SeaI/O User Manual

SeaI/O
Data Acquisition Solutions

SEALEVEL
SYSTEMS INCORPORATED

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Introduction

SeaI/O™ modules provide a powerful way to add I/O to a variety of computers, controllers, and PLCs. Each SeaI/O model is designed for maximum flexibility and easy field wiring. Ordering options allow connection to the host device via Wireless 802.11b/g (Coming Soon!), Ethernet, USB, RS-485, or RS-232, and multiple units can be daisy chained together using convenient pass-through connectors. For easy software integration, application programs or 3rd party software can use the Sealevel SeaMAX™ library or industry standard Modbus protocol.

This manual covers the installation and operation of these SeaI/O products:

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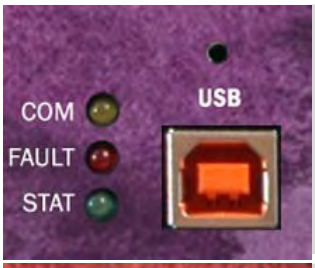

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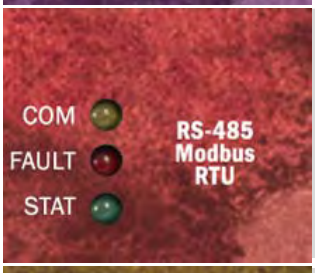

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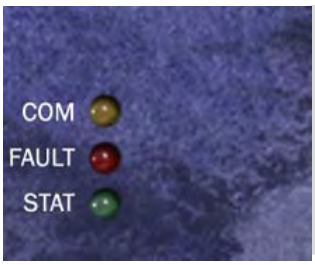
SeaI/O-462S – 96 Bit TTL I/O (DB-78)
SeaI/O-463S – 96 Bit TTL I/O (50-Pin IDC)
SeaI/O-470S – 8 Inputs/8 Outputs/2 D/A & 16 A/D
SeaI/O-520S – 8 Optically Isolated Inputs/8 High-Current Form C Outputs



Expansion Units (Connect to Base Unit via RS-485)
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Software Installation

SeaI/O modules can be used with industry standard Modbus protocol or easily controlled from application programs using the supplied **SeaMAX** software libraries. Included are two diagnostic and configuration tools: **MaxSSD** and **Ethernet Config**. The SeaMAX library features an object-oriented and functional interface for use with C++ and Visual Basic. Also included is the **CEthernet** API library for programmatic discovery and configuration of Ethernet enabled SeaI/O modules. Refer to the **SeaMAX Application Suite** section of this manual for detailed information.

Industry Segments

SeaI/O modules are perfect for a wide variety of applications and environments including:

- Process Control
- Data Acquisition
- Broadcast Automation
- Security
- Facility Management

Features

- Choice of Connectivity:
  - Wireless (802.11b/g) – coming soon!
  - Ethernet
  - USB
  - RS-485
  - RS-232
- Supports Industry Standard Modbus TCP & RTU Protocols
- Models Offering Choice of:
  - Optically Isolated Inputs
  - Reed Relay Outputs
  - Form C Relay Outputs
  - TTL Interfaces
  - Analog A/D & D/A
- Status Indicator LEDs for Communication, Fault, and Status
- Field Removable Terminal Block Connectors (most models)
- 9-30VDC Power Input
- Power Input via Terminal Block or DC Jack
- Daisy Chain up to 247 Modules
- Extended Temperature Available (-40°C to +85°C)
- Rugged Metal Enclosure
- Compact Size - 7.5"(L) x 5.1"(W) x 1.3"(H)
- Din Rail or Table Mount

SeaI/O Hardware Description

SeaI/O Base and Expansion Modules

Base Modules connect to the host via one of the following interfaces:

- E-Series - Ethernet Modbus TCP
- U-Series - USB Modbus RTU
- M-Series - RS-485 Modbus RTU
- S-Series - RS-232 Modbus RTU

After the Base unit is installed, up to 246 additional SeaI/O **N-Series Expansion Units** can be added to create an I/O network. These expansion modules interface via RS-485 and can be located local to the Base SeaI/O device or remotely located up to 4000 feet away. Local installations should use the 5" CAT5 RS-485 pass-through cable (Item number CA239) shipped with each N-series module to connect. Remote expansion modules should use RS-485 twisted pair wiring from the Base unit connected via the removable screw terminal connector.

For local installations power to the expansion modules is supplied from the Base unit via the pass-through connectors. For remote devices, separate power is required at each expansion unit. Refer to the Power Options section of this manual for more information on SeaI/O power requirements and power supply sizing.

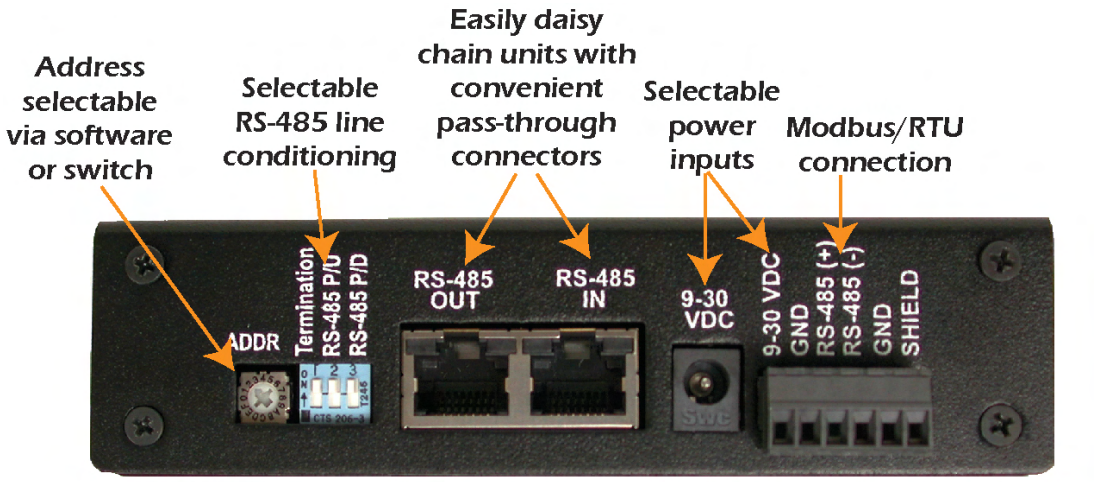
Included Communications and Expansion Accessories

SeaI/O modules are shipped with the following accessories:

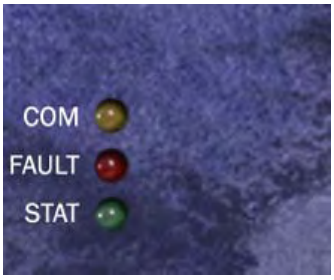
E-Series (Ethernet)	Item# **CA246 –** 1 x 7' straight through Ethernet cable, for connection to a hub or switch. Item# **CA251 –** 1 x 7' crossover cable, for direct connection to a computer's Ethernet port.
U-Series (USB)	Item# **CA179 –** 6' A to B USB cable.
M-Series (RS-485)	No cable is included. RS-485 twisted-pair wiring connects to screw terminals.
S-Series (RS-232)	Item# **KT119 –** RS-232 DB9/RJ45 Kit, includes a DB9F to RJ45 adapter with RS-232 pinout (Item# **DB109**) and a 7' CAT5 patch cable (Item# **CA246**) for connecting SeaI/O modules to both Sealevel and standard RS-232 serial ports.
N-Series (Expansion)	**KT122 –** Expansion & Strap Kit, includes 5" CAT5 RS-485 interconnect cable, four metal straps, and four #4-40 metal screws, for connecting two or more SeaI/O modules together in a "stack".
All Models	Each SeaI/O unit is shipped with 4 adhesive rubber feet that can be attached to the bottom of the enclosure to enhance stability in table mount applications.

SeaI/O Module Common Features

All SeaI/O modules include the same connectors and configuration options on the side of the unit:



NOTE: 	RS-485 networks should have termination enabled on each end of the network. Pull-up and pull-down resistors should also be enabled on the last device on the network. The 9-30VDC input barrel connector is center positive.



Status LEDs are included on the front of all SeaI/O devices to indicate Communication (Yellow), Fault (Red), and Status (Green).

Seal/O Configurations & Specifications

410 Series – 16 Optically Isolated Inputs/16 Reed Relay Outputs

SeaI/O-410 modules provide 16 optically isolated inputs and 16 Reed relay outputs. Inputs can range from 5-24VDC, while the Reed relays provide long life switch closures that are well suited for low current applications. Inputs and outputs are grouped into four-bit segments. Each group shares a common for easy wiring via removable 3.5mm terminal blocks.

Inputs

Type:	16 non-polarized optically isolated inputs
Voltage Range:	5-24VDC
Isolation:	300V
Input Resistance:	6.2K Ohms in series
Response Time:	4 microseconds

Outputs

Type:	16 SPST Form A Reed relays
Power:	10VA max.
Contact Voltage:	60VDC max.
Contact Current:	500mA max.
Operate Time:	0.5ms max.
Bounce Time:	0.5ms max.
Release Time:	0.2ms max.

420 Series – 16 Optically Isolated Inputs/8 Form C Outputs

The SeaI/O-420 provides 16 optically isolated inputs and 8 SPDT Form C relay outputs. Inputs can range from 5-24VDC and provide 300V isolation to ground. Each output offers normally open and normally closed contact connections via 3.5mm field removable terminal blocks.

Inputs

Type:	16 non-polarized optically isolated inputs
Voltage Range:	5-24VDC
Isolation:	300V
Input Resistance:	6.2K Ohms in series
Response Time:	4 microseconds

Outputs

Type:	8 SPDT Form C relays
Power:	DC 30W/ AC 60 VA
Contact Voltage:	60VDC max.
Contact Current:	2A max.
Operate Time:	2ms max.
Bounce Time:	7ms max.
Release Time:	1ms max.

430 Series – 32 Optically Isolated Inputs

SeaI/O-430 modules provide 32 optically isolated inputs with 300V external isolation and high channel-to-channel isolation. Ideal for low voltage monitoring applications, connection to real world signals is made via 3.5mm convenient removable screw terminal connectors.

RS-232 Interface Shown

Inputs

Type:	32 non-polarized optically isolated inputs
Voltage Range:	5-24VDC
Isolation:	300V
Input Resistance:	6.2K Ohms in series
Response Time:	4 microseconds

440 Series – 32 Reed Relay Outputs

The SeaI/O-440 provides 32 SPST Form A dry contact Reed relays. Reed relays offer long life performance and fast response time. Convenient removable 3.5mm screw terminal blocks compatible with 14-22 AWG wiring allow reliable connection to real world I/O.

RS-485 Interface Shown

Outputs

Type:	32 SPST Form A Reed relays
Power:	10VA max.
Contact Voltage:	60VDC max.
Contact Current:	500mA max.
Operate Time:	0.5ms max.
Bounce Time:	0.5ms max.
Release Time:	0.2ms max.

450 Series – 16 Form C Relay Outputs

Control a variety of low voltage, low current devices with the SeaI/O-450. The module's 16 channels of highly reliable SPDT Form C relay outputs are rated for up to 60VDC @ 2A. Each output offers normally open and normally closed contact connections via 3.5mm field removable terminal blocks.

Ethernet Interface Shown

Outputs

Type:	16 SPDT Form C relays
Power:	DC 30W/ AC 60 VA
Contact Voltage:	60VDC max.
Contact Current:	2A max.
Operate Time:	2ms max.
Bounce Time:	7ms max.
Release Time:	1ms max.

462 Series – 96 Channel TTL DB-78

Perfect for driving industry-standard solid-state relay (SSR) racks, the SeaI/O-462 provides 96 bits of buffered drive TTL I/O. Each DB-78 connector brings out 48 I/O bits addressable as six, eight-bit ports. For easy connection to relay racks, Sealevel offers a six-foot cable (Item# CA237) that terminates each DB-78 connector to two industry standard 50-pin IDC connectors. Order part number 462x-KT and receive two CA237 cables with each unit.

Expansion Interface Shown

Power Requirements

Max Output Power:	+5VDC @ 1A (5W)

Inputs

Logic High:	Min 2VDC
Logic Low:	Max 0.8VDC

Outputs

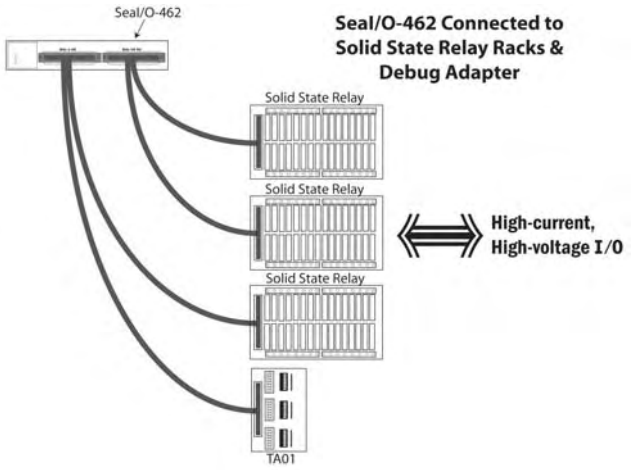
Logic High:	Min 2VDC @ 32mA
Logic Low:	Max 0.5VDC @ 64mA

SeaI/O-462 Optional Items

Depending upon your application, you are likely to find one or more of the following items useful for interfacing the SeaI/O-462 to real-world signals. All items can be purchased from our website (http://www.sealevel.com) or by calling 864-843-4343.

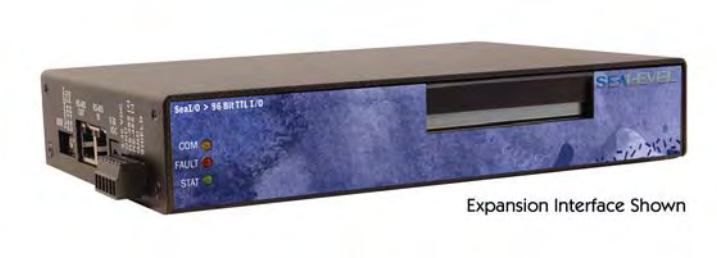
For high-current, high-voltage applications:

- DB-78 to Dual IDC 50 Pin Ribbon Cable (Item Number **CA237**)
  - 60" cable connects each SeaI/O-462's DB-78 connectors to solid-state relay racks equipped with 50-pin header interface.
- Solid-State Relay Racks:
  - Quad six position relay rack (Part Number **PB24HQ**)
    - Relay rack can accept up to six QSSRs for a total of 24 channels. Features a 50-pin header connector for easy interface via 50-conductor ribbon cables.
  - Quad four position relay rack (Part Number **PB16HQ**)
    - Relay rack can accept up to four QSSRs for a total of 16 channels. Features a 50-pin header connector for easy interface via 50-conductor ribbon cables.
- Quad Solid-State Relay Modules:
  - AC Input (Part Number **IA5Q**) – Provides 4 channels of discrete I/O interface to monitor AC inputs up to 140V @ 10mA.
  - DC Input (Part Number **IB5Q**) – Provides 4 channels of discrete I/O interface to monitor DC inputs from 3.3V to 32V.
  - AC Output (Part Number **OA5Q**) – Provides 4 channels of discrete I/O interface to control AC outputs up to 140V @ 3A.
  - DC Output (Part Number **OB5Q**) – Provides 4 channels of discrete I/O interface to control DC outputs up to 60V @ 3A.
- Simulation/debug module (Part Number TA01)
  - Module simulates the operation and load characteristics of a standard 24-channel relay rack. An LED corresponding to each port bit illuminates to indicate state. Eight position DIP-switches are used to generate input status changes.



463 Series – 96 Channel TTL 50-Pin

The SeaI/O-463 offers 96 bits of buffered drive TTL I/O via four internal industry-standard 50-pin header connectors. The interface module addresses the 96 channels of I/O as 12 eight-bit ports, each programmable as input or output. Using standard 50-pin IDC ribbon cables, connect up to four industry standard relay racks for PC based control and automation of equipment including sensors, switches, security control systems, and other industrial automation systems. A metal strain relief bracket is included to secure the cables after installation.



Expansion Interface Shown

Power Requirements

Max Output Power:	+5VDC @ 1A (5W)

Inputs

Logic High:	Min 2VDC
Logic Low:	Max 0.8VDC

Outputs

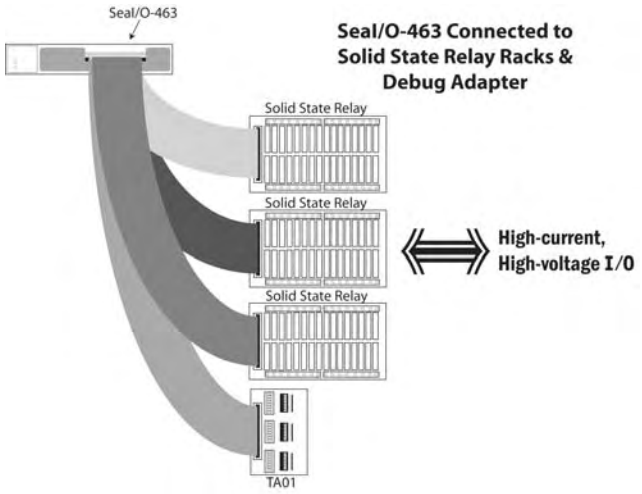
Logic High:	Min 2VDC @ 32mA
Logic Low:	Max 0.5VDC @ 64mA

SeaI/O-463 Optional Items

Depending upon your application, you are likely to find one or more of the following items useful for interfacing the SeaI/O-463 to real-world signals. All items can be purchased from our website (http://www.sealevel.com) or by calling 864-843-4343.

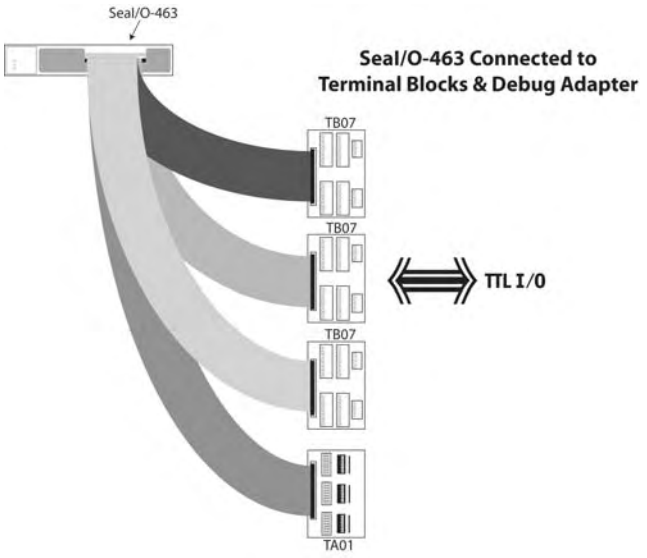
For TTL applications:

- Terminal Block Kit - (Item# **KT107**)
  - Kit includes the TB07 screw terminal block and CA167 ribbon cable for connecting one of the SeaI/O-463's 50-pin header connectors to your I/O. 6" Snap track and DIN rail clips are included for DIN rail mounting.
- IDC 50 to IDC 50 Pin 40" Ribbon Cable (Item# **CA167**)
  - Interfaces each of the SeaI/O-463's 50-pin header connectors.
- Simulation/debug module (Item# **TA01**)
  - Module allows monitoring status of output pins and controlling state of input pins. An LED corresponding to each port bit illuminates to indicate state. Eight position DIP-switches are used to generate input status changes.



For high-current, high-voltage applications:

- IDC 50 to IDC 50 Pin Ribbon Cable (Item# **CA167**)
  - 40" cable connects the SeaI/O-463 to solid-state relay racks equipped with 50-pin header interface.
- IDC 50 to IDC 50 Pin Ribbon Cable (Item# **CA135**)
  - 40" cable connects the SeaI/O-463 to solid-state relay racks equipped with 50-pin edge connector.
- Solid-State Relay Racks:
  - Quad six position relay rack (Item# **PB24HQ**)
    - Relay rack can accept up to six QSSRs for a total of 24 channels. Features a 50-pin header connector for easy interface via 50-conductor ribbon cables.
  - Quad four position relay rack (Item# **PB16HQ**)
    - Relay rack can accept up to four QSSRs for a total of 16 channels. Features a 50-pin header connector for easy interface via 50-conductor ribbon cables.
- Quad Solid-State Relay Modules:
  - AC Input (Item# **IA5Q**) – Provides 4 channels of discrete I/O interface to monitor AC inputs up to 140V @ 10mA.
  - DC Input (Item# **IB5Q**) – Provides 4 channels of discrete I/O interface to monitor DC inputs from 3.3V to 32V.
  - AC Output (Item# **OA5Q**) – Provides 4 channels of discrete I/O interface to control AC outputs up to 140V @ 3A.
  - DC Output (Item# **OB5Q**) – Provides 4 channels of discrete I/O interface to control DC outputs up to 60V @ 3A.
- Simulation/debug module (Item# **TA01**)
  - Module simulates the operation and load characteristics of a standard 24-channel relay rack. An LED corresponding to each port bit illuminates to indicate state. Eight position DIP-switches are used to generate input status changes.



470 Series – 16 A/D, 2 D/A, 8 24V Outputs, 8 Isolated Inputs

Designed using the Maxim MAX197 successive approximation-type A/D chip, the SeaI/O-470 provides eight differential or 16 single-ended 12-bit inputs. The A/D inputs can be individually configured for sensing 4-20mA current loop signals. Additionally, the module provides two 12-bit D/A output channels, eight optically isolated inputs, and eight open collector outputs, ideal for driving 24V devices commonly found in industrial environments. Perfect for a variety of data acquisition/control and test & measurement applications, the SeaI/O-470 includes removable screw terminals, which simplify field-wiring connections.

