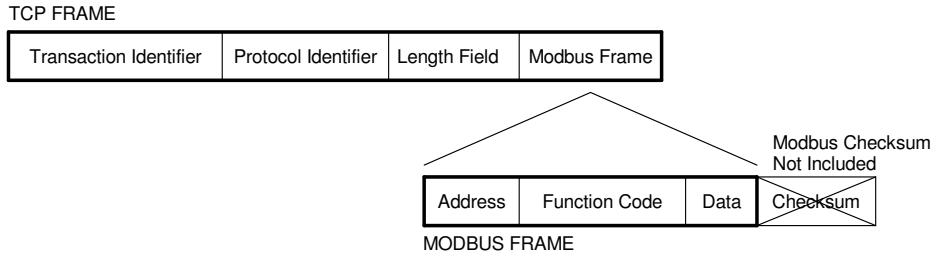
The EtherStax can utilize either TCP or UDP, transparently, as required by your application. The EtherStax will respond via UDP for messages received via UDP, and via TCP for messages received via TCP, while i2o messages are only sent via TCP/IP. In general, time-critical implicit messages can be sent using the faster UDP, while explicit messages can be sent securely using TCP. With UDP, lost data will not prevent subsequent time-critical data from being processed. Whereas, the slower but more reliable TCP will instead ensure that a message is received by retransmitting any lost data, but this process may not be suitable for real-time data.

Modbus uses TCP/IP or UDP/IP Ethernet to carry the data of the Modbus message structure between devices. That is, Modbus TCP/IP combines a physical network (Ethernet), with a networking standard (TCP/IP), and a standard method of representing data (Modbus).

ABOUT MODBUS TCP/IP & UDP/IP

A Modbus TCP/IP message is simply a Modbus communication encapsulated in an Ethernet TCP/IP wrapper. Likewise for Modbus UDP/IP.

To illustrate, Modbus TCP embeds a Modbus data frame into a TCP frame, sans the Modbus checksum, as shown in the following diagram. The Modbus checksum is not used, as the standard Ethernet TCP/IP link layer checksum methods are instead used to guaranty data integrity. For UDP/IP, error checking is left to the application layer protocol.



Note that the Modbus address field is referred to as the *Unit Identifier* in Modbus TCP. In a typical slave application, the Unit ID is ignored and just echoed back in the response.

It's important to make the distinction that Modbus UDP is a transaction oriented protocol, and if a message gets lost, this transaction will not be successfully executed. Thus, it is left to the master (the application layer protocol) to know and decide whether to retry the message, or just give up. Additionally, the package size of a Modbus UDP message is limited to 256 bytes to avoid the necessity of splitting a package. Thus, messages are unicast between nodes on the network, with only two packages to every transaction—a request and a response package/message. Modbus UDP also conforms to the traditional master-slave network relationships of Modbus TCP, and its permutations still allow multiple-master systems, as well as bidirectional communicative devices that are both masters and slaves at the same time.

With respect to the EtherStax I/O devices, these devices normally operate as network slaves (information servers) and do not initiate transactions on their own (except for i2o exchanges when this feature is enabled).

IP Addressing

A host is used to refer to any device on any network. On TCP/IP networks, each host has one or more unique IP addresses. An EtherStax unit connected to an Ethernet network acts as a host.

An IP Address is a unique identification number for any host (this unit) on any TCP/IP network (including the internet). The IP address is made up of four octets (8 bits), each octet having a value between 0-255 (00H-FFH). The IP address is comprised of two parts: the network address (first part) and the host address (last part). The number of octets of the four total that belong to the network address depend on the Class definition (see below).

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.

ABOUT MODBUS TCP/IP & UDP/IP

IP Addressing

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. Anything sent to the last IP address of a subnet is sent to every host on the subnet.

Subnets are further broken down into three size classes based on the 4 octets that make up the IP address. A Class A subnet is any subnet that shares the first octet of the IP address. The remaining 3 octets of a Class A subnet will define up to 16,777,214 possible IP addresses ($2^{24} – 2$). A Class B subnet shares the first two octets of an IP address (providing $2^{16} – 2$, or 65534 possible IP addresses). Class C subnets share the first 3 octets of an IP address, giving 254 possible IP addresses. Recall that the first and last IP addresses are generally 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).

For our example, the default IP address of this unit is 128.1.1.100. If we assume that this is a Class C network address (based on the default Class C subnet mask of 255.255.255.0), then the first three numbers represent this Class C network at address 128.1.1.0, the last number identifies a unique host/node on this network (node 100) at address 128.1.1.100.

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.

A *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 sub-network (0110), then we would use "11111111.11111111.11111111. 11110000" as our subnet mask. This would effectively subdivide our Class C network into 14 sub-networks of up to 14 possible nodes each.

With respect to the default settings of this device:

Subnet Mask 255.255.255.0 (11111111.11111111.11111111.00000000)
IP Address: 128.1.1.100 (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). Nodes 0, 10, and 255 are typically reserved for servers and may yield poor results if used.

Dynamic Host Configuration Protocol (DHCP)

DHCP refers to Dynamic Host Configuration Protocol and is a method used to assign 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.

ABOUT MODBUS TCP/IP & UDP/IP

The DHCP server will check the shared supply, and if all addresses are in use, the server will send a busy signal to the client which tells it to try again later. Static IP addresses will ensure a connection every time, but dynamic addresses do not.

Domain Name System (DNS)

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

MODBUS REGISTERS

Modbus registers are organized into reference types identified by the leading number of the reference address:

The "x" following the leading character represents a four-digit address location in user data memory.

The leading character is generally implied by the function code and omitted from the address specifier for a given function. The leading character also identifies the I/O data type.

Reference	Description
0xxxx	Read/Write Discrete Outputs or Coils. A 0x reference address is used to drive output data to a digital output channel.
1xxxx	Read Discrete Inputs. The ON/OFF status of a 1x reference address is controlled by the corresponding digital input channel.
3xxxx	Read Input Registers. A 3x reference register contains a 16-bit number received from an external source—e.g. an analog signal.
4xxxx	Read/Write Output or Holding Registers. A 4x register is used to store 16-bits of numerical data (binary or decimal), or to send the data from the CPU to an output channel.

Note: The ON/OFF state of discrete inputs and outputs is represented by a 1 or 0 value assigned to an individual bit in a 16-bit data word (port). This is sixteen 0x or 1x references per data word. With respect to mapping, the lsb of the word maps to the lowest numbered channel of a port and channel numbers increase sequentially as you move towards the msb.

All I/O values are accessed via the 16-bit Input Registers or 16-bit Holding Registers given in the Register Map. Input registers contain information that is read-only. For example, the current input value read from a channel, or the states of a group of digital inputs. Holding registers contain read/write information that may be configuration data or output data. For example, the high limit value of an alarm function operating at an input, or an output value for an output channel.

Register Functions

Each EtherStax unit has a default factory configuration as noted in the Specifications section. Your application will likely differ from the default configuration provided and the unit will need to be reconfigured. You may reconfigure most features of this unit by issuing the appropriate Modbus functions to Register Map registers, as required by your application. You may also use a standard web browser to access the built-in web pages of the unit to perform basic I/O & reconfiguration.

Register Functions

Below is a subset of standard Modbus functions that are supported by this unit along with the reference register address group that the function operates on. Use these functions to access these registers as outlined in the Register Map for sending and retrieving data.

The following standard Modbus functions operate on register map registers to monitor, configure, and control unit I/O:

CODE	FUNCTION	REFERENCE
01 (01H)	Read Coil (Output) Status	0xxxx
02 (02H)	Read Input Status	1xxxx
03 (03H)	Read Holding Registers	4xxxx
04 (04H)	Read Input Registers	3xxxx
05 (05H)	Force Single Coil (Output)	0xxxx
06 (06H)	Preset Single Register	4xxxx
15 (0FH)	Force Multiple Coils (Outputs)	0xxxx
16 (10H)	Preset Multiple Registers	4xxxx
17 (11H)	Report Slave ID (See Below)	*Hidden*

If an unsupported function code is sent to a unit, exception code 01 (Illegal Function) will be returned in the response. If a holding register is written with an invalid value, exception code 03 (Illegal Data Value) will be returned in the response message. You may refer to the Modbus specification for a complete list of possible error codes.

EtherStax ES2113-x0x0 Report Slave ID Example Response[1]

FIELD	DESCRIPTION
Unit ID	Echo Unit ID Sent In Query
Function Code	11
Byte Count	43
Slave ID (Model No.)[1]	00=ES2113-x0x0 (all ES2113 model variations)
Run Indicator Status	FFH (ON)
Firmware Number String (Additional Data Field)[1]	41 43 52 4F 4D 41 47 2C 39 33 30 30 2D 31 37 30 2C 45 53 32 31 31 33 2D 78 78 78 78 ("ACROMAG,9300-170,ES2113-xxxx,*serial number&rev,six-byteMACID*")

[1]**Note:** All ES2113-x0x0 models share slave ID "00" and firmware number 9300-170 (this number is also indicated on home page of the web browser).

For detailed information on Modbus, feel free to download our technical reference 8500-648, "Introduction To Modbus", at www.acromag.com*. You can also find more information specific to Modbus TCP/IP by down-loading whitepaper 8500-765, "Introduction To Modbus TCP/IP". Additional information regarding Ethernet can also be found in our whitepaper 8500-747, "Introduction To Ethernet/IP".*

Register Mirroring

For your convenience, the EtherStax mirrors the contents/operation of registers 0xxxx, 1xxxx, & 3xxxx (as applicable) into holding register space for systems and controllers that cannot directly access registers 0xxxx, 1xxxx, & 3xxxx.

All Modbus registers can be written to, or read from, using either the standard methods described in the Modbus specification, or through mapping (mirroring) to the Holding Registers. The registers are mapped as follows and specifics follow the mapping:

Register Mirroring

0xxxx Coil Registers are mapped to 42xxx Holding Registers
1xxxx Input Status Registers are mapped to 41xxx Holding Registers
3xxxx Input Registers are mapped to 43xxx Holding Registers

For 3xxxx Input Registers, the format of the registers are identical and you only need to offset your address by 43000. For example: if you want to read Input Register 1 through the Holding Registers, you would use the "Read Holding Registers" function with an address of 43001.

For the 1xxxx Input Status Registers, the return data is reformatted to match the Holding Register format. For example: if you request the Input Status for 16 digital inputs, instead of getting 2 bytes returned with the 16 bits representing the 16 digital inputs, you will get 16 separate words, each set to either 0000H (OFF), or FFFFH (ON).

For the 0xxxx Coil Registers, reads are handled in the same way as the 1xxxx Input Status Registers. You can also write to the coil registers by using the "Preset Single Register" function with an address offset of 42000. Setting the data to 0000H will turn the coil OFF, while setting the data to FF00H will turn the coil ON. Writing to multiple coils is not supported via register mirroring, you must use the "Write Multple Coils" function for that.

Data Types

I/O values for ES2100 units are represented by the following simple data types for temperature, percentage, and discrete on/off.

