BusWorks® 900EN Series – Modbus TCP/IP 10/100MB Industrial Ethernet I/O Modules

Model 981EN-4012 12 Active-Low Digital Inputs
Model 982EN-4012 12 Sinking Digital Outputs
Model 983EN-4012 12 Tandem Digital Input/Output

USER'S MANUAL

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TABLE OF CONTENTS

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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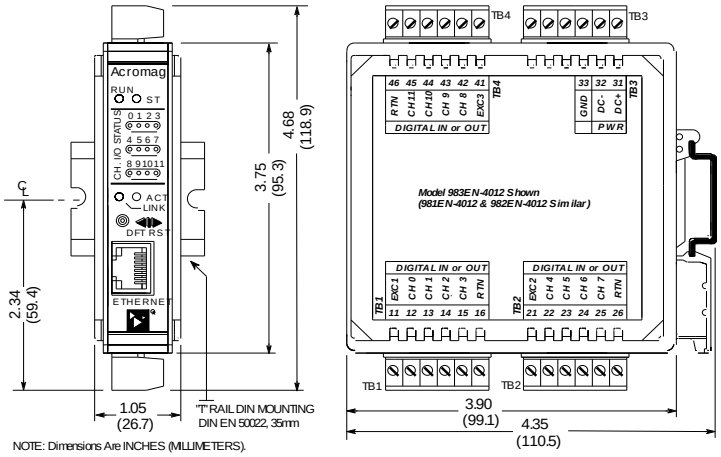
IMPORTANT SAFETY CONSIDERATIONS

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.

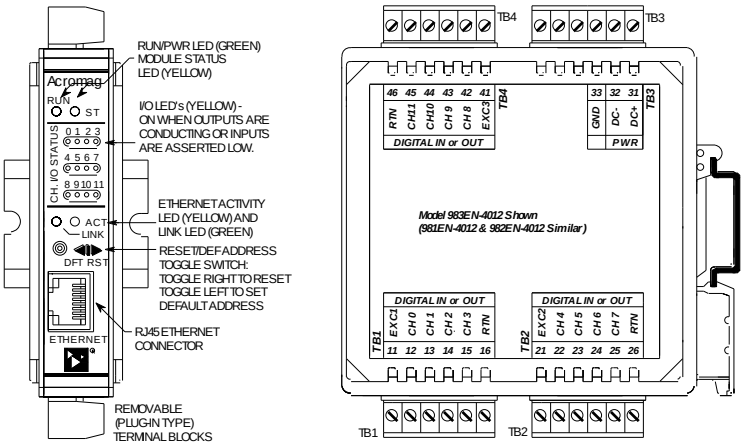
GETTING STARTED

TECHNICAL REFERENCE

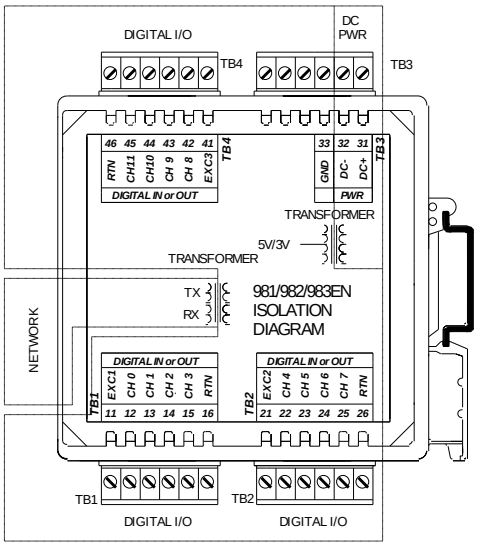


NOTE: Dimensions Are INCHES (MILLIMETERS).

MODEL 981/982/983EN ENCLOSURE DIMENSIONS



The toggle switch is used to toggle the module into or out of Default Mode (toggle left), or to reset the module (toggle right). In Default Communication Mode, the yellow ST LED blinks slowly and the module assumes 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 "password00".



MOUNTING AND DIMENSIONS

Unit mounts to "T" type DIN rails (35mm, type EN50022).

Units may be mounted side-by-side on 1-inch centers.

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

CONTROLS & INDICATORS

Green Run LED is ON if power is on and will blink in "wink" ID mode.

Yellow ST LED blinks ON/OFF slowly if module is in default communication mode and blinks rapidly if a watchdog timeout has occurred.

Yellow I/O LED's turn ON if corresponding output switch is closed, or input asserted low.

Green LINK LED ON if auto-negotiation has successfully established a connection.

Yellow ACT LED signals PHY network Activity (busy).

ISOLATION BARRIERS

Dashed Lines denote isolation barriers.

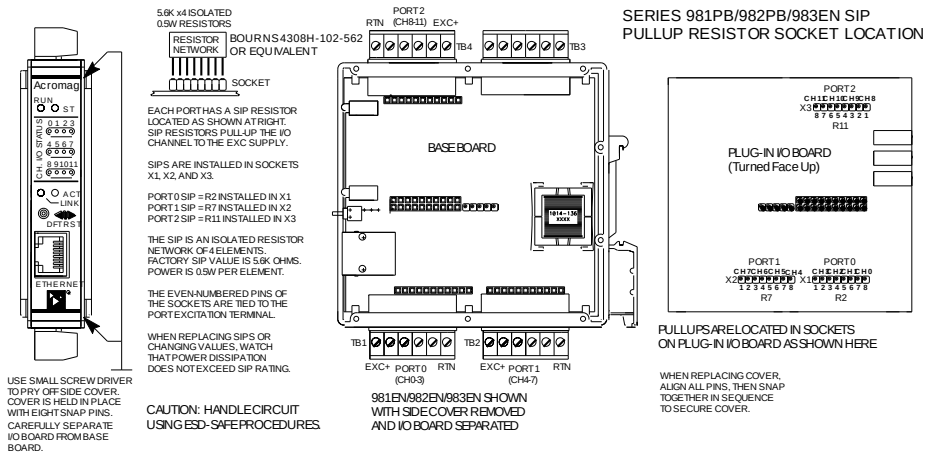
The I/O circuit, network, and power circuit are isolated from each other for safety and noise immunity.

I/O PULLUP RESISTOR INSTALLATION

You must connect excitation and/or install pull-ups for proper I/O operation. I/O terminals must not be left floating.

5.6KΩ I/O pull-up resistors are already installed from the factory. You do not need to refer to this information unless you need to change or remove these resistors.

If your application delivers power to the I/O terminals rather than the excitation terminal, the internal pull-ups should be removed to avoid coupling current into adjacent port channels.



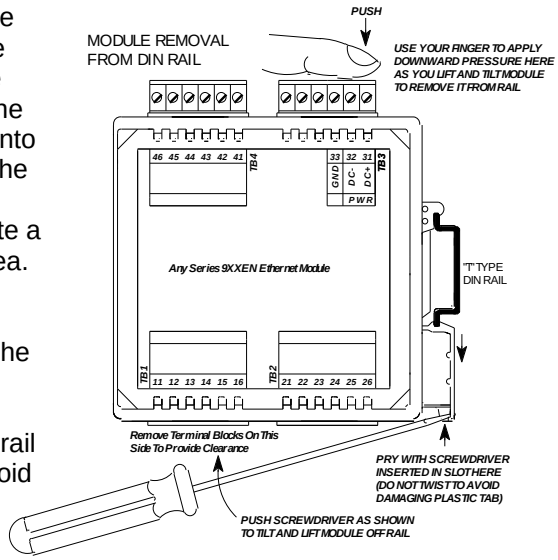
To Remove or Replace Factory Pullup Resistors…

Locate pullup resistor SIP's installed in sockets of plug-in I/O board as shown above. You must remove the right side cover and separate the two boards to remove or install these resistors. 5.6K resistor SIP's are installed from the factory. **Remove these resistors if I/O channels are pulled up externally.** Limit power in each SIP resistor to less than 0.5W.

CONNECTIONS

DIN-Rail Mounting & Removal

When attaching the module to the T-type DIN rail, angle the top of the unit towards the rail and locate the top groove of the adapter over the upper lip of the rail. Firmly push the unit towards the rail until it snaps into place. To remove, first separate the input terminal block(s) from the bottom side of the module to create a clearance to the DIN mounting area. Next, while holding the module in place from above, insert a screwdriver into the lower arm of the DIN rail connector and use it as a lever to force the connector down until the unit disengages from the rail (do not twist the screwdriver to avoid damaging plastic).



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 crossover 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.

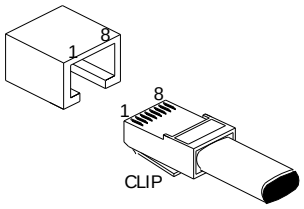
In either case, you are limited to 100 meters between any two devices.

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



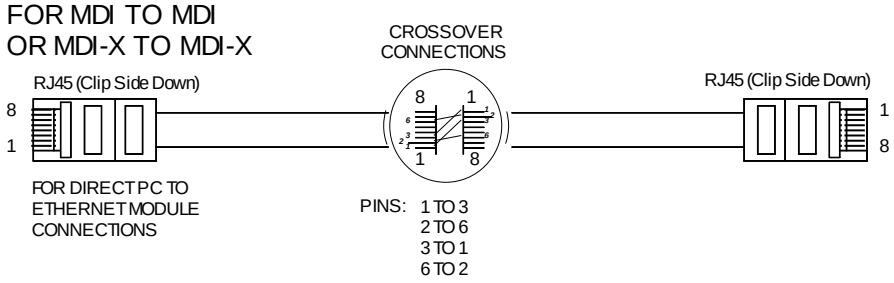
RJ-45 CONNECTOR

MINIMUM RECOMMENDED CABLE

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

The Ethernet port of this module is wired MDI and does not include automatic crossover. The Ethernet port of your PC is also wired MDI and may not include automatic crossover. As such, you must use a crossover cable like that shown below when connecting this device directly to a PC.