RS-232 Interface Shown

Optically Isolated Inputs

Input Range:	5-30VDC

Open Collector Outputs

Output Voltage:	Max. 30VDC
Output Current:	Max. 500mA (single output)
Output Current:	Max. 580mA (all outputs)

A/D Inputs

Number of Channels:	8 differential or 16 single-ended
Resolution:	12-bits
Sampling Rate:	100K/s

A/D Input Range

Software Selectable:	0-5V, 0-10V, +/-5V, +/-10V
Hardware Selectable:	0-20mA current loop (for 4-20mA devices)

D/A Outputs

Number of Channels:	2 single-ended
Resolution:	12-bits
Output Range:	0-5V, 0-10V
Load Resistance:	Min. 2K

520 Series – 8 Optically Isolated Inputs/8 High-Current Form C Outputs

The SeaI/O-520 provides 8 optically isolated inputs and 8 SPDT high-current Form C relay outputs. Inputs can range from 5-30VDC and provide 300V isolation to ground. Each output offers normally open and normally closed contact connections via 3.5mm field removable terminal blocks.

Inputs

Type:	8 non-polarized optically isolated inputs
Voltage Range:	5-30VDC
Isolation:	300V
Input Resistance:	6.2K Ohms in series
Response Time:	4 microseconds

Outputs

Type:	8 SPDT High-Current Form C relays
Contact Voltage:	250VAC/100VDC max.
Contact Current:	6A max.
Operate Time:	10ms max.
Release Time:	10ms max.

Power Options

Base Module Power Connection

Base modules are powered from a 9-30VDC source using either the DC jack or screw terminals on the side of the unit. Sealevel offers several power supply choices to make connection easy (see Accessories chapter at the end of this document).

SeaI/O Expansion Power Connection

Each SeaI/O product, including the expansion modules, contains an onboard switching regulator power supply rated for 9-30VDC. For local installations (less than 10' apart), expansion unit power is usually supplied from the Base unit via the pass-through connectors. The number of expansion modules that can be driven from the Base unit depends on the power source and number/type of expansion units. Refer to the chart below for power requirements. For expansion modules mounted remotely (greater than 10' apart), separate power is required at each expansion unit.

SeaI/O Max Power Requirements

	E-Series	U-Series	M-Series	S-Series	N-Series
SeaI/O-410	2.9W	1.7W	1.4W	1.6W	1.4W
SeaI/O-420	3.5W	2.3W	2.0W	2.2W	2.0W
SeaI/O-430	1.9W	0.7W	0.4W	0.6W	0.4W
SeaI/O-440	4.0W	2.8W	2.5W	2.7W	2.5W
SeaI/O-450	5.3W	4.1W	3.8W	4.0W	3.8W
SeaI/O-470	3.0W	1.8W	1.5W	1.7W	1.5W
SeaI/O-520	5.0W	3.8W	3.5W	3.7W	3.5W

TTL Power Requirements

The SeaI/O-462 and SeaI/O-463 use 74ABT245 octal bi-directional transceivers to provide TTL input/output capabilities and can sink 64mA and source 32mA. Each bit is pulled to +5V through a 10K ohm pull-up resistor to insure each bit is at a known state when not driven. The supply current and maximum output power are shown below.

	E-Series	U-Series	M-Series	S-Series	N-Series
SeaI/O-462	2.0W	0.8W	0.5W	0.7W	0.5W
SeaI/O-463	2.0W	0.8W	0.5W	0.7W	0.5W
Output Power	+5VDC @ 1A (5W) Maximum				

Sample Power Calculation

A typical application for SeaI/O products would use one Base module and several N-series units in a local expansion configuration. In this arrangement, with power applied to the Base module through either the DC jack or screw terminal connector and passed-through to the expansion units, attention should be given to ensure the input power to the Base module is adequate.

Example:

		Power (W)
Base Unit:	SeaI/O-430U	0.7
Expansion 1:	SeaI/O-410N	1.4
Expansion 2:	SeaI/O-440N	2.5
		4.6W Power Required

In this application, the Sealevel Item# **TR112** "wall wart" power supply is a good choice since it is low-cost and supplies 24VDC @ 250mA (6W).

NOTE: A complete listing of recommended power supplies is provided in the **Accessories** section of this manual.

Hardware Configuration

The SeaI/O-463 and SeaI/O-470 are the only two modules that require you to open the enclosure. On all SeaI/O modules, most device settings can be configured on the left side of the SeaI/O module. Refer to the **SeaI/O Hardware Description** section of this manual for a list of common features available and settings that can be changed on the left side of the SeaI/O module.

When connecting more than one SeaI/O module to a host computer, you will need to set the device address (Slave ID). This can be done in software or by using a rotary switch on the left side of the enclosure. Refer to the **SeaMAX Application Suite** section where you can find instructions for configuring the device address (Slave ID) and setting the termination pull up and pull down resistors.

SeaI/O-463 Ribbon Cable Installation Instructions

A copy of these instructions are included with the SeaI/O-463 module and can also be downloaded from the SeaI/O-463 product page on the Sealevel website.

NOTE: 	Do not perform these instructions with the power connected. Be sure to follow proper ESD procedures by grounding yourself and the SeaI/O module.

What you will need:

- SeaI/O-463 module
- Phillips head screwdriver
- Slotted screwdriver
- 50-pin IDC ribbon cable* (up to four)

***Ribbon cable accessories available:**

- CA167 – 40” IDC 50-pin to IDC 50-pin ribbon cable
- CA197 – 18” IDC 50-pin to IDC 50-pin ribbon cable
- CA135 – 40” IDC 50-pin to 50-pin edge connector ribbon cable

Step 1

Remove the terminal block from the left side and then remove the two black screws from each side of the module as shown in the image.

Step 2

On the front right side of the module, wedge a slotted screwdriver between the top and bottom halves as shown. Pry upwards – a pem in the top half must clear the metal lip in the bottom half of the enclosure.

Step 3

Remove the two screws from the metal strain relief, as shown.

Step 4

Remove the three screws from the bottom of the module and remove the front plate.

Step 5

Install up to four industry standard ribbon cables in the 50-pin header connectors. A list of optional cable part numbers is listed on the previous page.

Step 6

Replace the front plate and install the three screws in the bottom of the module as shown.

Step 7

Replace the metal strain relief. Start both screws and tighten only until snug. Do not over-tighten.

Step 8

Replace the top half by starting it on the left side over the connectors and then snapping the right side down into place. Be careful not to pinch fingers. Replace both screws on each side and then replace the terminal block on the left side.

Step 9

Continue with the installation of the SeaI/O-463 module. The **SeaI/O Hardware Description** section of this manual contains information on TTL applications and optional accessories. The **SeaMAX Application Suite** section walks you through setting up the hardware address (Slave ID) and software installation.

SeaI/O-470 Jumper and Dipswitch Settings Instructions

The SeaI/O-470 module ships factory configured with the D/A outputs set for 0-10V and current loop mode on the A/D inputs disabled. If you need to enable current loop mode or set the D/A outputs to 0-5V, you will need to open the enclosure and access the jumpers (shown on the next page).

NOTE: 	Do not perform these instructions with the power connected. Be sure to follow proper ESD procedures by grounding yourself and the SeaI/O module.

What you will need:

- SeaI/O-470 module
- Phillips head screwdriver
- Slotted screwdriver

Step 1

Remove the terminal block from the left side and then remove the two black screws from each side of the module as shown in the image.

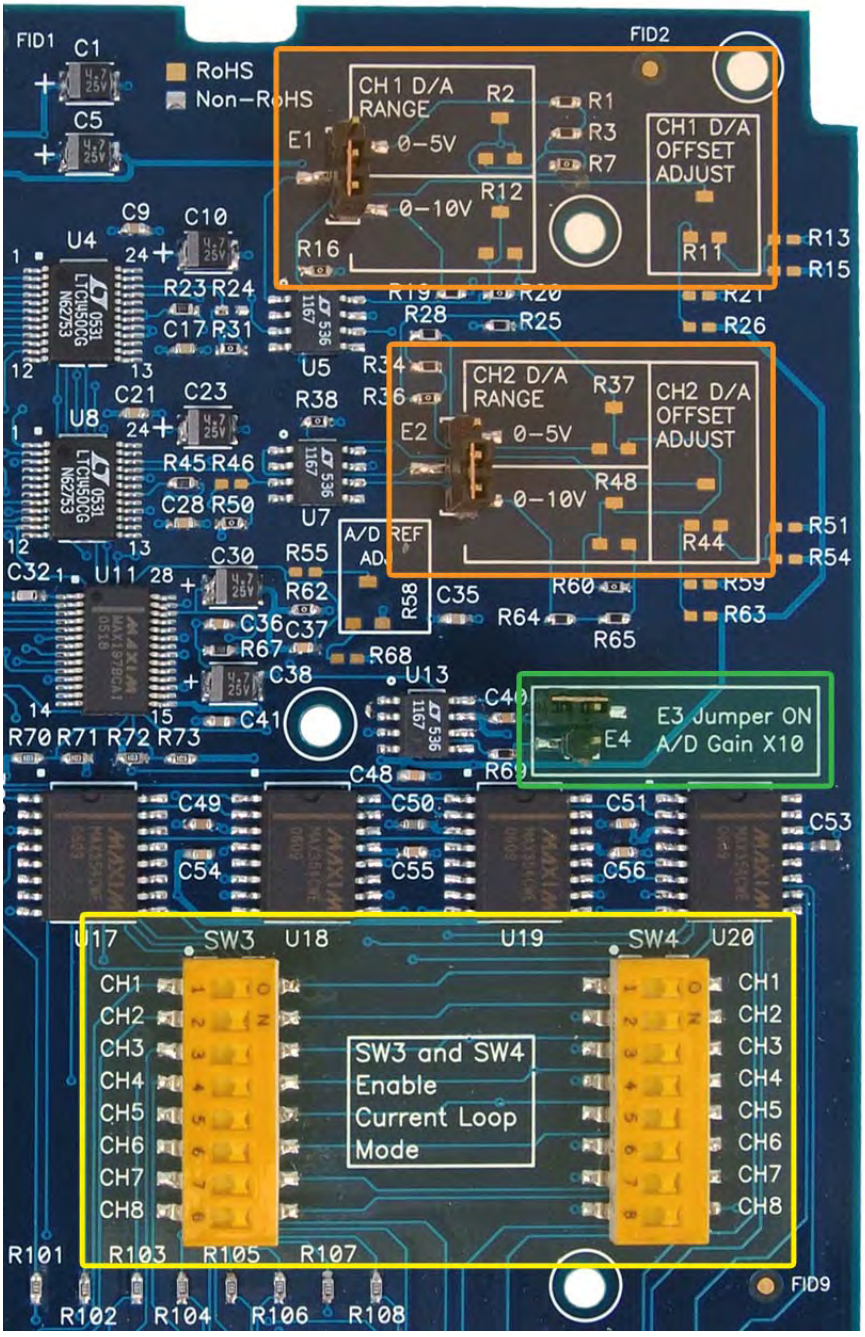
Step 2

On the front right side of the module, wedge a slotted screwdriver between the top and bottom halves as shown. Pry upwards – a pem in the top half must clear the metal lip in the bottom half of the enclosure.

Jumpers and dipswitch locations are shown on the following page.

SeaI/O-470 Jumper Locations

This detail image of the right side of the SeaI/O-470 circuit board shows the locations of the user configurable jumpers and dipswitches. Refer to the following pages for instructions on properly configuring the jumpers and switches. The colored boxes are shown here for clarity and are not visible on the actual circuit board.



D/A Settings

The (E1) and (E2) jumpers (shown in the orange boxes on the previous page) configure the D/A outputs for 0-5V or 0-10V. Both channels can be configured independently. The D/A outputs do not support negative voltages. You must also set the correct output voltage in your application or MaxSSD. Refer to the **SeaMAX Application Suite** section of this manual for help configuring software to work with the SeaI/O-470.

A/D 10X Gain

The A/D 10X gain (E3) jumper (shown in the green box on the previous page) is disabled at the factory. Position the hardware jumper on both pins to enable this functionality, which allows smaller voltages to be measured more accurately (e.g., a 0-1V input signal can be measured more accurately by enabling the 10x hardware gain jumper and setting the SeaI/O-470 A/D input channel for 0-10V range). You can also set the A/D input channel for 0-5V to sense voltages smaller than 0.5V.

When the jumper is enabled, the "10X Hardware Gain" checkbox will also be enabled on the A/D Inputs tab in MaxSSD. Refer to the **SeaMAX Application Suite** section of this manual for information on using MaxSSD.

A/D and Current Loop Dipswitches

The (SW3) and (SW4) dipswitches (shown in the yellow box on the previous page) configure the A/D inputs for current loop mode and are disabled at the factory. Since current loop mode is differential, the corresponding dipswitch on both (SW3) and (SW4) should be properly set (e.g., 'CH1' on both dipswitches needs to be set to 'ON' to enable current loop mode).

SW3 – enables the current-loop sensing resistor

SW4 – ties the other half of connection to ground

Wiring Options

SeaI/O Pass-Through Connector

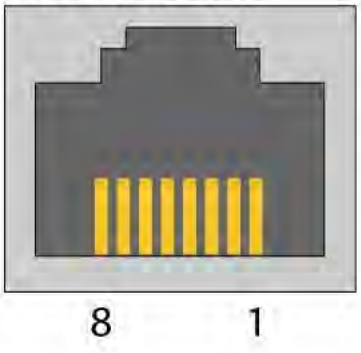
All SeaI/O modules include two RS-485 pass-through connectors on the left side of the unit that are internally connected to the same pins on the screw terminals. This offers two convenient options for adding additional expansion modules.

For connecting several SeaI/O modules together in a "stack", all N-series expansion modules ship with an expansion and strap kit (item# KT122) that includes four metal straps, four #4-40 screws, and a 5" RJ45 RS-485 interconnect cable (item# CA239). The metal straps allow you to securely connect multiple SeaI/O modules together. The interconnect cable can be used to connect SeaI/O modules together via the RJ45 pass-through connectors, providing an easy method to cascade RS-485 signals and power from one module to the next.

For expansion modules that are less than ten feet from a base unit, a standard RJ45 CAT5 patch cable may be used. For SeaI/O modules greater than ten feet apart, use twisted-pair cable connecting the data lines to the screw terminals instead. If RJ45 connectors are preferred, be sure to connect only the data lines (pins 4 & 5).

NOTE: Modules greater than ten feet apart must have separate power supplies. Refer to the **Power Options** section of this manual for recommendations.

RJ45 (RS-485 IN/OUT) Pass-Thru Connector

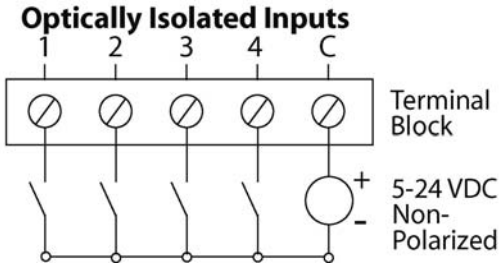


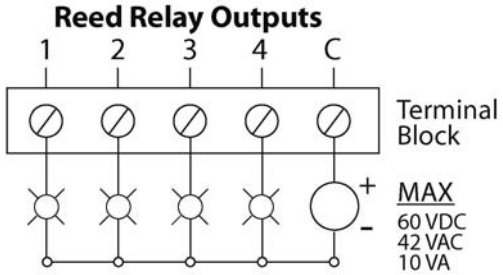
Pin Out

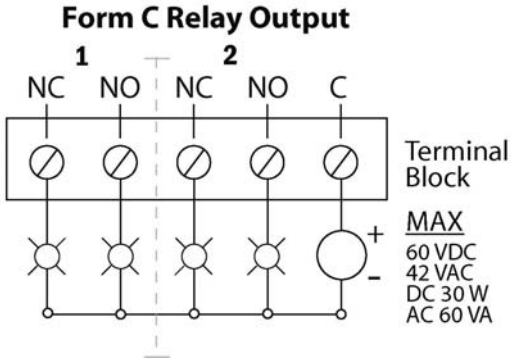
Pin #	Signal
1	9-30 VDC Source
2	9-30 VDC Source
3	Not connected
4	485+
5	485-
6	Common (GND)
7	Common (GND)
8	Common (GND)

I/O Wiring – Seal/O-410, 420, 430, 440, and 450 Modules

Optically isolated inputs are arranged such that each group of four shares a single common. The four I/O points and shared common are connected via a five-position removable screw terminal. Input voltage range is 5-24VDC. Like the inputs, each group of four Reed relays also shares a single common and connects via a five-position removable screw terminal. Form C Relay outputs are arranged such that each group of two relays shares a common. The NC and NO contacts of each relay along with the common are brought out via a five-position removable screw terminal.







SeaI/O-462 DB-78F Connectors

The SeaI/O-462's 96 digital I/O channels are brought out to two DB-78 Female connectors on the front of the enclosure (pinout shown below). Each connector provides 48 bits of digital I/O divided into six eight-bit ports. Each port may be individually configured via software command as an input or an output.

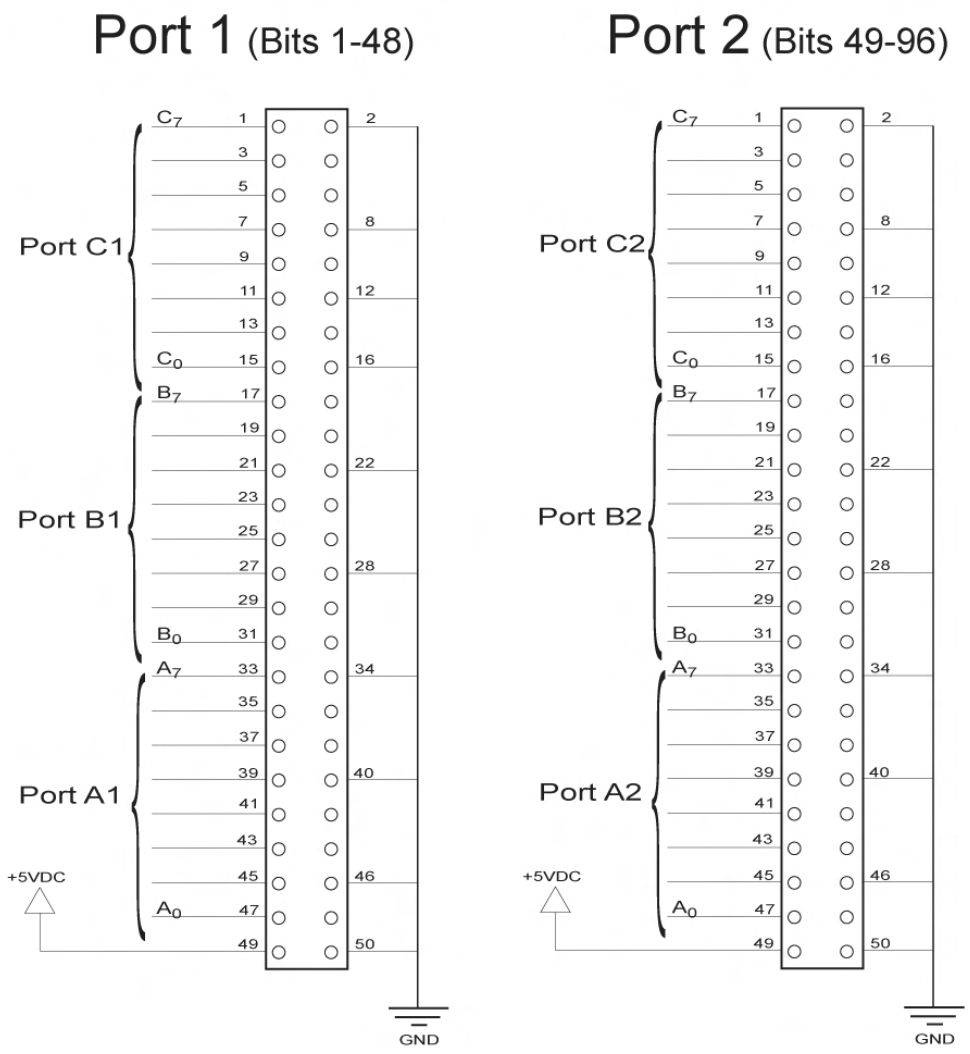
	Bits 1-48					
Bits	**A1**	**B1**	**C1**	**A2**	**B2**	**C2**
D0	75	38	18	10	30	2
D1	76	37	17	9	29	1
D2	77	36	16	8	28	22
D3	78	35	15	7	27	21
D4	59	34	14	6	26	40
D5	39	33	13	5	25	60
D6	20	32	12	4	24	61
D7	19	31	11	3	23	62

	Bits 49-96					
Bits	**A3**	**B3**	**C3**	**A4**	**B4**	**C4**
D0	75	38	18	10	30	2
D1	76	37	17	9	29	1
D2	77	36	16	8	28	22
D3	78	35	15	7	27	21
D4	59	34	14	6	26	40
D5	39	33	13	5	25	60
D6	20	32	12	4	24	61
D7	19	31	11	3	23	62

Power & Commons	
+5V	63, 74
Commons	41 – 58, 64 – 73

SeaI/O-462 Optional Cable (Item# CA237) Pinout

For easy connection to industry-standard solid-state relay racks, Sealevel manufactures a 6' cable, Item# CA237, that terminates the DB-78 to two industry standard 50-pin header connectors. Two cables and a SeaI/O unit can be order together as a kit using Item# 462x-KT. The pinout for the two 50-pin headers is shown below.