Summary Of Data Types Used By EtherStax Models

Data Types	Description
Discrete (This Model)	A discrete value is generally indicated by a single bit of a 16-bit word. The bit number/position typically corresponds to the discrete channel number for this model. 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 inputs, a value of 1 means the input is ON (Active low near 0V), while a value of 0 specifies the input is OFF or in its high state (usually >> 0V).
Count Value	A 16-bit signed integer in range of -32768 to +32767, or unsigned integer in range of 0 to 65535, representing an A/D or DAC count, time value, or frequency.
Analog Data	A 16-bit signed integer value in range of -32768 to +32767. ±20000 is used to represent ±100% of the pre-defined range with a resolution of 0.005%/lsb. For example, -100%, 0% and +100% are represented by decimal values –20000, 0, and 20000, respectively. The full possible range is –163.84% (-32768 decimal) to +163.835% (+32767 decimal). For example, a 0-20mA input would be represented by a register count of 0-20000.
Temperature	A 16-bit signed integer value with resolution of 0.1°C/lsb. For example, a value of 12059 is equivalent to 1205.9°C, a value of –187 equals –18.7°C. The maximum possible temperature range is –3276.8°C to +3276.7°C.

Register Map Model ES2113

The following table outlines the register map for all model variations of the EtherStax ES2113 I/O processors. The Modbus functions operate on these registers using the data types noted above (except for the Reset Slave and Report Slave ID functions).

Not all programmable features of this device will include a corresponding Modbus configuration register. Some functionality must be programmed via the built-in web browser interface. For example, parameters related to network communications do not have a Modbus register and are programmed solely through the built-in web interface.

The 96 channels of this model are organized as six ports of sixteen channels each, with input and output circuits connected in tandem at each channel.

Ref	Addr.	Description	Data Type/Format
Coil Registers (0x References, Read/Write)			
00001 Thru **0**0016	0-15 (0000-000F)	16 Discrete Outputs of Port 1 (CH00-15) **(Default=0)**	Port 1 Discrete Output Value. Addresses a specific bit of a 16-bit word that controls/monitors the ON/OFF status for the corresponding output (gate signal of the n-channel mosfet). 0=OFF; 1=ON. The lsb is channel 0.
00017 Thru **0**0032	16-31 (0010-001F)	16 Discrete Outputs of Port 2 (CH16-31)	*See explanation for Port 1 above, but apply to Port 2 channels 16-31 (lsb is channel 16).*
00033 Thru **0**0048	32-47 (0020-002F)	16 Discrete Outputs of Port 3 (CH32-47)	*See explanation for Port 1 above, but apply to Port 3 channels 32-47 (lsb is channel 32).*
00049 Thru **0**0064	48-63 (0030-003F)	16 Discrete Outputs of Port 4 (CH48-63)	*See explanation for Port 1 above, but apply to Port 4 channels 48-63 (lsb is channel 48).*
00065 Thru **0**0080	64-79 (0040-004F)	16 Discrete Outputs of Port 5 (CH64-79)	*See explanation for Port 1 above, but apply to Port 5 channels 64-79 (lsb is channel 64).*
00081 Thru **0**0096	80-95 (0050-005F)	16 Discrete Outputs of Port 6 (CH80-95)	*See explanation for Port 1 above, but apply to Port 6 channels 80-95 (lsb is channel 80).*
Note: This signal corresponds to the digital gate signal of the n-channel output mosfet. Thus, a read of this register may not reflect the actual output level at the drain of the mosfet for certain conditions. You can read the Contact Registers to obtain the actual output state(s) via closed loop feedback. ***I/O will not operate without port excitation.***			The bit position also corresponds to the output channel number (i.e. output 0 uses bit 0 of the 16-bit word at address 0, output 1 uses bit 1 of the 16-bit word at address 1, etc.) A set bit (1) means the output is turned ON (sinking current). A clear bit (0) means output is turned OFF (open). After reset, these registers read 0 (outputs OFF) and these registers are not maintained in EEPROM.

Register Map
Model ES2113

Ref	Addr.	Description	Data Type/Format
Contact Registers/Input Status (1x References, Read-Only)			
10001 Thru **1**0016	0-15 (0000-000F)	Port 1: 16 Discrete Inputs 0-15	Discrete Input Value. Addresses a specific bit of a 16-bit word that flags the ON/OFF status for the corresponding input or tandem output. 0=OFF; 1=ON. The lsb is channel 0.
10017 Thru **1**0032	16-31 (0010-001F)	Port 2: 16 Discrete Inputs 16-31	*See explanation for Port 1 above, but apply to Port 2 channels 16-31 (lsb is channel 16).*
10033 Thru **1**0048	32-47 (0020-002F)	Port 3: 16 Discrete Inputs 32-47	*See explanation for Port 1 above, but apply to Port 3 channels 32-47 (lsb is channel 32).*
10049 Thru **1**0064	48-63 (0030-003F)	Port 4: 16 Discrete Inputs 48-63	*See explanation for Port 1 above, but apply to Port 4 channels 48-63 (lsb is channel 48).*
10065 Thru **1**0080	64-79 (0040-004F)	Port 5: 16 Discrete Inputs 64-79	*See explanation for Port 1 above, but apply to Port 5 channels 64-79 (lsb is channel 64).*
10081 Thru **1**0096	80-95 (0050-005F)	Port 6: 16 Discrete Inputs 80-95	*See explanation for Port 1 above, but apply to Port 6 channels 80-95 (lsb is channel 80).*
Note: This signal reflects the actual state of the corresponding input signal relative to a 4.0V threshold, or the drain of the tandem output. This signal is active-low below 4V. ***I/O will not operate without port excitation.***			The bit position corresponds to the input channel number for the port (i.e. input 0 uses bit 0 of the 16-bit word at address 0, input 1 uses bit 1 of the 16-bit word at address 1, etc.). A set bit (1) means input is ON (active-low < 4V threshold). A clear bit (0) means input is OFF (high, > 4V threshold).
Input Registers (3x References, Read-Only)			
30001	0000	Unit Status *Use this register to check for fiber-optic option, wink mode, default mode, internal excitation fault, or watchdog timeout.*	Bit 15: **Fiber Optic Flag** 1 = Fiber Optic Transceiver Installed Bit 14: **Wink Mode** Flag 1 = Wink (Blinks Run LED for ID) (See Wink Unit Register) Bit 13: **Default Mode** Flag 1 = Default Mode Indication Bits 12-7: 0 (Not Used) Bit 6: Internal **Excitation Fault** 1 = Short/Over-Temp EXC Fault Bit 5: Port 6 (CH 80-95) **WD Fault** 1 = Port 6 Watchdog Fault Bit 4: Port 5 (CH 64-79) **WD Fault** 1 = Port 5 Watchdog Fault Bit 3: Port 4 (CH 48-63) **WD Fault** 1 = Port 4 Watchdog Fault Bit 2: Port 3 (CH 32-47) **WD Fault** 1 = Port 3 Watchdog Fault Bit 1: Port 2 (CH 16-31) **WD Fault** 1 = Port 2 Watchdog Fault Bit 0: Port 1 (CH 00-15) **WD Fault** 1 = Port 1 Watchdog Fault

Ref	Addr.	Description	Data Type/Format
Input Registers (3x References, Read-Only)			
30002	1 (0001)	Port 1 I/O Error Status *Use this register to check for output thermal fault, output over-voltage, excitation over-voltage, open output load, or input thermal fault.*	This register reflects the fault status for all port I/O channels 0-15. Bit 15-3: 0 (Not Used) Bit 2: Output "Any Fault" flag including thermal fault, excitation over-voltage, open-load detected, and output over-voltage. Bit 1: Output over-voltage only flag (drain-source or Exc over-voltage). Bit 0: Input Thermal Fault Flag. ***Note that only the faulted output(s) will shut-down if a fault flag is set, not the entire port. If excitation over-voltage is tripped, the entire port is shutdown. Open-load detection does not shut down the output.***
30003	2 (0002)	Port 2 I/O Error Status	*See explanation for Port 1 above, but apply to Port 2 channels 16-31 status.*
30004	3 (0003)	Port 3 I/O Error Status	*See explanation for Port 1 above, but apply to Port 3 channels 32-47 status.*
30005	4 (0004)	Port 4 I/O Error Status	*See explanation for Port 1 above, but apply to Port 4 channels 48-63 status.*
30006	5 (0005)	Port 5 I/O Error Status	*See explanation for Port 1 above, but apply to Port 5 channels 64-79 status.*
30007	6 (0006)	Port 6 I/O Error Status	*See explanation for Port 1 above, but apply to Port 6 channels 80-95 status.*
30008	7 (0007)	Port 1 Input Change Detect (Latching)	The bit position corresponds to the input channel number for the port. A set bit (1) means the corresponding channel of the port has changed states. Reading this register will clear all bits to 0. The lsb is channel 0.
30009	8 (0008)	Port 2 Input Chg Detect (Latching)	*See explanation for Port 1 above, but apply to Port 2 channels 16-31. The lsb is channel 16.*
30010	9 (0009)	Port 3 Input Chg Detect (Latching)	*See explanation for Port 1 above, but apply to Port 3 channels 32-47. The lsb is channel 32.*
30011	10 (000A)	Port 4 Input Chg Detect (Latching)	*See explanation for Port 1 above, but apply to Port 4 channels 48-63. The lsb is channel 48.*
30012	11 (000B)	Port 5 Input Chg Detect (Latching)	*See explanation for Port 1 above, but apply to Port 5 channels 64-79. The lsb is channel 64.*
30013	12 (000C)	Port 6 Input Chg Detect (Latching)	*See explanation for Port 1 above, but apply to Port 6 channels 80-95. The lsb is channel 80.*

Register Map Model ES2113

A drain-to-source voltage greater than 50V, or an excitation voltage between 28-35V could trigger the output over-voltage only flag (and the "Any Fault" flag).

Note that if output fault fast shutdown is selected, the output error status flag may not get set.

The error status flag is only set while the output attempts to drive the fault. The output will shut down, then the error status flag will clear as the part cools. If auto-retry and/or auto-refresh are enabled via the Global Shutdown & Retry Control register, the error status flag may appear to be intermittent while the fault condition remains. This is because the output periodically retries its drive, shuts-down, then recycles with each retry.