CROSSOVER CABLE
FOR MDI TO MDI
OR MDI-X TO MDI-X

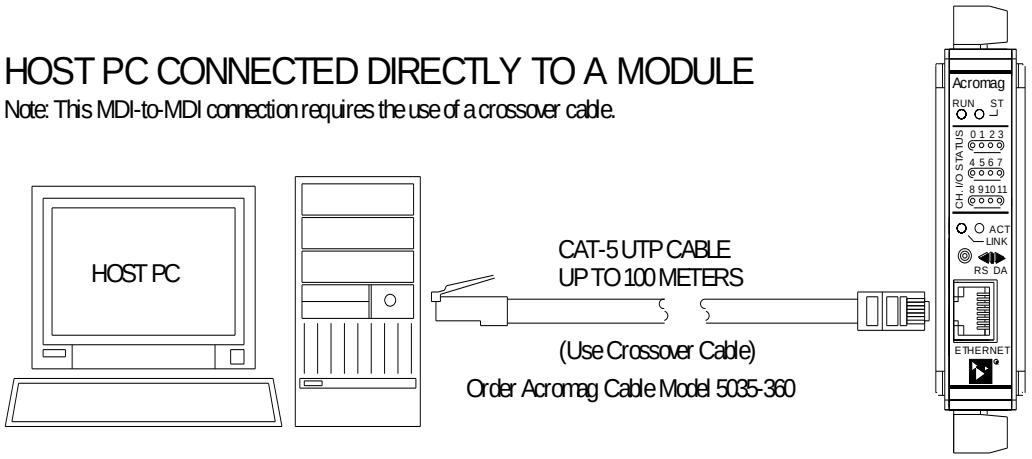


A crossover cable simply connects the differential transmit pair on each end, to the receive pair on the opposite end.

Use a standard (direct) cable when connecting to a hub or switch port, which are generally wired MDI-X.

HOST PC CONNECTED DIRECTLY TO A MODULE

Note: This MDI-to-MDI connection requires the use of a crossover cable.



Acromag 983EN-4012 Ethernet Module.

The ethernet port of this module is not automatic MDI/MDI-X crossover and is wired MDI.

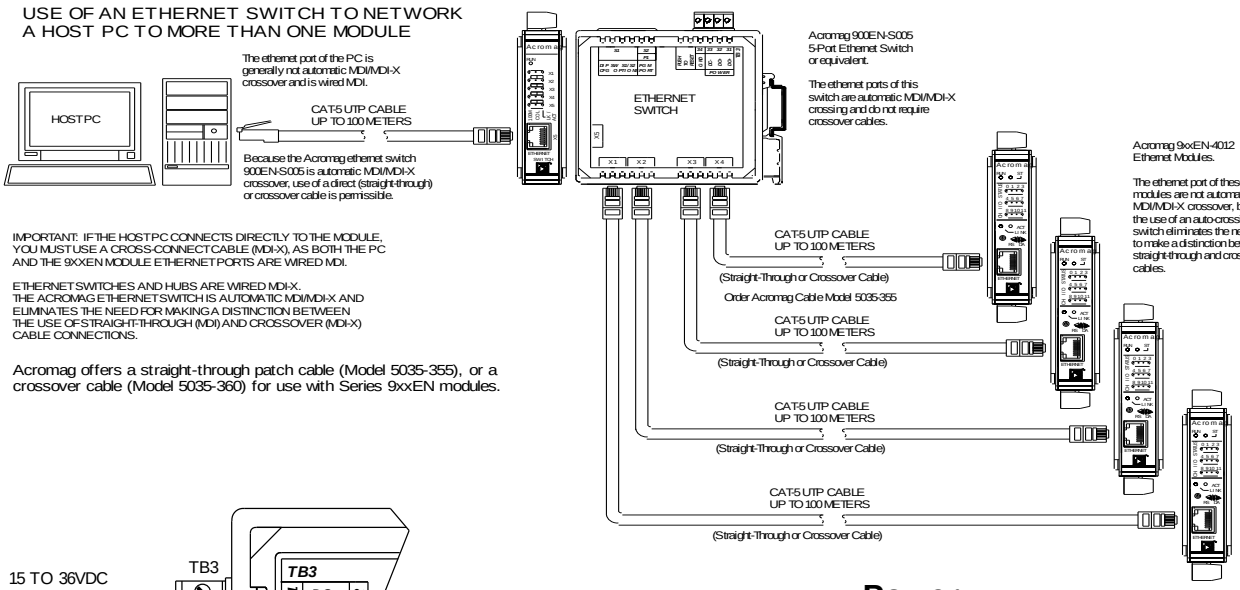
CONNECTIONS

Network

Refer to the Accessory Cables section at the back of this manual for more information on accessory cables including patch and crossover cables available from Acromag and other vendors.

TIP: You can significantly enhance the EMI/RFI performance of your network connections by using Category 5E STP cable (Shielded Twisted Pair) with shielded RJ45 plug connectors. This will also help to protect your installation from damage due to ESD (Electro-Static Discharge). The use of shielded cable is strongly recommended for installations in harsh industrial environments and/or in the presence of strong electrical fields.

You can use an Ethernet switch or switching hub to build a network of Ethernet modules, similar to that shown below. This drawing shows how to network-connect these modules to a 5-port Ethernet switch (Acromag Model 900EN-S005). Note that the 900EN-S005 switch includes automatic MDI/MDI-X crossover and straight-through or crossover cable(s) may be used, but it is generally not good practice to use crossover cables when connecting to an auto-crossing switch.



Power

Voltage	Current
15VDC	123mA
18VDC	106mA
24VDC	80mA
36VDC	59mA

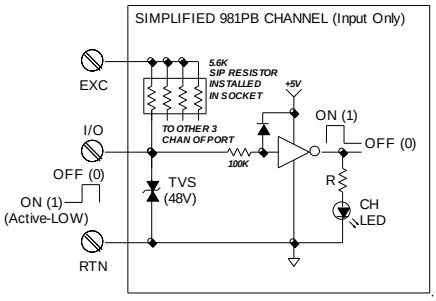
✓

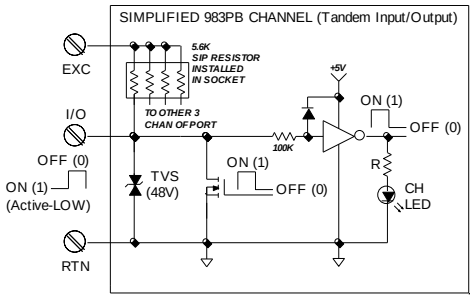
Connect 15-36V DC to the power terminals labeled DC+ & DC-. Observe proper polarity. For supply connections, use No. 14 AWG wires rated for at least 75°C. **CAUTION:** Do not exceed 36VDC peak.

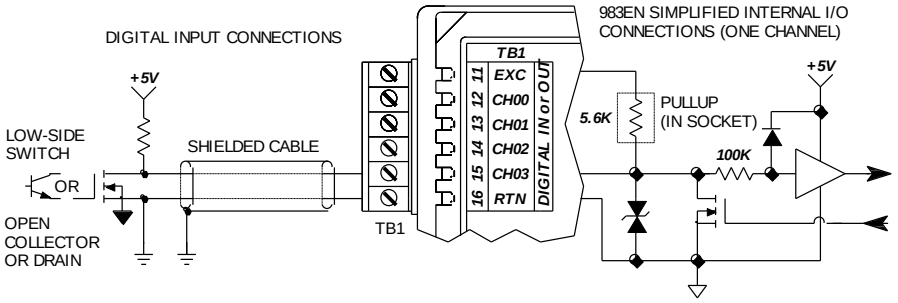
CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize equipment before servicing.

IMPORTANT – External Fuse: If unit is powered from a supply capable of delivering more than 1A to the unit, it is recommended that this current be limited via a high surge tolerant fuse rated for a maximum current of 1A or less (for example, see Bel Fuse MJS1).

✓ Connect digital input signals to the input terminals (see figures below):

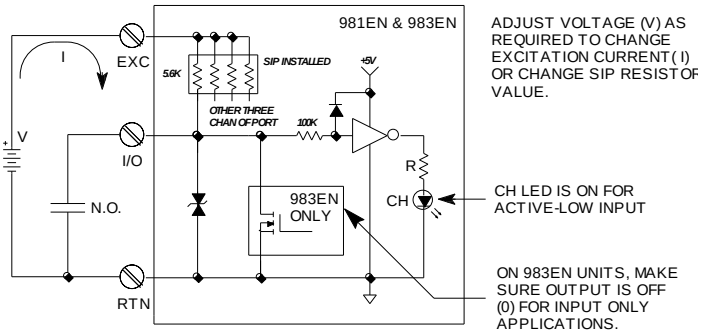




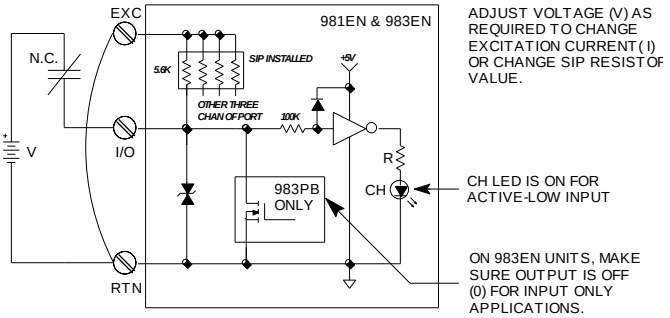


Refer to the examples below for examples of other types of input connections.

DRY-CONTACT RELAY CONNECTIONS - NORMALLY OPEN



DRY-CONTACT RELAY CONNECTIONS - NORMALLY CLOSED



CONNECTIONS

Digital Inputs (981EN & 983EN Only)

Inputs are active-low.

Input threshold is TTL compatible.

Limit Input Voltages to 35V maximum.

***Note:** Do not allow EXC or unused inputs to float. If pull-ups are installed, this will cause one I/O signal to pull the other floating port channels via the pull-ups and common EXC lead connection.*

Normally Open Dry Contact Relay.

Normally Closed Dry Contact Relay.