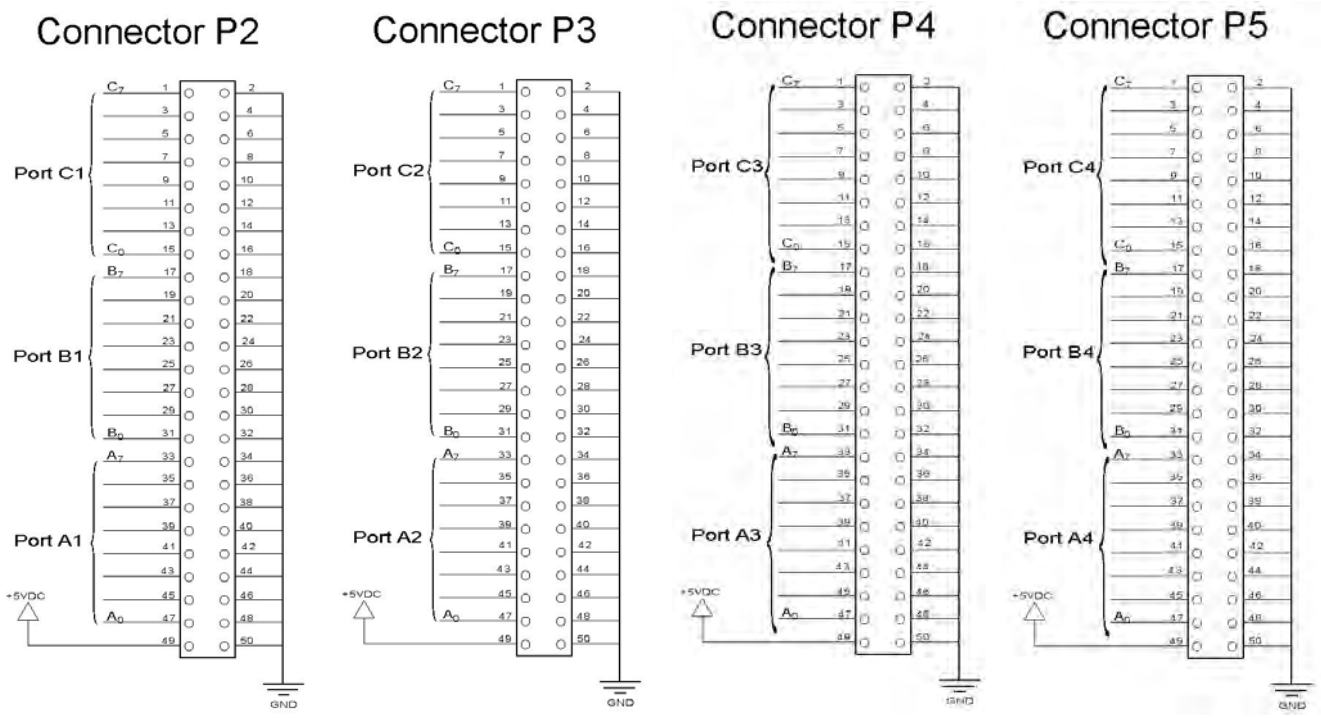


SeaI/O-463 50-Pin Header Connectors

The SeaI/O-463's 96 digital I/O channels are accessed via four industry-standard 50-pin header connectors. Each header provides 24 bits of digital I/O divided into three eight-bit ports. Each port may be individually configured via software command as an input or an output.

You will need to open the SeaI/O-463's enclosure to access the four header connectors: P2, P3, P4, and P5. The connector designators are silk-screened onto the PCB for easy identification. Once cables are connected to the headers, route them through the opening in the front of the enclosure, attach the included strain-relief bracket to secure the cables and reassemble the enclosure. Refer to the ribbon cable installation instructions included with the SeaI/O-463.

Each of the four 50-pin connectors has the following pinout, which is compatible with a wide variety of industry-standard solid-state relay racks:



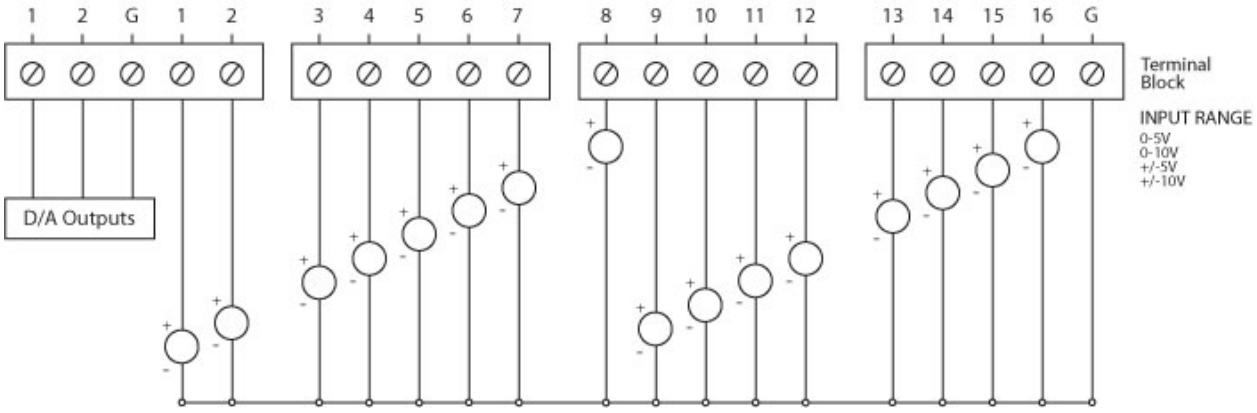
I/O Wiring – SeaI/O-470 Modules

A/D Wiring Connections

The SeaI/O-470 supports single-ended, differential, and current loop A/D inputs. Single-ended and differential modes can be configured in software. Current loop mode requires configuring dipswitches inside the enclosure. Refer to the **Hardware Configuration** section of this manual for instructions on configuring the current loop dipswitches.

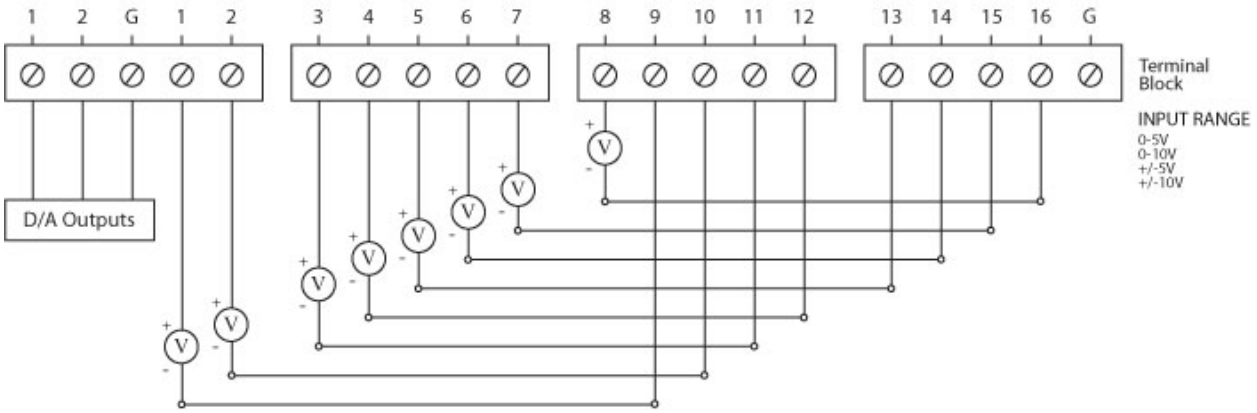
The SeaI/O-470 can be configured for up to sixteen 12-bit single-ended A/D inputs. Each input is referenced to a common ground. The user selectable voltage ranges are 0-5V, 0-10V, +/-5V, and +/-10V.

Sixteen 12-Bit Single-Ended A/D Inputs



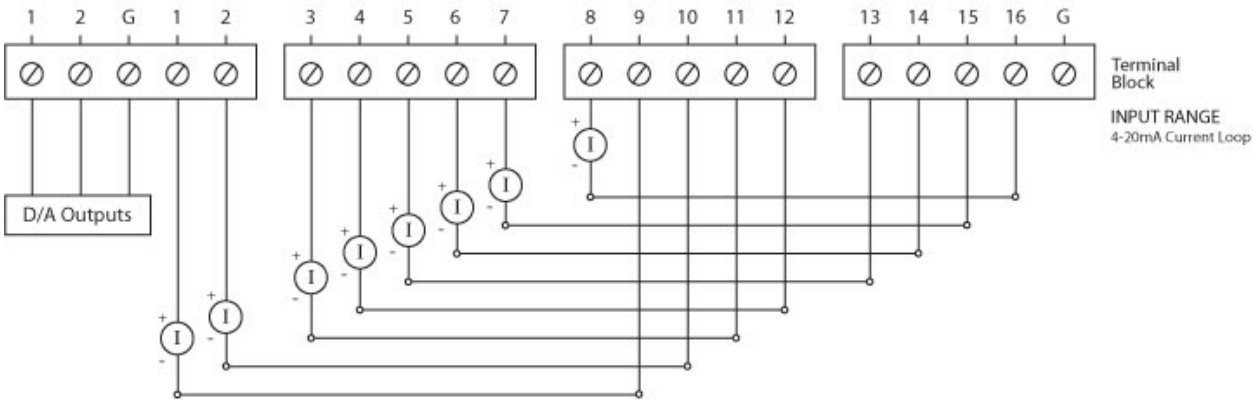
The SeaI/O-470 can be configured for up to eight 12-bit differential A/D inputs. The inputs are not referenced to ground. The user selectable voltage ranges are 0-5V, 0-10V, +/-5V, and +/-10V.

Eight 12-Bit Differential A/D Inputs



The SeaI/O-470's A/D channels can also be configured to provide up to eight 12-bit current loop inputs. Each input has two terminals – one positive and one negative. The input current range is 0-20mA for interfacing commonly used 4-20mA devices. The dipswitches inside the enclosure must be properly configured for each current loop input.

Eight 12-Bit Current Loop A/D Inputs

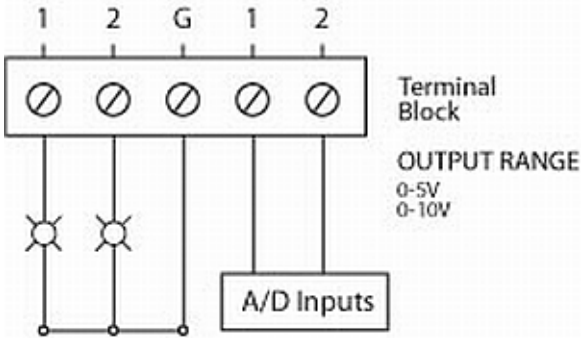


D/A Wiring Connections

The SeaI/O-470 provides two 12-bit D/A output channels, configured for 0-10V. 0-5V mode requires different jumper settings inside the enclosure. Refer to the **Hardware Configuration** section of this manual for instructions on configuring the D/A jumpers.

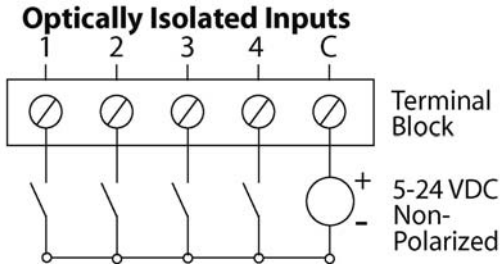
The SeaI/O-470 module's D/A output channels can be independently configured for 0-5V or 0-10V. The D/A outputs do not support negative voltages.

Two 12-Bit Single-Ended D/A Outputs

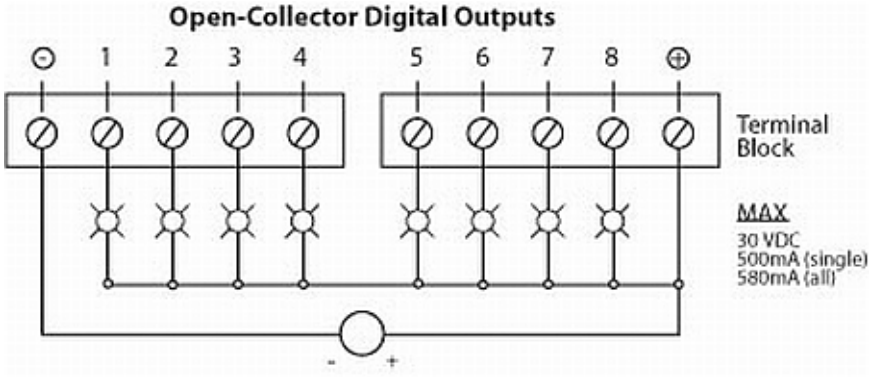


Digital I/O Wiring Connections

The SeaI/O-470 modules include eight optically isolated inputs that are arranged such that each group of four inputs shares a single common. The four I/O points and shared common are connected via a five-position removable screw terminal.

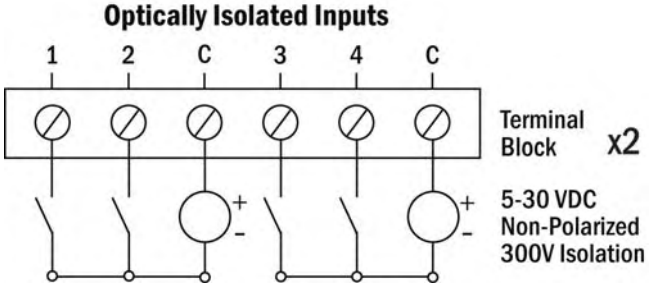


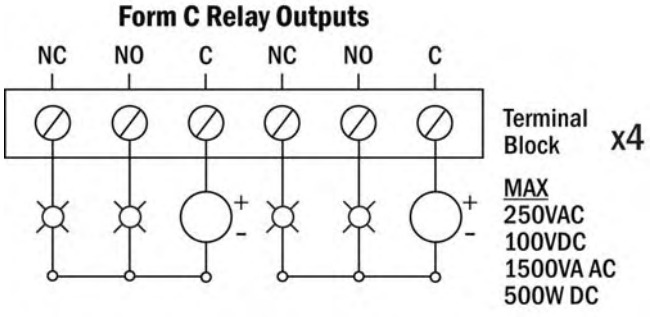
The SeaI/O-470 modules provide eight open-collector digital outputs. The outputs do not source any current and must be connected to an external power source, max 30VDC. The outputs act as a switch and the circuit is open until energized. When the output circuit is energized in software, the output sinks the current to ground, closing the circuit.



I/O Wiring – Seal/O-520 Modules

Optically isolated inputs are arranged such that each group of two shares a single common. The four I/O points and shared common are connected via a six-position removable screw terminal. Input voltage range is 5-30VDC. Like the inputs, each group of two Form C relays also shares a single common. The NC and NO contacts of each relay along with the commons are brought out via a six-position removable screw terminal.



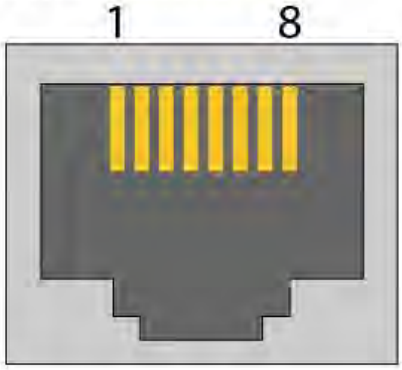


Connector Pin Outs

SeaI/O (RS-232) S-Series Modules

SeaI/O S-Series (RS-232) modules have an RJ45 connector on the face of the enclosure. Each S-series module includes a kit (item# KT119) to convert the RJ45 RS-232 pin out to a standard DB9 RS-232 pin out. The kit ships with a DB-9F to RJ45 modular adapter (item# DB109) with RS-232 pin out and a standard 7' CAT5 patch cable (item# CA246). This kit allows SeaI/O S-series modules to be easily connected to a standard DB9 RS-232 serial port. For other interfacing options, the RJ45 pin out is shown below.

RJ45 RS-232 (DCE) Serial Connector



Pin Out

Pin #	Signal
1	TD
2	RD
3	CTS
4	DTR
5	DSR
6	RTS
7	DCD
8	GND

Mounting Options

SeaI/O Mounting Kit

Expanding your I/O count is as simple as adding N-Series expansion units to the Base SeaI/O module (or other N-series modules). Each N-Series module includes an expansion and strap kit (Item# **KT122**), which includes a 5" CAT5 interconnect cable, four metal straps, and four #4-40 metal screws. The image shows a SeaI/O stack configuration using the expansion kit.

DIN Rail Mounting

All SeaI/O modules are available with a factory-installed DIN-rail mounting clip. Alternatively DIN-rail mounting clips can be ordered as a field upgrade kit (Item# **DR104)**. The bracket with clip is easily attached using two included #4-40 Phillips head machine screws.

Table/Wall Mounting

The flush mount bracket kit (Item# **KT123)** is extremely versatile and can be used to mount SeaI/O modules from the top, bottom, or back edge. Individual modules or a stack of SeaI/O modules can be mounted flat to a tabletop, underneath a counter, or inside an enclosure. The kit can be used to mount SeaI/O modules flat to a wall, or along the back edge, similar to DIN-rail mounting options.

Universal Mounting Bracket

The universal mounting bracket (Item# **KT125**) can be used as a "backpack" to mount power supplies and other devices to SeaI/O modules. The bracket has holes for both 75mm and 100mm VESA mounting options. The universal arrangement of slots and holes accept bolt sizes to M4 and can be used for virtually any mounting configuration.

Accessories

Power Supplies

US Options

TR112 – 120VAC to 24VDC 250mA "Wall Wart" Power Supply with 1.3mm Plug (for single SeaI/O module)

TR109 – 120VAC to 24VDC 500mA "Wall Wart" Power Supply with 1.3mm Plug (for multiple SeaI/O modules)

TR108-US – 100-250VAC to 24VDC 36W 1.5A "Desktop" Power Supply with 1.3mm Plug, includes (CA248) Nema 5-15P 6' US Power Cord

PS101 – 100-240VAC to 24VDC 7.5W 300mA DIN Rail Mount Power Supply (connects via screw terminals, no wire included)

PS103 – 100-240VAC to 24VDC 50W 2.1A DIN Rail Mount Power Supply (connects via screw terminals, no wire included)

International Options

TR108-AU - 100-250VAC to 24VDC 36W 1.5A "Desktop" Power Supply with 1.3mm Plug, includes (CA187) "AS 3112" 6' Australian Power Cord

TR108-EC - 100-250VAC to 24VDC 36W 1.5A "Desktop" Power Supply with 1.3mm Plug, includes (CA188) "Schuko" 6' Continental European Power Cord

TR108-UK - 100-250VAC to 24VDC 36W 1.5A "Desktop" Power Supply with 1.3mm Plug, includes (CA189) "BS 1363" 6' UK Power Cord

TR108 – 100-250VAC to 24VDC 36W 1.5A "Desktop" Power Supply with 1.3mm Plug, requires IEC country-specific Power Cord

Mounting Options

KT122 – Expansion & Strap Kit. Includes 5" RS-485 Interconnect Cable (item# CA239), four metal straps, and four #4-40 metal screws, for connecting two SeaI/O modules together in a "stack"

KT123 – Flush Mount Bracket Kit. Includes two metal brackets and four #4-40 metal screws, for mounting SeaI/O modules or stacks in a variety of positions and locations

KT125 – Universal Mounting Bracket. Includes metal mounting bracket and four #4-40 metal screws, for mounting devices to SeaI/O modules or mounting SeaI/O modules to VESA mounts and other devices.

DR104 – DIN Rail Mounting Assembly. Connects to the back edge of SeaI/O modules to facilitate an easy DIN rail mounting option and a cleaner installation

RK1U – 1U 19" Rack Tray

RK2U – 2U 19" Rack Tray

RK-CLAMP – Securely holds SeaI/O modules to rack trays

Cabling Options

CA239 – 5" CAT5 RS-485 Interconnect Cable, used to connect SeaI/O modules together in a stack (included in 4xxN SeaI/O expansion modules)

CA246 – 7' Blue Ethernet Patch Cable. Can be used to connect SeaI/O Ethernet modules to a hub (included with 4xxE SeaI/O Ethernet modules). Can be used to connect SeaI/O RS-232 modules to both Sealevel and standard RS-232 serial ports (included with 4xxS SeaI/O RS-232 modules as part of p/n: KT119). Optionally, it can be used as an RS-485 interconnect cable to cascade additional SeaI/O modules via the RS-485 In/Out ports on the side of SeaI/O modules

CA251 – 7' Yellow Crossover Cable. Used to connect SeaI/O Ethernet modules directly to a computer's Ethernet port without having to go through a hub or switch

CA247 – 10' Blue Ethernet Patch Cable. Can be used to connect SeaI/O Ethernet modules to a hub, or can be used as an RS-485 interconnect cable to cascade SeaI/O modules via the RS-485 In/Out ports

CA179 – USB 6' A to B Cable (included with 4xxU SeaI/O USB modules)

KT119 – RS-232 DB9/RJ45 Kit, includes (DB109) DB9F to RJ45 adapter with RS-232 pinout, and (CA246) 7' CAT5 patch cable. For connecting SeaI/O modules to both Sealevel and standard RS-232 serial ports (included with 4xxS SeaI/O RS-232 modules)

KT120 – RS-422 DB9/RJ45 Kit, includes (DB110) DB9F to RJ45 adapter with RS-422 pinout, and (CA246) 7' CAT5 patch cable. Optional accessory for connecting SeaI/O modules to Sealevel RS-422 serial port products

KT121 – RS-485 DB9/RJ45 Kit, includes (DB111) DB9F to RJ45 adapter with RS-485 pinout, and (CA246) 7' CAT5 patch cable. Optional accessory for connecting SeaI/O modules to Sealevel RS-485 serial port products

SeaMAX Application Suite

Introduction

The SeaMAX Suite is a collection of software libraries, and configuration and diagnostic utilities that facilitates rapid application development. The following libraries and utilities are included in the SeaMAX Suite:

- MaxSSD Configuration & Diagnostics utility
- Ethernet Config utility
- SeaMAX API
- CEthernet API

Sealevel SeaI/O modules are available in various I/O configurations, each designed for maximum flexibility and easy field wiring. Host devices can communicate with SeaI/O modules using Modbus TCP (Ethernet) or Modbus RTU (RS-232, RS-485, and USB). Up to 246 expansion modules can be daisy chained together via RS-485 using convenient pass-through connectors. Coupled with the SeaMAX Suite, Sealevel SeaI/O modules offer powerful data acquisition solutions, perfect for a range of applications and environments, and easy interfacing to a variety of computers, controllers, and PLCs.