Register Map
Model ES2113

IMPORTANT: *Changes to Holding Registers take effect immediately.*

Note: *A port timeout can only be cleared via a write to any output channel of the same port, or upon a software or power-on reset of the unit or by resetting the outputs.*

TIP: *Critical applications subject to conditions of severe shock or interference should utilize the built-in watchdog timer and alarm relay to signal an interruption in communication, link loss, and optionally power failure (w/failsafe contacts).*

Note: *Clearing a timeout via an I/O write does not return the output(s) to their initial state. They remain in their timeout states until otherwise written.*

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40001	0 (0000)	Port 1 (CH 00-15) Watchdog WD Time **Def=FFFFH (Disabled)**	Set a watchdog time from 1 to 65534 seconds in 1 second intervals. Set to 65535 (FFFFH) or 0 (0000H) to disable the port watchdog timer. Default is 65535 (disabled).
40002	1 (0001)	Port 2 (CH 16-31) WD Time	*See explanation for Port 1 above, but apply to Port 2 channels 16-31.*
40003	2 (0002)	Port 3 (CH 32-47) WD Time	*See explanation for Port 1 above, but apply to Port 3 channels 32-47.*
40004	3 (0003)	Port 4 (CH 48-63) WD Time	*See explanation for Port 1 above, but apply to Port 4 channels 48-63.*
40005	4 (0004)	Port 5 (CH 64-79) WD Time	*See explanation for Port 1 above, but apply to Port 5 channels 64-79.*
40006	5 (0005)	Port 6 (CH 80-95) WD Time	*See explanation for Port 1 above, but apply to Port 6 channels 80-95.*
40007	6 (0006)	Port 1 (CH 00-15) Timeout/TO State **Def=0000H (All Clear)**	The bits of this 16-bit register value define the state that the output channels of Port 1 will be programmed to following a watchdog timeout. Bit 0 corresponds to channel 0 (lsb), bit 1 to channel 1, bit 2 to channel 2, and so on.
40008	7 (0007)	Port 2 (CH 16-31) TO State	*See explanation for Port 1 above, but apply to Port 2 channels 16 (lsb) to 31 (msb).*
40009	8 (0008)	Port 3 (CH 32-47) TO State	*See explanation for Port 1 above, but apply to Port 3 channels 32 (lsb) to 47 (msb).*
40010	9 (0009)	Port 4 (CH 48-63) TO State	*See explanation for Port 1 above, but apply to Port 4 channels 48 (lsb) to 63 (msb).*
40011	10 (000A)	Port 5 (CH 64-79) TO State	*See explanation for Port 1 above, but apply to Port 5 channels 64 (lsb) to 79 (msb).*
40012	11 (000B)	Port 6 (CH 80-95) TO State	*See explanation for Port 1 above, but apply to Port 6 channels 80 (lsb) to 95 (msb).*

Register Map
Model ES2113

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40013	12 (000C)	Port 1 Timeout (TO) Action **Def=FFFFH (Change)**	Tells what to do to the outputs of port 1 upon watchdog timeout. 0000H=Do Not Change Port 1 Outputs FFFFH=Change Port 1 Outputs per Timeout State Register settings.
40014	13 (000D)	Port 2 TO Action	*See explanation for Port 1 above, but apply to Port 2 channels 16 to 31.*
40015	14 (000E)	Port 3 TO Action	*See explanation for Port 1 above, but apply to Port 3 channels 32 to 47.*
40016	15 (000F)	Port 4 TO Action	*See explanation for Port 1 above, but apply to Port 4 channels 48 to 63.*
40017	16 (0010)	Port 5 TO Action	*See explanation for Port 1 above, but apply to Port 5 channels 64 to 79.*
40018	17 (0011)	Port 6 TO Action	*See explanation for Port 1 above, but apply to Port 6 channels 80 to 95.*
40019	18 (0012)	Wetting Current Select Register Port 1 DI0-15 Increasing wetting current helps to prevent oxide buildup on switched contacts. **Def=FFFFH (16mA)**	Each input channel has two levels of wetting current, 16mA and 2mA. These bits are used to change the wetting currents for all input channels of the port on the fly. Actual wetting current levels are reduced for excitation voltages below 7.2V Set this register to 0000H to set all 16 channels of the port to 2mA continuous. Set this register to FFFFH to temporarily set all 16 channels to 16mA for 20ms, upon crossing the 4V input threshold, then return to 2mA continuous. **Note:** The 16mA wetting current selection is subject to a built-in timer which will automatically change the wetting current back to 2mA, 20ms after the input crosses the 4V threshold.
40020	19 (0013)	Port 2 Wetting Sel DI16-31	*See explanation of Port 1 above, but apply to Port 2 channels 16 to 31.*
40021	20 (0014)	Port 3 Wetting Sel DI32-47	*See explanation of Port 1 above, but apply to Port 3 channels 32 to 47.*
40022	21 (0015)	Port 4 Wetting Sel DI48-63	*See explanation of Port 1 above, but apply to Port 4 channels 48 to 63.*
40023	22 (0016)	Port 5 Wetting Sel DI64-79	*See explanation of Port 1 above, but apply to Port 5 channels 64 to 79.*
40024	23 (0017)	Port 6 Wetting Sel DI80-95	*See explanation of Port 1 above, but apply to Port 6 channels 80 to 95.*

If 16mA is selected, then each input channel uses a 20ms wetting current timer to automatically send the wetting current from 2mA, to 16mA, for 20ms as the input signal crosses the 4V threshold, then returns to 2mA continuous.

Wetting currents are reduced slightly for low excitation voltages below 7.2V (for example, to ~1.6mA/12mA with internal excitation).

***IMPORTANT:** The internal excitation supply cannot support simultaneously switching all 96 channels with 16mA wetting currents selected. Internal current limiting will prevent more than 0.5-1.0A from being sourced internally. Either set wetting current to 2mA, limit the number of ports with 16mA wetting selected, or avoid simultaneously changing multiple inputs. The use of external excitation is recommended where 16mA wetting is desired over many channels, or for greater I/O voltage.*

Register Map
Model ES2113

Tri-stated inputs operate as a high-impedance comparator input with a 4.0V threshold.

With inputs tri-stated, wetting current is turned OFF and unconnected I/O may be left floating. Unused I/O should be pulled above the 4V threshold in order to properly register the OFF state.

***IMPORTANT:** If inputs are set to a high impedance state (tri-stated), the tandem output drain of the channel may be left floating and will require a pull-up or load connection to operate properly. In general, tri-stated inputs should not be left floating.*

You can optionally utilize the open-load detect pull-downs built into the part to pull the unused tri-stated inputs to the ON state.

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40025	24 (0018)	Input Tri-State Port 1 DI 0-15 ***This function also disables the input wetting current.*** ***Def=0000H (TS Disabled)***	Inputs may optionally be set to a high-impedance state. In this state the wetting current source will be turned off and the input will function as a simple comparator with a 4.0V threshold (3.7-4.3V range). 0000H= Tri-State Disabled (default). FFFFH= Tri-State Enabled. Port inputs are set to high impedance and wetting currents are disabled.
40026	25 (0019)	Input Tri-State Port 2 DI 16-31	*See explanation for Port 1 above, but apply to port 2 channels 16-31.*
40027	26 (001A)	Input Tri-State Port 3 DI 32-47	*See explanation for Port 1 above, but apply to port 3 channels 32-47.*
40028	27 (001B)	Input Tri-State Port 4 DI 48-63	*See explanation for Port 1 above, but apply to port 4 channels 48-63.*
40029	28 (001C)	Input Tri-State Port 5 DI 64-79	*See explanation for Port 1 above, but apply to port channels 64-79.*
40030	29 (001D)	Input Tri-State Port 6 DI 80-95	*See explanation for Port 1 above, but apply to port channels 80-95.*
40031	30 (001E)	Output Open-Load Current Enable for Port 1 DO0-15 *Enables ~50uA pull-down currents at the outputs for open-load detection with inputs tri-stated.* ***Def=0000H (Open-Load Disabled)***	For open-load detection with inputs tri-stated, this register allows you to enable/disable a 50uA open-load detection pull-down current at the port outputs. This only works if inputs are tri-stated (wetting current pull-ups are disabled). 0000H= Disable open-load pull-down currents for the port (default). FFFFH= Enable open-load pull-down currents for open-load detection. *Note that open-load detection pulls unused inputs to the ON state. Do not enable if driving loads that may be sensitive to ~50uA in OFF state.*
40032	31 (001F)	Open-Load Current Enable Port 2 DO16-31	*See Port 1 explanation above, but apply to Port 2 outputs 16-31.*
40033	32 (0020)	Open-Load Current Enable Port 3 DO32-47	*See Port 1 explanation above, but apply to Port 3 outputs 32-47.*
40034	33 (0021)	Open-Load Current Enable Port 4 DO48-63	*See Port 1 explanation above, but apply to Port 4 outputs 48-63.*
40035	34 (0022)	Open-Load Current Enable Port 5 DO64-79	*See Port 1 explanation above, but apply to Port 5 outputs 64-79.*
40036	35 (0023)	Open-Load Current Enable Port 6 DO80-95	*See Port 1 explanation above, but apply to Port 6 outputs 80-95.*

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40037	36 (0024)	Short Fault Protection Control (SFPC) Output Port 1 (DO 0-15) *Enables a fast output shut-down without using an over-temperature trigger.* *This allows the protection to be tailored for inductive versus incandescent lamp loads.* *This is also useful in helping prevent a shorted load from blowing an external series fuse.* *Fast fault protection is not reflected in the I/O Error Status bits.* ***Def=FFFFH (Enable Fast)***	Outputs already have built-in current-limiting and thermal shutdown protection with programmable retry. This is not the same thermal limiting that applies to inputs. This register is used to optionally select a fast shutdown of the outputs when over-current conditions are detected, but thermal limits have not been reached, such as with a shorted load. Thus, it would be useful for tailoring specific outputs to inductive loads, and specific outputs for incandescent lamp loads. 0000H (Default) = Thermal Only (Slower) – Output will rely on over-temperature shutdown only (this is slower than Vds based trigger). Outputs that shutdown thermally are reported in the port I/O status registers and can optionally be automatically retried via the GSRC register controls. FFFFH = Drain-to-Source Voltage (Faster) – Output will shut down after 100-450us during turn-on into a short circuit. The decision for shutdown is based on an output drain-to-source voltage > 2.7V. This provides protection for loads that experience higher than expected current and require a fast shutdown. It is also useful to prevent a shorted load from blowing a series fuse.
40038	37 (0025)	SFPC Output Port 2 (DO 16-31)	*See explanation for Port 1 above, but apply to Port 2 channels 16 to 31.*
40039	38 (0026)	SFPC Output Port 3 (DO 32-47)	*See explanation for Port 1 above, but apply to Port 3 channels 32 to 47.*
40040	39 (0027)	SFPC Output Port 4 (DO 48-63)	*See explanation for Port 1 above, but apply to Port 4 channels 48 to 63.*
40041	40 (0028)	SFPC Output Port 5 (DO 64-79)	*See explanation for Port 1 above, but apply to Port 5 channels 64 to 79.*
40042	41 (0029)	SFPC Output Port 6 (DO 80-95)	*See explanation for Port 1 above, but apply to Port 6 channels 80 to 95.*

Register Map Model ES2113

IMPORTANT: *Outputs that utilize fast shutdown are not subject to the automatic retry mechanism of the GSRC register. That is, faulted outputs that are shutdown fast do not retry their control until reset, or optionally via the output refresh cycle (when enabled).*

Outputs that were shutdown fast in response to a fault are also not reported in the Port I/O Error Status registers.

Register Map
Model ES2113

This device includes an automatic output refresh cycle that occurs every 5 seconds to help ensure that outputs recover their programmed state if EMI or ESD ever causes an inadvertent state change without resetting the system (an output or system reset will always cause the outputs to turn OFF).

The automatic output refresh cycle is enabled by default (GSRC bit 15 is set to 1).

If you elect to leave outputs OFF after an output fault has occurred via the GSRC register controls (bits 1 and/or 0), then you should also turn off the internal automatic output refresh cycle via bit 15 of the GSRC register or outputs will not stay OFF.

Outputs that utilize fast shutdown, as opposed to thermal shutdown (see SFPC register) are not subject to the automatic retry mechanism of the GSRC register. That is, outputs shutdown fast in response to a fault do not retry their control until reset, or optionally via the output refresh cycle.