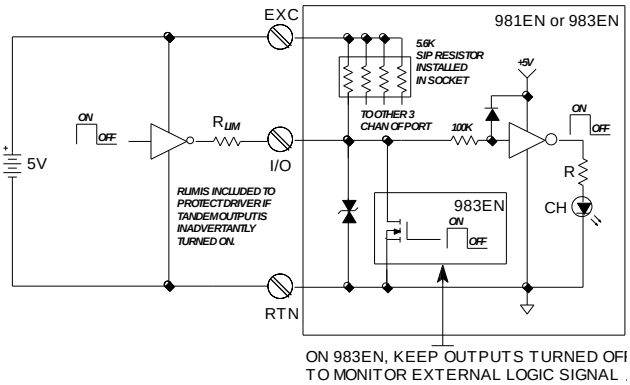
CONNECTIONS

Digital Inputs (981EN & 983EN Only)

Digital TTL Logic Monitor

Note: *Do not allow EXC or unused inputs to float. If pull-ups are installed, this will cause one I/O signal to pull the other floating port channels via the pull-ups and common EXC lead connection.*

LOGIC (TTL) MONITOR (981EN & 983EN ONLY)

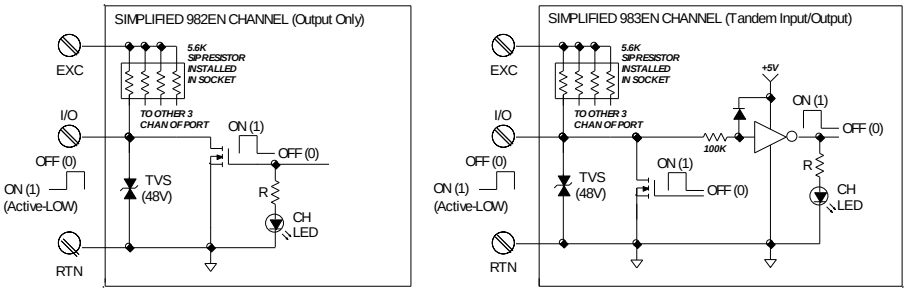


Digital Outputs (982EN & 983EN Only)

Outputs are the open-drains of DMOS mosfet switches for DC current-sinking applications only.

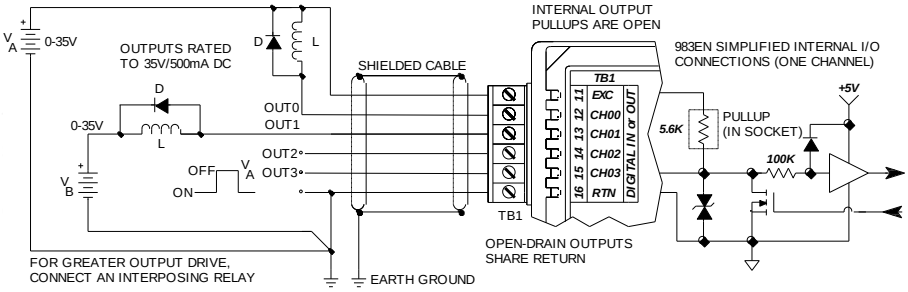
Outputs turn OFF (open) following a software or power-on reset of the module.

✓ Connect digital outputs to the output terminals. Refer to figures below:



DIGITAL OUTPUT CONNECTIONS

POSSIBLE VARIATIONS - CURRENT SINKING DC APPLICATIONS ONLY



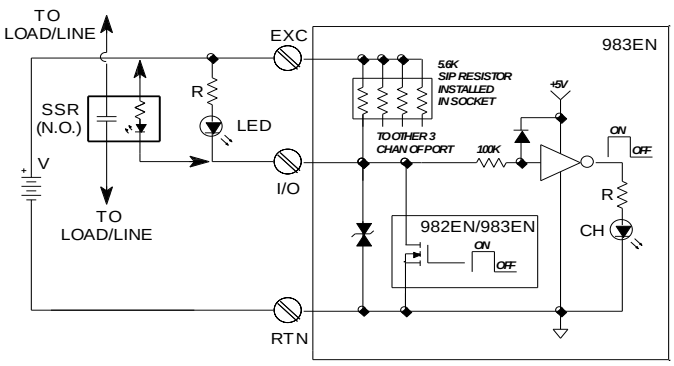
CONNECTIONS

Digital Outputs (982EN & 983EN Only)

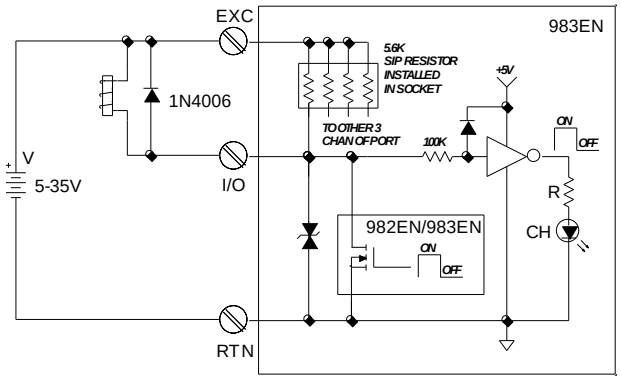
Examples:
- *Solid-State Relay (SSR) or LED Driver*
- *Relay Coil or Solenoid Driver (Note Protection).*
- *Lamp Driver.*

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

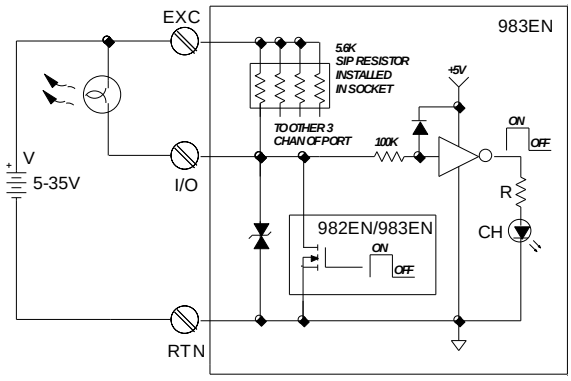
SOLID-STATE RELAY (SSR) OR LED DRIVER



RELAY COIL/SOLENOID DRIVER



INCANDESCENT LAMP CONTROL



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

✓ Connect Earth Ground as shown in the connection drawings above. Additionally, connect the GND terminal (TB3-33) to earth ground.

The ground connections noted are recommended for best results. If sensors are already grounded, use caution and avoid making additional ground connections which could create ground loops.

The plastic module housing does not require earth ground.

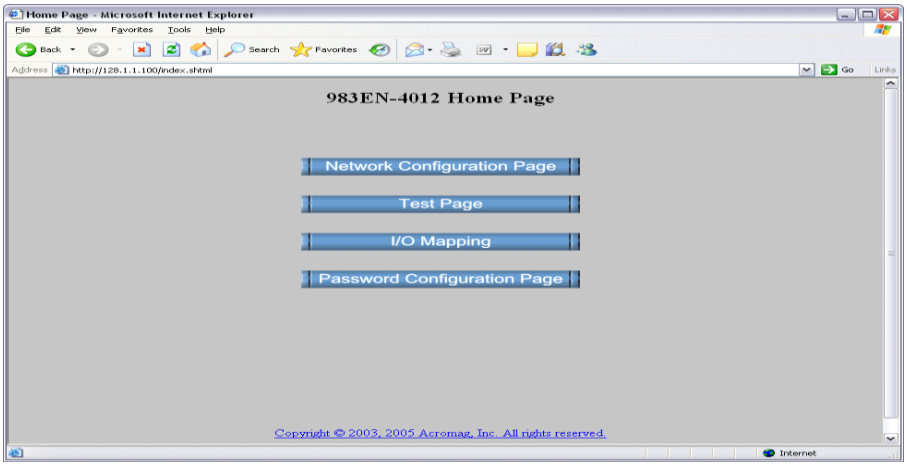
Earth Ground

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.*

WEB BROWSER

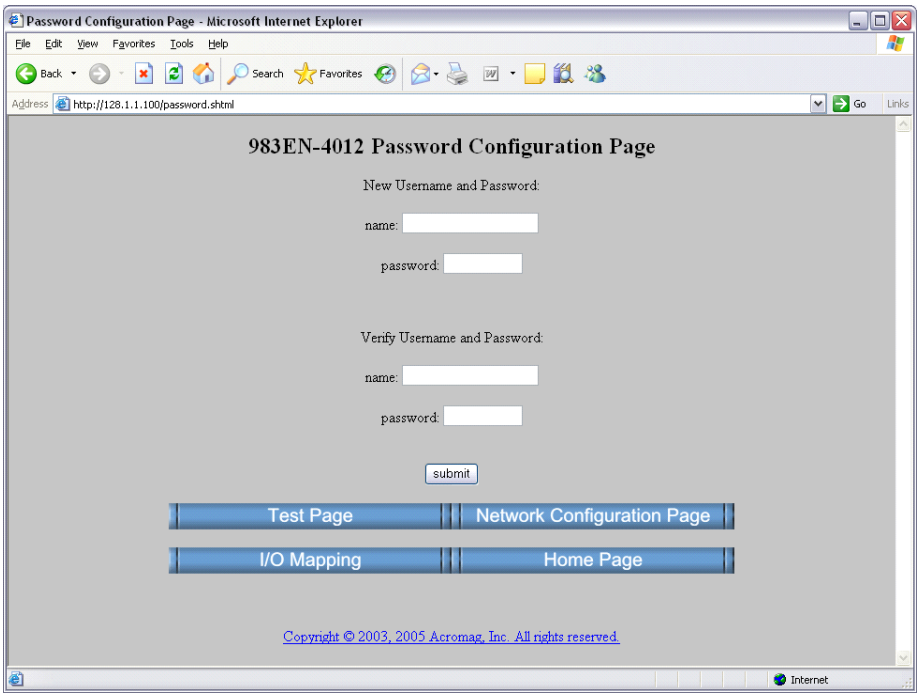
Home Page

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



The Home Page provides buttons to access the other web pages of this module that are used to configure the network parameters, change the user name and password, and operate the module. For each new browser session that accesses the Home Page of this module, you will be presented with a window prompting you to enter the current User Name and Password as shown below. This information is required before the program will allow you to make any other selections. **The default user name and password is "User" and "password00" respectively.** After entering these defaults, you may wish to 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 module into default mode via the default mode toggle switch at the front of the module, and the password and username will revert to the original defaults noted above, thus allowing you to re-invoke the Password Configuration Page and change the username and password as required.