The source code referenced in this document is designed to offer a high-level overview of how to utilize the libraries contained on the Sealevel software CD-ROM that ships with all SeaI/O modules. These code samples are meant as examples to assist in your application development. Any questions about the code samples may be emailed to technical support at support@sealevel.com.

SeaI/O Architecture

The memory map for the I/O listed in the table below describes how to address the SeaI/O modules in both Modbus compliant applications as well as through the SeaMAX API library.

SeaI/O Model	Type	No.	Modbus Function	Modbus Range	Access
410	Reed Relays	16	0x01	0 – 15	Bit
	Opto. Inputs	16	0x02	0 – 15	Bit
420	Form C Relays	8	0x01	0 – 7	Bit
	Opto. Inputs	16	0x02	0 – 15	Bit
430	Opto. Inputs	32	0x02	0 – 31	Bit
440	Reed Relays	32	0x01	0 – 31	Bit
450	Form C Relays	16	0x01	0 – 15	Bit
462	Programmable I/O	96	0x41 0x42	–	–
463	Programmable I/O	96	0x41 0x42	–	–
470	Outputs	8	0x01	0 – 7	Bit
	Opto. Inputs	8	0x02	0 – 7	Bit
	D/A Outputs	2	0x06	0 – 1	16 Bits
	A/D Inputs	16	0x04	0 – 15	16 Bits
520	Form C Relays	8	0x01	0 – 7	Bit
	Opto. Inputs	8	0x02	0 – 7	Bit

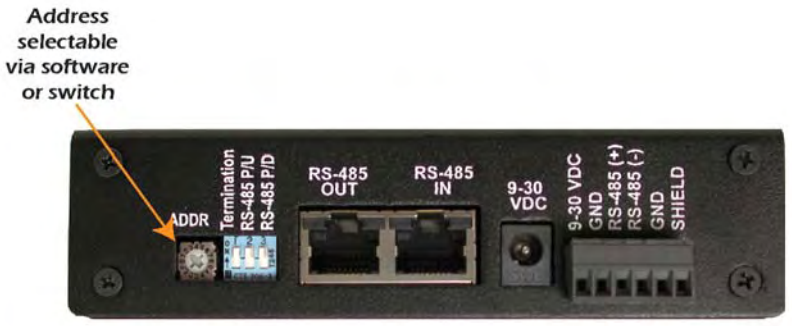
When communicating with SeaI/O modules, the users needs to be aware of the following:

- When accessing multiple I/O points, they must be addressed linearly.
- The output memory space is separate from the input I/O space; therefore individual reads must be issued for each type of I/O (i.e., a 16-input and 16-output module has two unique spaces. A program that wants to read all 32 digital I/O points must issue two sixteen position reads for each I/O space).
- In terms of Modbus, digital outputs are mapped into coil space and digital inputs are mapped into discrete input space.

Device Address Configuration

Before configuring SeaI/O modules using MaxSSD, you must first select a device addressing method. Next, you must properly set termination and pull-up/pull-down resistors. Finally, you must configure the SeaI/O modules one at a time before MaxSSD and any subsequent applications (using the SeaMAX API) will be able to successfully communicate.

Setting Device Address (Slave ID)

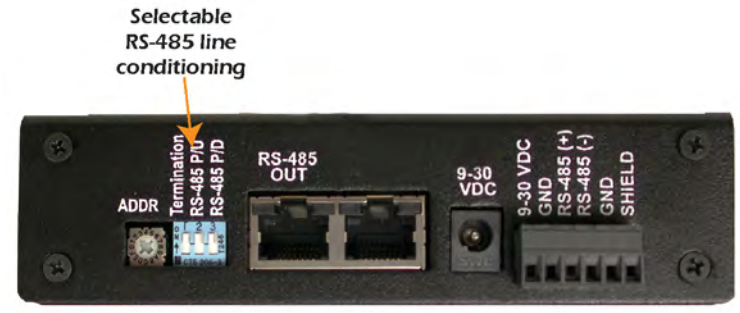


SeaI/O modules have a rotary switch, labeled "ADDR", located on the left side of the device that is used to set the device address (slave ID). The default position for all SeaI/O modules is position "0" (zero). Each SeaI/O module must be set to a unique slave ID in order to properly communicate with the host device, which can be a computer or Modbus device. The slave ID can be set by hardware using the rotary switch, which is recommended for most users. The slave ID can also be set in software by leaving the rotary switch at position "0" and using MaxSSD to set the slave ID. The rotary switch has three functions:

- **Set Address (slave ID) via Hardware –** If the rotary switch is set to a position between "1" and "15" (F), then the SeaI/O module will always respond to commands issued at that slave ID. This is useful when there are fewer than 16 SeaI/O modules in a chain and the slave ID is not required to change. This method is recommended for most users.
- **Set Address (slave ID) via Software –** If the rotary switch is left in the "0" (zero) position, the SeaI/O module uses a default slave ID of 247 for communications. By using MaxSSD (or the SeaMAX libraries), it is possible to set the slave ID to a software address between 1 and 247. This is useful when there are more than 16 SeaI/O modules in a chain, or when the slave ID of a module needs to be frequently changed.
- **Hardware Reset –** If you have an existing SeaI/O module set to an unknown slave ID or baud rate, you may wish to reset the device. If the rotary switch is rotated clockwise one full revolution, the SeaI/O module will be reset to factory defaults (slave ID 247, 9600 bps, and no parity).

NOTE: A Hardware Reset will not reset the communication rate of an Ethernet (E-series) module. Rotate the rotary switch clockwise one full revolution, and then use the MaxSSD utility to broadcast a set baud rate command to 9600 bps and no parity.

Setting Termination & Pull-Up/Pull-Down Resistors



A "stack" or "chain" of SeaI/O modules, connected via the pass-through connectors or screw terminals on the left side of the enclosure, communicates via an RS-485 bus, which must be properly terminated to work correctly. A set of three dipswitches is located on the left side of enclosure, next to the "ADDR" rotary switch. These switches control line termination and the RS-485 pull-up and pull-down resistors.

The pull-up and pull-down resistors ensure that the input ports are at a known state when not being driven by the RS-485 line. In most cases, all three of the dipswitches on each SeaI/O module should be in the down position, except the two end modules. The first and last SeaI/O modules in the chain should have all three dipswitches in the up (enabled) position.

NOTE: Make sure that only the first and last SeaI/O modules have line termination enabled (up position). Improper termination settings can result in invalid data or communication failures.

Configuring the "Base" SeaI/O Module

After you have decided which address (slave ID) method you intend to use, proceed with installing the **SeaMAX Software Suite** (discussed in the following section). Once SeaMAX has been installed successfully, start by connecting the E-, U-, M-, or S-series module to your computer. This module will be referred to as the "base" module.

If you are chaining multiple SeaI/O modules together, only one SeaI/O module in the chain can be the "base". All other SeaI/O modules connected to the "base" module are referred to as expansion modules. Multiple "base" modules can be directly connected to a host computer, but expansion modules must be connected (daisy chained) to a "base" module.

NOTE:  If you are configuring an Ethernet SeaI/O (E-series) module, skip ahead to the **Configuring an Ethernet Module** section for additional information on installing an Ethernet module.

For all other SeaI/O modules (U-series, S-series, or M-series), locate the COM port by expanding the 'Ports' list in Windows Device Manager.

Start MaxSSD (Start → All Programs → Sealevel SeaMAX → MaxSSD) and choose the correct port (IP address or COM port) to communicate with the "base" module. Ensure a successful **Get** operation (refer to the **MaxSSD** section on the following pages for more information).

Set the slave ID of the "base" module using the rotary switch or software selection method discussed in the **Setting Device Address** section on the previous pages. This guarantees that any expansion modules connected next will not conflict with the "base" module. Perform another **Get** operation to verify that you can communicate with the "base" module at the new slave ID.

NOTE:  Configure the SeaI/O modules one at a time. Set the address to a hardware slave ID other than "0" or a software slave ID other than 247, which avoids device conflicts during setup.

After the "base" module is successfully communicating via MaxSSD, you can proceed with adding SeaI/O expansion modules (N-series), as required.

NOTE:  If the "base" module doesn't respond as expected, turn the rotary switch (ADDR) clockwise one full revolution to reset. Configure the PC to communicate at 9600 bps and no parity and then try again.

Configuring N-Series Expansion Modules

Once you have successfully connected and communicated with a "base" module, you can begin adding expansion modules (N-series). Connect a single expansion module to the "base" module via the RJ45 pass-through connectors or screw terminals on the left side of the enclosure. Expansion modules include a convenient 5" interconnect cable (item# CA239) to simplify daisy-chaining SeaI/O modules together. Alternately, you can use standard network patch cables to chain expansion modules to a "base" module.

NOTE:  The RJ45 pass-through connectors are **NOT** Ethernet connectors. **Do not** connect the ports to Ethernet enabled devices else damage to Ethernet devices **WILL** result.

Ensure a successful **Get** operation (refer to the MaxSSD section on the following pages for more information). Set the slave ID of the expansion module using the rotary switch or software selection method discussed in the Setting Device Address section on the preceding pages. Perform another **Get** operation to verify that you can communicate with the expansion module at the new slave ID.

Continue adding expansion modules (N-series), one at a time, until all modules have been successfully daisy-chained together and respond to a **Get** operation in MaxSSD. Once all SeaI/O modules are configured and communicating successfully, they are ready to communicate with your application.

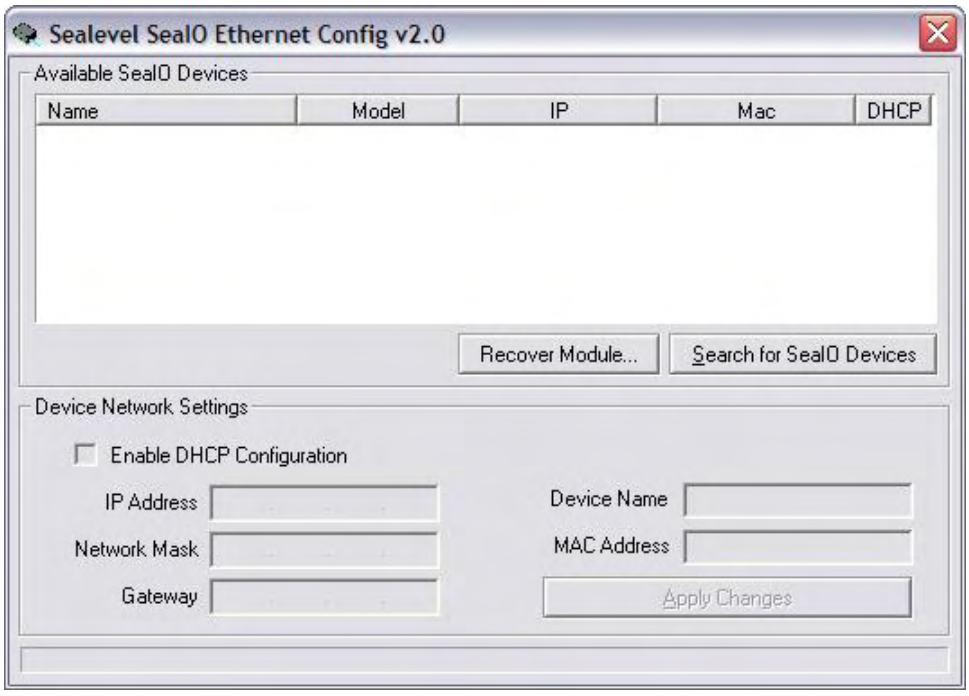
Configuring an Ethernet Module (E-Series)

NOTE: This section applies only to Ethernet SeaI/O (E-series) modules. For all other SeaI/O modules, refer to the **Configuring a "Base" SeaI/O Module** and **Configuring Expansion Modules** sections on the previous pages.

Verify that SeaMAX has been installed successfully and that an Ethernet SeaI/O module is connected to your computer. This module will become the "base" module.

All Ethernet SeaI/O (E-series) modules are shipped with DHCP enabled. When you first connect an Ethernet SeaI/O module to the network, the status LEDs on the front of the module will blink while it searches for a DHCP server. Once it receives an IP address, the status LEDs will remain on.

If no DHCP server is available, the Ethernet SeaI/O module will default to a random IP address in the range 169.254.x.x. To discover the Ethernet SeaI/O module's IP address, start the **Ethernet Config** utility (Start → All Programs → Sealevel SeaMAX → Ethernet Config) installed with SeaMAX.



Click on the "Search for SeaI/O Devices" button and the 'Available SeaI/O Devices' pane should refresh with any Ethernet SeaI/O modules that are found on the network. Select one of the modules in the list by clicking on it. You can update the settings in the Device Network Settings pane and then confirm these changes by clicking the "Apply Changes" button. The module list should refresh, indicating that your changes were successful.

Configuring an Ethernet Module (Continued)

NOTE: If the module does not change or respond, the PC and the module may be on different subnets. Proceed to the Recover Module section on the following page.

Start MaxSSD (Start → All Programs → Sealevel SeaMAX → MaxSSD) and choose the correct IP address to communicate with the "base" Ethernet SeaI/O module. Ensure a successful **Get** operation (refer to the **MaxSSD** section on the following pages for more information).

Set the slave ID of the "base" Ethernet SeaI/O module using the rotary switch or software selection method discussed in the **Setting Device Address** section on the previous pages. This guarantees that any expansion modules connected next will not conflict with the "base" module. Perform another **Get** operation to verify that you can communicate with the "base" Ethernet SeaI/O module at the new slave ID.

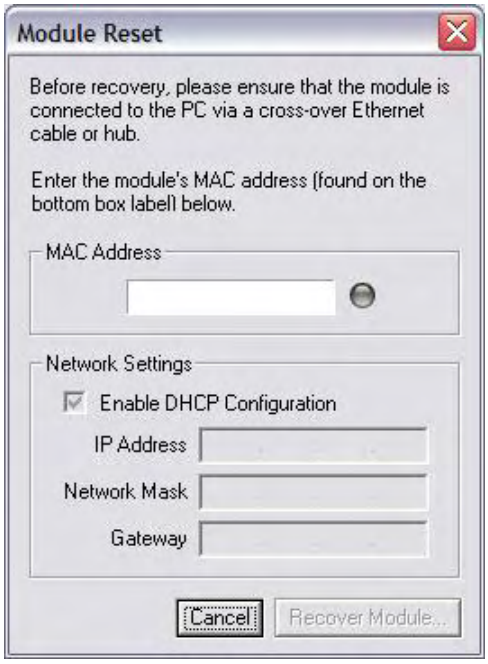
NOTE: Configure the SeaI/O modules one at a time. Set the address to a hardware slave ID other than "0" or a software slave ID other than 247, which avoids device conflicts during setup.

After the "base" Ethernet SeaI/O module is successfully communicating via MaxSSD, you can proceed with adding SeaI/O expansion modules (N-series). Refer to the **Configuring Expansion Modules** section on the previous pages.

Resetting an Ethernet SeaI/O Module

An Ethernet SeaI/O module may become no longer visible in the module list in the **Ethernet Config** utility if the Ethernet SeaI/O module has been configured to use a different subnet than the host computer.

In other cases, the Ethernet SeaI/O module doesn't appear in the module list due to a DHCP discovery failure. In either case, clicking on the "Recover Module" button (see image on previous page) in the **Ethernet Config** utility will bring up the "Module Reset" window shown below.



Before recovery begins, make certain that the PC and Ethernet SeaI/O module are on the same network segment – they should be connected with an Ethernet crossover cable, through a hub, or through a non-routing switch. Ethernet SeaI/O modules are shipped with both an Ethernet patch cable (blue) and an Ethernet crossover cable (yellow).

Enter the MAC address found on the label on the bottom of the SeaI/O enclosure. A MAC address is made up of six pairs of hex digits separated by dashes (i.e., xx-xx-xx-xx-xx-xx). While entering the MAC address, the indicator to the right of the field will turn red if the MAC address entered is invalid. Once a MAC address is successfully entered, the indicator light will turn green and the "Network Settings" options will be enabled.

Contact your network administrator if you are unsure of the proper network settings to choose. If a DHCP server is available, select the "Enable DHCP Configuration" checkbox. Otherwise, complete the network settings and click the "Recover Module" button to complete the configuration changes.

Proceed with configuring expansion modules, explained in the previous section, or refer to the **Troubleshooting** section at the end of the manual for more information.

MaxSSD Configuration & Diagnostics Utility

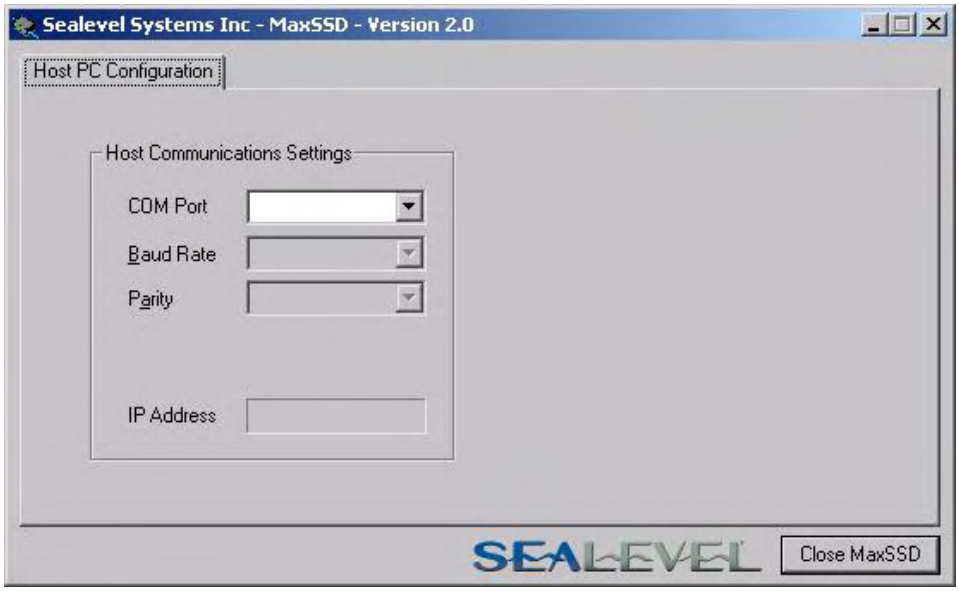
The Sealevel Systems configuration utility, **MaxSSD**, is designed to simplify the installation, configuration, and diagnostics of Sealevel SeaI/O modules. MaxSSD is a Microsoft Windows application and has been tested with Windows 2000 and XP.

Host PC Configuration Tab

The first time you run the MaxSSD utility (Start → All Programs → Sealevel SeaMAX → MaxSSD) it will default to the "Host PC Configuration" tab. This tab allows the user to set the initial communication settings. The "COM Port" dropdown box allows the selection of a serial COM port (from COM1 to COM256) or Ethernet. Once a COM port is selected, the baud rate and parity can be selected.

NOTE: The baud rate and parity of the PC **must** match the settings of the SeaI/O module to be configured. The factory default settings for all SeaI/O modules are 9600 baud and no parity.

To use an Ethernet connection, select "ETHERNET" from the "COM Port" dropdown box. When Ethernet is selected, MaxSSD searches for any SeaI/O Ethernet modules on the network and displays their IP addresses in the "Available Ethernet Devices" list box (not shown). When an IP address is selected from the list box, a socket is opened to the SeaI/O module and it is ready for communication.



NOTE: If no IP address is shown when using Ethernet modules, review the previous **Hardware Configuration** section, or proceed to the **Troubleshooting** section at the end of this manual.

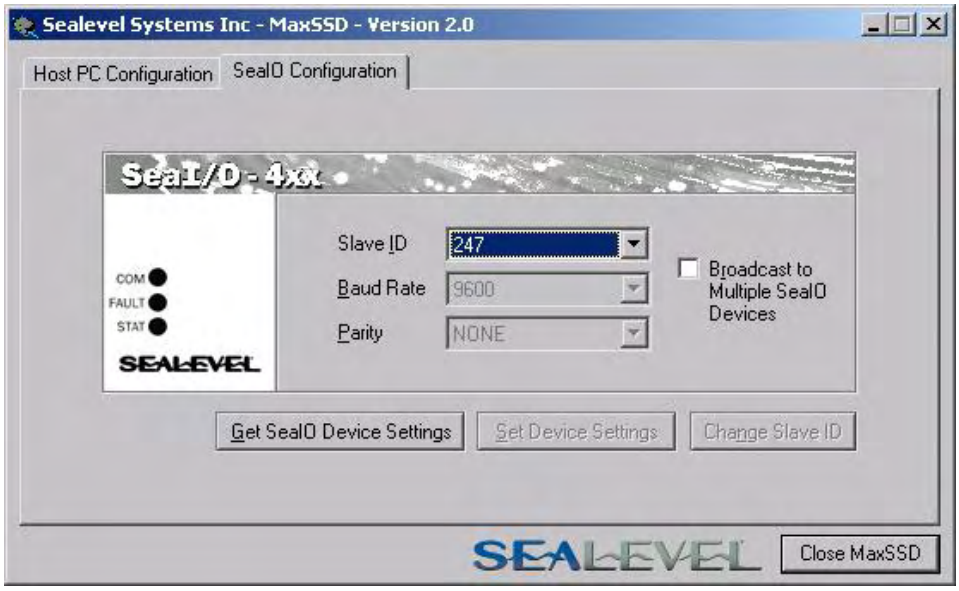
SeaI/O Configuration Tab

Once the host computer is configured correctly, the "SeaI/O Configuration" tab becomes available.