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40043	42 (002A)	Global Shut-Down & Retry Control (GSRC) Register Output Port 1 (DO 0-15) *Use this register to pick an output thermal or over-voltage shut-down recovery strategy.* ***Def=8003H (Refresh ON, Retry Out, Restore Out)***	This register selects the output fault & recovery strategy to be applied for over-voltage and thermal protection. Bit 15: 1=Enable Output Refresh (default), 0=Disable Refresh. Bits 14-2: Not Used (Set to 0) Bit 1: **Thermal over-load/short-circuit action** – If port output power dissipation exceeds its internal limit, the output will temporarily shut down. This bit determines how the outputs act after they cool. 0=Outputs turn OFF at thermal limit & remain OFF even after cooling. 1=Outputs turn OFF at thermal limit & retry their prior state after cooling. Bit 0: **Excitation & output over-voltage action** – When the port excitation voltage exceeds 28V minimum, port outputs temporarily shut down. This bit determines how they act after the port excitation or output over-voltage fault is removed. 0=Force port outputs OFF after drain or Ex voltage returns to normal. 1=Send port outputs to their previous state after drain/Ex returns to normal.
40044	43 (002B)	GSRC Port 2 Outputs 16-31	*Shutdown & Retry Control - See Port 1 above, apply to Port 2 ch 16 to 31.*
40045	44 (002C)	GSRC Port 3 Outputs 32-47	*Shutdown & Retry Control - See Port 1 above, apply to Port 3 ch 32 to 47.*
40046	45 (002D)	GSRC Port 4 Outputs 48-63	*Shutdown & Retry Control - See Port 1 above, apply to Port 4 ch 48 to 63.*
40047	46 (002E)	GSRC Port 5 Outputs 64-79	*Shutdown & Retry Control - See Port 1 above, apply to Port 5 ch 64 to 79.*
40048	47 (002F)	GSRC Port 6 Outputs 80-95	*Shutdown & Retry Control - See Port 1 above, apply to Port 6 ch 80 to 95.*
40049	48 (0030)	Local Relay Failsafe/ Non-Failsafe Selection & Alarm Trigger ***Def=0100H (Alarm for watchdog timeout and link loss, use failsafe relay contacts)***	Relay contacts can signal a watch-dog timeout only, or a watchdog timeout and media failure (link loss). The lsb of this register sets the local relay contacts to failsafe (normally energized, 0), or non-failsafe (non-energized, 1). Relay can signal a power loss if set to failsafe. Bits 15-9: Not Used (Set to 0) Bit 8: Local Alarm Functionality 0=Alarm @ watchdog timeout only 1=Alarm @ watchdog timeout and link error (Default) Bits 7-1: Not Used (Set to 0) Bit 0: 0=Failsafe, 1=Non-Failsafe

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40050	49 (0031)	Internal Excitation Control **Def=0001H (Internal Excitation ON)** *Turn internal excitation OFF when using external excitation to conserve power, or to drive higher currents at low voltage.* *Minimum external excitation is 7.2V with internal excitation ON, or 6.2V with it OFF.*	Bits 15-1: Not Used (Set to 0) Bit 0: 0=Disable, 1=Enable (Default) This device has a limited built-in port excitation supply that can be used to provide 6.1V port excitation in the absence of an external excitation source. The lsb of this register will disable (0), or enable (1), the internal excitation supply. Output drive capability is limited to about 5.8V and the wetting current level with only internal excitation enabled. Note that in order for an externally wired excitation supply to carry the load for the port, it must be greater than the internal supply (6.1V) by a diode drop, or the internal excitation must be turned OFF. The internal supply is approximately 6.1V (before Schottky diode). I/O drive with only internal excitation is limited to the wetting current level (~2mA per channel). Use external excitation for maximum drive and to conserve input power. Never attempt to input or switch voltages greater than 31V. Note that input wetting current levels are reduced with internal excitation, or excitation voltages below 7.2V.
40051	50 (0032)	Wink Unit Toggle & System Reset Register *Used to help identify network units or to drive a system reset (there is also a RST switch on the unit).*	Write 21845 (5555H) to this register to cause the unit to "wink" its green Run LED in order to ID the unit. Write the same value a second time to stop "winking". Write a value of A1D5H (41429) to this register to cause a system reset and reboot. This register will always read back as 0000H. Use the Unit Status Register wink mode flag (bit 14) to determine the wink state.
40052	51 (0033)	*Reserved*	*Reserved – Do Not Use*
40053	52 (0034)	*Reserved*	*Reserved – Do Not Use*

Register Map Model ES2113

I/O cannot operate without excitation. *Note that your output load current, input wetting current, and I/O circuitry currents are all drawn from the excitation supply.*

Internal excitation is current-limited to 0.5-1.0A.

Your excitation voltage will determine the range of your output control and output drive capability. It will also effect your input wetting current level and capability.

External excitation up to 28V is recommended for full I/O capability, but limited internal excitation is provided for your convenience and useful for low current/voltage applications when an external excitation supply is not present.

You may safely connect excitation voltages up to 31V, but your outputs may temporarily shut down for excitation over-voltages above 28V.

Wink is useful to differentiate a unit when networked together with other units.

A System Reset will set all outputs OFF (default), then to their Power/Reset state, and will also clear any watchdog timeouts.

Note that this unit will acknowledge the System Reset command before actually triggering the system reset.

Register Map
Model ES2113

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40054	53 (0035)	Port 1 Digital Inputs 0-15	Bit field (Read Only) – The 16 bits of this field correspond to the states of channels 0-15, with the bit position corresponding to the channel number (lsb is channel 0). A clear bit (0) is OFF, while a set bit (1) is ON.
40055	54 (0036)	Port 2 Digital Inputs 16-31	*See explanation for Port 1 above, but apply to Port 2 input channels 16-31 (lsb is channel 16).*
40056	55 (0037)	Port 3 Digital Inputs 32-47	*See explanation for Port 1 above, but apply to Port 3 input channels 32-47 (lsb is channel 32).*
40057	56 (0038)	Port 4 Digital Inputs 48-63	*See explanation for Port 1 above, but apply to Port 4 input channels 48-63 (lsb is channel 48).*
40058	57 (0039)	Port 5 Digital Inputs 64-79	*See explanation for Port 1 above, but apply to Port 5 input channels 64-79 (lsb is channel 64).*
40059	58 (003A)	Port 6 Digital Inputs 80-95	*See explanation for Port 1 above, but apply to Port 6 input channels 80-95 (lsb is channel 80).*
40060	59 (003B)	Port 1 Digital Outputs 0-15	Bit field (Read/Write) – The 16 bits of this field correspond to channels 0-15. The bit position corresponds to the output channel number (lsb is channel 0). A clear bit (0) is OFF, while a set bit (1) is ON.
40061	60 (003C)	Port 2 Digital Outputs 16-31	*See explanation for Port 1 above, but apply to Port 2 output channels 16-31 (lsb is channel 16).*
40062	61 (003D)	Port 3 Digital Outputs 32-47	*See explanation for Port 1 above, but apply to Port 3 output channels 32-47 (lsb is channel 32).*
40063	62 (003E)	Port 4 Digital Outputs 48-63	*See explanation for Port 1 above, but apply to Port 4 output channels 48-63 (lsb is channel 48).*
40064	63 (003F)	Port 5 Digital Outputs 64-79	*See explanation for Port 1 above, but apply to Port 5 output channels 64-79 (lsb is channel 64).*
40065	64 (0040)	Port 6 Digital Outputs 80-95	*See explanation for Port 1 above, but apply to Port 6 output channels 80-95 (lsb is channel 80).*
40066	65 (0041)	Port 1 Input Reset DI 0-15 (Inputs Only)	Port inputs may be independently reset with this command (does not reset the outputs or controller). This is useful for trouble-shooting. Write FFFFH to this register (all bits set) to trigger a reset of the port. FFFFH=Reset All Port Inputs. 0000H=Do Not Reset Port.

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40067	66 (0042)	Port 2 Input Reset DI 16-31	*See explanation for Port 1 above, but apply to channel 16 (lsb) to 31(msb).*
40068	67 (0043)	Port 3 Input Reset DI 32-47	*See explanation for Port 1 above, but apply to channel 32 (lsb) to 47 (msb).*
40069	68 (0044)	Port 4 Input Reset DI 48-63	*See explanation for Port 1 above, but apply to channel 48 (lsb) to 63 (msb).*
40070	69 (0045)	Port 5 Input Reset DI 64-79	*See explanation for Port 1 above, but apply to channel 64 (lsb) to 79 (msb).*
40071	70 (0046)	Port 6 Input Reset DI 80-95	*See explanation for Port 1 above, but apply to channel 80 (lsb) to 95 (msb).*
40072	71 (0047)	Port 1 Output Reset DO0-15 (Outputs Only)	Port outputs may be independently reset with this command (this does not reset the inputs or controller and does not send the outputs to their reset state). This is useful for trouble-shooting. Write FFFFH to this register (all bits set) to trigger a reset of the port. FFFFH=Reset All Port Outputs. 0000H=Do Not Reset Port.
40073	72 (0048)	Port 2 Output Reset DO16-31	*See explanation for Port 1 above, but apply to channels 16 to 31.*
40074	73 (0049)	Port 3 Output Reset DO32-47	*See explanation for Port 1 above, but apply to channels 32 to 47.*
40075	74 (004A)	Port 4 Output Reset DO48-63	*See explanation for Port 1 above, but apply to channels 48 to 63.*
40076	75 (004B)	Port 5 Output Reset DO64-79	*See explanation for Port 1 above, but apply to channels 64 to 79.*
40077	76 (004C)	Port 6 Output Reset DO80-95	*See explanation for Port 1 above, but apply to channels 80 to 95.*
40078	77 (004D)	Port 1 Power-On/ Reset State for DO0-15 (Outputs Only)	Bit field (Read/Write) – The 16 bits of this field correspond to channels 0-15 and set the initial Power On and Reset states for the port channels. The bit position corresponds to the output channel number with the lsb as channel 0. A clear bit (0) is OFF, while a set bit (1) is ON.
40079	78 (004E)	Port 2 Pwr/Rst State DO16-31	*See explanation for Port 1 above, but apply to channels 16 to 31.*
40080	79 (004F)	Port 3 Pwr/Rst State DO32-47	*See explanation for Port 1 above, but apply to channels 32 to 47.*
40081	80 (0050)	Port 4 Pwr/Rst State DO48-63	*See explanation for Port 1 above, but apply to channels 48 to 63.*
40082	81 (0051)	Port 5 Pwr/Rst State DO64-79	*See explanation for Port 1 above, but apply to channels 64 to 79.*
40083	82 (0052)	Port 6 Pwr/Rst State DO80-95	*See explanation for Port 1 above, but apply to channels 80 to 95.*

Register Map Model ES2113

Port Input and Output resets are normally not required, but are sometimes useful in troubleshooting I/O and will reset the input or output circuitry independent of each other, a power-on, system, CPU, or communication controller reset.

Resetting port outputs via the Port Output Reset register will set all outputs OFF and clear any watchdog timeouts. This form of reset does not honor the power-on/reset state setting.

The Power-On/Reset States are not honored for Output Reset via the Output Reset button of the I/O Configuration Page, and only apply for a power-on reset, system reset (RST Switch), clicking the Reset ES2113 button of the I/O Configuration web page, and a software reset (writing 41429 to the Wink/Reset Register).

Register Map Model ES2113

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
41001 . . .		This block Mirrors 1xxxx Registers.	Refer to Register Mirroring. 1xxxx Input Status Registers are mapped to the 41xxx Holding Register space using an address offset of 41000.
42001 . . .		This block Mirrors 0xxxx Registers.	Refer to Register Mirroring. 0xxxx Coil Registers are mapped to the 42xxx Holding Register space using an address offset of 42000.
43001 . . .		This block Mirrors 3xxxx Registers.	Refer to Register Mirroring. 3xxxx Input Registers are mapped to the 43xxx Holding Register space using an address offset of 43000.

Default Register Settings

Here is a summary of the ES2113 default register settings and corresponding default behavior.