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 module.
After completing your username/password changes, click on the appropriate button at the bottom of the page to select another web page. If you made changes, you may be prompted to re-enter your new username and password before being permitted to move to other pages.

WEB BROWSER

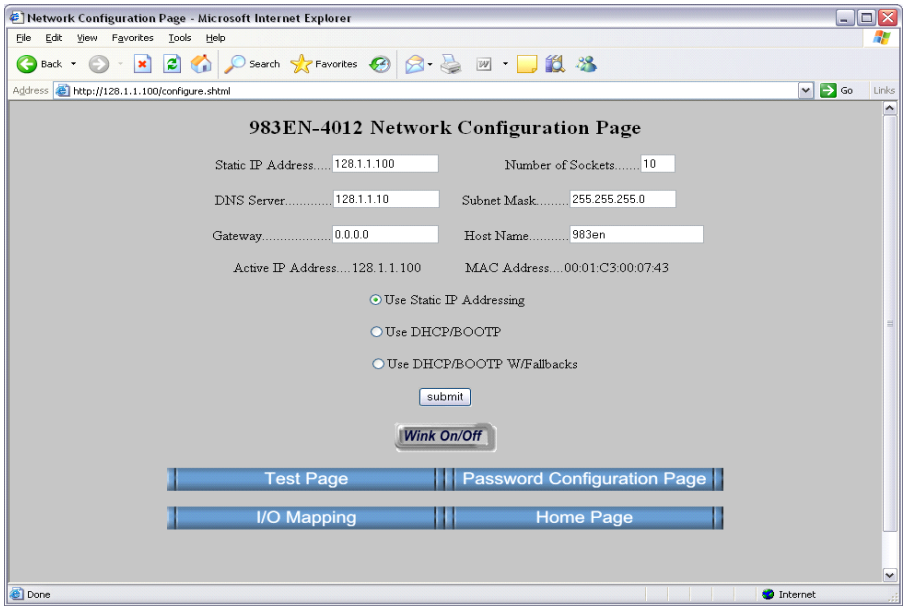
Network Configuration

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 module. You may have to consult your network administrator to complete the contents of this page.

An **IP Address** is a unique identification number for any host (this module) 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 module is 128.1.1.100 (refer to product side label).

Note that Acromag Series 9xxEN Ethernet I/O modules may take from 3 to 30 seconds to boot upon power-up, depending on your network configuration and whether a DHCP server is present.



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

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 "password00".

NOTE: In order to network your PC with an Acromag module, you may have to consult with your network administrator and either temporarily change 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 to help accomplish this (located on the CDROM shipped with your module or via download from our web site at www.acromag.com).

The **Number of Sockets** refers to the number (1-10) of Modbus TCP/IP access points to allow for this host. The default allows up to 10 sockets, but you can restrict access by reducing this number. Internally, the module uses port number 502 which is reserved for Modbus.

The **DNS Server** refers to the IP address of the Domain Name Server used on this network. A DNS server relates symbolic names to actual 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.

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.

WEB BROWSER

Network Configuration

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 hardware of this device. This is a unique fixed address assigned to this module at the factory. In IEEE 802 networks, the Data Link Control (DLC) layer of the OSI Reference Model is divided into two sublayers: the Logical Link Control (LLC) layer, and the Media Access Control (MAC) layer. The MAC layer interfaces directly with the network media (each different type of network media requires a different MAC layer).

By default, the module 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.

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

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 "password00".

Click the **Submit** button to complete any changes made on this page.

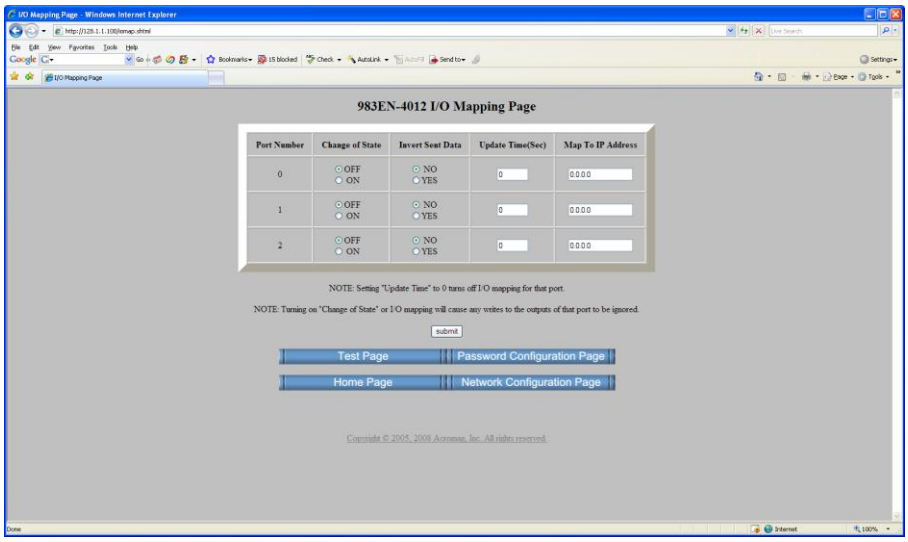
Click the **Wink On/Off** button to toggle the module in/out of "wink" ID mode. In this mode, the module's green RUN LED will blink to confirm identification.

Refer to the Technical Reference section of this manual to learn more about IP Addressing terms and concepts.

WEB BROWSER

I/O Mapping Page (Optional i2o Function)

This module includes special remote messaging functionality (i2o, input-to-output communication) that allows it to send its digital input information (983EN only) to an output channel on another Acromag 982EN-4012 or 983EN-4012 digital output module. The I/O Mapping page shown below is used to specify the static IP address of the 982/983EN module to send an input channel's data to, either upon change-of-state, or cyclically at the update rate specified. Optionally, the data can be inverted on a port-by-port basis, before being sent via i2o by selecting "Yes" for Invert Sent Data.



Note: *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.*

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

If the input module or the target module(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.

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 module is a special application that may cause confusion for some master/client devices linked to the same network. Other master devices should be restricted from attempting to control i2o target devices.

These models have three ports of 4 digital I/O channels. Port 0 refers to digital I/O channels 0, 1, 2, and 3. Port 1 refers to digital I/O channels 4, 5, 6, and 7. Port 2 refers to digital I/O channels 8, 9, 10, and 11. Each input port of a 983EN may be mapped to the corresponding output port of another 982EN (or 983EN). Optionally, you can invert the input state data sent to an output port. 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). Note that the digital inputs only map externally and always control the exact same channels of target modules (port-to-port), but individual ports may map to output ports of different modules (at different IP addresses).

WEB BROWSER

I/O Mapping Page (Optional i2o Function)

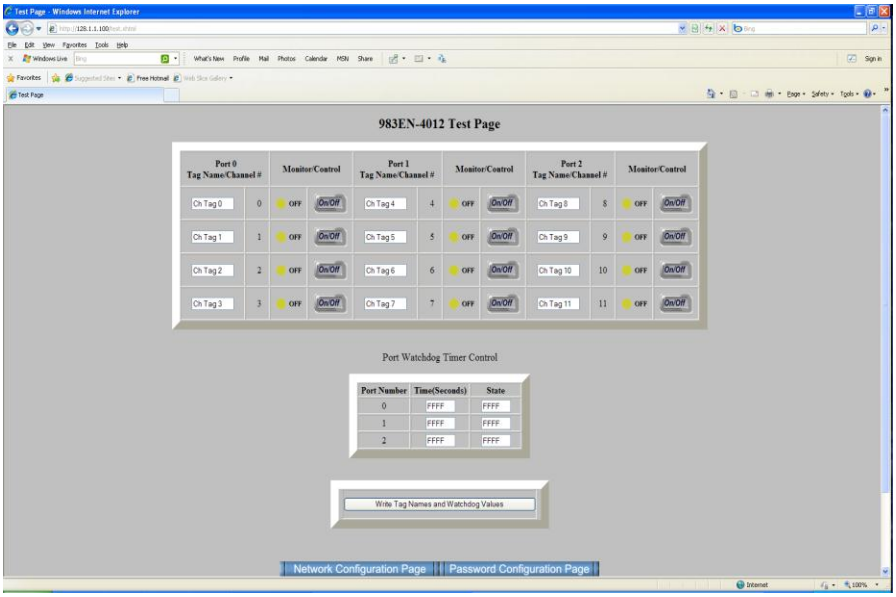
Each input port of this device may be mapped to the same port of another Acromag 982/983EN-4012 digital I/O module (different IP address). Subsequent messages will be sent at a periodic rate specified via the update time. Note that the target output port channels may still be controlled independently, but their state will be overwritten by subsequent mapped messages when enabled. It is recommended that you do not control the mapped output ports directly.

Change-of-State: Set ON to enable output 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.
Invert Sent Data: Select "Yes" to invert the port data before sending it to the destination port. Select "No" to send the actual states of the port channels.
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 982/983EN module on the network). Each digital input port may be mapped to the same port at one IP address.