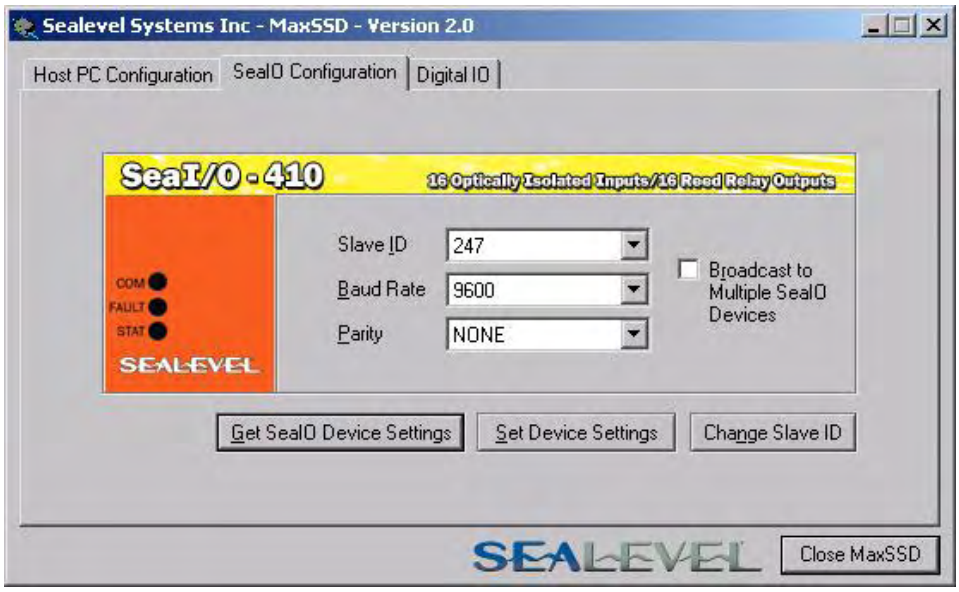
Before communicating with a SeaI/O module, the configuration utility must determine if there is a SeaI/O module at that slave ID address, and if so, what type of module it is. This is the purpose of the **Get** operation.

To perform a **Get** operation, first select the slave ID to which the module is configured. SeaI/O modules are shipped at hardware setting **0** (labeled "ADDR" on the left side of the module) and slave ID **247** by default. All other slave ID addresses (from 1 to 246) are available. However, each daisy chained SeaI/O module must have a unique slave ID address - no duplicates are allowed.

Once a slave ID is selected, click the "Get SeaI/O Device Settings" button. After a short delay, the information for that SeaI/O module should be displayed. If no information appears, verify the host settings and baud rates are correct and make changes, if necessary. Check the hardware settings (on the left side of the module) and try again.



After the **Get** command is executed, the "SeaI/O Configuration" tab will display colored labels showing the SeaI/O model number and interface type. The "Set Device Settings" and "Change Slave ID" buttons will also be enabled for this module. In the example shown, the module found at slave ID 247 is a SeaI/O 410 module with an RS-485 interface.



After a successful **Get** operation, additional tabs may be displayed in MaxSSD, depending on the found device model. These tabs display device I/O and allow easy configuration for the entire SeaI/O family of devices.

The "Broadcast to Multiple SeaI/O Devices" checkbox, along with the "Set Device Settings" button can be used to change the baud rate and parity on multiple SeaI/O modules at once. MaxSSD broadcasts a set data rate and set parity command to all devices on the RS-485 bus, but only those modules listening at the current baud rate will be able to receive and respond. For example, if you have five SeaI/O modules chained together and two are set to 9600 bps and no parity and three are set to 115.2k bps and the PC is set to 9600 bps, only the two modules set to 9600 bps will receive the broadcast set data rate and parity message.

NOTE: **Important note regarding SeaI/O Ethernet (E-series) modules**

The broadcast feature sets the Ethernet SeaI/O (E-series) module's TCP/IP to RS-485 translation data rate independently of the SeaI/O module itself. Therefore, if you have an Ethernet SeaI/O module and you set the data rate to 115.2K bps via a MaxSSD broadcast command, both the RS-485 port and the Ethernet port will respond thereafter to 115.2K bps, as expected. However, if you reset the SeaI/O module by rotating the rotary switch clockwise one complete revolution, the RS-485 port will reset to 9600 bps and no parity, but the Ethernet port will remain unaffected. To restore communications, broadcast another set data rate and parity command (9600 and no parity) via MaxSSD.

Digital I/O Tab

The “Digital IO” tab of MaxSSD is displayed when using SeaI/O devices featuring discrete inputs and outputs. It displays the device’s current input and/or output status in an intuitive and usable manner.

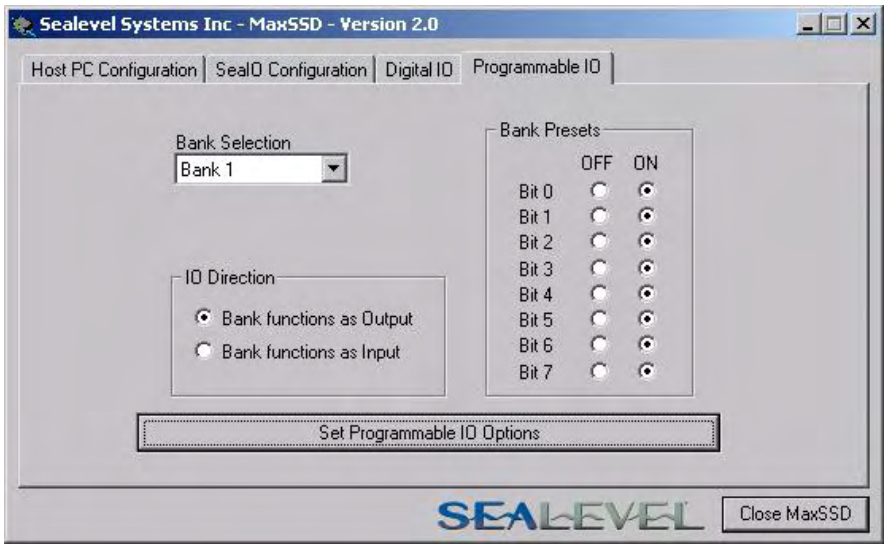
The “Digital IO” tab displays inputs and outputs in groupings (or banks) of eight. Therefore, a SeaI/O device with 16 inputs and 8 outputs would show two banks of inputs and one bank of outputs.

When displaying banks of inputs, the status LEDs update on each of the banks automatically. This allows the user to dynamically monitor external signals.

With a bank of outputs, the output coils can be set using the buttons below each output LED. As each coil is set, the SeaI/O module is read. The corresponding status LED in the “Digital IO” window indicates the state of the coil.

Programmable I/O Tab

The “Programmable IO” tab of MaxSSD is displayed when using SeaI/O devices featuring programmable inputs or outputs. This tab allows for bank configuration, input/output configuration, as well as bit-level presets.



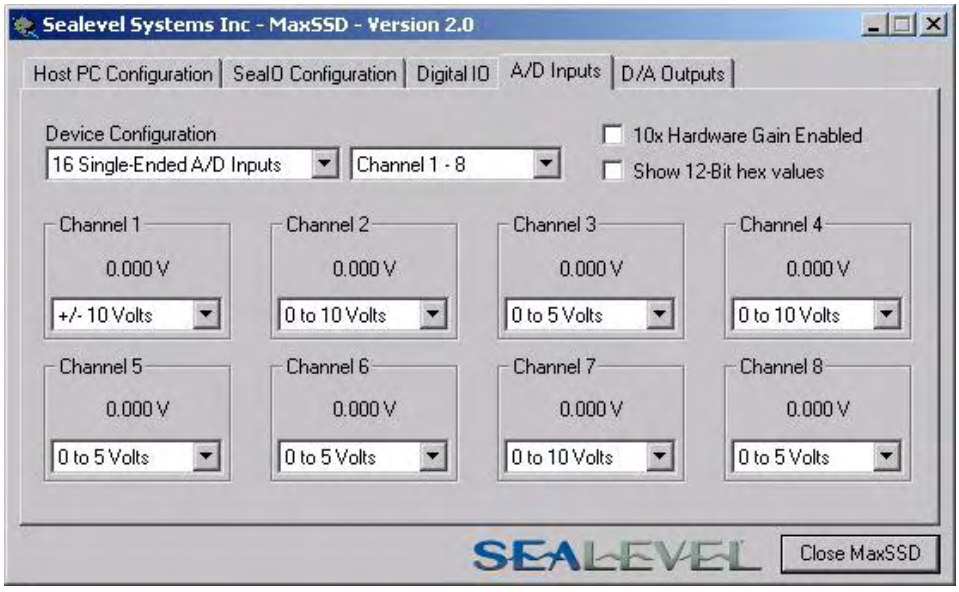
Each bank of programmable I/O can be set as either an 8-bit group of inputs or outputs. By selecting “Bank 1” from the drop-box, clicking the “Bank functions as Input” radio button, and then clicking the “Set Programmable IO Options” button, the first 8 PIO bits on the device will now function as inputs. For ease of configuration, an “All Banks of IO” option is available to configure all of the I/O at one time.

Inputs have no preset mode; therefore, the preset options are disabled for any bank of inputs. Outputs; however, have bit-addressable presets. These presets are used whenever the device is powered up or the bank direction changes from input to output.

NOTE: The output presets, will not lock the outputs into a specified on or off state. They only set the state of the outputs on a power on or bank direction change.

A/D Inputs Tab

The "A/D Inputs" tab displays the current state of the analog-to-digital channels for devices that feature A/D inputs. Settings are provided for both device wide and per-channel configuration.



The "Device Configuration" selection drop-box adjusts the arrangement and function of the A/D input channels. Input channels are displayed as banks (groups of eight). Each channel is range configurable via the voltage range dropdown list. Both the channel voltage range and device-wide configuration are set on a dropdown list. There is no need to save your settings – they are automatically saved to the device as you select the various configuration options.

"10x Hardware Gain Enabled" checkbox – Indicates whether or not the onboard hardware gain jumper is currently set. This option is **not** user configurable – it only reflects the status of the onboard hardware jumper settings. Set the hardware jumper to enable this functionality, which allows smaller voltages to be measured more accurately (e.g., a 0-1V input signal can be measured more accurately by enabling the 10x hardware gain jumper and setting the SeaI/O-470 A/D input channel for 0-10V range).

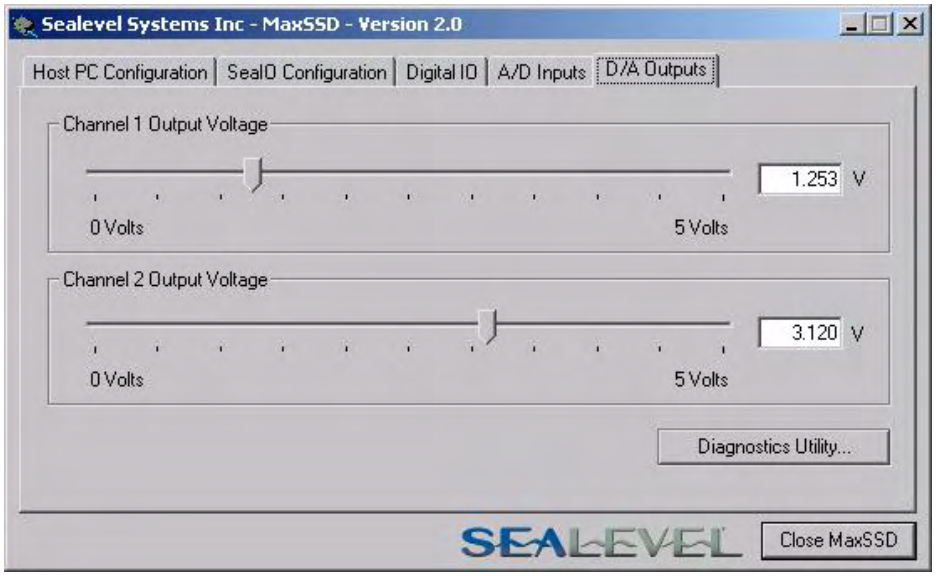
"Show 12-Bit Hex Values" checkbox – Displays the values returned by the A/D converter as a hexadecimal value without converting the values to engineering units (i.e., Amps or Volts)

D/A Outputs Tab

The "D/A Outputs" tab is useful for manually setting the digital to analog output voltages. A preliminary diagnostics utility (see following page) has been provided to verify proper hardware functionality.

The D/A outputs of the SeaI/O-470 are factory set for 0-10V. To configure the D/A outputs for 0-5V, you will need to open the enclosure and set the correct jumpers. Refer to the **Hardware Configuration** section of this manual for instructions on opening the enclosure and accessing the correct jumpers.

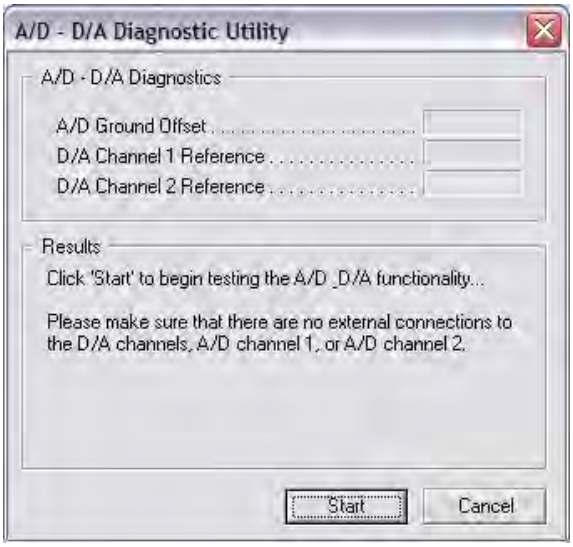
To adjust a particular channel's output voltage, drag the slider until the desired voltage is displayed in the window on the right side. Also, you may type the desired voltage directly into the voltage display and press the 'Enter' key.



NOTE: The output voltage will not change until the 'Enter' key is pressed or you have clicked on the window anywhere outside of the field.

Diagnostics

To check basic functionality of both the A/D and D/A converters, press the "Diagnostics Utility" button on the "D/A Outputs" tab (shown on the previous page) and then press the "Start" button, as shown below. Any errors will be shown in the "Results" pane. If errors occur, please contact technical support for further help.



Modbus Commands

Sealevel SeaI/O modules are designed to integrate seamlessly into existing Modbus networks. The supported command set will vary depending on the SeaI/O model number used. Below is a list of valid commands for each SeaI/O model number.

SeaI/O 410 **0x01** Read Coils **0x02** Read Discrete Inputs **0x05** Write Single Coil **0x0F** Write Multiple Coils	**SeaI/O 420** **0x01** Read Coils **0x02** Read Discrete Inputs **0x05** Write Single Coil **0x0F** Write Multiple Coils	**SeaI/O 430** **0x02** Read Discrete Inputs
SeaI/O 440 **0x01** Read Coils **0x05** Write Single Coil **0x0F** Write Multiple Coils	**SeaI/O 450** **0x01** Read Coils **0x05** Write Single Coil **0x0F** Write Multiple Coils	**SeaI/O 462/463** **0x41** Read PIO Data **0x42** Write PIO Data **0x43** Read PIO Config **0x44** Write PIO Config
SeaI/O 470 **0x01** Read Coils **0x02** Read Discrete Inputs **0x05** Write Single Coil **0x0F** Write Multiple Coils **0x04** Read Input Register **0x06** Write Single Register **0x10** Write Multiple Reg.	**SeaI/O 520** **0x01** Read Coils **0x02** Read Discrete Inputs **0x05** Write Single Coil **0x0F** Write Multiple Coils	

Specialized diagnostic commands and other RTU specific codes are not supported at this time. An overview of the Modbus specification for both RTU and TCP connections is covered in subsequent sections. The official Modbus specification can be found at www.modbus.org.

Modbus RTU

The Modbus RTU specification is a serial line style of communication where the packets are determined by a series of timeouts. The last byte of an arriving packet is defined as no more bits have been clocked into the shift registers for 3.5 character times (i.e., no more bytes have been received for at least 3.5 character times). The layout of a Modbus RTU packet is shown below.

Address	Payload	CRC-16

The payload consists of function code, followed by the function specific data. That data is well defined within the Modbus Application Protocol specification. The extended commands, defined in this manual, are good examples of how the payload of a Modbus command is designed.

Modbus TCP

The SeaI/O E-Series (Ethernet) modules utilize the Modbus TCP communications package. The libraries provided with the SeaI/O modules will operate virtually the same as the Modbus RTU libraries.

The Modbus TCP protocol is slightly easier to use because there is no CRC attached. Instead, Modbus TCP relies on the TCP implementation to ensure the message gets to the sender without error.

The defined port for Modbus TCP communications is 502. This port has been reserved on TCP modules that implement Modbus TCP. All Ethernet enabled SeaI/O modules support a bridging mode, where all connected modules can respond to Modbus commands as if they were a single unit. The modules utilize their unique Slave ID (Unit ID) and will respond to a command that the Ethernet bridge will then transmit back to the user. The header of the TCP message is named the MBAP Header, and is designed as follows:

Tx ID (h)	Tx ID (l)	Protocol ID (h)	Protocol ID (l)	Length (h)	Length (l)	Unit ID

Following the MBAP header is the same payload of the RTU messages described in the Modbus Application Protocol Specification.

Extended Modbus Command Set

Sealevel SeaI/O modules support an extended Modbus command set that allows an application to easily modify the Slave ID (address) and communication parameters.

(0x45) Get Config

The **Get Config** request is designed to obtain model and configuration information for SeaI/O modules and can be used as a mechanism to verify that the unit is operational and responding. A **Get Config** request must be issued to a SeaI/O module before attempting to set the address or the communication parameters of the module. This simplistic security model is designed to protect the module from multiple get/set operations that could occur when multiple masters query the same module.

This transaction shows that the SeaI/O module queried is a SeaI/O-410E, operating at a baud rate of 14400, with no parity. To change the parameters for this module, the Magic Cookie, **0xCA**, is required.

Request		**Response**	
Field Name	(Hex)	Field Name	(Hex)
Function	**45**	Function	**45**
		Model (lower byte)	**9A**
		Bridge Unit	**01**
		Baud Rate	**05**
		Parity	**00**
		Magic Cookie	**CA**

NOTE: If the **Get Config** response returns (00) for the model number, the module being queried is outside the original SeaI/O 4xx series. Query the module using the **(0x66) Get Extended Module Information** request to retrieve the full two-byte model number.

NOTE: There are no exception codes possible with this transaction. The tables in **Appendix A** illustrate how to decode transaction data.

(0x66) Get Extended Module Information

When querying SeaI/O modules, perform a standard **Get Config (0x45)** request. If the **Get Config** response returns zero (00) for the model number, the module being queried is outside the original SeaI/O 4xx series. Use the **Get Extended Module Information** request to retrieve the (full two-byte) model number for SeaI/O modules outside the original SeaI/O 4xx series.

This transaction shows that the SeaI/O module queried is a SeaI/O-520 (e.g., Hex 0208 = Decimal 520). The additional 14 bytes of data has been reserved for future use. There are no exception codes possible with this transaction.

Request		**Response**	
Field Name	(Hex)	Field Name	(Hex)
Function	**66**	Function	**66**
		Model (upper byte)	**02**
		Model (lower byte)	**08**
		RESERVED	**[14 bytes]**

NOTE: The **(0x45) Get Config** request should still be used to retrieve the bridge unit, baud rate, and parity of all SeaI/O modules.

(0x46) Set Address

SeaI/O modules can be configured to use a software address, which can be any number from 1 to 247. By verifying that the Hexadecimal switch (labeled "ADDR" on the left side of the module) is set to "0", the module can then be set to respond to any address between 1 and 247. A **Get Config** transaction must first be issued to obtain the Magic Cookie byte. A sample transaction is shown with an assumed Magic Cookie byte of **0xCA**.

Request		**Response**	
Field Name	(Hex)	Field Name	(Hex)
Function	**46**	Function	**46**
New Address	**F6**	New Address	**F6**
Pad Byte	**00**	Pad Byte	**00**
Magic Cookie	**CA**	Magic Cookie	**CA**

NOTE: If the Hexadecimal switch is not set to the "0" position, the **`Set Address`** command will fail.

Upon a successful **Set Address** operation, the SeaI/O module will respond with the same packet it received. However, an exception can be generated if one of the following conditions occurs:

- The address set is not within the range [1, F7] (Hex)
- The Magic Cookie is invalid
- The message was broadcast
- The Hexadecimal switch is not at position "0"

(0x47) Set Communication

The **Set Communication** command can be used two different ways. The first method is a direct one-to-one communication with a single SeaI/O module. This requires a **Get Config** request to obtain the Magic Cookie byte. However, to easily change the communication parameters of multiple SeaI/O modules at the same time, the **Set Communication** operation can be broadcast to all daisy-chained modules. A sample transaction is shown with an assumed Magic Cookie byte of **0xCA**, which is only required for one-to-one communication.

Request		**Response**	
Field Name	(Hex)	Field Name	(Hex)
Function	**47**	Function	**47**
Baud Rate	**0A**	Baud Rate	**0A**
Parity	**00**	Parity	**00**
Magic Cookie	**CA**	Magic Cookie	**CA**

Upon a successful **Set Communication** operation, the SeaI/O module will respond with the same packet it received. An exception can be generated if one of the following conditions occurs:

- The baud rate is not within the range [1, 0A] (Hex)
- The parity rate is not within the range [0, 2]
- The Magic Cookie is invalid (one-to-one communication only)

(0x41) Read From Programmable I/O (PIO) Modules

The **Read** command is used differently for SeaI/O PIO modules. The data, model number, and configuration are all returned with the state of the module. A sample **Read** transaction packet is shown.