ES2113 Default Register Settings

REGISTER	HEX	ACTION
Watchdog Time Registers	FFFFH	Disabled
Watchdog Timeout State	00000H	All Clear (OFF)
Watchdog Timeout Action	FFFFH	Change Outputs
Wetting Current Selection	FFFFH	16mA/20ms
Input Tri-State	0000H	Do Not Tri-State Inputs
Open-Load Detection	0000H	Disable, No Pull-Down
Short-Circuit Fault Control	FFFFH	Enable Fast Shut-Down
Global Shutdown & Retry Control	8003H	Enable Refresh, Retry Out
Relay Failsafe/Non-Failsafe Select	0100H	Enable Failsafe
Internal Excitation Control	0001H	Enabled
Wink Register	0000H	OFF
Output Power On & Reset State	00000H	All Clear (OFF)

Configuration Parameters Not Programmable Via Modbus Registers

Use the built-in web interface screens to set these parameters, which are generally required to setup communications.

The web interface is not limited to communication parameters, but will allow you to also exploit other features of the product normally set via Modbus registers.

Not all parameters of this device can be set via Modbus registers. In general, parameters related to I/O will have a Modbus register, while those related to network communication must be set via the web interface. Here is a list of configuration parameters which do not have a Modbus register.

Username & Password
Static IP Address
Number of Modbus Sockets
DNS Server Address
Subnet Mask
Gateway Address
Host Name
Select Static, DHCP/BOOTP, or DHCP/BOOTP w/Fallback Addressing
Wink On/Off
Select Network Port Hub Mode or Switch Mode Operation
Copper Network Port 1 & 2 Forced Speed & Duplex or via Auto-Negotiation
Fiber Port Half or Full Duplex Selection
i2o Update via Change-of-State or Cyclical Rate
i2o Update Time and i2o Map-To Address
Self-Test Utility
Export Configuration & Export IP Address

SPECIFICATIONS

This high-density, industrial Ethernet I/O system includes 96 combination digital input/output channels and provides dual isolated 10/100M Ethernet ports for monitoring and control via Modbus TCP/IP or UDP/IP. The unit is DC-powered with redundant power inputs and reverse polarity protection. Outputs are open-drain, low-side switches, while inputs are active-low comparators with a 4.0V threshold. All I/O channels share common and include transient protection. Dual Ethernet ports allow the unit to be conveniently cascaded with other EtherStax units, or for implementation of end-node redundancy schemes when connected to Ethernet switches that implement redundancy. Dual network ports also provide a low-latency/low jitter hub/repeater mode. Channel I/O, network ports, and power circuits are isolated from each other, and from earth ground (chassis). Outputs have high voltage and current carrying capacity for discrete on/off control of external devices. Buffered inputs provide support for digital level sensing, or for simply reading back the tandem output state. Built-in current sources on each input provide wetting current to sense switch closure, and this allows the tandem outputs to be sensed without having to connect pull-up resistors (these may be turned off by tri-stating the inputs). Outputs also have selectable, 50uA open-load detection pull down sinks which may operate when inputs are tri-stated. Excitation supply connections are included at each I/O port (every 16 channels), allowing individual ports to operate at different voltage levels. Limited built-in 6.1V excitation allows the I/O to operate at low voltages and low current without external excitation. Non-volatile reprogrammable memory in the unit stores configuration information.

Model Numbers

Examples:

ES2113-0000 (96 Digital I/O)
ES2113-0010 (wo/Enclosure)
ES2113-1000 (w/Fiber Port)
ES2113-1010 (w/Fiber, wo/Encl.)

The Etherstax model prefix is "ES" to denote the EtherStax I/O family. The "21" digits denote the 2100 series. The "1" following "21" denotes a digital I/O model. The trailing "3" specifies 96 discrete digital I/O channels. Other options are selected via a four digit suffix to this model (-xxxx). The first suffix digit specifies the physical connection (0=Dual 10/100M copper, 1=one 10/100M copper port and one 100BaseFX fiber port). The second suffix digit specifies the protocol (0=Modbus TCP/IP & UDP/IP). The third digit specifies the housing (0=aluminum extrusion, 1=open-frame with no housing). The last digit specifies the input power (0=18-36V DC).

Mounting Options

Standard units are designed to interlock and stack together up to 3 units high. A single unit or stack of units can be bolted to a flat surface, or mounted on deep-channel "T" type DIN rails (35mm x15mm), depending on the optional mounting kit selected. These mounting options are listed below. Detailed drawings of these items are included in the Mounting and Dimensions section at the front of this manual.

ESA-DIN-VMK, DIN Rail Vertical Mount Kit: This kit includes two plastic DIN clips that slide into the dovetail channel at the bottom of the housing. You can use one clip to mount a single unit, or both clips for added stability, or when stacking two units. The "vertical" designation refers to the orientation of an EtherStax unit relative to the DIN rail.

ESA-SMK, Surface-Mount Kit: This kit includes a shock mounted aluminum base plate and four bolts to attach to the bottom of a housing, allowing one to three units to be bolted to a wall or flat surface.

ESA-DIN-HMK, DIN Rail Horizontal Mount Kit: This kit includes the same bolt-on aluminum base plate as ESA-SMK above, but adds a heavy-duty DIN clip and screws to mount the base plate on a DIN rail, allowing up to three units to be stacked together and mounted on the rail. The "horizontal" designation refers to the orientation of an EtherStax relative to the DIN rail.

SPECIFICATIONS

Mounting Options

ESA-OMK, Open Mounting Kit: EtherStax units can be ordered without their enclosure and already include the threaded standoffs and screws necessary to stack two circuits together, plus the screws and standoffs for mounting the assembly to a flat surface. Units may optionally bolt to the surface-mount base plate of ESA-SMK or ESA-DIN-HMK with this hardware. This kit contains the identical replacement hardware for stacking two open circuits together and/or mounting them to a flat surface.

Digital Inputs

All ES2113 models include 96, active-low, buffered inputs, with a common return connection (R). Input channels are organized as 16 channels to a port, with 6 ports providing 96 inputs. Inputs are connected in tandem with the open-drains of output mosfets (see below). Inputs also include transient voltage suppression and are intended for DC voltage applications only. An external excitation supply connection between port Ex and Return is required at each port (each group of 16 channels) for I/O operation. Internal port excitation of 6.1V can be utilized for most input applications. Inputs include programmable wetting current pull-ups for sensing switch closure (see below), and inputs may be optionally tri-stated (disables wetting current). The wetting current generators also allow the tandem open-drain output to operate without adding a pull-up. Internal excitation and integrated wetting current help facilitate an I/O self-test without actual wiring.
IMPORTANT: Inputs (and outputs) will not operate without port excitation. Internal excitation is enabled by default, but may be turned OFF. External port excitation is 7.2-31V (or 6.2-31V with internal excitation OFF).

CAUTION: *Failure to pull the I/O channel above the 4.3V maximum threshold when the output is OFF, or with the input tri-stated, can result in the OFF output state being erroneously indicated as ON. Likewise, attempting to drive output loads with IR exceeding 4V will cause the input to indicate an OFF state with the mosfet ON , as the input threshold crosses back above 4V (there is up to 16mA of wetting current per channel).*

Note: *With only 6.1V internal excitation, the wetting currents are reduced to ~1.6mA and 12.2mA. External excitation of 7.2V or greater is required to deliver the full 2mA/16mA of wetting current.*

Internal excitation is current limited from 0.5-1.0A and cannot drive 96 channels of wetting current at 16mA simultaneously.

Input Signal Voltage Range: 0 to 31V maximum. Input operating range is first limited by the I/O transient protection (31V), then the input circuitry itself (38V), then the tandem output mosfet drain-source voltage (50V).

Input Signal Threshold: Voltage signals below 4.0V DC (3.7 to 4.3V range) are ON. Voltages above 4V (3.7 to 4.3V range) are OFF.

Input Scan Time: Input updates are obtained every 1ms, typical. Output writes will interrupt this cycle and cause this time to vary slightly.

Input "Wetting" Current (2mA, 16mA, or OFF): Input wetting current sources are used to sense contact closure and act like I/O pull-ups to excitation. Wetting current is set to 16mA by default. This current is drawn from the port excitation supply. This current can be set to provide a higher initial current level during contact transfer to help keep the external switch contacts from building up oxides that can form on the contact surface and eventually impede connection. The input wetting current can be set to 2mA continuous, or 16mA/20ms (default, switches from 2mA to 16mA for 20ms as the input crosses the 4V threshold, then returns to 2mA). This current can also be disabled by tri-stating the inputs. A built-in 20ms timer controls the amount of time the current stays at 16mA before switching back to 2mA in order to limit power dissipation. However, with only internal excitation, no more than 0.5A total (all channels combined) can be sourced at one time. Thus, setting wetting current to 16mA and simultaneously switching the inputs may temporarily cause the internal excitation supply to current-limit and its voltage to fall below its required minimum (until the wetting current timer switches back to 2mA). This can produce unpredictable results for Modbus commands issued while the excitation supply is limited. In addition, the use of internal excitation (or external excitation below 7.2V) will cause the wetting current levels to be reduced. External excitation is recommended for best results and will allow the unit to achieve full wetting current drive capability.

Input "Tri-State" (Disables Wetting Current): Inputs may be set to a high impedance state via the Input Tri-State register. In this state, the wetting current sources are disabled and the input acts like a simple comparator with a 4.0V threshold. Unused inputs in the high impedance state should not be allowed to float, as they may indicate the wrong I/O state. External pull-up resistors may be needed for some applications. You can also enable open-load detection to pull-down unused tri-stated inputs.

Input Temperature Monitor: With multiple switch inputs closed, high ambient, and many wetting currents set to 16mA, there is a small potential for excessive input port power dissipation. When dissipation is such that the input port die temperature rises above the thermal limit (155°C to 185°C), a built-in temperature monitor will generate an interrupt, force any 16mA current sources to 2mA continuous, set the thermal flag bit in the input state register, and still maintain operation. The input thermal bit will be cleared when the die temperature has cooled ~10°C below the thermal limit (with 5-15°C of hysteresis range). The device will then return to its previous programmed settings.

Input Excitation: Inputs will not operate without port excitation. Excitation is normally connected between the port Ex and Return terminals and must be a DC voltage from 7.2 to 28V DC (31V Maximum), or 6.2-28V with internal excitation OFF. The tandem outputs may temporarily shut down for excitation voltages above 28V. Optionally, excitation may be generated internally, but is limited to 6.1V. A reverse blocking diode in the Ex terminal also limits the I/O drive current to ~2mA/channel (the wetting current) with only internal excitation present. Connect an external excitation source to raise the output drive voltage and current. The excitation input includes transient protection and filtering. You may disable the internal excitation if connecting to external excitation. Note that the input wetting currents are sourced from the excitation supply.

SPECIFICATIONS

Digital Inputs

Note: *For input-only operation, the corresponding tandem output channel must be turned OFF to avoid contention with an externally driven input signal.*

Digital Outputs

Unit includes 96, open-drain, mosfet switches with a common source connection at the port Return terminal. Outputs also include transient voltage suppression and are intended for low-side, DC voltage switching applications only. Output channels are grouped 16 channels to a port, with 16 outputs sharing a single port return terminal (R). There are 6 ports providing 96 outputs that are connected in tandem with buffered inputs (see above). Outputs incorporate over-voltage, over-temperature, and over-current protection (see below). External excitation connected between the port Excitation (Ex) and Return (R) terminals is required at each port for output operation. Group one Ex & R connection per each port terminal group of 16 outputs. Limited internal excitation of 6.1V is available for low current/voltage applications. Open-drain outputs do not require pull-ups to operate, as the tandem input circuit already includes the "wetting current" generator (integrated pull-ups). You can add pull-ups to increase output current drive capability beyond 2mA/channel.