Note that if you perform the procedure for restoring a module 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

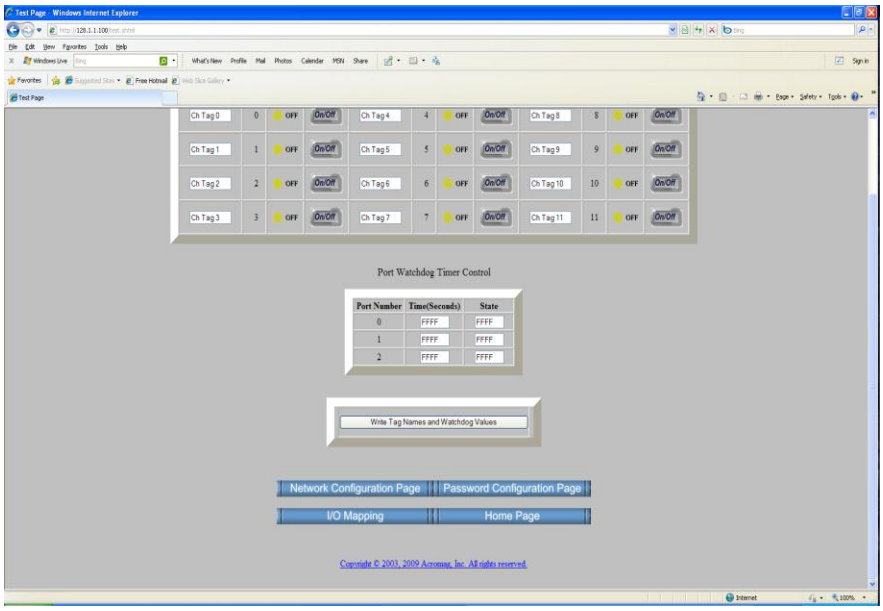
After completing the username and password assignment, plus the network configuration parameters and optional I/O mapping assignments, you can use the Test Page to operate your module and read inputs, turn outputs on and off, set tag names, configure the watchdog timer, and set watchdog timeout states.



WEB BROWSER

Test Page

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



TIP: *Viewing a module's web page is treated similar to viewing a web page on the internet. The first time you open a page, its image is stored as a temporary internet file in PC memory. However, each subsequent attempt to view that page will need to automatically update that image, especially when making configuration changes. With Internet Explorer, click the "Internet Options" of the "Tools" menu, select the "General" tab, locate the "Temporary Internet Files" information and click on the "Settings" button. Then select "Automatically" under "Check for newer versions of stored pages:". Then click [OK] to return to the "General" screen, and click [OK] again to save your settings.*

Note that the 12 channels of this module are divided into 3 groups (ports) of 4 channels each. Each port represents one pluggable I/O terminal block (6 screws). Port Number 0 refers to I/O channels 0-3, port number 1 refers to channels 4-7, and port number 3 to channels 8-11. The state of a channel is indicated by the color of the simulated LED's and the text "ON" or "OFF". These states also reflect the actual yellow I/O status LED's of the module. Tag names can be up to 9 characters.

IMPORTANT: The input state indication only reflects the state of the inputs at the moment this screen is invoked and this does not continuously update. You can click your browser's refresh button to get a new input update. The output states are updated each time you click the channel's On/Off button. You can use the On/Off buttons adjacent to the channel number to turn the outputs of 982EN and 983EN modules ON or OFF. The output state indication is updated each time you click On/Off.

A watchdog timeout is triggered at the port if no channel read or 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 via the lower 4 bits of the 16-bit value entered into the State field for the port. Enter FFFFH into the State field to leave the port outputs unchanged following a timeout. Note that the lower order bit (bit 0) corresponds to the lowest channel number for the port, bit 1 to the next channel number, and so on. Except for FFFFH, the first three hexadecimal digits of State are ignored (each port has only 4 channels and the least significant nibble (4-bits) of the State value are all that's required for control. For example, Enter a state value of "0000" to turn OFF (open) all port outputs (failsafe state) upon watchdog timeout. You would enter "000F" to turn all port outputs ON upon watchdog timeout.

TROUBLE-SHOOTING

Upon power-up, the green "Run" LED should light. This indicates the unit is operating normally. A continuous blinking Run LED indicates "wink" ID mode. If the Run LED remains OFF and correct power has been applied, then either the internal power supply has failed or a fatal processor error (firmware) has occurred.

Diagnostics Table

SYMPTOM	POSSIBLE CAUSE	POSSIBLE FIX
Green RUN LED does not light.	Internal +3.3V power has failed.	Return module for repair.
Continuous flashing green RUN LED.	Module in "wink" mode.	Read Module Status register to verify "wink" status. Write 5555H to Wink Mode Toggle Register to toggle wink mode off/on.
Cannot communicate.	Power ON at the module?	Check power. Is green RUN LED ON?
	Connecting cable is not a crossover cable. ***TIP:*** *To check cable, hold both ends in same position and read the wire colors through the clear portion of the plug from left to right. If colors are arranged in the same order, you have a straight cable.*	This module's ethernet port is wired MDI. You must use a crossover cable when connecting this module to your PC or another device also wired MDI. If you are connecting to an Ethernet switch or hub, then a direct cable is used. **Note:** If your Link LED is ON, you have connected using the correct type of cable, but it could still be defective.
	Wrong IP Address	Change the IP address of the module or the PC so that both match. Try the default module address of 128.1.1.100.
Many Communication Errors.	Is cable segment longer than 100M?	Max distance between two 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 TB3-33 GND terminal adjacent to power terminal.
Outputs Not Working.	Missing excitation connection?	Connect an excitation supply between the port EXC and RTN terminals
	Missing pull-up resistors?	Install SIP resistor in socket of board for port of interest, or pullup outputs externally.
Cannot Browse Module.	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).

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 module 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

Please refer Acromag Application Note 8500-734 for help in setting up network communication with your module (located on the CDROM shipped with your module or via download from our web site at www.acromag.com). This document gives details for changing your PC's TCP/IP configuration in order to communicate with your module (see TCP/IP Properties of Network Configuration in Windows).

Trouble Browsing Your Module?

If you have carefully followed this procedure and you still cannot browse your module, 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" pulldown 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.

You should now be able to use Internet Explorer to browse the module 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

There is no built-in error detection to prevent you from writing invalid values to a configuration register. As such, if you inadvertently write an invalid value to an internal register, you could cause the module to become inoperable under certain conditions. If this happens, in order to regain control of the module, the module can either be re-downloaded at the factory, or you can try restoring the module to its initial configuration by following this procedure:

So, your module's "gone wild", follow this procedure to restore it to its initial configuration and regain control.

Procedure For Restoring any 9xxEN Module to its Initial Configuration

1. While module power is OFF, press and hold the front-panel toggle switch in the default (DFT left) position.
2. While continuing to hold the toggle switch in the default position, apply power to the module.
3. After a few seconds, the Status LED will begin to blink quickly and you can release the default switch at this point. The module will continue to boot itself as it normally does. That is, the green RUN LED will blink for 1-10 seconds as the unit acquires its address, then remain ON for normal operation.
4. If the STATUS LED fails to blink rapidly after a few seconds and the RUN LED just blinks for a few moments as it normally does, then reinitializing the module has failed and you should try it again. This time, make sure that the DFT switch is completely depressed and held while powering the unit. Also make sure that you are pressing the DFT toggle in the DFT direction (left), rather than the RST direction (right).

Note that if you perform the procedure for restoring a module to its original configuration as outlined above, all of the I/O mapping variables are returned to their default values and I/O mapping may have to be reconfigured.