Request		**Response**	
Field Name	(Hex)	Field Name	(Hex)
Function	**41**	Function	**41**
		Model (lower byte)	**CE**
		Config (channel 2)	**3F**
		Config (channel 1)	**00**
		Data (Port A1)	**AA**
		Data (Port B1)	**55**
		Data (Port C1)	**AA**
		Data (Port A2)	**55**
		Data (Port B2)	**AA**
		Data (Port C2)	**55**
		Data (Port A3)	**AA**
		Data (Port B3)	**55**
		Data (Port C3)	**AA**
		Data (port A4)	**55**
		Data (port B4)	**AA**
		Data (port C4)	**55**

Upon a successful **Read** operation, the SeaI/O module will respond with the appropriate packet. In this example, the module queried is a SeaI/O-462. The higher channel is set to all inputs and the lower channel is set to all outputs, with the data read alternating with **0xAA** and **0x55**.

NOTE:

Appendix C covers the layout of PIO enabled module registers.

(0x42) Write To PIO Modules

The **Write** command for a Sealevel SeaI/O PIO module simply sends a request with function code **0x42** followed by the 12 bytes of data to write. Upon a successful **Write** operation, the response packet will be identical to the request.

NOTE:

Appendix C covers the layout of PIO enabled module registers.

(0x43) Get PIO Config

The **Get PIO Config** command is used to retrieve the current status of the ports. The SeaI/O module queried will respond with the model number and the port-by-port I/O configuration. The module will not respond with any data contained in those ports; use a **Read** command to retrieve that information. A sample transaction packet is shown, below.

Request		**Response**	
Field Name	(Hex)	Field Name	(Hex)
Function	**43**	Function	**43**
		Model (lower byte)	**CE**
		Config (channel 2)	**3F**
		Config (channel 1)	**00**

NOTE:

Appendix C covers the layout of PIO enabled module registers.

(0x44) Set PIO Config

The **Set PIO Config** command is used to set the I/O configuration of the ports on a SeaI/O PIO module. The two most significant bits of each Config channel should be set to "0", while the lower six bits determine whether the port will be an input or output. A bit value of "1" indicates an input and a bit value of "0" indicates an output.

In this example, channel 2 is set to be all inputs (3F, 00111111), and channel 1 is set to be all outputs (00, 00000000).

Request		**Response**	
Field Name	(Hex)	Field Name	(Hex)
Function	**44**	Function	**44**
Config (channel 2)	**3F**	Config (channel 2)	**3F**
Config (channel 1)	**00**	Config (channel 1)	**00**

NOTE:

Appendix C covers the layout of PIO enabled module registers.

(0x64) Set A/D, D/A Configuration

SeaI/O devices featuring analog to digital or digital to analog conversions can be configured via a Modbus command. Upon a successful operation, the SeaI/O module will respond with the response packet shown below.

Request		**Response**	
Field Name	(Hex)	Field Name	(Hex)
Function	**64**	Function	**64**
Device Config	**00**		
Channels 1-4 Config	**00**		
Channels 5-8 Config	**00**		
Channels 9-12 Config	**00**		
Channels 13-16 Config	**00**		

The configuration byte stream is defined as follows:

	BYTE							
	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Device Config	A/D Voltage Reference				A/D Channel Mode			
1-4 Config	Ch 1 Range		Ch 2 Range		Ch 3 Range		Ch 4 Range	
5-8 Config	Ch 5 Range		Ch 6 Range		Ch 7 Range		Ch 8 Range	
9-12 Config	Ch 9 Range		Ch 10 Range		Ch 11 Range		Ch 12 Range	
13-16 Config	Ch 13 Range		Ch 14 Range		Ch 15 Range		Ch 16 Range	

The actual values for the configuration options above (A/D Voltage Reference, A/D Channel Mode, and A/D Ch xx Ranges) are enumerated in SeaMaxW32.h, included with the SeaMAX libraries, and shown in the table below.

A/D Voltage Reference		**A/D Channel Mode**		**Ch xx Ranges**	
ANALOG_OFFSET	= 0	SINGLE_ENDED	= 0	ZERO_TO_FIVE	= 0
GND_OFFSET	= 1	DIFFERENTIAL	= 1	PLS_MIN_FIVE	= 1
AD_REF_OFFSET	= 2	CURRENT_LOOP	= 2	ZERO_TO_TEN	= 2
DA_CHANNEL_1	= 4			PLS_MIN_TEN	= 3
DA_CHANNEL_2	= 8				

(0x65) Get the A/D, D/A Configuration

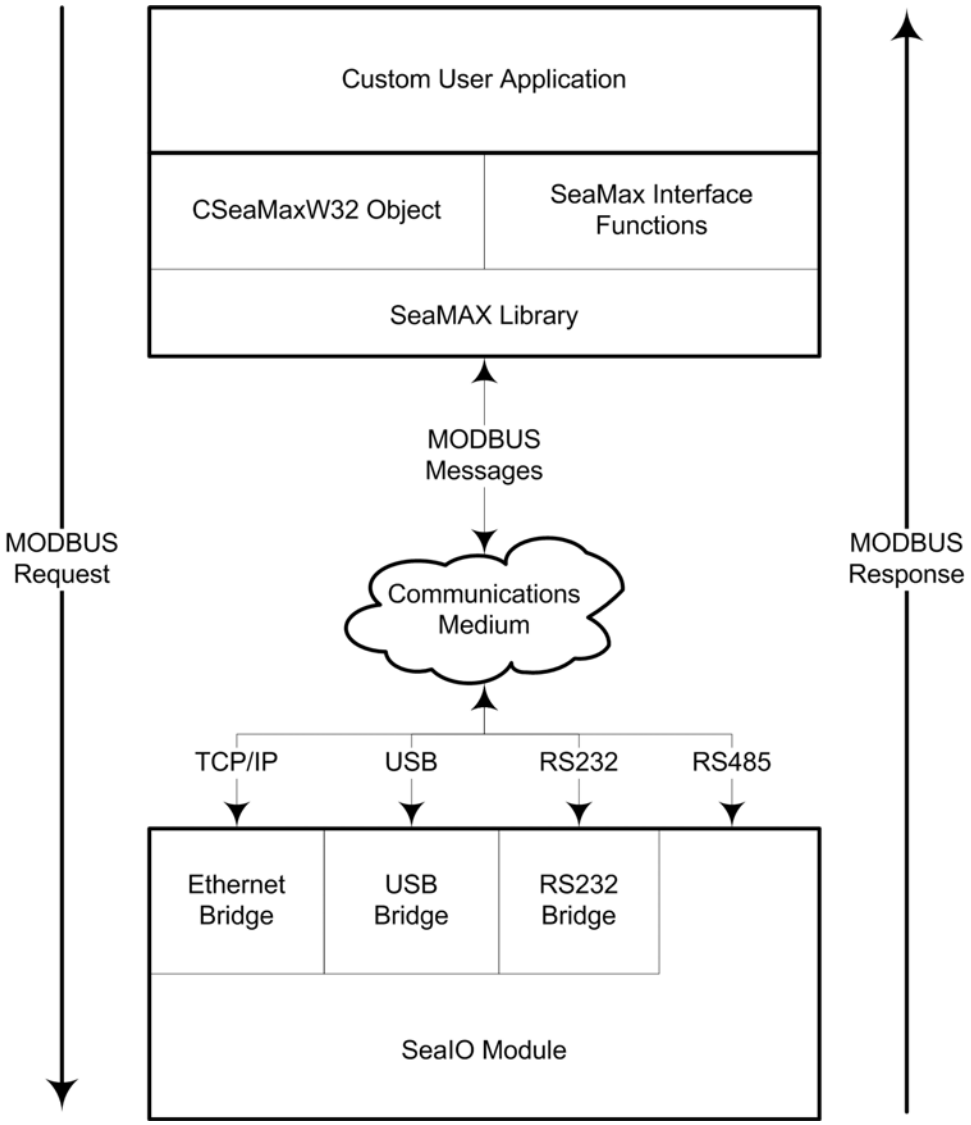
Before setting the configuration, it is often useful to retrieve the current configuration of the SeaI/O module. Modbus command 0x65 will retrieve the settings currently in use, so that they may be altered and set via command 0x64.

Request		**Response**	
Field Name	(Hex)	Field Name	(Hex)
Function	**65**	Function	**65**
		Device Config	**00**
		Channels 1-4 Config	**00**
		Channels 5-8 Config	**00**
		Channels 9-12 Config	**00**
		Channels 13-16 Config	**00**

The actual values for the configuration are enumerated in SeaMaxW32.h, included with the SeaMAX libraries. Upon a successful operation, the SeaI/O module will respond with the response packet containing the current module configuration.

Developing Custom Applications Using SeaMAX API

The SeaI/O modules are also designed to work with third party applications. In order to supplement this development work, Sealevel Systems provides libraries that are linked into an application and provide an easy interface to the SeaI/O modules. These libraries are provided for Visual C++ and Visual Basic. The interaction of the SeaMAX API with SeaI/O modules is shown in the diagram below.



SeaMAX API

A functional description of each method in the class, including the possible return values, is provided. All return values less than zero are standard error codes listed and defined in the standard C library header file <errno.h>. In the following, with the Object-Oriented model, the Visual C++ DLL is designed as a single class. This class has the following model:

Open

CSeaMaxW32::Open(unsigned char* filename)

Description	*Opens the specified resource. The filename parameter can be one of two different types, Modbus RTU or Modbus TCP.* *To specify a Modbus RTU connection (used for all non-Ethernet enabled modules) the string "sealevel_rtu://COMx" should be used, where x is a valid COM port number.* *To specify a Modbus TCP connection (used only for Ethernet enabled modules) the string "sealevel_tcp://x.x.x.x" should be used, where x's represent the valid IP address of the module to be accessed.*		
Parameters	unsigned char*	filename	
Return Codes	-38	ENAMETOOLONG	The length of the filename is greater than 256 characters.
	-22	EINVAL	The specified protocol is invalid, or, the module could not be contacted.
	-9	EBADF	The specified location is invalid
	0		Success

Close

CSeaMaxW32::Close( )

Description	*Closes a previously opened SeaIO module resource.*	
Parameters	*None*	
Return Codes	0	Success

Read

CSeaMaxW32::Read(slave_address_t slaveID, seaio_type_t type, address_loc_t starting_address, address_range_t range, void* data)

Description

Read performs a Modbus read on an opened SeaIO module and returns the data by reference.

The actual Modbus read type is specified by the 'type' argument. Since Modbus is actually base one, the starting location should be no less than one. Likewise, the range indicates how many consecutive inputs should be read.

The final parameter, 'data', is a pointer to a buffer in which to store the returned data – most often, an array of bytes. Consult the provided code examples for model specific information.

Parameters

slave_address_t	slave_id
seaio_type_t	type
address_loc_t	starting_address
address_range_t	range
void*	data

Return Codes

-14	EFAULT	A Modbus read exception has occurred – the first byte of the data buffer contains the exception code.
-22	EINVAL	A NULL pointer has been supplied where a pointer to a data buffer was expected.
-9	EBADF	The specified communication is not currently established.
-19	ENODEV	The SeaIO module did not respond.
≥ 0		Success – The number of valid data bytes in the buffer.

Write

CSeaMaxW32::Write(slave_address_t slaveID, seaio_type_t type, address_loc_t starting_address, address_range_t range, unsigned char* data)

Description

Write performs a Modbus write on an opened SeaIO module and returns the data by reference.

The actual Modbus write type is specified by the 'type' argument. Since Modbus is actually base one, the starting location should be no less than one. Likewise, the range indicates how many consecutive inputs should be read.

The final parameter, 'data', is a pointer to a buffer in which to store the returned data – specifically, an array of bytes. Consult the provided code examples for model specific information.

Parameters

slave_address_t	slave_id
seaio_type_t	type
address_loc_t	starting_address
address_range_t	range
unsigned char*	data

Return Codes

-14	EFAULT	A Modbus read exception has occurred – the first byte of the data buffer contains the exception code.
-22	EINVAL	A NULL pointer has been supplied where a pointer to a data buffer was expected.
-9	EBADF	The specified communication is not currently established.
-18	EXDEV	Can not write data to the outbound connection – connection error.
-19	ENODEV	The SeaIO module did not respond.
-34	ERANGE	Attempting to write to more IO points than are available.
-27	EFBIG	Illegal data value
≥ 0		Success – The number of valid data bytes in the buffer.

Ioctl

CSeaMaxW32::Ioctl(slave_address_t slaveID, IOCTL_t which, unsigned char * data)

Description

Ioctl has been provided as a muli-function tool to configure and access non-standard Modbus features of the SeaIO module.

The actual Modbus transaction (and corresponding action) is specified by the 'which' argument. Ioctl can be used to set module parameters, configure state, and access data. Consult the provided example source code for model specific information.

The final parameter, 'data', is a pointer to a data type which is appropriate for the particular IOCTL call. Consult the provided code examples for model specific information.

Parameters

slave_address_t	slave_id
IOCTL_t	which
void*	data

Return Codes

-22	EINVAL	A NULL pointer has been supplied where a pointer to a data buffer was expected.
≥ 0		Success

(Reference the return values for both Read( ) and Write( ))

set_intermessage_delay

CSeaMaxW32::set_intermessage_delay(int delay)

Description	*This function is used to set the intermessage delay time in effort to optimize the number of messages that can be sent. This time must be at least 4 character times long. The default is a function of the baud rate and should not be changed unless necessary.* *The parameter 'delay' is the delay (in milliseconds) to wait between sending back to back messages.*
Parameters	int delay
Return Codes	≥ 0 Success – A Windows HANDLE to the COM resource.

getCommHandle

CSeaMaxW32::getCommHandle(*void*)

Description	*This method may be used to return the HANDLE type data used by SeaMAX as the communications resource.*
Parameters	None
Return Codes	*None*

Non Object-Oriented SeaMAX API

The methods following methods have been created to ease use for those more familiar with non-Object-Oriented or functional design. These functions use the same parameters as their method counterparts and are used interchangeably.

Before using the functions below, `SeaMaxW32Create()` should first be called in order to create a global SeaMAX object and return a pointer as a long data type. Before the end of program execution, `SeaMaxW32Destroy()` should be called in order to clean up the global memory space and release the SeaMAX object.

SeaMaxW32Create

SeaMaxW32Create(***void*** **)**

Description	*Creates an instance of the SeaMAX object in the global memory space.*	
Parameters	None	
Return Codes	> 0	Success – A long pointer to the SeaMAX object.

SeaMaxW32Destroy

SeaMaxW32Destroy(CSeaMaxW32* SeaMaxPointer)

Description	*Releases the globally allocated SeaMAX object.*	
Parameters	CSeaMaxW32*	SeaMaxPointer
Return Codes	0 Success	

SeaMaxW32Open

SeaMaxW32Open(CSeaMaxW32* SeaMaxPtr, char* filename)

Description	*See CSeaMaxW32::Open( )*	
Parameters	CSeaMaxW32*	SeaMaxPointer
	char*	filename
Return Codes	*See CSeaMaxW32::Open( )*	

SeaMaxW32Close

SeaMaxW32Close(CSeaMaxW32* SeaMaxPointer)

Description	*See CSeaMaxW32::Close( )*	
Parameters	CSeaMaxW32*	SeaMaxPointer
Return Codes	*See CSeaMaxW32::Close( )*	

SeaMaxW32Read

SeaMaxW32Read(CSeaMaxW32 *SeaMaxPointer, slave_address_t slaveId, seaio_type_t type, address_loc_t starting_address, address_range_t range, void* data)

Description	*See CSeaMaxW32::Read( )*	
Parameters	CSeaMaxW32*	SeaMaxPointer
	slave_address_t	slaveId
	seaio_type_t	type
	address_loc_t	starting_address
	address_range_t	range
	void*	data
Return Codes	*See CSeaMaxW32::Read( )*	

SeaMaxW32Write

SeaMaxW32Write(CSeaMaxW32* SeaMaxPointer, slave_address_t slaveId, seaio_type_t type, address_loc_t starting_address, address_range_t range, unsigned char* data)

Description	*See CSeaMaxW32::Write( )*	
Parameters	CSeaMaxW32*	SeaMaxPointer
	slave_address_t	slaveId
	seaio_type_t	type
	address_loc_t	starting_address
	address_range_t	range
	unsigned char*	data
Return Codes	*See CSeaMaxW32::Write( )*	

SeaMaxW32Ioctl

SeaMaxW32Ioctl(CSeaMaxW32* SeaMaxPointer, slave_address_t slaveId, IOCTL_t which, void* data)

Description	*See CSeaMaxW32::Ioctl( )*	
Parameters	CSeaMaxW32*	SeaMaxPointer
	slave_address_t	slaveId
	IOCTL_t	which
	void*	data
Return Codes	*See CSeaMaxW32::Ioctl( )*	

SeaMaxW32GetCommHandle

SeaMaxW32GetCommHandle(CSeaMaxW32* SeaMaxPointer)

Description	*See CSeaMaxW32::getCommHandle( )*	
Parameters	CSeaMaxW32*	SeaMaxPointer
Return Codes	*See CSeaMaxW32::getCommHandle( )*	

IOCTL Calls and Functionality

The Ioctl method allows multiple functions to be implemented through a single, convienient call. The last parameter of all Ioctl calls is a void pointer – a pointer that is cast to a particular data type depending on the use of the Ioctl call. Likewise, the actual Modbus traffic generated depends on the 'which' parameter and the type of Ioctl functionality desired. The following is a list of the Ioctl call types and their functionality.

Read Module Communications Parameters

Which	IOCTL_READ_COMM_PARAM (1)
Description	*Reads the communication parameter, model specific information, and configuration data from the SeaIO module.* *The last parameter is expected to be a pointer to a 'seaio_ioctl_s' structure. This structure will be populated with relavent information regarding the module mode, bridge type, baud rate, parity.* *All the returned information is stored in the 'seaio_ioctl_s' structure as a union named 'params'.*
Models	All SeaIO modules
Expected Data Type	Pointer to a seaio_ioctl_s structure
Return Codes	None

Set Module Software-Selectable Address

Which	IOCTL_SET_ADDRESS (2)		
Description	*Sets the SeaIO module's software selectable address.* *The last parameter is expected to be a pointer to a 'seaio_ioctl_s' structure. Only one field is used in the structure (u.address) and should be populated with a valid address before calling Ioctl.*		
Models	All SeaIO modules		
Expected Data Type	Pointer to a seaio_ioctl_s structure		
Return Codes	-22	EINVAL	A NULL pointer has been supplied where a pointer to a data buffer was expected.
	≥ 0		Success
	(Reference the return values for both Read( ) and Write( ))		

Set Module Baud Rate & Parity

Which	IOCTL_SET_COMM_PARAM (3)		
Description	*Sets the SeaIO module's baud rate and parity.* *The last parameter is expected to be a pointer to a 'seaio_ioctl_s' structure. Two fields are used in the structure (u.comms.new_baud_rate and u.comms.new_parity) and should be populated with valid data before calling Ioctl.*		
Models	All SeaIO modules		
Expected Data Type	Pointer to a seaio_ioctl_s structure		
Return Codes	-22	EINVAL	A NULL pointer has been supplied where a pointer to a data buffer was expected.
	≥ 0		Success
	(Reference the return values for both Read( ) and Write( ))		

Retrieve Module PIO Configuration

Which	IOCTL_GET_PIO (4)		
Description	*Requests from the SeaIO module the IO space configuration, as well as the module model.* *The last parameter is expected to be a pointer to a 'seaio_ioctl_s' structure. Firstly, the u.pio.model will be populated on return with an integer representation of the SeaIO module model number.* *Secondly, depending on the model, several fields may be populated. For the 462/463 models, the u.pio.config_state.PIO96.channel1 and u.pio.config_state.PIO96.channel2 fields will each contain a one-byte representation of the IO direction of 6 ports.* *The 'Set PIO Config' section under Modbus commands better describes the returned data format.*		
Models	SeaIO 462 / 463		
Expected Data Type	Pointer to a seaio_ioctl_s structure		
Return Codes	-22	EINVAL	A NULL pointer has been supplied where a pointer to a data buffer was expected.
	≥ 0		Success
	(Reference the return values for both Read( ) and Write( ))		

Set Module PIO Configuration

Which	IOCTL_SET_PIO (5)		
Description	*Sets the SeaIO module IO space configuration.* *The last parameter is expected to be a pointer to a 'seaio_ioctl_s' structure. Depending on the model, several fields should be populated before calling Ioctl.* *For the 462/463 models, the u.pio.config_state.PIO96.channel1 and u.pio.config_state.PIO96.channel2 fields should each contain a one-byte representation of the IO direction of 6 ports.* *The 'Set PIO Config' section under Modbus commands better describes the required data format.*		
Models	SeaIO 462 / 463		
Expected Data Type	Pointer to a seaio_ioctl_s structure		
Return Codes	-22	EINVAL	A NULL pointer has been supplied where a pointer to a data buffer was expected.
	≥ 0		Success
	(Reference the return values for both Read( ) and Write( ))		

Get Module A/D & D/A Configuration

Which	IOCTL_GET_ADDA_CONFIG (6)		
Description	*Requests from the SeaIO module the A/D and D/A configuration.* *The last parameter is expected to be a pointer to a 'adda_struct' structure. On return the adda_struct will contain the software selectable module A/D configuration and individual channel voltage ranges.* *The 'Set A/D, D/A Configuration' section under Modbus commands better describes the returned data format.*		
Models	SeaIO 470		
Expected Data Type	Pointer to a adda_struct structure		
Return Codes	-22	EINVAL	A NULL pointer has been supplied where a pointer to a data buffer was expected.
	≥ 0		Success
	(Reference the return values for both Read( ) and Write( ))		