IMPORTANT: Outputs (and inputs) will not operate without port excitation.

Output "OFF" Voltage Range: 0 to 28V DC, 31V maximum. Output control voltage range is first limited to 28V or the excitation voltage level, whichever is less, then the transient voltage suppression (31V, see below), then the input circuitry (38V), then the output driver (50V). Built-in over-voltage protection limits the output operating range (see below) and may temporarily shut the output down for excitation voltages greater than 28V, or output drain-source voltages greater than 50V.

SPECIFICATIONS

Digital Outputs

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

WARNING: Individual output current is limited to 450mA maximum and 3.6A per port, or 300mA maximaum and 4.8A per port. Do not attempt to operate outputs above these limits or you may exceed the safe operating range for the foils of the circuit board, which may result in permanent damage to the unit.

Output Drain-to-Source ON Resistance (Rds): 0.55Ω typical (25℃), 1.1Ω maximum (125℃ junction temperature).
NOTE: Although Rds is a small value, a large number of simultaneous ON channels will dissipate considerable heat inside the enclosure through this resistance. Thus, it is important that your load current not exceed 450mA per channel and 3.6A per port, or 300mA per channel and 4.8A per port.

Output "ON" Current Range: 1mA to 300mA DC continuous, each output, 4.8A total per port (16 channels). Optionally, outputs may sink up to 450mA DC continuous maximum, but limited to 3.6A total per port (8 of 16 port output channels sinking 450mA each). See Operating Temperature. Individual outputs have an internal over-current fault limit of 1.2A typical (0.9-2.5A range) that will limit current until the internal over-temperature limit is reached, triggering a thermal shutdown of the output (see below). Note the input wetting current is additive to the load current (2mA/16mA), but may be optionally turned off by tri-stating the inputs.

Output "OFF" Leakage Current: : 10uA typical, 20uA maximum. This increases by 50uA if open-load detection is enabled.

Output Excitation: Connect a DC voltage from 7.2 to 28V DC between the port Ex and Return terminals. A limited low voltage/current internal excitation supply allows outputs to drive the wetting current (5.8V, 2mA/channel) without external excitation connected. Internal excitation may be optionally disabled, but inputs and outputs will not operate without excitation. The excitation input includes transient protection and filtering, plus a series connected reverse polarity blocking diode. The port input wetting current and internal logic currents are all sourced from the port excitation supply. A reverse blocking diode in the Ex terminal prevents the internal excitation from sourcing the load, limiting output drive to the input wetting current without an excitation supply connected and with internal excitation enabled.

Output Over-Voltage Protection: Outputs switch voltages within the excitation voltage range, but will shutdown operation for excitation over-voltage conditions above 28V (30V typical, 35V max), and any drain-to-source voltages greater than 50V. Normal operation will resume following shutdown upon return to proper voltage level. Note that sustained voltages above 31V can damage the transient voltage suppressor. Following a fault shutdown, the outputs may be configured to retry the previous state, or remain OFF, depending on the settings of the Output Global Shutdown/Retry Control register.

Output Over-Current Protection: The outputs have internal self-limiting ON state currents of 1.2A typical (0.9A to 2.5A range). An output will limit fault current in this range until the output thermal limit is reached and the output enters over-temperature shutdown, whereupon a thermal fault flag will be set. Only the faulted output will shut-down, not the entire port. Upon removal of the fault, the output will automatically return to its previous state, or stay OFF, based upon the control bit settings in the Output Global Shutdown/Retry Control Register.

Output Over-Temperature Protection: Internal limiting triggers for a junction temperature of 165°C (155°C to 180°C range), and only the output experiencing an over-temperature condition will shut-down (not the entire port). Upon return to normal temperature (a 10°C typical hysteresis applies, 5-20°C range), the output will automatically resume its prior setting, or remain OFF according to the control bit settings in the Port Output Global Shutdown/Retry Register. If you exceed 4A of combined load current per 16-channel port at elevated temperatures, you may trigger the internal over-temperature protection.

Output Power-Up/Reset States (16 bit Hex value) – Outputs are normally turned OFF on power-up or after a reset (default), but can be configured to automatically go to a pre-defined state following power-up, a system reset (reset switch), or software reset by writing 41429 to the Wink/Reset Register. This does not apply to output resets triggered via the port Output Reset button of the I/O Configuration Page, or by writing FFFFH to the Port Output Reset register.

Output Open-Load Detection (w/Inputs Tri-Stated): Outputs can utilize internal ~50uA current sink pull-downs to facilitate open load detection when the tandem inputs are tri-stated (note that they pull to the ON state). This is also useful to help keep the tandem tri-stated input from floating. This feature is disabled by default and would not be appropriate where 50uA of OFF state current cannot be tolerated, where pulling to the ON-state is not appropriate, or if tandem inputs are not tri-stated (tri-stating inputs turns OFF the opposing built-in pull-ups).

Output Refresh Cycle: Output states are refreshed with the last written state every 5 seconds if not rewritten (also true for outputs written via i2o). This is done to help ensure outputs recover their programmed state if EMI or ESD ever causes an inadvertent state change without resetting the system. Optionally, this internal refresh cycle may be turned OFF to allow outputs that experience a fault to stay off after the fault is removed, rather than retry their control (see Global Shutdown and Retry Control Register).

SPECIFICATIONS

Do not enable open-load detection without tri-stating the inputs, as this adds a pull-down to the I/O channel that opposes the pull-up present outside of tri-state mode.

Turn output refresh OFF if you wish outputs to remain OFF following a shutdown due to a fault condition.

Alarm Relay Output

This device includes a set of isolated relay contacts adjacent to power at the A & B terminals. The state of these contacts can be set as normally open (de-energized, non-failsafe), or normally closed (energized, fail-safe). These contacts will transfer states upon media failure (link loss), or power failure (if normally energized/failsafe operation is selected), or watchdog timeout. A red relay LED indicates that the relay contacts are energized (closed).

Type: SPST-NO, 1 Form A, Class I, Division II approved.

Manufacturer Part: Omron, G6M-1A-DC5.

Maximum Ratings: AC rated to 3A at 250VAC, or 750VA maximum (100K operations minimum). DC rated to 3A at 30VDC, or 90W maximum. Your AC application switching voltage/ current must not exceed 750VA and 250VAC and 5A. Your DC application voltage/current must not exceed 90W and 125VDC and 5A.

Contact Resistance: 100 milliohms, maximum.

Agency Rating: 3A at 250VAC or 24VDC (General Use, 100K Operations), or 5A at 250VAC or 24VDC (Resistive Load, 6K Operations). UL508 File No. E41515/CSA C22.2 (No. 14) File No. LR31928. Hazardous Location ratings are 2A at 240VAC or 30VDC.

Minimum Permissible Load: 10mA at 5VDC at 120 operations/minute.

SPECIFICATIONS

General

WARNING: *The I/O voltage range must not exceed 31V, or damage to the I/O circuit may result (sustained voltages greater than 31V can damage the input transient voltage suppressor).*

I/O Transient Voltage Suppression: Bipolar transient voltage suppressors rated to 31V (working), 39V (breakdown), and 67V (fully clamped).

Excitation: Internal 6.1V excitation is enabled by default, but the use of isolated external excitation is recommended to raise the I/O voltage and current drive capability. Connect excitation to the port Ex & R (Return) terminals from a 6.2V-31V source with internal excitation OFF, or 7.2V-31V source with internal excitation left ON. Port I/O will not operate without port excitation. If internal excitation is disabled, you must connect external excitation to all I/O ports, even if you are not using every port. Leaving internal excitation enabled will not damage the unit when also connecting external excitation, as the internal supply is separately diode-coupled to each Ex terminal, but only suitable for driving the input wetting current at 2mA/channel (a reverse blocking diode in the Ex terminal prevents it from being loaded externally). To drive more current at lower voltage, or for application voltages greater than 6.1V, you should turn the internal excitation supply OFF and connect your own 6.2-31V excitation supply to the Ex terminals of each I/O port (recommended). External excitation must be capable of providing 44mA continuous, 268mA (w/ sixteen 16mA wetting currents ON per port), plus any load currents, for each port (group of 16 channels).

I/O Cable Length: I/O port interface cables should not exceed 30m in length for rated performance.

Agency Approvals

Safety Approvals: Applies to Enclosed Models ES2113-0000 & ES2113-1000. UL Listed (USA & Canada) suitable for use in Class I, Division 2, Groups A, B, C, D Hazardous Locations, or Nonhazardous Locations only.

Open-Frame Models (ES2113-0010 & ES2113-1010)

These models are UL/cUL Recognized components suitable for use in Hazardous Locations per Class 1, Division 2, Groups A, B, C, and D, where the acceptability of the combination is determined by Underwriters Laboratories. These components have been judged on the basis of required spacing's in the standard for Industrial Control Equipment, UL 508, Table 36.1, which would cover the component itself if submitted for unrestricted Listing. As a condition of Acceptability when installed in end-user equipment, consider the following:

1. The device shall be installed in compliance with the enclosure, mounting spacing, casualty (including markings), and segregation requirements of the ultimate application.
2. The accessibility of the live parts through openings in the enclosure, reliable retention of guards or barriers for prevention of risk of electric shock, etc. shall be considered in the end product evaluation.
3. The acceptability of the connection headers shall be determined in the end product.
4. These devices shall be operated within their electrical ratings and in an ambient temperature not exceeding 75°C.
5. When used in end product, programmable controllers must meet requirements for use in Class I, Groups A, B, C, and D, Division 2 or Class I, Zone 2, Group IIC Hazardous Locations.
6. The following temperature code should be noted: "T4A".

SPECIFICATIONS

Enclosure & Physical

Dimensions: IP20 rated enclosure, 8.226 inches wide, 2.444 inches tall, 6.125 inches deep. Enclosed units stack together on 2.175 inch centers. Open frame units are 1.88" tall with 0.375" standoffs. Units will require an optional surface mounting plate and or DIN-rail mount to securely mount the unit (see below). Refer to the Mounting & Dimensions section at the front of this manual for more details.

Surface/Wall-Mounting: Requires optional surface-mounting kit ESA-SMK. This kit includes an 8x8" machined aluminum base-plate and hardware for bolting a stack of 1 to 3 units to a wall or flat surface. See Mounting & Dimensions section for details on this option.

DIN-Rail Mounting: The unit can be mounted to 35x15mm, T-type DIN rails using optional ESA-DIN-VMK, or ESA-DIN-HMK mounting kits. Refer to the Mounting & Dimensions section for more details.

Open-Face (Circuit Board) Mounting/Stacking: Device may be ordered without its enclosure. Enough screws and standoffs for stacking two boards are included with every open unit and also in the Acromag ESA-OMK Open Mounting Kit. Individual boards can be stacked using the threaded standoffs and 6-32 jack-screws provided in this kit. Refer to the Mounting & Dimensions section for more details.

I/O Connectors: Removable plug-in type terminal blocks are rated for 15A/300V; AWG #12-24 stranded or solid copper wire. The torque ratings for field wiring terminals is 5-7 lb-inches.

Enclosure Material: Extruded aluminum, 6063 T6 alloy, silver anodized finish, IP20 minimum rated.

Circuit Boards: Military grade fire-retardant epoxy glass per IPC-4101/98.

Shipping Weight: 3.8 pounds (1.8 Kg) packed (unit w/enclosure is 3.4lbs); 1.5 (0.7Kg) packed (open-frame unit/no enclosure is 1.05lbs).

Network Connectors (Copper): Two 8-pin RJ-45 sockets (ES2113-0xxx), or one 8-pin RJ45 socket (ES2113-1xxx). RJ-45 connections are wired MDI-X by default (like an Ethernet switch, as opposed to MDI), but include automatic MDI/MDI-X crossover. Use CAT-5 or better cable to connect to these ports. Acromag offers an optional Cable Termination Kit (ESA-CTK) that includes the necessary hardware for building one end of your cable for mating to the IP20 clip-frame that surrounds the RJ45 port. This is done for increased immunity to shock & vibration.

RJ-45	Signal	Description (MDI-X)
1	Rx+	Receive Positive
2	Rx-	Receive Negative
3	Tx+	Transmit Positive
4	Not Used	Connects to Pin 5
5	Not Used	Connects to Pin 4
6	Tx-	Transmit Negative
7	Not Used	Connects to Pin 8
8	Not Used	Connects to Pin 7

Network Connector (ES2113-1 w/100FX Fiber): One 8-pin RJ45 socket as wired above (for port 2), plus one 100BaseFX, SC-Type, multi-mode fiber-optic connector (for port 1). The auto-negotiation & auto-crossing features do not apply to the fiber connection and transmit and receive cables must be crossed manually when making fiber cable connections.

SPECIFICATIONS

Environmental

Note that the network ports are safety isolated from each other. The I/O, power, and network ports are also safety isolated from the enclosure.

Operating Temperature:
ES2113-x010 (open-frame units): -40°C to **+75**°C (-40°F to +167°F).
ES2113-x000 (enclosed units): -40°C to **+75**°C (-40°F to +167°F) with 96 outputs sinking up to 175mA; or -40°C to **+70**°C maximum with 96 outputs sinking 300mA. See Output Current.

Storage Temperature: -40°C to +85°C (-40°F to +185°F).

Relative Humidity: 5 to 95%, non-condensing.

Isolation: I/O channel, power, and network circuits are 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). Complies with test requirements of ANSI/ISA-82.01-1988 for voltage rating specified.

Installation Category: Suitable for installation in a Pollution Degree 2 environment with installation category (over-voltage category) II rating.

CAUTION: *Do not exceed 36VDC peak, to avoid damage to the unit.*

Power Requirements (Unit Main): 18-36V DC SELV (Safety Extra Low Voltage), 5.1W max (ES2113-1), 3.9W max (ES2113-0). Observe proper polarity. Keep DC power cables less than 10m in length. Divide power by your voltage to calculate max current. Then select a supply that can deliver at least twice this amount.

CAUTION: Risk of Electric Shock *– More than one disconnect switch may be required to de-energize the equipment before servicing.*

Power Supply	Model ES2113-0	Model ES2113-1
18V	189mA Typical	249mA Typical
24V	143mA Typical	187mA Typical
30V	115mA Typical	152mA Typical
36V	96mA Typical	127mA Typical

Current noted above is with one network port linked, internal port excitation ON, and all outputs ON (sinking ~2mA). You can reduce input power ~1W by disabling internal excitation and connecting each I/O port to an external excitation supply.

NOTE: *I/O will not operate without port excitation.*

Power Requirements (I/O Port Excitation): Connect 7.2-28V DC to port excitation (Ex) & return (R) terminals w/internal excitation ON, or 6.2V-28VDC w/internal excitation OFF. Observe proper polarity. External excitation should deliver 270mA peak per port (with 16mA wetting currents), and 45mA continuous (2mA wetting currents). Add current capacity according to load requirements Internal port excitation is 6.1V and its use will limit the output drive to a low voltage and the wetting current level (~2mA/channel). You should connect external excitation to raise the output voltage and current drive.
IMPORTANT: Limited internal excitation of 6.1V is enabled by default and can be turned OFF if external excitation is used. This will conserve power and permit a higher drive capability at a lower excitation voltage. Use of external excitation allows higher I/O voltages and output drive currents. If internal excitation is left ON, then the external excitation supply must be adjusted to a voltage level at least one diode-drop above the internal excitation to carry the load (these supplies are each series diode-coupled to the same point).

Shock & Vibration Immunity: Surface mounted unit with enclosure rated to 5g Random Vibration, 5-500Hz, in 3 axis at 2 hours/axis per IEC60068-2-64; Mechanical Shock to 50g, 3ms, with 3 half-sine shock pulses in each direction along 3 axis (18 shocks), and 30g, 11ms, with 3 half-sine shock pulses in each direction along 3 axis (18 shocks), per IEC60068-2-27.

Electromagnetic Interference Immunity (EMI): Inputs/outputs have demonstrated resistance to inadvertent state changes with interference from switching solenoids, commutator motors, and drill motors.

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

Immunity per BS EN 61000-6-2:

1) Electrostatic Discharge Immunity (ESD), per IEC 61000-4-2.
2) Radiated Field Immunity (RFI), per IEC 61000-4-3.
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.

Emissions per BS EN 61000-6-4:

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

WARNING: This is a Class A product. In a domestic environment, this product may cause radio interference in which the user may be required to take adequate measures.

IMPORTANT: Power and I/O wiring must be in accordance with Class I, Division 2 wiring methods of Article 501-4(b) of the National Electrical Code, NFPA 70 for installations in the US, or as specified in section 18-1J2 of the Canadian Electrical Code for installations within Canada and in accordance with the authority having jurisdiction.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D, or non-hazardous locations only.

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

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

The maximum surrounding air temperature is 75°C.

The torque ratings for field wiring terminals is 5-7 lb-inches.

Reference Standard: CNR indicates investigation to Canadian Standard C22.2, No's. 142-M1987 & 213-M1987; USR indicates investigation to United States UL Standards 508 Seventeenth Edition & ISA 12.12.01:2011.

SPECIFICATIONS

Environmental

These limits represent the minimum requirements of the applicable standard, but this product has typically been tested to comply with higher standards in some cases.

***TIP:** For critical applications or units subject to severe shock or interference, utilize the built-in watchdog timer and alarm relay to signal an interruption in communication, link loss, or optionally power failure (w/failsafe contacts).*

SPECIFICATIONS

Ethernet Interface

Note: *The slower data rate 10Base-T is not supported in hub/repeater mode. Further, hubs & repeaters are inherently half-duplex devices, and full-duplex communication will not be possible in hub/ repeater mode. As such, auto-negotiation will also not be supported in hub/repeater mode.*

Refer to Acromag Application Note 8500-734 for instructions on how to change the IP address of your PC network interface card in order to talk to this unit.

Optionally, port 1 may be selected to interface with fiber-optic cable at 100Mbps. This allows a unit to operate as a local media converter, with a fiber-optic home-run connection, and a local area copper network connection.

Fiber ports are fixed at 100Mbps, half or full duplex, and auto-negotiation and automatic MDI/MDI-X crossing does not apply.

In hub/repeater mode, ports are 100Mbps only at half-duplex and auto-negotiation does not apply.

This device utilizes a 3-port Ethernet switch to provide an interface from an internal MII processor, to the two external 10/100M Ethernet ports. This built-in switch has two modes of operation—it may function as a two-port store & forward Ethernet switch (default), or as a low latency hub/repeater. Switch mode is useful to facilitate a cascaded network connection between units for stacking purposes. It may also extend network distances another 100 meters per segment, without consuming an additional external Ethernet switch port. The hub/repeater mode is useful to help facilitate end-node media redundancy right to this device, when connected to external Ethernet switches that happen to support redundancy (Ring, STP, or RSTP). Hub mode is also useful for low-latency cascaded network connections, or where multi-unit network traffic is concentrated. Switch mode is the recommended (default) mode of operation, with hub mode reserved for redundant media applications using copper connections, or where low-latency network connections are required.

Network Connector (Copper): One (ES2113-1xxx), or two (ES2113-0xxx), 8-pin RJ-45 sockets for 10BaseT/ 100BaseTX connections.

Network Connector (Fiber, ES2113-1xxx Models): One duplex SC-type, multi-mode transceiver for IEEE 802.3u 100Base-FX cable connections. Multimode transmission distance is 2Km.

Wiring (Copper): Wired MDI-X (Ethernet switch), but unit supports automatic crossover for copper (RJ-45) connections.

Data Rate: Auto-sensed, 10Mbps or 100Mbps on copper connections, fixed to 100Mbps on fiber connection. In hub/repeater mode, the data rate is fixed to 100Mbps and auto-negotiation does not apply.

Duplex: Auto-negotiated, Full Duplex, or Half Duplex. Half-duplex only in hub/repeater mode (auto-negotiation does not apply). The fiber port cannot operate half duplex in repeater mode.

Compliance: IEEE 802.3, 802.3u, 802.3x.

IP Address: Default mode static IP address is 128.1.1.100.

Transient Protection: Transient Voltage Suppressors are applied differentially at both the transmit and receive channels of both ports.

Protocol: Modbus TCP/IP or UDP/IP with integrated web-browser reconfiguration. Unit will respond via UDP for messages received via UDP, and via TCP for messages received via TCP. Up to 10 Modbus TCP/IP sockets are supported using port 502 (reserved for Modbus). The number of sockets limit does not apply to messages sent via UDP/IP, as UDP is a connectionless protocol. Unit functionality is configured via memory map registers using Modbus commands & built-in web pages.

MAC Address Table: 1K MAC Address table.

Password/User-Name Default: Default web-browser password for access is "password" and the user-name is "User".

Network Distance: Distance between two devices on an Ethernet network is generally limited to 100 meters using recommended copper cable, and 2Km using multi-mode fiber optic cable. Distances may be extended using hubs and switches. However, the total round trip delay time along a network path must never exceed 512 bit times for collision detection to work properly.

Address: Unit IP address can be preset by the user (static) and loaded from internal non-volatile memory, or it can be automatically acquired at startup via a network server using a BOOTP (Bootstrap Protocol), or DHCP (Dynamic Host Configuration Protocol). The unit also includes a default mode toggle switch to cause the unit to assume a "known" fixed static IP address of 128.1.1.100, useful for troubleshooting purposes.

LED Indicators (Rear Panel):

Rear System Status Indication (Located next to power terminals)

RELAY (Red) – Indicates the energized state of the adjacent SPST-NO relay contacts A & B. ON indicates these contacts are closed. OFF indicates these contacts are open. ON by default following power-up indicates a failsafe contact setting (normally energized).

STATUS (Yellow) – Slowly blinks ON/OFF in default mode, blinks rapidly if a watchdog timeout has occurred.

RUN (Green) – Blinks momentarily upon power-up but turns constant ON if power is on and unit is OK. Continuous flashing after power-up may also indicate that the network cable is not connected or is bad. Continuous flashing ON/OFF indicates unit is in "wink" ID mode.

Controls (Front-Panel):

External (User Access)

Reset/Default Address Toggle: This momentary toggle switch is located on the front panel adjacent to the network LED indicators and is used to either reset the unit (momentary toggle down), or toggle the unit into, or out of, Default Communication Mode (toggle up, hold for 4 seconds). In Default Mode, the unit assumes the fixed static IP address "128.1.1.100", a default subnet mask "255.255.255.0", a default username of "User", and a default password of "password". This switch can also be used to restore the unit to its initial factory configuration by holding the switch in its default position while powering up the unit (see "Getting Out Of Trouble" in the Troubleshooting section for more information). Reset is useful for trouble-shooting purposes without having to cycle power. If communication with a unit is ever lost, it can typically be restored by simply resetting the unit via this switch, or by cycling power (note that all outputs are turned OFF following reset).

Front Network Status Indication Per Port (next to network ports)

These LED's indicate different information according to whether the network ports are in switch mode, or hub/repeater mode. In switch mode, column 1 corresponds to port 1 status and column 2 corresponds to port 2 status.

Note: Switch Mode is the default mode of communication for this device.

Port SWITCH Mode

Port 1 and Port 2 Indicator Columns 1 & 2, Top to Bottom

3 Green (No Function) – LED (top) has no function in switch mode.

2 Yellow (LINK/ACT) – Constant ON indicates auto-negotiation has successfully established a connection/link. Blinking indicates Ethernet activity on the link (Ethernet connection is busy/traffic is present). OFF indicates no link.

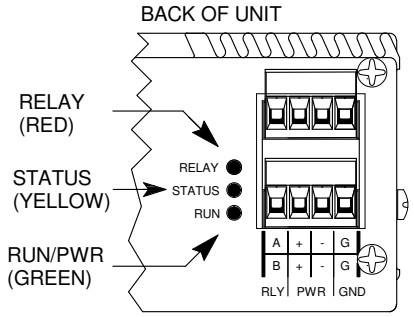
1 Yellow (FDX/COL) – Constant ON indicates full-duplex connection (no collisions possible). Intermittent ON indicates collisions (half-duplex). Constant OFF indicates half-duplex and no collisions.

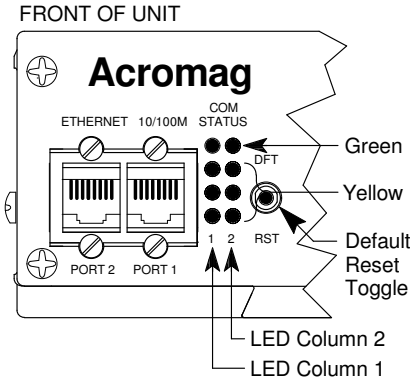
0 Yellow (SPEED) – This LED (bottom) indicates 100Mbps speed (ON), and 10Mbps speed (OFF).

Note: Fiber ports are 100Mbps only, half or full duplex. In hub/repeater mode, both ports are 100Mbps only and half-duplex.

SPECIFICATIONS

Controls & Indicators





SWITCH MODE
LED Column 1 - Port 1
LED Column 2 - Port 2

GREEN - No Function in Switch Mode.

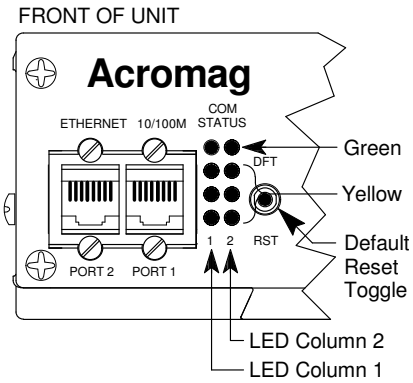
YELLOW - Link/Activity: ON if Linked/Blinks if Activity.

YELLOW - Full-Duplex/Collision: ON for FD, Blinks for HD Collisions, OFF for HD and No Collisions.

YELLOW - Speed: ON for 100Mbps, OFF for 10Mbps.

SPECIFICATIONS

Controls & Indicators



HUB/REPEATER MODE
1=LED of Column 1
2=LED of Column 2

GREEN: 1=Hub Activity, 2=Hub Collision.

YELLOW: 1=MII/CPU Link/Activity, 2=MII/CPU Err

YELLOW: 1=Port 2 Link/Activity, 2=Error at Port 2.

YELLOW: 1=Port 1 Link/Activity, 2=Error at Port 1.

Port HUB/REPEATER Mode

Indicator Column 2 (Top to Bottom)

3 Green (ACT) – The top LED indicates repeater activity on the link (ON or blinking).

2 Yellow (ERR3) – ON indicates an error has been encountered at internal port 3 (the processor MII port). Error is related to isolation, partition, jabber, or JK error.

1 Yellow (ERR2) – ON indicates an error has been encountered at network port 2 (the left port). Error is related to isolation, partition, jabber, or JK error.

0 Yellow (ERR1) – ON indicates an error has been encountered at network port 1 (the right port). Error is related to isolation, partition, jabber, or JK error.

Indicator Column 1 (Top to Bottom)

3 Green (Collision) – The top LED turns ON when a collision occurs.

2 Yellow (Link3/Rx ACT) – Constant ON indicates auto-negotiation has successfully established a connection/link at internal port 3 (the processor MII port). Blinking indicates receive activity on the link (connection is busy/traffic is present). OFF indicates no link.

1 Yellow (Link2/Rx ACT) – Constant ON indicates auto-negotiation has successfully established a connection/link at network port 2 (the left port). Blinking indicates receive activity on the link (connection is busy/traffic is present). OFF indicates no link.

0 Yellow (Link 1/Rx ACT) – Constant ON indicates auto-negotiation has successfully established a connection/link at network port 1 (the right port). Blinking indicates receive activity on the link (connection is busy/traffic is present). OFF indicates no link.

CABLES & CONNECTORS

Copper Connections

The minimum cable required for full operation of this device is Category 5. The term "Category" refers to classifications of UTP (Unshielded Twisted Pair) cables. There are 3 main categories of cable – Category 3, Category 4, and Category 5. The differences in classification is found in their electrical performance and this is documented in the TIA/EIA 568A standard. Category 5 cable includes four twisted wire pairs at eight twists per foot.

This device is designed for use in harsh industrial environments. Acromag recommends the use of shielded cable when wiring to this device. Select STP (Shielded Twisted Pair) cable rather than UTP (Unshielded Twisted Pair). The use of shielded cable will help protect the transmitted data from harmful EMI (Electromagnetic Interference) and RFI (Radio Frequency Interference). It will also help to lower your radiated emissions by keeping the cable from emitting EMI and RFI.

There are two types of cable: solid cable and stranded cable. Stranded cables are more flexible than solid cables. But since attenuation is higher for stranded cables than solid conductor cables, these are generally reserved for short runs and patch applications less than 6 meters.

Currently there are two types of shielding employed in Category 5 STP cable: single-shielded cable and double-shielded cable. Both of these cables have the same core and jacket as UTP cables, but also include a thin foil outer shield that covers all four twisted-wire pairs. Some variations will also include a drain wire that encircles the outer foil. The double-shielded version adds an outer wire screen that wraps around the foil shield and also functions as a drain wire. The drain wire or wire screen typically makes contact at each end of the cable with the metal shield around special shielded RJ45 plug connectors. The metal shield of these connectors then makes contact with the metal shield of shielded RJ45 sockets (the EtherStax units do not have this shield because they are safety isolated from their enclosure/earth ground). The socket shield may make direct contact with earth ground, or it may capacitively couple to earth ground. In addition to minimizing radio frequency and electromagnetic interference, this arrangement also has the added benefit of enhanced protection from ESD (Electro-Static Discharge).

Acromag recommends the use of *enhanced* Category 5 cable (CAT-5e). This cable has all the characteristics of Category 5, but includes enhancements that help to minimize crosstalk. It is rated for frequencies up to 200MHz, double the rate of Category 5. Category 5e cable also has a greater number of turns-per-inch in its twisted pairs, making its performance more suitable for applications that make use of all four wire pairs for simultaneous bidirectional data transmission (full-duplex). This cable is defined in TIA/EIA-568A-5 (Addendum 5).

Note that you do not need to use a crossover cable to connect your PC to an EtherStax unit, as it is auto-crossing (copper only). However, the auto-crossing feature is not applicable to the fiber-port. Fiber ports require that transmit be manually crossed over to receive, and visa-versa.

CABLES & CONNECTORS

Copper Connections

You may obtain cable from other vendors in varied lengths and colors, as required for your application. For example, shielded CAT-5e cable is available from the following vendors:

- L-com Connectivity Products, www.L-com.com
- Pro-Link, www.prolink-cables.com

For very noisy environments or in the presence of strong electrical fields, you can obtain double-shielded CAT-5e cable and shielded RJ45 plugs from the following vendors (the EtherStax does not require shielded plugs as it uses unshielded RJ45 connectors):

- L-com Connectivity Products, www.L-com.com, see cable model TFSC2004 and shielded plug T8P8CSR.
- Regal Electronics, www.regalusa.com, see shielded plug model 1003B-8P8CSR-C5.

Complete premium double-shielded Category 5e standard and crossover cables in variable lengths can be obtained from Lumberg at www.lumbergusa.com (refer to their EtherMate line). For example, specify RJ45S-RJ45S-656/B/3M for a double-shielded, 3 meter straight cable. Specify RJ45S-RJ45S-656/BX/3M for a double-shielded, 3 meter crossover cable.

Acromag offers the following cable termination kit for building cables that take advantage of the special clip-frame provided at the RJ45 socket of the EtherStax unit. These are not required as standard plugs are still supported, but will help to secure network connections for units subject to severe shock and vibration.

Cable Termination Kit ESA-CTK: The EtherStax enclosure includes a panel mounted frame around the RJ45 network port that accommodates special IP20 clip-type plug connectors that help to secure the network connections from shock and vibration. You can still utilize standard RJ45 modular plug connectors, but if you want the added security of this clip frame, then you have to use the compatible cable plug connectors provided by this kit. This kit provides the male plug and sleeve housing for one end of Category 5 Ethernet cable that will mate to this frame. You can purchase these items from us by referencing Acromag ESA-CTK. The Category 5 cable is not included, but readily available from other vendors. You can use a standard modular crimping tool for attaching the RJ45 plug of this kit to your cable (for example, see Phoenix crimping tool CRIMPFOX-LC-RJ45S catalog #1207420). You will need one kit for each EtherStax connection.

CABLES & CONNECTORS

Fiber Connections

Model ES2113-1xxx units include an SC-type fiber-optic port for multi-mode fiber connection.

Note that the standard EtherStax units use SC-type (Stab & Click) fiber connectors. If your application requires ST (Stab & Twist) type fiber connectors, you can request this option from the factory at an additional charge.

You can obtain compatible fiber cable and accessories from a variety of other vendors, and some are listed below:

L-com Connectivity Products (www.L-com.com)
fiber.com (www.fiber.com)
Belkin (www.belkin.com)
CablesToGo (www.cablestogo.com)
CablesPlus (www.cablesplusUSA.com)

Be sure to specify dual or duplex, SC type cables or patch cords. SC cables utilize a snap-in connector that latches with a push-pull motion.

If you wish to build your own cables, you will also need special tools and equipment for cutting, splicing, and polishing the fiber.

With respect to the EtherStax, note that the auto-crossing feature does not apply to the fiber-optic ports, and the transmit and receive channels of these ports must be mechanically crossed over. Likewise, auto-negotiation does not apply to the fiber port, as the speed is fixed at 100MB. Units with a fiber port cannot be placed into hub/repeater mode, as this is a full-duplex fiber connection and hubs/repeaters operate half-duplex.

For reference, when facing the front endplate of the unit, the Transmit (Tx) channel is the bottom half of the SC fiber connector, while the Receive (Rx) is the top half of the fiber connector.

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