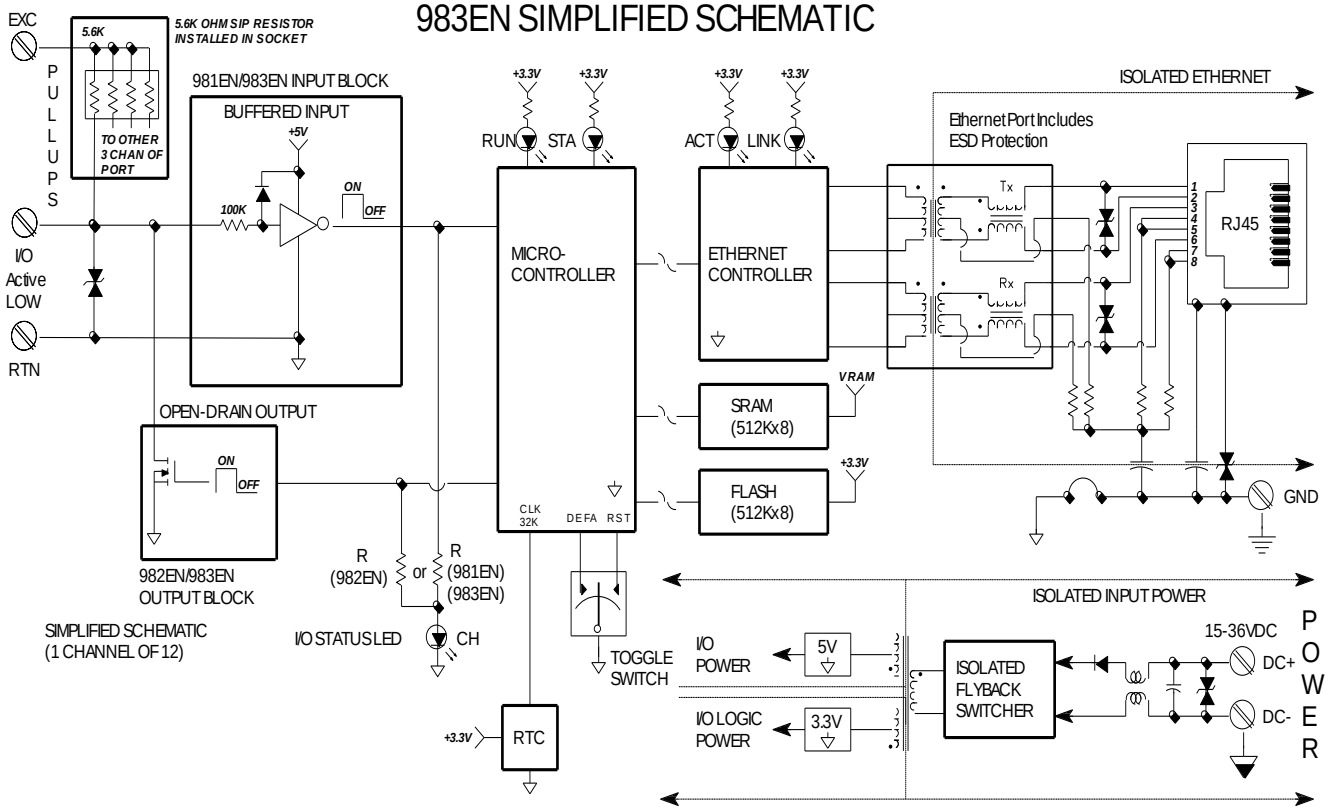
TECHNICAL REFERENCE

KEY FEATURES

- **Safety Agency Approvals** – CE, UL, & cUL listed, plus Class I; Division 2; Groups A, B, C, D approval.
- **Fully Isolated** – I/O channels, network, and power are all isolated from each other for safety and increased noise immunity.
- **Modbus TCP/IP Protocol Support –** Supports up to 10 sockets/ masters using port number 502 (Modbus TCP/IP Default).
- **I/O Mapping (i2o) Feature** – Allows the inputs of a 983EN device to control the outputs of an Acromag 982EN or 983EN output module.
- **Flexible IP Addressing** – Supports static, DHCP, or BOOTP.
- **Built-In Web Pages -** Allow unit to optionally be configured, controlled, and monitored via access with a standard web browser over ethernet.
- **Convenient "Wink" ID Mode Support** – Blinks green RUN LED in wink mode as a tool to help identify specific remote units.
- **Fully Independent w/ Direct I/O Connection** – Self-contained with no special bus couplers, power supply, or rack mount required to operate.
- **Network Port is Transient Protected** – Shielded RJ45 port includes transient protection from ESD, EFT, and other transients.
- **10Base-T and 100Base-TX Support** – Auto-negotiated 10/100Mbps, Half or Full Duplex.
- **Plug-In Terminal Blocks & DIN-Rail Mount -** Make mounting, removal, and replacement easy.
- **Flexible Discrete Inputs & Outputs** - High voltage/current open-drain outputs provide direct (low-side) control of external devices. Buffered inputs allow outputs to be read back, or input levels to be monitored.
- **Tandem Input/Output Circuitry (983EN Only)** - Input buffers are connected in tandem with open-drain outputs for convenient loop-back monitoring of the output state.
- **Convenient Pullup Resistors Mounted In Sockets** – SIP resistors are installed in sockets on the I/O board and provide input and output pull-ups to the excitation supply. These SIP resistors can be removed or exchanged according to your application.
- **Outputs Have Built-in Protection** – Over-temperature/current shut-down protection is built-in and include active clamping circuitry for switching inductive loads.
- **Failsafe Mode Support w/Watchdog Time Control** – Outputs can be sent to a failsafe state if the host fails and a watchdog timeout occurs.
- **Nonvolatile Reprogrammable Memory** – Allows the functionality of this device to be reliably reprogrammed thousands of times.
- **Operation/Diagnostic LED Indicators Aide Troubleshooting** – 12 yellow LED's indicate active-low I/O state. Yellow ACT LED indicates port activity (busy). Green LNK LED indicates link (auto-negotiation complete and connection established). Green RUN LED indicates power or blinks in wink ID mode. Yellow ST LED indicates default communication mode (slow flash) and timeout status (fast flash).
- **Internal Watchdog** - A hardware watchdog timer is built into the microcontroller 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.
- **Wide-Range DC-Power** – Wide range diode-coupled for use with redundant supplies, and/or battery back-up.
- **Hardened For Harsh Environments** - For protection from RFI, EMI, ESD, EFT, & surges. Has low radiated emissions per CE requirements.
- **Wide Ambient Operation** – Reliable over a wide temperature range.

HOW IT WORKS

These digital I/O modules will interface with any mix of up to twelve digital input and/or output signals according to the model, and provide an isolated 10/100Mbps Ethernet interface for configuration, monitoring, and control of the I/O. Outputs of these models are the open-drains of n-channel mosfets (982EN & 983EN). Input buffers are connected in tandem with the drain circuits via series 100KΩ resistors, and include over-voltage clamps to +5V connected at the buffer inputs (981EN & 983EN). The I/O terminals and the Ethernet port terminals also include transient suppression. On board sockets are included for installation of optional input or output drain pull-up resistors, and 5.6K SIP resistors are installed from the factory. These resistors are pulled up to an external supply connected to the EXC and RTN terminals. An internal microcontroller will switch outputs ON/OFF and sample the digital inputs. Embedded configuration parameters are stored in non-volatile memory integrated within the micro-controller. A dedicated Ethernet controller handles Ethernet communication. A wide input switching regulator (isolated flyback) provides isolated power to the I/O circuit and the Ethernet controller. Refer to the simplified schematic shown below to help gain a better understanding of the circuit.



ABOUT MODBUS TCP/IP

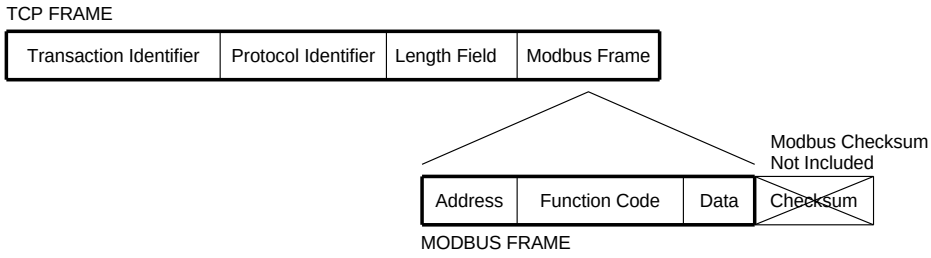
TCP/IP refers to Transmission Control Protocol and Internet Protocol. TCP/IP allows blocks of binary data to be exchanged between computers. TCP/IP is everywhere and is the foundation for the World Wide Web. The primary function of TCP is to ensure that all packets of data are received correctly, while IP makes sure that messages are correctly addressed and routed. Note that the TCP/IP combination does not define what the data means or how the data is to be interpreted, it is merely a *transport protocol*.

You can find more information on Modbus TCP/IP by visiting our web site and down-loading whitepaper 8500-765, Introduction To Modbus TCP/IP.

Modbus is an *application protocol*. It defines rules for organizing and interpreting data and is essentially a messaging structure that is independent of the underlying physical layer. It is freely available and accessible to anyone, easy to understand, and widely supported by many manufacturers.

Modbus TCP/IP uses TCP/IP and 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). A Modbus TCP/IP message is simply a Modbus communication encapsulated in an Ethernet TCP/IP wrapper.

In practice, 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.



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.

The operation of the 981/982/983EN industrial Ethernet modules is very similar to Acromag's 901/902/903MB ModBus modules. The operation over Ethernet is essentially transparent to the Modbus register/command structure. If you are already familiar with Modbus or with Acromag Series 900MB modules, then you are already familiar with the operation of the 981/982/983EN modules.

IP Addressing

A host is any device on any network. On TCP/IP networks, each host has one or more unique IP addresses. This module connected to an ethernet network is a host.

An IP Address is a unique identification number for any host (this module) 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).

IP Addressing

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

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

A *Subnet* is a contiguous string of IP addresses. The first IP address in a subnet is used to identify the subnet, while the last IP address in a subnet is always used as a broadcast address. 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 always used as a network number and broadcast address respectively, and this is why we subtract 2 from the total possible unique addresses that are defined via the remaining octet(s).

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

For our example, the default IP address of this module 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.

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

With respect to the default settings of this module:
Subnet Mask 255.255.255.0 (11111111.11111111.11111111.00000000)
IP Address: 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. 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 and refers to the system used to associate an alphanumeric character string with a numeric IP address. The DNS is actually a distributed database of domain names and corresponding IP addresses. These servers contain information on some segment of the domain name space and make this information available to clients called *resolvers*. For example, the DNS allows us to use "Acromag.com" as an IP address rather than a complicated number string.

MODBUS REGISTERS

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

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.

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.

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. 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 group and channel numbers increase sequentially as you move towards the MSB. Unused bit positions are set to zero.

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 module has a default factory configuration as noted in the SPECIFICATIONS section. Your application will likely differ from the default configuration and the module will need to be reconfigured. You may reconfigure this module 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 module to perform basic operations.

Register Functions

Below is a subset of standard Modbus functions that are supported by this module 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.

IMPORTANT: *When using your own software to manipulate the module, please note that the maximum query through the Modbus TCP interface is only 50 registers, due to the maximum buffer size limitations of the TCP/IP stack. As such, you can only request data from 50 registers at one time for commands that access multiple registers. For example, the Read Holding Registers command may only retrieve the contents of registers 40001 to 40051 in one read.*

The following Modbus functions operate on register map registers to monitor, configure, and control module 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 module, 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.

983EN-4012 Report Slave ID Example Response[1]

FIELD	DESCRIPTION
Unit ID	Echo Unit ID Sent In Query
Function Code	11
Byte Count	30
Slave ID (Model No.)[1]	0E=983EN-4012 (12 DI/O)
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 33 32** 2C 39 **38 33** 45 4E 2D **34 30 31 32** 2C *30 31 32 33 34 35 41* 2C *30 31 32 33 34 35* ("ACROMAG,9300-**132**,9**83**EN-**4012**,*serial number&rev*,*six-byteMACID*")

[1]**Note:** The 981EN slave ID is "0C" and the firmware number is 9300-130. The 982EN slave ID is "0D" and the firmware number is 9300-131. The 983EN slave ID is "0E" and firmware number is 9300-132.

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".

Register Mirroring

For your convenience, this module 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 of this model can now 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 12 digital inputs, instead of getting 2 bytes returned with the first 12 bits representing the 12 digital inputs, you will get 12 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.

Note that with respect to the Acromag 9xxMB Modbus RTU modules, only the 3xxxx Input Registers are mirrored into 4xxxx space, not Coil or Input Status registers as noted here for 9xxEN models.

Data Types

I/O values for Series 900EN modules are represented by the following simple data types for temperature, percentage, and discrete on/off.