Set Module A/D & D/A Configuration

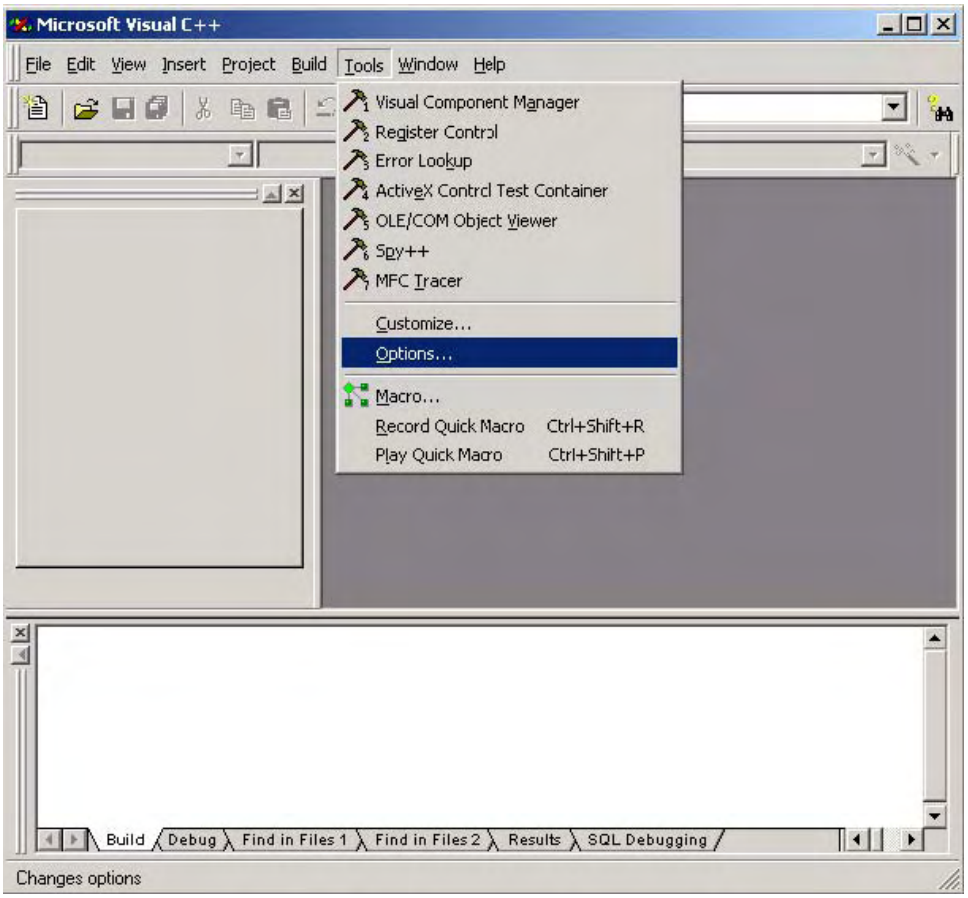
Which	IOCTL_SET_ADDA_CONFIG (7)		
Description	*Sets the SeaIO module A/D and D/A configuration.* *The last parameter is expected to be a pointer to a populated 'adda_struct' structure.* *The 'Set A/D, D/A Configuration' section under Modbus commands better describes the required data format.*		
Models	SeaIO 470		
Expected Data Type	Pointer to a adda_struct structure		
Return Codes	-22	EINVAL	A NULL pointer has been supplied where a pointer to a data buffer was expected.
	≥ 0		Success
	(Reference the return values for both Read( ) and Write( ))		

Get Module Onboard Hardware Configuration

Which	IOCTL_GET_ADDA_EXT_CONFIG (8)
Description	*Requests from the SeaIO module the current state of the on-board A/D and D/A jumper configuration.* *The last parameter is expected to be a pointer to a 'adda_extended_struct' structure. On return the structure will contain the state of the hardware jumpers specific to the SeaIO module.*
Models	SeaIO 470
Expected Data Type	Pointer to a adda_extended_struct structure
Return Codes	-22 EINVAL A NULL pointer has been supplied where a pointer to a data buffer was expected. ≥ 0 Success *(Reference the return values for both Read( ) and Write( ))*
NOTE	This particular call determines the on-board jumper settings by altering many of the outputs, reading the values returned, and determining the jumper settings required to match the results. This Ioctl functionality has been provided to determine the hardware settings on an unknown SeaIO module. If the hardware configuration is known, this call should be replaced with software coded values due to the time required to resolve the hardware configuration.

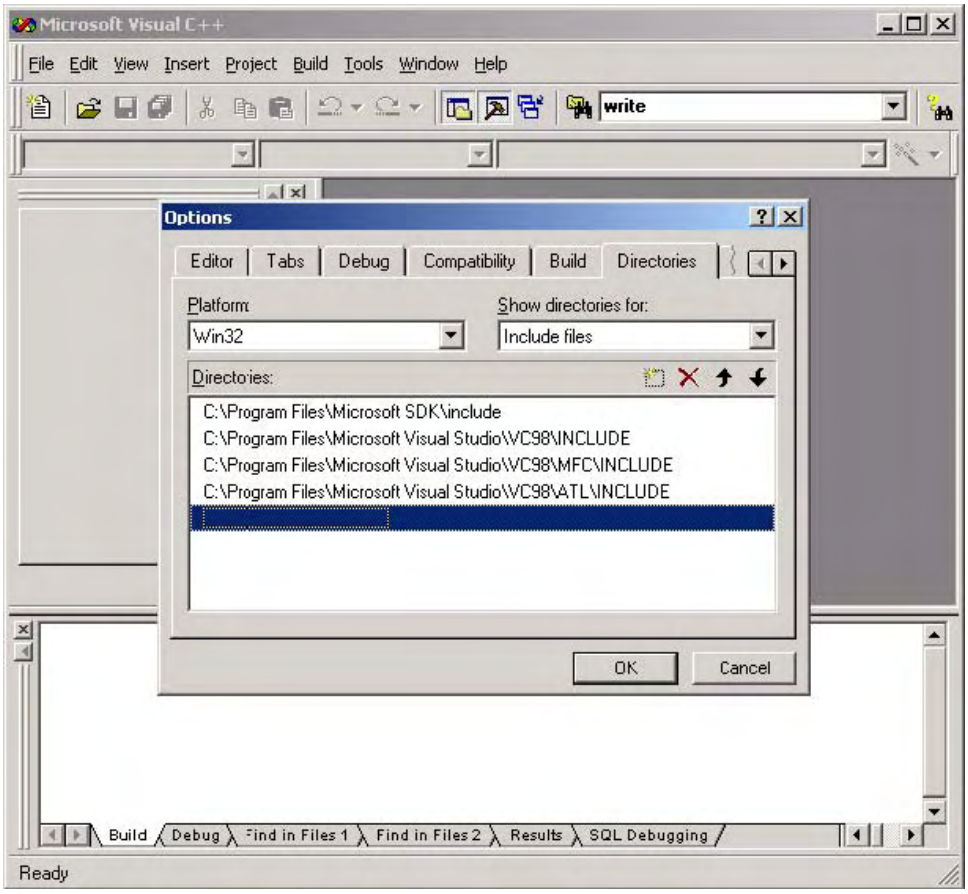
Using SeaMAX with Visual C++ 6.0

Before using SeaMAX within your Visual C++ 6.0 application, you must add the include paths and the library paths to help Visual C++ find the libraries. To configure Visual C++ to use the libraries, open Microsoft Visual C++ 6.0, and click the 'Tools' menu. Click on the 'Options' item to select the application options, as shown below.



To include the SeaMAX library files, choose the ‘Directories’ tab and select the ‘Include files’ option as shown below. Select the bottom blank line, click the new entry button, and add your SeaMAX installation directory.

NOTE: The default SeaMAX installation directory is: ‘C:\Program Files\Sealevel Systems\SeaMAX’



Perform the same operation for the “Library files” option. To add a new folder, click on the ‘Add’ button, and then click on the ‘(...)’ button to browse to your installation directory. You are now ready to use SeaMAX in your custom application.

Using SeaMAX with Visual Basic 6.0

In order to use the SeaMAX library with your Visual Basic program, it will first be necessary to import the SeaMAX functions using Declare. In each of the example folders, there exists a file named 'SeaMAX.bas' which contains the various type and function imports.

The following is an example of how to import the various SeaMAX functions into Visual Basic:

```
Public Declare Function SeaMaxW32GetCommHandle Lib "CSeaMaxW32.dll" _
    (ByVal ptr As Any) As Long

Public Declare Function SeaMaxW32Create Lib "CSeaMaxW32.dll" _
    () As Long

Public Declare Function SeaMaxW32Destroy Lib "CSeaMaxW32.dll" _
    (ByVal ptr As Any) As Long

Public Declare Function SeaMaxW32Open Lib "CSeaMaxW32.dll" _
    (ByVal ptr As Any, _
    ByVal portStr As String) As Long

Public Declare Function SeaMaxW32Close Lib "CSeaMaxW32.dll" _
    (ByVal ptr As Any) As Long

Public Declare Function SeaMaxW32Read Lib "CSeaMaxW32.dll" _
    (ByVal ptr As Any, _
    ByVal slaveId As Integer, _
    ByVal seaioType As Integer, _
    ByVal addressLoc As Integer, _
    ByVal addressRange As Integer, _
    ByRef readData As Any) As Long

Public Declare Function SeaMaxW32Write Lib "CSeaMaxW32.dll" _
    (ByVal ptr As Any, _
    ByVal slaveId As Integer, _
    ByVal seaioType As Integer, _
    ByVal addressLoc As Integer, _
    ByVal addressRange As Integer, _
    ByRef writeData As Any) As Long

Public Declare Function SeaMaxW32Ioctl Lib "CSeaMaxW32.dll" _
    (ByVal ptr As Any, _
    ByVal slaveId As Integer, _
    ByVal ioctlType As Integer, _
    ByRef data As Any) As Long
```

Example SeaMAX Programming Tasks

The following is a sampling of the various tasks that can be performed with the SeaMAX library. For more complete examples, see the provided Visual C++ and Visual Basic examples installed with the SeaMAX libraries.

> **NOTE:**  The SeaMAX installation places all these examples in the SeaMAX installation folder. Refer to those examples for more complete and in-depth information.

Opening/Closing a SeaI/O Module

Whether in C++ or Visual Basic, the process of accessing the SeaMAX libraries begins with the creation of a SeaMAX object. After creating the SeaMAX object, **Open()** can be called with a string argument indicating where the resource exists – either as COM resource or as a TCP/IP resource.

The following is an example of how to open a COM based SeaI/O module with an RS-232 bridge, USB bridge, or direct RS-485 connection.

```
CSeaMaxW32 cw32;
char *portString = “sealevel_rtu://COM6”;
int result = cw32.Open(portString);
```

For a TCP/IP connection to a SeaI/O module with a Ethernet bridge, the example port string below is valid. The code below is an example of how to open a TCP/IP enabled SeaI/O module in Visual Basic.

```
dim seaMaxPointer as Long
dim portString as String

portString = “sealevel_tcp://10.0.0.1”

seaMaxPointer = SeaMaxW32Create()
returnValue = SeaMaxW32Open(seaMaxPointer, portString)
```

Reading From Inputs / Outputs

In order to read from the inputs or outputs, the SeaIO module must first be opened successfully. The VC++ example below shows how to read in four inputs, starting at input 3 and continuing until input 6. In this case, since we are not reading in a full 8 bits, the data will be present in the lowest order bits of the data array.

```
unsigned char data[1] = {0};
int slaveId = 247
int type = D_INPUTS;
int start = 3;
int range = 4;

result = cw32.Read(slaveId, type, start, range, data);
```

Reading in inputs within Visual Basic is similar; D_INPUTS is the read type required for either language to access the inputs. The example below shows how it can be done through VB. If the current status of the outputs is required, a read can be performed using the COILS type.

```
dim slaveId, startLoc, range as Integer
dim recvData(2) as Byte

slaveId = 247
startLoc = 1
range = 16

returnValue = SeaMaxW32Read(seaMaxPointer, slaveId, D_INPUTS, _
    startLoc, range, recvData(0))
```

Writing to Outputs

Writing outputs is similar to reading inputs, with the single exception that Write or SeaMaxW32Write is called instead of Read. The two examples below show how to write to digital outputs using Write and SeaMaxW32Write in Visual C++ and Visual Basic, respectively.

```
result = cw32.Write(slaveId, COILS, start, range, data);

returnValue = SeaMaxW32Write(seaMaxPointer, slaveId, COILS, startLoc,
range, sendData(0))
```

Changing the Programmable I/O Configuration

For SeaI/O modules featuring programmable IO, it may be necessary to configure the IO direction and presets from a custom application, rather than through MaxSSD.

In such a case, the holding registers hold the module IO configuration. Specifically, holding registers 4 – 9 contain the bit presets for the module. However, these registers must be written singly, rather than performing a multi-register write (i.e. only one register should be written to at a time). Please note that holding registers are two bytes wide, each.

After the bit presets have been written, the IO direction can be set by writing to holding register three. For more information, consult the section labeled "Set PIO Config" and the appendix section titled "Model 462/463 Holding Registers."

```
result = cw32.Write(slaveId, HOLDINGREG,  4 + index, 1,
&writeHoldRegs[index]);

result = cw32.Write(slaveId, HOLDINGREG, 3, 1, &writeHoldRegs[0]
```

The following is an example of how to set the holding registers within a Visual Basic application.

```
returnValue = SeaMaxW32Write(seaMaxPointer, slaveId, HOLDINGREG, 4 +
Counter, 1, writeHoldRegs(i))

returnValue = SeaMaxW32Write(seaMaxPointer, slaveId, HOLDINGREG, 3, 1,
writeHoldRegs(0))
```

NOTE: Each group of 8 PIO is considered a port. Ports may be set either as a group of inputs or a group of outputs – with bit selectable presets for ports configured as outputs.

NOTE: The output port presets do not define a constant state for the output ports. Rather, the presets indicate the default state for when the ports change IO directions (i.e. from input to output) or when the device is reset.

Reading from Analog Inputs

In order to read from an A/D channel, SeaMAX requires that an input register read occurs – much like a discreet input read is required to read the digital input. It's important to note that a read of input register type requires that there be 2 bytes of available space allocated for each register being read. The example below exemplifies an input register read from within Visual C++.

```
result = cw32.Read(slaveId, INPUTREG, start, range, ad_input);
```

Following is an example of an input register read performed within a Visual Basic application.

```
returnValue = SeaMaxW32Read(seaMaxPointer, slaveId, INPUTREG, startLoc,
range, recvData(0))
```

The data returned by the Read function is only a binary value. In order to translate the data into a meaningful unit such as Volts or milliamps, refer to the example documentation provided within the SeaMAX installation.

Writing to Analog Outputs

Similar to reading from an A/D channel, writing to an analog output occurs by issuing a holding register write. Holding registers are two bytes wide and require that the data be available in Big Endian format.

```
result = cw32.Write(slaveId, HOLDINGREG, start, range, da_output);
```

The following example shows how to write to a holding register within Visual Basic.

```
returnValue = SeaMaxW32Write(seaMaxPointer, slaveId, HOLDINGREG,
startLoc, range, sendData(0))
```

Similar to reading A/D values, in order to convert a desired Voltage value into the appropriate Write data, consult the examples installed with the SeaMAX installation.

Configuring A/D or D/A Channels

In order to read the A/D channels properly, it is often necessary to first configure them to be within the proper voltage ranges. The following VC++ example shows how to get the current device configuration via an Ioctl call, adjust the channel and device settings, and then commit those changes back to the SeaIO module.

```
adda_ext_config     extended_configuration;

result = cw32.Ioctl(slaveId, IOCTL_GET_ADDA_EXT_CONFIG,
&extended_configuration);

configuration.device.reference_offset   = ANALOG_OFFSET;
configuration.device.channel_mode       = SINGLE_ENDED;
configuration.channels.ch_1             = PLS_MIN_TEN;

result = cw32.Ioctl(slaveId, IOCTL_SET_ADDA_CONFIG, &configuration);
```

In the example above, the device was set to measure the analog inputs as 16 single-ended inputs and the first channel was configured to be within the plus or minus 10 Volt range. In the Visual Basic example below, however, the device has been configured to read the analog inputs in current loop mode and channel 1 has been configured to the zero to five Volt range.

```
Dim configuration As adda_config

returnValue = SeaMaxW32Ioctl(seaMaxPointer, slaveId,
IOCTL_GET_ADDA_CONFIG, configuration)

configuration.device.reference_offset = ANALOG_OFFSET
configuration.device.channel_mode = SINGLE_ENDED
configuration.channels.ch_1 = PLS_MIN_TEN

returnValue = SeaMaxW32Ioctl(seaMaxPointer, slaveId,
IOCTL_SET_ADDA_CONFIG, configuration)
```

NOTE:  Please note that when setting the configuration, all channel ranges are set concurrently on an Ioctl set configuration call. In order to change a single channel's configuration, the current configuration must be requested, altered, and then reset.

CEthernet API

The CEthernet API is designed as an extension library that enables programmers to develop applications to automatically find, configure, and use Ethernet-enabled Sealevel devices. This library removes the manual hard-coding requirement of locating a device on the network and replaces it with an automatic search function. The CEthernet Development Libraries support the SeaI/O (Digital I/O) E-series and SeaLINK (Ethernet Serial Servers) product families.

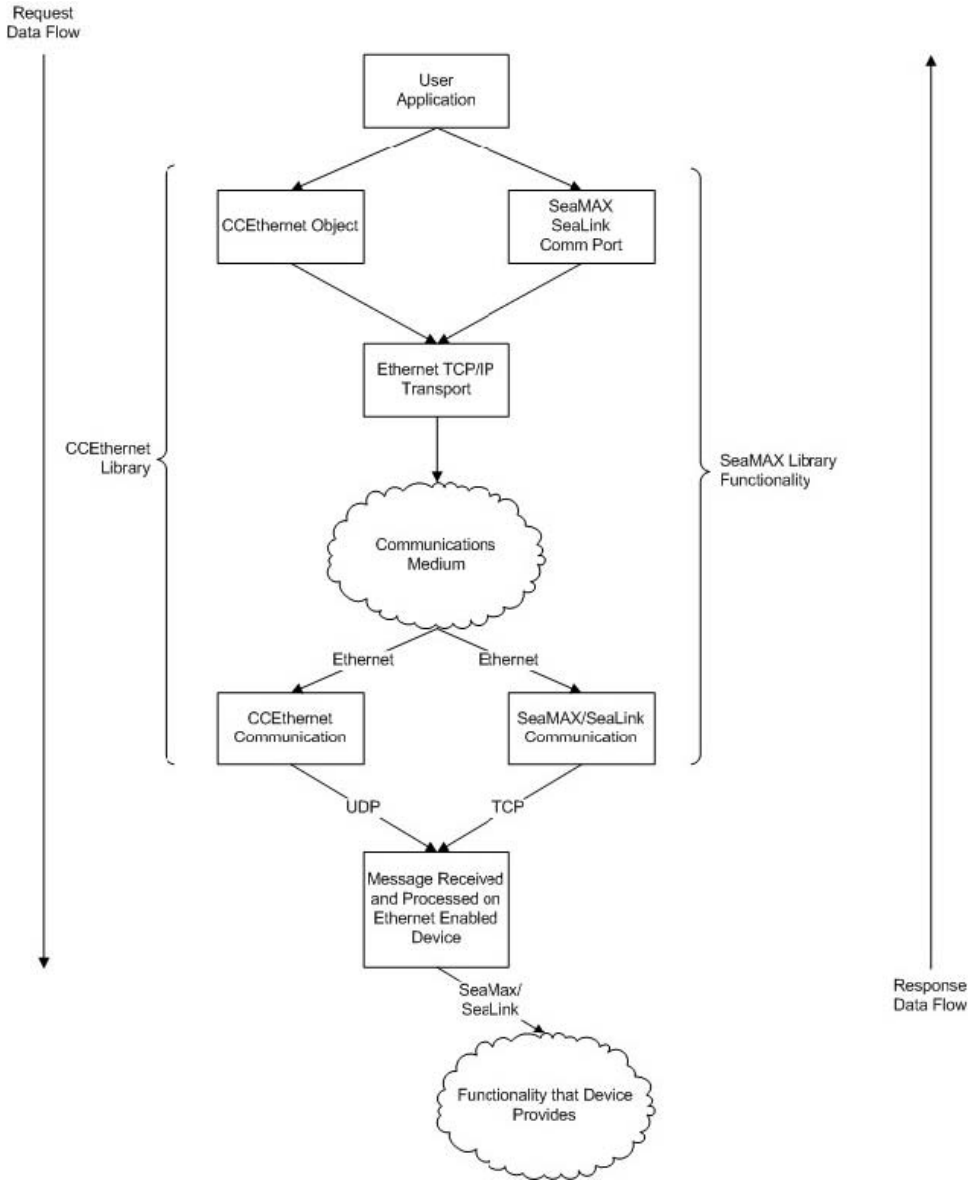
The source code contained in this document is designed to offer a high-level overview of how to utilize the libraries contained on the Sealevel software CD-ROM that ships with all SeaI/O modules. These code segments are meant as examples to assist in your application development. Contact technical support regarding any questions about the included code segments.

NOTE:

This library is **not** required to use any Sealevel Ethernet device.

CEthernet Architecture

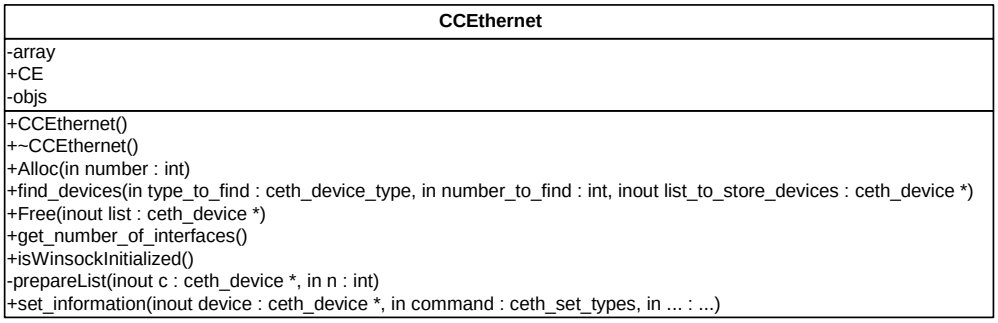
The diagram below is a high-level overview of how the CEthernet Library co-exists with other libraries, such as SeaMAX, to communicate with Ethernet-enabled devices. As stated in the introduction, this is a supplementary library and is not required for the device to be functional. All packets from the CEthernet library are UDP based.