Summary Of Data Types Used By 900MB/900EN Modules

Data Types	Description
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.
Normalized Data Count	A 16-bit signed integer value is used to represent ±20000 counts for bipolar input or output ranges and 0-20000 counts for unipolar I/O ranges. For example, -1V, 0V and +1V are represented by integer values –20000, 0, and 20000 for bipolar devices, respectively.
Temperature	A 16-bit signed integer value with resolution of 0.1°C/lsb represents the range of a TC type measured in degrees C. For example, a JTC type has a range of -210 to 760C, which read -2100 to 7600 counts within the data register respectively.
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).

Register Map Model 983EN-4012

The following table outlines the register map for the Model 983EN-4012 network I/O module. The same register map is used for sub-models 981EN-4012 and 982EN-4012 and some registers will not apply to the sub-models. The Modbus functions operate on these registers using the data types noted above (except for the Reset Slave and Report Slave ID functions).

Note that this register map is very similar to the register map of Acromag 901/902/903MB ModBus modules, except that registers for slave address, baud rate, parity, turnaround delay, and reset have been removed.

Unless otherwise noted, Holding Register values are maintained in non-volatile flash memory.

Ref	Addr.	Description	Data Type/Format
Coil Registers (0x References, Read/Write)			
00001 Thru **0**0012	0-11 (0000-000B)	12 Discrete Outputs 0-11 (983EN & 982EN Only)	Discrete Output Value. Addresses a specific bit of a 16-bit word that controls/monitors the ON/OFF status for the output (the gate signal of the n-channel mosfet). 0=OFF; 1=ON. 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.) Unused bits are set to 0. A set bit (1) means the output is turned ON (sinking current). A clear bit (0) means output is turned OFF (open). Bits 15-12: Not Used. Additionally, unused bits in range 11-0 are set to 0. After reset, these registers read 0 (outputs OFF) and these registers are not maintained in EEPROM.
Note: This signal corresponds to the 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 if the open-drain is not pulled up or is left floating. Excitation must be provided in order to operate the outputs. On 983EN units, you can read the Contact Registers to obtain the actual output state(s) via closed loop feedback.			
Contact Registers/Input Status (1x References, Read-Only)			
10001 Thru **1**0012	0-11 (0000-000B)	12 Discrete Inputs 0-11 (983EN & 981EN Only)	Discrete Input Value. Addresses a specific bit of a 16-bit word that monitors the ON/OFF status for the input or tandem output. 0=OFF; 1=ON. The bit position corresponds to the input channel number (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.) Unused bits of a word are set to 0. A set bit (1) means the input is ON (active-low). A clear bit (0) means the input is OFF (high). Bits 15-12: 0/Not Used. Additionally, unused bits in range 11-0 are set to 0.
Note: This signal reflects the actual state of the corresponding input signal (981EN & 983EN), or the drain of the tandem output (983EN). This signal is active-low. Failure to install I/O pullups or provide port excitation will leave inputs floating.			

Register Map
Model 983EN-4012

Ref	Addr.	Description	Data Type/Format
Input Registers (3x References, Read-Only)			
30001	0000	Module Status	Bit 15: 0 (Not Used) Bit 14: Wink Mode Flag 1 = Wink Mode (Blinks Run LED for ID) 0 = Normal Operation (See Wink Module Register) Bit 13: Default Mode Flag 1 = Default Mode Indicator 0 = Not Default Mode Bits 12-3: 0 (Not Used) Bit 2: Port 2 (CH 8-11) 1 = Port 2 Watchdog Fault Bit 1: Port 1 (CH 4-7) 1 = Port 1 Watchdog Fault Bit 0: Port 0 (CH 0-3) 1 = Port 0 Watchdog Fault
Holding Registers (4x References, Read/Write)			
40001	0 (0000)	Port 0 (CH0-3) Watchdog Time **Default=0, Disabled**	Can be set from 1 to 65534 seconds. Set to 65535 (FFFFH) or 0 (0000H) to disable the watchdog timer.
40002	1 (0001)	Port 1 (CH 4-7) Watchdog Time **Default=0, Disabled**	Can be set from 1 to 65534 seconds. Set to 65535 (FFFFH) or 0 (0000H) to disable the watchdog timer.
40003	2 (0002)	Port 2 (CH 8-11) Watchdog Time **Default=0, Disabled**	Can be set from 1 to 65534 seconds. Set to 65535 (FFFFH) or 0 (0000H) to disable the watchdog timer.
40004	3 (0003)	Port 0 (CH 0-3) Timeout State (982EN and 983EN Only) **Default= 65535, Disabled.**	The four lower order bits of this 16-bit register value define the state the output channels of the port will be programmed to following a watchdog timeout. Bit 0 corresponds to channel 0, bit 1 to channel 1, bit 2 to channel 2, and bit 3 to channel 3. Write 65535 (FFFFH) to this register to leave the outputs unchanged following a timeout (this is also the default value).

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

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

Register Map
Model 983EN-4012

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

Configuration variables stored in holding registers (4xxxx reference addresses) are maintained in EEPROM except as noted.

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40005	4 (0004)	Port 1 (CH 4-7) Timeout State (982EN and 983EN Only) Default= 65535, Disabled.	The four lower order bits of this 16-bit register value define the state the output channels of the port will be programmed to following a watchdog timeout. Bit 0 corresponds to channel 4, bit 1 to channel 5, bit 2 to channel 6, and bit 3 to channel 7. Write 65535 (FFFFH) to this register to leave the outputs unchanged following a timeout (this is also the default value).
40006	5 (0005)	Port 2 (CH 8-11) Timeout State (982EN and 983EN Only) **Default= 65535, Disabled.**	The four lower order bits of this 16-bit register value define the state the output channels of the port will be programmed to following a watchdog timeout. Bit 0 corresponds to channel 8, bit 1 to channel 9, bit 2 to channel 10, and bit 3 to channel 11. Write 65535 (FFFFH) to this register to leave the outputs unchanged following a timeout (this is also the default value).
40007	6 (0006)	Wink Module Toggle Register	Write 21845 (5555H) to this register to cause the module to "wink" its green Run LED in order to ID the module. Write the same value a second time to stop "winking". This register will always read back as 0000H. Use the Module Status Register wink mode flag (bit 14) to determine the wink state.
40008	(0007)	*Reserved*	*Do Not Use*
40009	(0008)	*Reserved*	*Do Not Use*
40010	9 (0009)	Digital Inputs (981EN and 983EN Only)	Bit field (Read Only) – The 12 lower order bits of this field correspond to the states of channels 0-11, with the bit position corresponding to the channel number.
40011	10 (000A)	Digital Outputs (982EN and 983EN Only)	Bit field (Read/Write) - the 12 lower order bits of this field correspond to channels 0-11, with the bit position corresponding to the channel number.
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.

SPECIFICATIONS

These DIN-rail mount, industrial ethernet, digital I/O modules include twelve digital inputs (981EN), twelve digital outputs (982EN), or twelve combination digital input/output channels (983EN), and provide an isolated 10/100BaseT Ethernet port for monitoring and control. Units are DC-powered and include reverse polarity protection. Outputs are open-drain, low-side switches, while inputs are active-low. Channel I/O, network, and power circuits are isolated. Outputs have high voltage/current capacity for discrete on/off control of external devices. Non-inverting, buffered inputs provide support for digital level sensing, or for simply reading back the tandem output (983EN only). I/O channels share common. Pull-up resistors to the port EXC supply (every four channels) are installed in sockets on the board. Non-volatile reprogrammable memory in the module stores configuration information.

Model Numbers

The BusWorks model prefix "900" denotes the Series 900 network I/O family. The "EN" suffix denotes EtherNet. Select 981EN for digital inputs, 982EN for digital outputs, or 983EN for tandem digital inputs and outputs. The four digit suffix of this model number represents the following options, respectively: "4" = Ethernet; "0" = Default; "12" = 12 Channels.

981EN-4012 (Input Only)
982EN-4012 (Output Only)
983EN-4012 (Input/Output)

Digital Inputs (981EN & 983EN Only)

Twelve active-low, buffered inputs, with a common connection (RTN). For DC voltage applications only. Inputs include transient suppression and have series connected 100KΩ resistors, plus diode over-voltage clamps to the internal +5V supply. Sockets are provided at each port (group of four channels) for installation of SIP resistor networks that serve as pullups to the port EXC supply terminal. 5.6K pull-up resistor SIP's are installed from the factory. External excitation (pull-up supply) is required for proper operation and is connected between the port EXC and RTN terminals.

Input Signal Voltage Range: 0 to +35VDC.
Input Current: 293uA, typical at 35VDC. This is computed as the applied input voltage minus 5.7V, divided by the series 100KΩ input resistance.
Input Signal Threshold: TTL compatible with 100mV of hysteresis, typical. Low-to-High threshold is 1.7VDC typical, High-to-Low threshold is 1.6VDC, typical. Limit logic transition to TTL levels of 0.8VDC (Max LOW level) and 2.0VDC (Min HIGH level).
Input Resistance: 100KΩ, typical.
Input Hysteresis: 100mVDC typical.
Input Response Time: 800ns typical, measured from input step to logic transfer. Actual input response will vary with interrupts.

Digital Outputs (982EN & 983EN Only)

Twelve open-drain, DMOS mosfet switches with a common source connection at the port RTN terminal. For DC voltage and current-sinking applications only. Outputs have built-in transient protection. Sockets are provided at each port (four channels) for quick replacement and installation of SIP resistor networks that serve as pullups to the port EXC supply terminal. 5.6K pull-up resistor SIP's are installed from the factory.

Output "OFF" Voltage Range: 0 to 35V DC. Limit voltage to 35V or less or damage to the unit may result.
Output "OFF" Leakage Current: : 0.1uA typical, 50uA maximum (mosfet only, 25°C, 35V). Does not include the tandem input bias current of 983EN models (see below).

Digital Outputs (982EN & 983EN Only)

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

Note (983EN): The 100KΩ series input buffer resistors in combination with the +5V voltage clamps at the input buffers will tend to increase the off-state drain current with increased drain voltage (up to 0.3mA at 35V). This is due to the fact that the input buffer circuitry and output mosfet drain circuitry are connected in tandem to the same I/O pin for the Model 983EN.