Flow Model for Ethernet Enabled Devices

CEthernet API

The API to CCEthernet is easy to use, straightforward, and designed to be as user-friendly as possible. Looking at the UML diagram, one can determine that there are only six functions that the interface provides. Of those, only four are required for basic operation. Sample code segments are provided in a later section. Each of the methods are documented below, including the parameters and the associated return codes.



UML Class Model for CCEthernet

find_devices

Parameters

- **type_to_find**
  - Can be: SeaIO_Ethernet, SeaLink_Dev, or Sealevel_All_Devices.

- **number_to_find**
  - number <= number allocated using Alloc().

- **list_to_store_devices**
  - pointer to the list previously allocated.

Return Values

- **-100XX**
  - Socket Error. Refer to Winsock documentation for error code.

set_information

Parameters

- **device**
  - The device to modify the parameters of

- **command**
  - which parameters to modify, (SetIPAddress, SetDHCP, SetName).

- **...**
  - This list is based off the command parameter above. For more information, see below.

The variable argument list above, (denoted by the **...**) is defined by which command parameter is passed in. The commands can be logically OR'd together to make the sequence easier. First, each command individually:

- SetIPAddress
  - New IP Address
  - New Netmask
  - New Gateway

- SetDHCP
  - None

- SetName
  - New Name

If the IP configuration (DHCP or Static) is logically OR'd with the SetName option, the parameters for the IP address must come first, and the last parameter will be the name.

Return Values

- **-100XX**
  - Socket Error. Refer to Winsock documentation for error code.

Alloc

Parameters

- **number**
  - Number of devices to allocate space for. allocated.

Return Values

- **> 0**
  - Valid list.

- **-ENOMEM**
  - Error allocating memory.

Free

Parameters

- **list**
  - Pointer to the list previously allocated.

Return Values

- **None**

NOTE: 	Because the allocation masks much of the socket communication, the interface provides a mechanism to allocate and free the device structures. It will not automatically perform this operation and use of this library requires the explicit calls to **Alloc()** and **Free()**.

CEthernet Application Development

Using Visual C++

To use the CCEthernet Class, simply ensure that the SeaMAX directory is in the include and library path for Visual C++. Once that is complete, simply include the *CEthernet.lib* file is contained on the link tab settings for the project.

Required Code

For all of the following examples, the following must be in either the *StdAfx.h* file if using Precompiled Header Files (PCH) or at the top of the individual C++ file. Once these files are added, the code will know the definitions and locations for the provided library.

```
#include     <stdio.h>
#include     <windows.h>
#include     <stdlib.h>
#include     "CEthernet.h"
```

Simple Find Using `print_info` Function

This section will show a simple find on all Sealevel Devices. There is a helper function that is used to print out the information discovered about each unit. The source code segment for the helper function is listed below.

```
void print_info(ceth_device_p c)
{
	printf("Type : %s\n",
			c->type==SeaIO_Ethernet?"SeaIO Ethernet"
			:c->type==SeaLink_Dev?"SeaLink Device"
			:"Who Knows?");
	printf("Mac : %2.2X:%2.2X:%2.2X:%2.2X:%2.2X:%2.2X\n",
			c->mac_address.c[0],
			c->mac_address.c[1],
			c->mac_address.c[2],
			c->mac_address.c[3],
			c->mac_address.c[4],
			c->mac_address.c[5]);
	printf("IP : %d.%d.%d.%d\n",c->ip_address.c[0],
			c->ip_address.c[1],
			c->ip_address.c[2],
			c->ip_address.c[3]);
	printf("NetMask : %d.%d.%d.%d\n",c->net_mask.c[0],
			c->net_mask.c[1],
			c->net_mask.c[2],
			c->net_mask.c[3]);
	if(c->gateway.i == 0)
	{
		printf("Gateway: Not Set\n");
	}
	else
	{
		printf("Gateway : %d.%d.%d.%d\n",c->gateway.c[0],
			c->gateway.c[1],
			c->gateway.c[2],
			c->gateway.c[3]);
	printf("Name : %s\n",c->name);
	printf("DHCP Enabled? : %s\n",
			c->dhcp_enabled?"Yes":"No");
}
```

Finding All Devices

This simple code segment issues a find on all devices and then prints out each device using the `print_info` function code segment from the previous page.

This code segment allocates space for ten devices and then performs a find for devices. If the return code is greater than zero, then the function successfully found the number of devices returned.

Notice that we have to explicitly Free() the allocated buffers, and then delete the class for proper memory management.

```
int main(int argc, char* argv[])
{
	CCEthernet *a;
	ceth_device_p b;
	ceth_device_p d;
	int c;
	int i;

	a = new CCEthernet();
	b = a->Alloc(10);
	c=a->find_devices(Sealevel_All_Devices,10,b);
	if(c<0)
	{
		printf("Error %d\n",c);
		goto end;
	}
	printf("Found %d\n",c);
	d=b;
	for(i=0;i<c;i++)
	{
		dump_out(d);
		d++;
	}
end:
	a->Free(b);
	delete(a);
	return 0;

}
```

Appendix A – Data Encoding Tables

These tables help to decode **Get Config** responses from Sealevel SeaI/O modules. A **Get Config** response contains five bytes in the following order:

Model Number	Baud Rate	Bridge Type	Parity	Magic Cookie

For more information, refer to the **Get Config** request explained in the **Extended Modbus Command Set** section of this manual.

Model Numbers	
Result	**Model**
9A	410x
A4	420x
AE	430x
B8	440x
C2	450x
CE	462x
CF	463x
D6	470x
00	**See Note**

Baud Rates	
Result	**Baud Rate**
01	1200
02	2400
03	4800
04	9600
05	14.4K
06	19.2K
07	28.8K
08	38.4K
09	57.6K
0A	115.2K

NOTE: A '**Get**' request (0x45) resulting in (00) means that a '**Get Extended Module Information**' (0x66) request should be performed to retrieve the actual device number.
Refer to the **Extended Modbus Command** section of this manual for additional information.

Bridge Types	
Result	**Bridge**
00	RS-485
01	Ethernet
02	USB
03	RS-232
04	Expansion Unit

Parity	
Result	**Parity**
00	None
01	Odd
02	Even

Appendix B – CRC Calculation

To further illustrate the example shown in the **CRC-16** section, the algorithm for generating the CRC-16 is shown below.

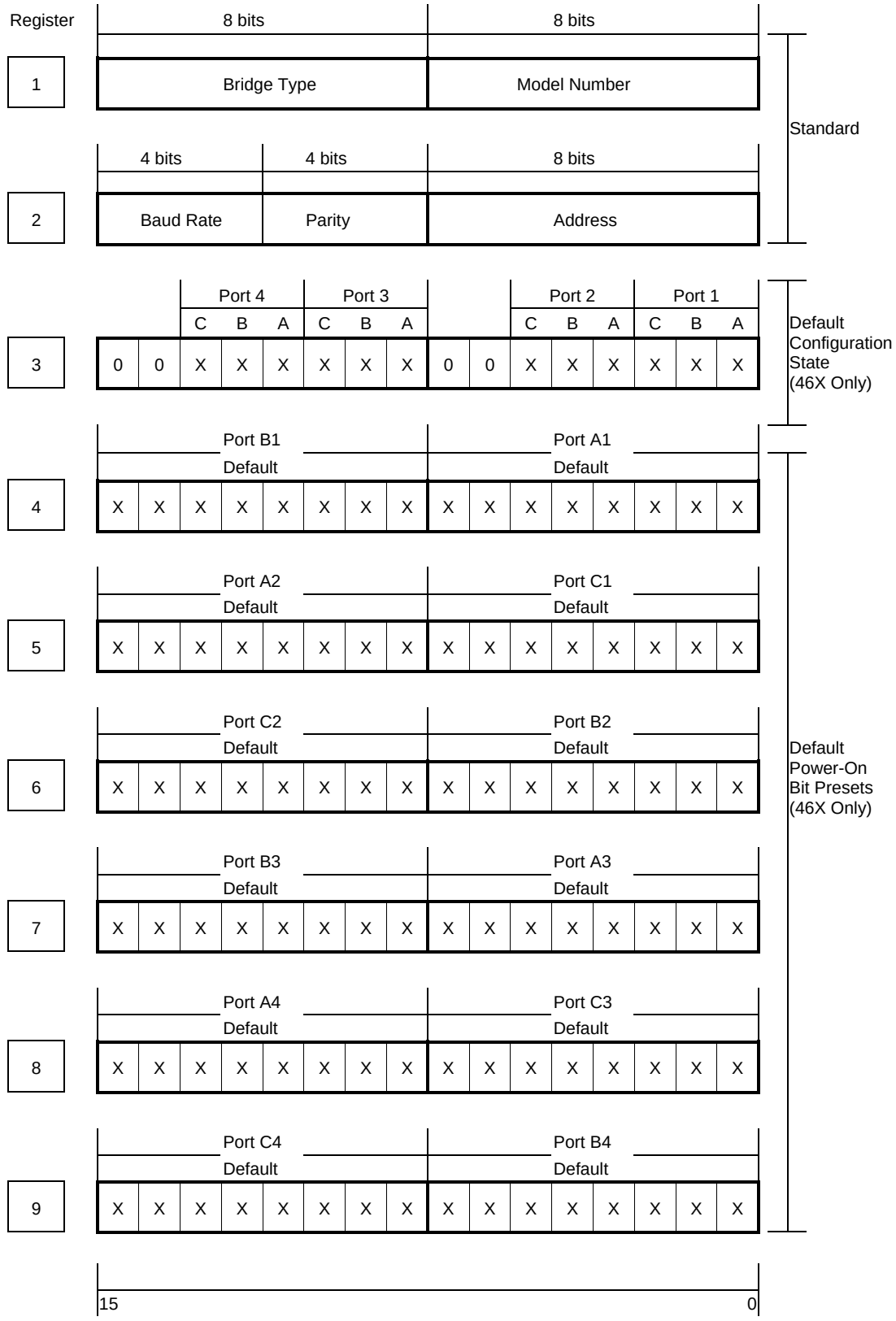
```
unsigned short calc_crc(int n,unsigned char *outbound_message)
{
   unsigned char carry_flag;
   unsigned short crc=0xFFFF;

   for (int i = 0; i < n; i++)
   {
          crc = crc ^ outbound_message[i];

          for (int j = 0; j < 8; j++)
          {
                 carry_flag = crc & 0x01;
                 crc = crc >> 1;
                 if (carry_flag == 1)
                 {
                        crc = crc ^ 0xA001;
                 }
          }
   }

   return crc;
}
```

Appendix C – SeaIO Model 462/463 Holding Register Set



Appendix D – SeaMAX Data Types and Structures

PIO Data Structure

```
struct PIO48_s
{
	unsigned char portA1;
	unsigned char portB1;
	unsigned char portC1;
	unsigned char portA2;
	unsigned char portB2;
	unsigned char portC2;
};

struct PIO96_s
{
	unsigned char portA1;
	unsigned char portB1;
	unsigned char portC1;
	unsigned char portA2;
	unsigned char portB2;
	unsigned char portC2;
	unsigned char portA3;
	unsigned char portB3;
	unsigned char portC3;
	unsigned char portA4;
	unsigned char portB4;
	unsigned char portC4;
};
```

PIO Configuration Structure

```
struct PIO48_config_s
{
	unsigned char channel1;
};

struct PIO96_config_s
{
	unsigned char channel1;
	unsigned char channel2;
};
```

PIO Get Ioctl Structure

```
struct SeaMAX_PIO_ioctl_s
{
	unsigned short model;
	union
	{
		PIO48_config_s PIO48;
		PIO96_config_s PIO96;
	} config_state;
};
```

Ioctl Structure

```
struct seaio_ioctl_get_params_s
{
	unsigned short model;
	unsigned char bridge_type;
	baud_rates_t baud_rate;
	parity_t parity;
	unsigned char magic_cookie;
};

struct seaio_ioctl_address_s
{
	unsigned char new_address;
};

struct seaio_ioctl_comms_s
{
	baud_rates_t new_baud_rate;
	parity_t new_parity;
};

struct seaio_ioctl_s
{
	union
	{
		seaio_ioctl_address_s address;
		seaio_ioctl_comms_s   comms;
		seaio_ioctl_get_params_s params;
		SeaMAX_PIO_ioctl_s pio;
		union
		{
			PIO48_config_s PIO48;
			PIO96_config_s PIO96;
		} config;
	} u;
};
```

PIO Read Structure

```
struct SeaMAX_PIO_s
{
	unsigned short model;
	union
	{
		PIO48_config_s PIO48;
		PIO96_config_s PIO96;
	} config_state;
	union
	{
		PIO48_s PIO48;
		PIO96_s PIO96;
	} data;

};
```

Channel Range Types

```
typedef enum
{
      ZERO_TO_FIVE  = 0,
      PLS_MIN_FIVE  = 1,
      ZERO_TO_TEN   = 2,
      PLS_MIN_TEN   = 3

} channel_range_type;
```

Channel Mode Types

```
typedef enum
{
      SINGLE_ENDED  = 0,
      DIFFERENTIAL  = 1,
      CURRENT_LOOP  = 2

} channel_mode_type;
```

A/D Voltage Reference Types

```
typedef enum
{
	ANALOG_OFFSET= 0,
	GND_OFFSET   = 1,
	AD_REF_OFFSET= 2,
	DA_CHANNEL_1 = 4,
	DA_CHANNEL_2 = 8

} ad_reference_type;
```

A/D D/A Configuration Structure

```
typedef struct
{
	struct
	{
		unsigned char reference_offset;
		unsigned char channel_mode;

	} device;

	struct
	{
		unsigned char ch_1;
		unsigned char ch_2;
		unsigned char ch_3;
		unsigned char ch_4;
		unsigned char ch_5;
		unsigned char ch_6;
		unsigned char ch_7;
		unsigned char ch_8;
		unsigned char ch_9;
		unsigned char ch_10;
		unsigned char ch_11;
		unsigned char ch_12;
		unsigned char ch_13;
		unsigned char ch_14;
		unsigned char ch_15;
		unsigned char ch_16;

	} channels;

} adda_config;
```

A/D D/A Extended Configuration Structure

```
typedef struct
{
	unsigned char       ad_multiplier_enabled;

	channel_range_type  da_channel_1_range;
	channel_range_type  da_channel_2_range;

} adda_ext_config;
```

Appendix E – Troubleshooting

Following these simple steps can eliminate most common problems.

1. Read this manual thoroughly before attempting to install the device in your system.
2. Uninstall any previous versions of the SeaMAX software before installing any new versions.
3. **Install SeaMAX software first**. Installing the software places the necessary files in the proper locations on your system. After installing the software, proceed with adding the hardware.
4. Install the SeaI/O modules one at a time. The "base" module must be properly configured and communicating successfully before adding additional expansion modules. Verify each expansion module can communicate before adding additional expansion modules.
5. Confirm that all screw terminal connections are correct and secure and that the correct cables are being used, including network cables (crossover vs. patch cables).
6. Verify that the device address (slave ID) is properly set. Refer to the **Hardware Configuration** section of this manual for instructions on setting the device slave ID.
7. Use the MaxSSD utility, included on the software CD, to verify proper installation. MaxSSD is designed to simplify the installation, configuration, and diagnostics of Sealevel SeaI/O modules.
8. If the SeaI/O modules only sometimes respond to a **Get** operation or return invalid data, you may have termination improperly set. Refer to the **Hardware Configuration** section of this manual for instructions on properly setting line termination and pull-up/pull-down resistors.
9. Refer to the **Troubleshooting Ethernet Modules** section on the following page for additional steps regarding Ethernet (E-series) modules.
10. If these steps do not solve your problem, please contact Sealevel Technical Support. Our technical support is free and available from 8:00AM-5PM Eastern Time, Monday through Friday. You can contact Technical Support via:

    Phone: (864) 843-4343

    Email: support@sealevel.com

Troubleshooting Ethernet (E-series) Modules

Problem: The SeaI/O module starts up with a strange IP address (i.e., 169.254.x.x)

All Ethernet SeaI/O (E-series) modules are shipped with DHCP enabled. If no DHCP server is available or the DHCP server cannot be reached, the Ethernet SeaI/O module will default to a random IP address in the range 169.254.0.1 to 169.254.255.254. Change the PC's network settings to place both the SeaI/O module and PC on the same subnet. Adjust the SeaI/O module's IP address and Netmask using the **Ethernet Config** utility (Start → All Programs → Sealevel SeaMAX → Ethernet Config) installed with SeaMAX. Then restore the PC's network settings.

Problem: The SeaI/O module is visible in Ethernet Config, but the network settings cannot be changed

The SeaI/O module is most likely on a different subnet than the PC. The PC's IP address and Netmask must be altered to place both the SeaI/O module and the PC within the same subnet. Contact your network administrator for assistance.

Problem: The SeaI/O module doesn't show up in Ethernet Config

The Ethernet SeaI/O modules are discovered via a UDP broadcast. Verify that any firewall software, such as Windows Firewall, ZoneAlarm, etc., or router settings that would hinder UDP transmissions are disabled.

It is also possible that the SeaI/O module may not be discovered if the PC and module are on separate subnets. This may occur if the module's IP address is configured outside the range of the PC's subnet. It can also occur during a failed DHCP discovery. In either case, the "Recover Module" button in Ethernet Config utility may be used to recover the device. Refer to the **Hardware Configuration** section of this manual for more information.

Problem: The rotary switch (ADDR) was used to reset an Ethernet SeaI/O module, but it no longer responds to a 'Get' operation.

If you reset the SeaI/O module by rotating the rotary switch clockwise one full revolution, the RS-485 port will reset to 9600 bps and no parity, but the Ethernet port will remain unaffected.

The broadcast feature in MaxSSD sets the Ethernet SeaI/O (E-series) module's TCP/IP to RS-485 translation data rate independently of the SeaI/O module itself. Therefore, if you have an Ethernet SeaI/O module and you set the data rate to 115.2K bps via a MaxSSD broadcast command, both the RS-485 port and the Ethernet port will respond thereafter to 115.2K bps, as expected. Using the rotary switch will reset the RS-485 port, but the Ethernet port will still try to communicate at 115.2k bps. To restore communications, broadcast a set data rate and parity command (9600 and no parity) via MaxSSD.

Appendix F – How To Get Assistance

When calling for technical assistance, please have your user manual and current device settings ready. If possible, please have the device installed and ready to run diagnostics.

Sealevel Systems maintains a website on the Internet. Our homepage address is http://www.sealevel.com. The latest software updates and newest manuals are available via our FTP site that can be accessed from our home page. Manuals and software can also be downloaded from the product page for your device.

Sealevel Systems provides an FAQ section on our website. Please refer to this to answer many common questions. This section can be found at http://www.sealevel.com/faq.asp

Technical support is available Monday to Friday from 8:00 a.m. to 5:00 p.m. eastern time. You can contact Technical Support via:

Phone: (864) 843-4343

Email: support@sealevel.com

Appendix G – Compliance Notices

Federal Communications Commission Statement

FCC - This equipment has been tested and found to comply with the limits for Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in such case the user will be required to correct the interference at the users expense.

EMC Directive Statement

CE

Products bearing the CE Label fulfill the requirements of the EMC directive (89/336/EEC) and of the low-voltage directive (73/23/EEC) issued by the European Commission.

To obey these directives, the following European standards must be met:

EN55022 Class A - "Limits and methods of measurement of radio interference characteristics of information technology equipment"

EN55024 – "Information technology equipment Immunity characteristics Limits and methods of measurement".

EN60950 (IEC950) - "Safety of information technology equipment, including electrical business equipment"

Warning
This is a Class A Product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures to prevent or correct the interference.

Always use cabling provided with this product if possible. If no cable is provided or if an alternate cable is required, use high quality shielded cabling to maintain compliance with FCC/EMC directives.

Warranty

Sealevel's commitment to providing the best I/O solutions is reflected in the Lifetime Warranty that is standard on all Sealevel manufactured products. We are able to offer this warranty due to our control of manufacturing quality and the historically high reliability of our products in the field. Sealevel products are designed and manufactured at its Liberty, South Carolina facility, allowing direct control over product development, production, burn-in and testing.

Sealevel Systems, Inc. (hereafter "Sealevel") warrants that the Product shall conform to and perform in accordance with published technical specifications and shall be free of defects in materials and workmanship for life. In the event of failure, Sealevel will repair or replace the product at Sealevel's sole discretion. Failures resulting from misapplication or misuse of the Product, failure to adhere to any specifications or instructions, or failure resulting from neglect or abuse are not covered under this warranty. Warranty service is obtained by delivering the Product to Sealevel and providing proof of purchase.

NOTE: **Return authorization must be obtained from Sealevel Systems before returned merchandise will be accepted. Authorization is obtained by calling Sealevel Systems and requesting a Return Merchandise Authorization (RMA) number.**

The Customer agrees to insure the Product or assume the risk of loss or damage in transit, to prepay shipping charges to Sealevel, and to use the original shipping container or equivalent. Warranty is valid only for original purchaser and is not transferable.

Sealevel Systems assumes no liability for any damages, lost profits, lost savings or any other incidental or consequential damage resulting from the use, misuse of, or inability to use this product. Sealevel Systems will not be liable for any claim made by any other related party.

This warranty applies to Sealevel manufactured Product. Product purchased through Sealevel but manufactured by a third party will retain the original manufacturer's warranty.

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