Output "ON" Current Range: 0 to 500mA DC, continuous (up to 6A total for all 12 channels combined). No deration required at elevated ambients. Group one RTN per each group of 4 outputs.

Output R_{ds} ON Resistance: 0.13Ω typical, 0.28Ω Maximum.

Output Response Time: 220us typical measured from output trigger at the controller to corresponding input transition at the controller. Actual switch time will vary with output load and interrupts.

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

General Specifications

Note: *Do not allow EXC or unused inputs to float. If pull-ups are installed, this will cause one I/O signal to pull the other floating port channels via the pull-ups and common EXC lead connection.*

I/O Pullups & Socket: I/O channels include sockets for installation of SIP resistor networks to act as pull-ups for the channel (see I/O Pullup Resistor Installation drawing of page 4). These resistors are located on the plug-in I/O board (cover removal required). A SIP socket is included for each group of four channels (port) and a 5.6KΩ resistor SIP is installed from the factory. The even-numbered pins of these sockets (common leads) connect to the port EXC+ terminal. An external excitation supply is typically connected between the EXC+ and RTN terminals of the port. The recommended SIP resistor is a four isolated resistor type (8 pins) and may be obtained from Acromag or another vendor. These SIP resistors typically come rated for 0.2W, 0.3W, 0.4W, or 0.5W per element. For example, refer to Bourns 4308R-102, 4308M-102, or 4308H-102 parts. You may also refer to Dale CSC08C03, MSP08C03, or MSM08C-03 parts. The 5.6KΩ SIP provided is a high-power type from Bourns (part number 4308H-102-562) and is rated at 0.5W per resistor up to 70°C. See I/O Pullup Resistor Installation section for more information.

IMPORTANT: When selecting a SIP resistor, be sure to limit the individual resistor power dissipation to less than the rated power per element. Further, do not exceed 500mA of drain current per output, or 2A total per RTN terminal.

Excitation (External): External voltage is applied between the port EXC and RTN terminals and must be limited to 35V or less. The EXC terminal is tied to the even-numbered pins of the resistor SIP socket provided for each port or group of 4 channels.

Enclosure and Physical

Dimensions: 1.05 inches wide, 4.68 inches tall, 4.35 inches deep. Refer to the dimensions drawing at the front of this manual.

DIN Rail Mount: Type EN50022; "T" rail (35mm).

I/O Connectors: Removable plug-in type terminal blocks rated for 15A/300V; AWG #12-24 stranded or solid copper wire.

Network Connector: 8-pin RJ-45 connector socket with metal shield (shield is isolated and bypassed to earth ground at the GND terminal with an isolation TVS and capacitor). Connections are wired MDI, as opposed to MDI-X. You must use a CAT-5 crossover cable to connect this module to a PC. Otherwise you may use an auto-crossing Ethernet switch, such as the Acromag 900EN-S005 to make connections.

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

Enclosure & Physical

Case Material: Self-extinguishing NYLON type 6.6 polyamide thermoplastic UL94 V-2, color beige; general purpose NEMA Type 1 enclosure.
Printed Circuit Boards: Military grade FR-4 epoxy glass.
Shipping Weight: 1 pound (0.45 Kg) packed.

Agency Approvals

Safety Approvals: : UL Listed (USA & Canada). Hazardous Locations- Class I, Division 2, Groups A, B, C, D. Consult factory.

ATEX Certified: Assessment by TUV Rheinland of North of America, Inc. per
ATEX Directive 94/9/EC.
Ex II 3 G
Ex nA T4-25°C< Ta < +70°C
TUVNA 07 ATEX 7145X
X= Special Conditions
1) "WARNING-EXPLOSION HAZARD-DO NOT MAKE OR BREAKCONNECTIONS IN HAZARDOUS LOCATIONS OR AREAS"
2) "Warning: Must be installed in suitable enclosure with an Ingress Protection of IP54 minimum, in Hazardous Locations or Areas"

Environmental

Operating Temperature: -25°C to +70°C (-13°F to +158°F).
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95%, non-condensing.
Power Requirements: Non-polarized 15-36V DC SELV (Safety Extra Low Voltage). Observe proper polarity. See table for current.

Supply	981/982/983EN-4012 Current Draw
15V	112mA Typical, 123mA Maximum
18V	96mA Typical, 106mA Maximum
24V	73mA Typical, 80mA Maximum
36V	54mA Typical, 59mA Maximum

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

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

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

External Fuse: *Select a high surge tolerant fuse rated for 1A or less to protect unit.*

Note that I/O channels are not isolated channel-to-channel.

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: Designed to operate in an installation in a Pollution Degree 2 environment with an installation category (over-voltage category) II rating.

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) -
Immunity Per European Norm BS EN 61000-6-2:2005:

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

Electrostatic Discharge (ESD) Immunity: 4KV direct contact and 8KV air-discharge to the enclosure port per IEC61000-4-2.

Radiated Field Immunity (RFI): 10V/M, 80 to 1000MHz AM, 1.4 to 2GHz 3V/M, and 2 to 2.7GHz 1V/M, per IEC61000-4-3.

Electrical Fast Transient Immunity (EFT): 2KV to power, and 1KV to signal I/O per IEC61000-4-4.

Environmental

Conducted RF Immunity (CRFI): 10Vrms, 150KHz to 80MHz, per IEC61000-4-6.
Surge Immunity: 0.5KV per IEC61000-4-5.
Emissions Per European Norm BS EN 61000-6-4:2007
Radiated Frequency Emissions: 30 to 1000MHz per CISPR16 Class A

EMC – CE Marked

Electromagnetic Compatibility (EMC): CE marked, per EMC Directive 2004/108/EC. Consult factory.
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, input, and output (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 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.

Ethernet Interface

Connector: Shielded RJ-45 socket, 8-pin, 10BaseT/100BaseTX.
Wiring: Wired MDI. Unit does NOT support auto-crossover.
Protocol: Modbus TCP/IP w/Web Browser Configuration.
IP Address: Default mode static IP address is 128.1.1.100.
Port: Up to 10 sockets supported, uses port 502 (reserved for Modbus).
Transient Protection: Transient Voltage Suppressors are applied differentially at both the transmit and receive channels. The metal shield is capacitively coupled to earth ground terminal via an isolation TVS and capacitor.
Data Rate: Auto-sensed, 10Mbps or 100Mbps.
Duplex: Auto-negotiated, Full or Half Duplex.
Compliance: IEEE 802.3, 802.3u, 802.3x.
Modbus TCP/IP Protocol Support: : Up to 10 sockets may be selected. Web pages for configuration and control are built-in and may be accessed over Ethernet via a standard web browser. Most module

functionality is configured via memory map registers or web pages, but some functionality may only be configured via web pages.

Rx/Tx Memory: 8K bytes internal SRAM memory for receive and transmit buffers (FIFO).

Communication Distance: The distance between two devices on an Ethernet network is generally limited to 100 meters using recommended copper cable. Distances may be extended using hubs, switches, or fiber optic transmission. However, the total round trip delay time must not exceed 512 bit times for collision detection to work properly.

Port Status Indicators: Green LED indicates link status (ON if auto-negotiation has successfully established a connection), yellow LED indicates activity (ethernet connection is busy/traffic is present).

Address: The module 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 module to assume a "known" fixed static IP address of 128.1.1.100 for troubleshooting purposes.

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 an Acromag module.

Controls & Indicators

LED Indicators:

RUN (Green) - Constant ON if power is on and unit is OK. Continuous flashing ON/OFF indicates unit is in "wink" ID mode.

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

LINK (Green) – Indicates Ethernet link status (ON if auto-negotiation has successfully established a connection).

ACT (Yellow) – Indicates Ethernet activity (Ethernet connection is busy/traffic is present).

Output (Yellow, One Per Output) – ON if output relay is ON (closed) or input is asserted low. **Note:** This LED is driven by the input buffer of 981/983EN units and will reflect the actual input state. On 982EN units (output only), this LED is driven by the output mosfet gate signal and may not reflect the actual open-drain output state (for example, if the outputs are floating or not pulled up).

Controls:

Reset/Default Address Switch: This momentary toggle switch is located on the front panel and is used to either reset the module (toggle right), or toggle the module into, or out of Default Communication Mode (toggle left). In Default Mode, the module 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 "password00". This switch can also be used to restore the module to its initial factory configuration by holding this switch in its default position while powering up the unit (see "Getting Out Of Trouble" in the Troubleshooting section for more information).

ACCESSORY CABLES

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 data being transmitted 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.

ACCESSORY CABLES

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 RJ45 plug connectors. The metal shield of these connectors then makes contact with the metal shield of shielded RJ45 sockets. The socket shield may make direct contact with earth ground, or it may be capacitively coupled to earth ground. In the Acromag 9xxEN modules, this shield contacts earth ground via a high voltage capacitor and transient voltage suppressor. In addition to minimizing radio frequency and electromagnetic interference, this arrangement also has the added benefit of enhanced protection from ESD (Electro-Static Discharge).

Further, 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).

Patch Cable & Crossover Cable

Acromag offers the following cable accessories for use with this module:

Cable Model 5035-355 – A yellow, 3 foot long, single-shielded Category 5e STP patch cable with drain wire and an RJ45 plug at both ends. Use this cable to connect an Acromag 9xxEN I/O module to the Acromag 900EN-S005 switch.
Cable Model 5035-360 – A green, 5 foot long, single-shielded Category 5e STP crossover cable with a drain wire and an RJ45 plug at both ends. This cable performs the Ethernet crossover function and is used to connect a PC directly to an Acromag Series 9xxEN I/O module.

Note that you do not need to use a crossover cable to connect your PC to this module if the Acromag 900EN-S005 switch is used between the PC and module, as the switch is auto-crossing. However, you must use a crossover cable when directly connecting your PC to a Series 9xxEN I/O Module without the use of an auto-crossing switch or hub.

Patch Cable & Crossover Cable

You may obtain cable in other lengths and colors as required for your application from other vendors. 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:

- 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.

Notes: