SeaRAQ™ I/O Modules

User Manual

Item# SeaRAQ™ I/O Modules

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Introduction

Sealevel SeaRAQ™ modules offer powerful data acquisition solutions that are perfect for a wide range of applications.SeaRAQ™ modules are available in various digital, analog, and serial I/O configurations. Each SeaRAQ model is designed for maximum flexibility and easy field wiring.

For easy software integration, application programs or 3rd party software can use the Sealevel SeaMAX™ library or industry standard Modbus RTU protocols.

Before You Get Started

Advisory Conventions

Warning - The highest level of importance used to stress a condition where damage could result to the product or the user could suffer serious injury.

Important– The middle level of importance used to highlight information that might not seem obvious or a situation that could cause the product to fail.

Note – The lowest level of importance used to provide background information, additional tips, or other non-critical facts that will not affect the use of the product.

Industry Segments

SeaRAQ™ modules are perfect for a wide variety of applications and environments including:

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

Features

- Supports Industry Standard Modbus RTU Protocol
- Models Offering Choice of:
  - Optically Isolated Inputs
  - Form A Relay Outputs
  - Form C Relay Outputs
  - Isolated Analog A/D & D/A
  - Thermocouple and RTD inputs
- Field Removable Terminal Block Connectors
- Extended Temperature Range (-40˚C to +85˚C)

SeaRAQ Products in This Manual

Model #	Description
6510	8 Channel-to-Channel Isolated Analog Inputs
6511	6 Channel Isolated RTD Analog Inputs
6512	6 Channel Isolated Thermocouple Inputs (Type E, J, or K)
6513	8 Channel Isolated Analog Inputs
6520	8 Channel-to-Channel Isolated Analog Outputs
6525	4 Channel-to-Channel Isolated Analog Outputs
8510	16 Channel Isolated Digital Inputs
8511	16 Channel Isolated AC Digital Inputs (0-132 VAC)
8512	16 Isolated Digital Inputs 4 Form C Relay Outputs
8520	16 Channel Isolated Form A Relay Outputs (5-30 VDC; 5-250 VAC)
8521	8 Channel Isolated Form A Relay Outputs

Installing SeaRAQ™ Modules

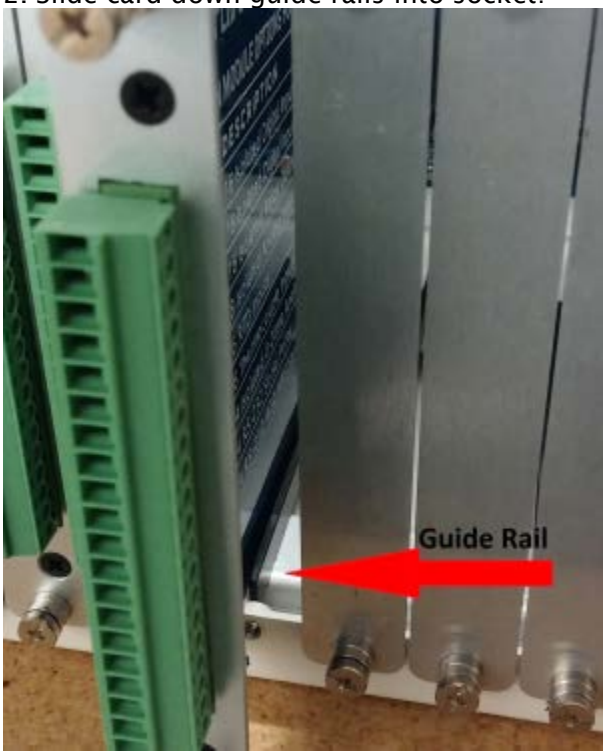
IMPORTANT NOTE:
The computer system must be shut down *before* any I/O expansion cards are inserted or removed. Ensure the front Power LED is OFF before adding or removing any I/O cards.[1]

Installing SeaRAQ™ modules is a simple matter of selecting a slot on the rear of the unit then removing the blank plate of the slot that you want to insert the module. Slide the card down the card guide and then seat into the connector in the rear of the slot, then tighten the thumbscrews into the chassis.

1. Loosen screws to blank plate:

[1] Backplane may also be powered down via Sealevel Talos software.

2. Slide card down guide rails into socket:



3. Tighten screws on top and bottom of bracket to securely mount the card.

General Wiring Guidelines

In addition to the following wiring suggestions, we strongly urge that you follow all wiring and safety codes that apply to your area or your type of equipment. In the United States, most areas have adopted the National Electrical Code standard and specify that all wiring conform to its requirements. In other countries, different codes will apply. For maximum safety to personnel and property, you must follow these codes. Failure to do so can lead to personal injury or death, property damage or destruction, or both.

Color Coding Wires

The following color codes are commonly used in industrial equipment manufactured in the United States. They are listed here as a reference. Where they are in conflict with codes that apply to your area or your type of equipment, you should follow your applicable codes instead. Besides satisfying code requirements, wire color-coding makes testing and troubleshooting safer, faster, and easier.

- Green or green with stripe – Ground
- Black – Primary AC
- Red – Secondary AC
- Blue – DC
- White – Common or neutral
- Yellow – Secondary power source not controlled by the main disconnect. Alerts maintenance personnel that there may be power present (from an external source) even if the equipment is disconnected from its main power source.

Wire Routing

To reduce noise coupling from external sources, it is recommended you keep electrically noisy wiring, such as AC power wiring and Discrete Output Module wiring, physically separated from low-level signal wiring such as DC and Analog Input module wiring or communications cables. This can be accomplished by grouping separately, where practical, the following categories of wiring:

- **Analog Input or Output Module wiring**. This wiring should be shielded to further reduce noise coupling.
- **Communications Cables.** Wiring such as Ethernet, USB, or serial communications cables should be kept away from noise-producing wiring.
- **DC Input Module wiring.** Although suppressed internally, these low-level inputs should be further protected against noise coupling by observing these wiring practices.
- **Discrete Output Module wiring.** These often switch inductive loads that produce noise spikes when switched off.

Where AC or Output wiring bundles must pass near noise-sensitive signal wiring bundles, avoid running them parallel with each other. Route them so that, if they have to cross, they do so at a right angle. This will minimize possible coupling between them.

SeaRAQ™ Module Common Features

Most SeaRAQ™ modules include the same connectors and are designed for the Sealevel R3 and R4 systems. You can remove the terminal block from the module in order to wire it, if desired. Then, when you are finished wiring it, you can easily reinstall it on the module. However, some prefer to leave it on the module when wiring. If you ever need to replace a module, you do not have to do any rewiring. Simply remove the wired terminal block from the old module and install it on the new module. The terminal block screw terminals are also convenient points for measuring voltages while testing or troubleshooting.

MODBUS Numbering Convention, Error Codes, and CRC Calculations

Since Modbus was initially created to talk to PLCs and they wanted things to make sense to technicians that were accustomed to ladder logic, Modbus applications start numbering registers, coils, inputs, etc. as number one. The applications then subtracted one from all of the addresses to pass to the actual PLC. Therefore, in all of the following messages, we have started addressing the register, coils, inputs, etc. starting at address zero.

When you send a Modbus message, you will get back either a good response or an error code. The error codes are defined in "Modbus Error Codes".

All Modbus/RTU messages end with a two character CRC (Cyclic Redundancy Check). The CRC is 16 bits long and can be calculated as shown in "CRC Calculation".

The Modbus message format documents can be obtained from www.modbus.org and are documented in the Modbus Application Protocol Specification.

Definition of Positive and Negative Logic

The IEC definitions for positive logic and negative logic, as applied to SeaRAQ™ I/O modules, are defined as follows.

Positive Logic - Input Modules

Input modules designed with positive logic characteristics sink current from the input device to the user common or negative power bus. The input device is connected between the positive power bus and the input terminal.

Positive Logic - Output Modules

Output modules designed with positive logic characteristics source current to the loads from the user common or positive power bus. The load is connected between the negative power bus and the module output.

Negative Logic - Input Modules

Input modules designed with negative logic characteristics source current through the input device to the user common or positive power bus. The input device is connected between the negative power bus and the input terminal.

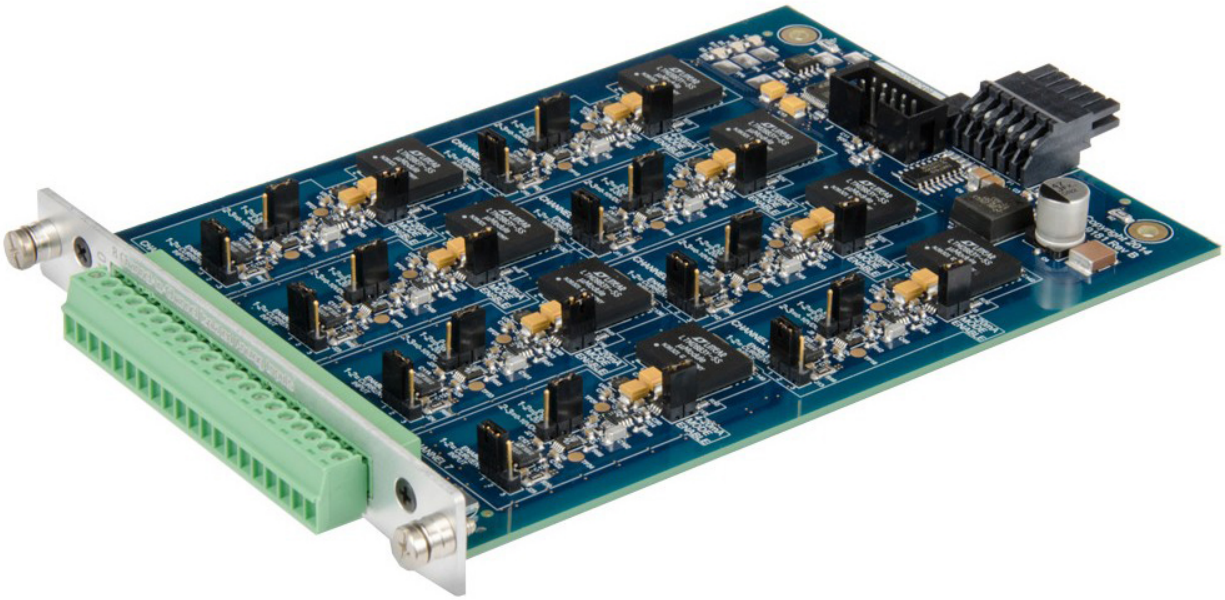
Negative Logic - Output Modules

Output modules designed with negative logic characteristics sink current from the loads to the user common or negative power bus. The load is connected between the positive power bus and the output terminal.

SeaRAQ™ Hardware Description

6510 - 8 Channel-to-Channel Isolated Analog Inputs

The SeaRAQ™ 6510 supports two input analog voltage ranges 0-5VDC and 0-10 VDC as well as 0-20mA input on each of its 8 isolated channels.



SPECIFICATIONS

Input Range	0-20ma, 0-5 VDC, 0-10 VDC
Update Rate	<0.1 Seconds (all points on card)
Resolution	5 µA
Impedance	250 Ohms
Maximum Error (Accuracy)	0.05% Full scale (0.01ma)
Linearity	0.02% Full Scale
Isolation (Field Side to Logic)	1500 VAC RMS
Channel-to-Channel Isolation	1500 VAC, +/- 2000 VDC
Common Mode Voltage	500 VAC RMS, +/- 500 VDC
Common Mode Rejection	> 70 dB, DC and 60 Hz
Analog Input Filter Response	1 KHz

6510 PIN OUT

1	Channel 1 +	11	Channel 5 +
2	Channel 1 -	12	Channel 5 -
3	Shield	13	Shield
4	Channel 2 +	14	Channel 6 +
5	Channel 2 -	15	Channel 6 -
6	Channel 3 +	16	Channel 7 +
7	Channel 3 -	17	Channel 7 -
8	Shield	18	Shield
9	Channel 4 +	19	Channel 8 +
10	Channel 4 -	20	Channel 8 -

CONFIGURATION

There are no software configurable options with this card. All configuration is accomplished with jumpers on the card.

Current Input Enable – Install this jumper to place a 249 ohm resistor in the circuit for 0/4-20mA inputs.
Input Range – This jumper has two settings for either 0 – 5VDC in or 0 – 10VDC in. The default is 0 – 5VDC so the only time this jumper needs to be moved is if a 0 – 10VDC voltage input is connected.

4-20mA Mode – This jumper is a digital input to the microcontroller to enable it to "0" out 4 – 20mA mode should that be desirable from the controller side. A 4mA input with the circuit scaling will produce nominally 10, 879 counts.

Full scale input is either 6V or 12V depending on the selected input range. The circuit allows full scale but does not max out the A/D to allow for measurements of voltages that are slightly higher than expected at full scale.

To derive the counts that should be expected at a known voltage, use the following equation:

(Vin/(Vrange/65535)), where Vrange is 6 or 12 and Vin is the voltage input to the channel.

With 5V applied (0-5 VDC range) a nominal count of 54612 should be returned with the requested 0.05% full scale accuracy window around that.

Note that in current input mode full scale input signal swing is 0 – 4.98V due to the inclusion of the .1% 249ohm current resistor. This should return a nominal full scale count of 54394. However, the full scale accuracy is reduced to 0.1% due to unavoidable losses in the PCB traces when that much current is pushed through. In voltage mode, very high input impedance minimizes this effect.

MESSAGE FORMAT – READ ANALOG VALUES

16 bit analog values are read from the card starting at Modbus location 0. The 16 bit values are stored in Holding Registers 0 through 7. To read all 8 analog values, use the following Modbus message.

Offsets (bytes)	Value	Description
0	n	Address based on which slot the card has been inserted
1	0x03	Read Holding Registers
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Registers to Read
5	0x08	Low Byte of Number of Registers to Read
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

The response back from the unit containing the returned data will be:

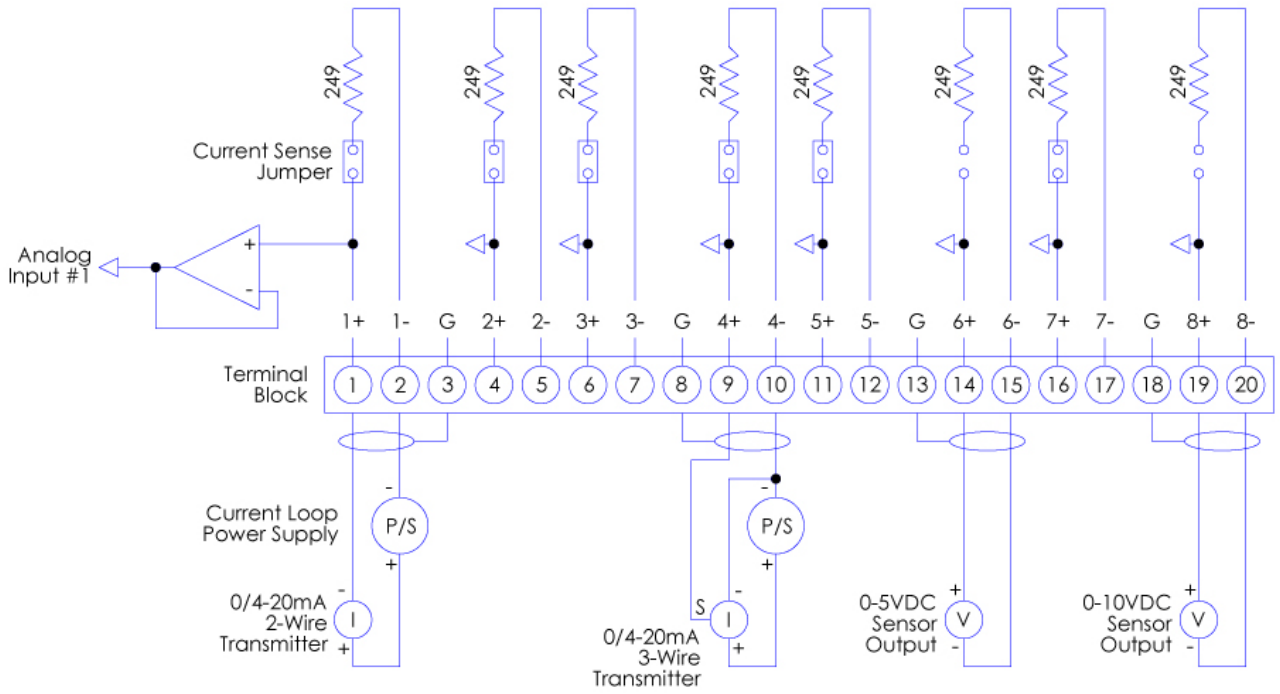
Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x03	Read Holding Registers
2	0x10	Byte count of returned values
3	?	High Byte of Register 0
4	?	Low Byte of Register 0
5	?	High Byte of Register 1
6	?	Low Byte of Register 1
7	?	High Byte of Register 2
8	?	Low Byte of Register 2
9	?	High Byte of Register 3
10	?	Low Byte of Register 3
11	?	High Byte of Register 4

12	?	Low Byte of Register 4
13	?	High Byte of Register 5
14	?	Low Byte of Register 5
15	?	High Byte of Register 6
16	?	Low Byte of Register 6
17	?	High Byte of Register 7
18	?	Low Byte of Register 7
19	CRC	Low Byte of CRC
20	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

- SM_ReadAnalogInputs(): Read analog-to-digital inputs
- SM_GetAnalogConfig(): Query the analog-to-digital interface configuration
- SM_Open():Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity (for serial SeaI/O modules only).
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX™ handle

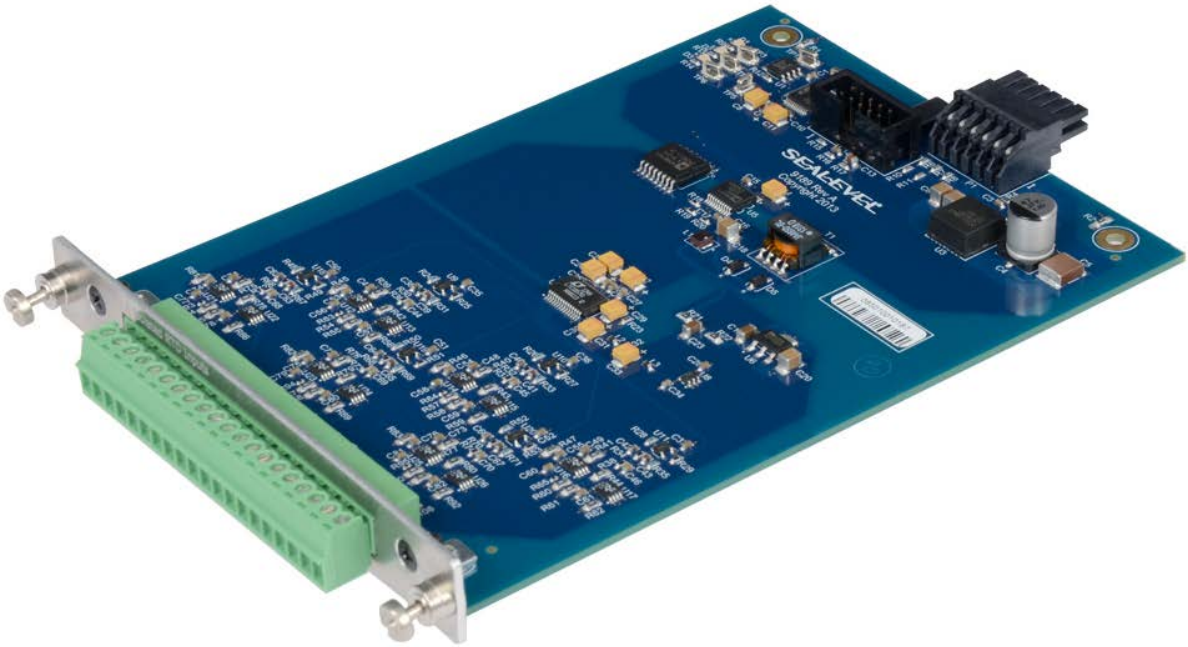
WIRING DIAGRAM



NOTES:
1.) REMOVE CURRENT SENSE JUMPER FOR VOLTAGE INPUT.
2.) SET GAIN JUMPER FOR 0-10VDC INPUT.

6511 - 6 Channel Isolated RTD Analog Inputs

The SeaRAQ™ 6511 is a 6 channel isolated Resistance Temperature Detector card. The module's 6 channels can accept a variety of RTD sensor types. The input module is a single slot module and requires no external power supply.



SPECIFICATIONS

RTD Types	RTD Platinum PT-100, Copper Cu-10, Nickel Ni-120 (2 or 3 wire configuration) Inputs
Update Rate	<5 Milliseconds per point
Resolution	0.1 ˚C
Accuracy	+/- 0.3 ˚C
Impedance	>20 MOhms
Maximum Error	0.05% Full scale
Linearity	0.02% Full scale
Isolation	1500 VAC RMS
Common Mode Rejection RTD	>60 dB DC and 50 or 60 Hz
Maximum Sustained Overvoltage	+/- 35 Volts

6511 PIN OUT

1	Shield	11	RTD 4 +
2	RTD 1 +	12	RTD 4 Sense +
3	RTD 1 Sense +	13	RTD 4 Sense -
4	RTD 1 Sense -	14	RTD 5 +
5	RTD 2 +	15	RTD 5 Sense +
6	RTD 2 Sense +	16	RTD 5 Sense -
7	RTD 2 Sense -	17	RTD 6 +
8	RTD 3 +	18	RTD 6 Sense +
9	RTD 3 Sense +	19	RTD 6 Sense -
10	RTD 3 Sense -	20	Shield

CONFIGURATION

There are no software configurable options with this card.

MESSAGE FORMAT – READ ANALOG VALUES

16 bit analog values are read from the card starting at Modbus location 0. The 16 bit values are stored in Holding Registers 0 through 5. To read all 6 analog values, use the following Modbus message.

Offsets (bytes)	Value	Description
0	n	Address based on which slot the card has been inserted
1	0x03	Read Holding Registers
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Registers to Read
5	0x06	Low Byte of Number of Registers to Read
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

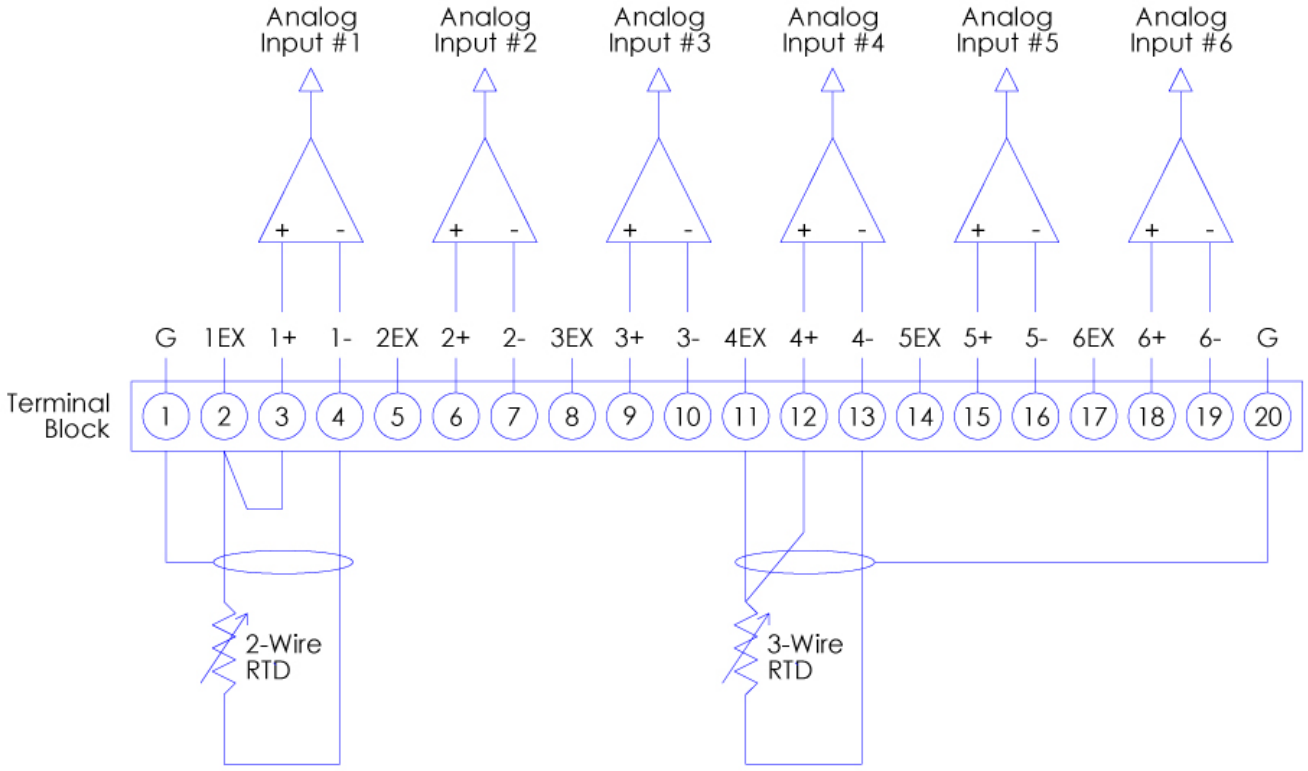
The response back from the unit containing the returned data will be:

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x03	Read Holding Registers
2	0x0C	Byte count of returned values
3	?	High Byte of Register 0
4	?	Low Byte of Register 0
5	?	High Byte of Register 1
6	?	Low Byte of Register 1
7	?	High Byte of Register 2
8	?	Low Byte of Register 2
9	?	High Byte of Register 3
10	?	Low Byte of Register 3
11	?	High Byte of Register 4
12	?	Low Byte of Register 4
13	?	High Byte of Register 5
14	?	Low Byte of Register 5
15	CRC	Low Byte of CRC
16	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

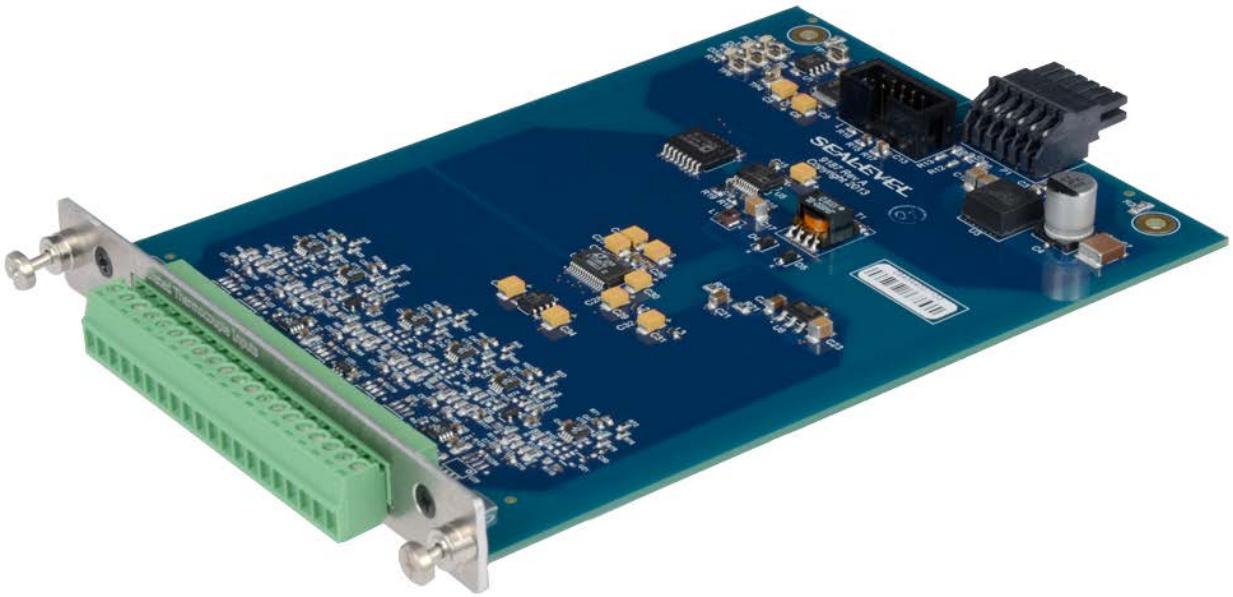
- SM_ReadAnalogInputs(): Read analog-to-digital inputs
- SM_GetAnalogInputConfig() & SM_GetAnalogInputRanges(): Query the analog-to-digital interface configuration
- SM_Open(): Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity.
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX™ handle

WIRING DIAGRAM



6512 - 6 Channel Isolated Thermocouple Inputs

The SeaRAQ™ 6512 is a 6 channel isolated Thermocouple input module. The 6512 can improve system performance by offering high channel-to-channel isolation that reduces the possibility of channel cross talk in electrically noisy environments. The 6512 supports most thermocouple input types and can measure millivolt inputs from peripheral sensors. Installation is simplified and costs are reduced by eliminating the need for external signal conditioners. The input module is a single slot module and requires no external power supply.



SPECIFICATIONS

Thermocouple Types	J, K, or E Thermocouples
Update Rate	<5 Milliseconds per point
Impedance	>20 MOhms
Maximum Error	0.05% Full Scale
Linearity	0.02% Full Scale
Isolation	1500 VAC RMS
Common Mode Rejection T/C	>100 dB DC and 50 or 60 Hz
Maximum Sustained Overvoltage	+/- 35 Volts

6512 PIN OUT

1	Shield	11	Shield
2	Channel 1 +	12	Channel 4 +
3	Channel 1 -	13	Channel 4 +
4	Shield	14	Shield
5	Channel 2 +	15	Channel 5 +
6	Channel 2 -	16	Channel 5 -
7	Shield	17	Shield
8	Channel 3 +	18	Channel 6 +
9	Channel 3 -	19	Channel 6 -
10	Shield	20	Shield

CONFIGURATION

There are no software configurable options with this card.

MESSAGE FORMAT – READ ANALOG VALUES

16 bit analog values are read from the card starting at Modbus location 0. The 16 bit values are stored in Holding Registers 0 through 7. To read all 8 analog values, use the following Modbus message.

Offsets (bytes)	Value	Description
0	n	Address based on which slot the card has been inserted
1	0x03	Read Holding Registers
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Registers to Read
5	0x08	Low Byte of Number of Registers to Read
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

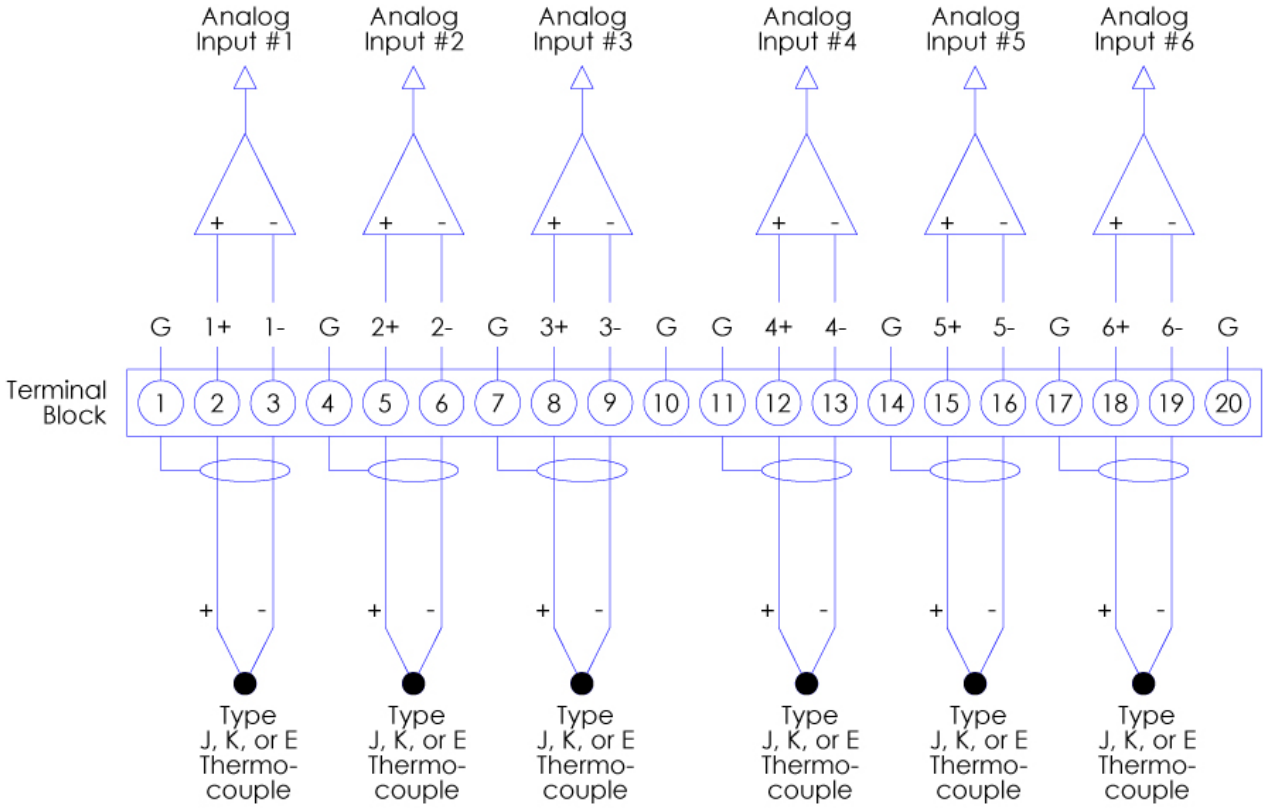
The response back from the unit containing the returned data will be:

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x03	Read Holding Registers
2	0x10	Byte count of returned values
3	?	High Byte of Register 0
4	?	Low Byte of Register 0
5	?	High Byte of Register 1
6	?	Low Byte of Register 1
7	?	High Byte of Register 2
8	?	Low Byte of Register 2
9	?	High Byte of Register 3
10	?	Low Byte of Register 3
11	?	High Byte of Register 4
12	?	Low Byte of Register 4
13	?	High Byte of Register 5
14	?	Low Byte of Register 5
15	?	High Byte of Register 6 – compensation for channels 1-3
16	?	Low Byte of Register 6
17	?	High Byte of Register 7 – compensation for channels 4-6
18	?	Low Byte of Register 7
19	CRC	Low Byte of CRC
20	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

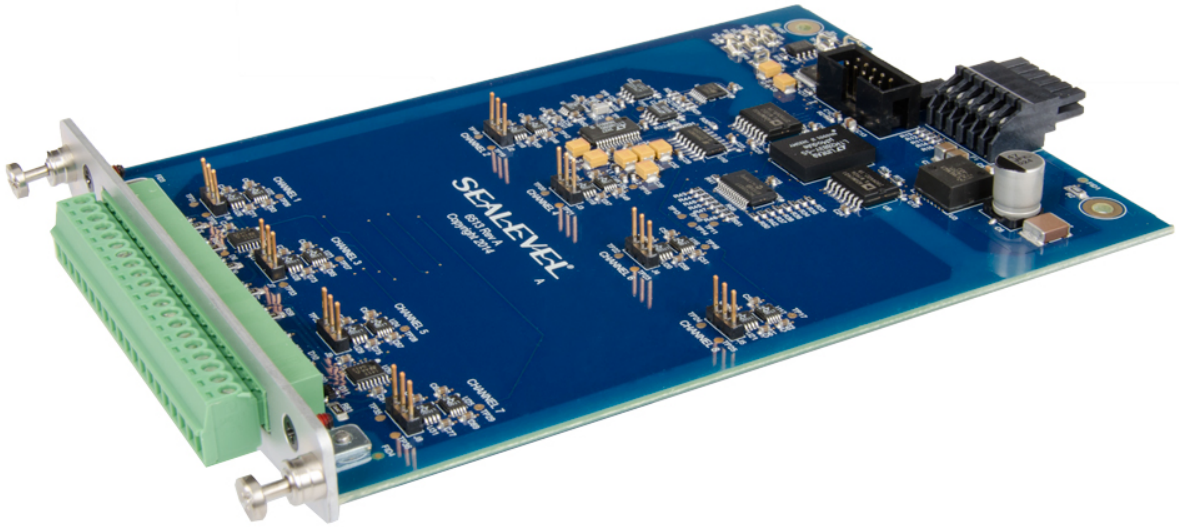
- SM_ReadAnalogInputs(): Read analog-to-digital inputs
- SM_GetAnalogInputConfig() & SM_GetAnalogInputRanges(): Query the analog-to-digital interface configuration
- SM_Open(): Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity.
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX™ handle

WIRING DIAGRAM



6513 - 8 Channel Isolated Analog Inputs

The SeaRAQ™ 6513 supports differential analog voltage ranges +/- 10VDC, +/- 5VDC, +/- 1VDC, +/- 0.5VDC, and +/- 0.15VDC as well as current 0-25mA independently configurable through software control on each of its 8 channels.



SPECIFICATIONS

Input Ranges	+/- 10VDC +/- 5VDC +/- 1VDC +/- 0.5VDC +/- 0.15VDC, 0-25mA
Update Rate	<0.1 Seconds (all points on card)
Resolution	16-bit (305µV, 153µV, 30µV, 15µV, 5µV, 1µA)
Impedance	>10Mohm (Voltage) 249 Ohms (Current)
Maximum Error (Accuracy)	+/-0.1% (Voltage) +/-0.2% (Current)
Linearity	0.02% Full Scale
Isolation (Field Side to Logic)	1500 VAC RMS
Common Mode Voltage	500 VAC RMS, +/- 500 VDC
Common Mode Rejection	> 70 dB, DC and 60 Hz
Analog Input Filter Response	1KHz

6513 PIN OUT

1	Channel 1 +	11	Channel 5 +
2	Channel 1 -	12	Channel 5 -
3	GND	13	GND_ISO
4	Channel 2 +	14	Channel 6 +
5	Channel 2 -	15	Channel 6 -
6	Channel 3 +	16	Channel 7 +
7	Channel 3 -	17	Channel 7 -
8	GND_ISO	18	GND
9	Channel 4 +	19	Channel 8 +
10	Channel 4 -	20	Channel 8 -

CONFIGURATION

The 6513 has software configurable voltage input scaling and the ability to in-line a 200 ohm resistor in order to measure current. Software configuration is supported through a proprietary format implemented in the SeaMAX library v3.3.6 or later. For configuration information see SM_SetAnalogInputRanges().

Ideal Transfer Function (Voltage)

$$Vin = K * (20.0 / 2^{16}) * DATA\ [VDC]$$

Where K is a hardware dependent factor and varies with range selection according to the following table.

Range	K
+/-10 VDC	1.0000
+/-5 VDC	0.5025
+/-1 VDC	0.1000
+/-0.5 VDC	0.0502
+/-0.15 VDC	0.01531

Ideal Transfer Function (Current)

$$Iin = ((5.0 * 1000) / 2^{16} / 200.5) * DATA\ [mA]$$

MESSAGE FORMAT – READ ANALOG VALUES

16-bit analog values are read from the card starting at Modbus location 0. The 16-bit values are stored in Input Registers 0 through 7. To read all 8 analog values, use the following Modbus message.

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x04	Read Input Registers
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Registers to Read
5	0x08	Low Byte of Number of Registers to Read
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

The response back from the unit containing the returned data will be:

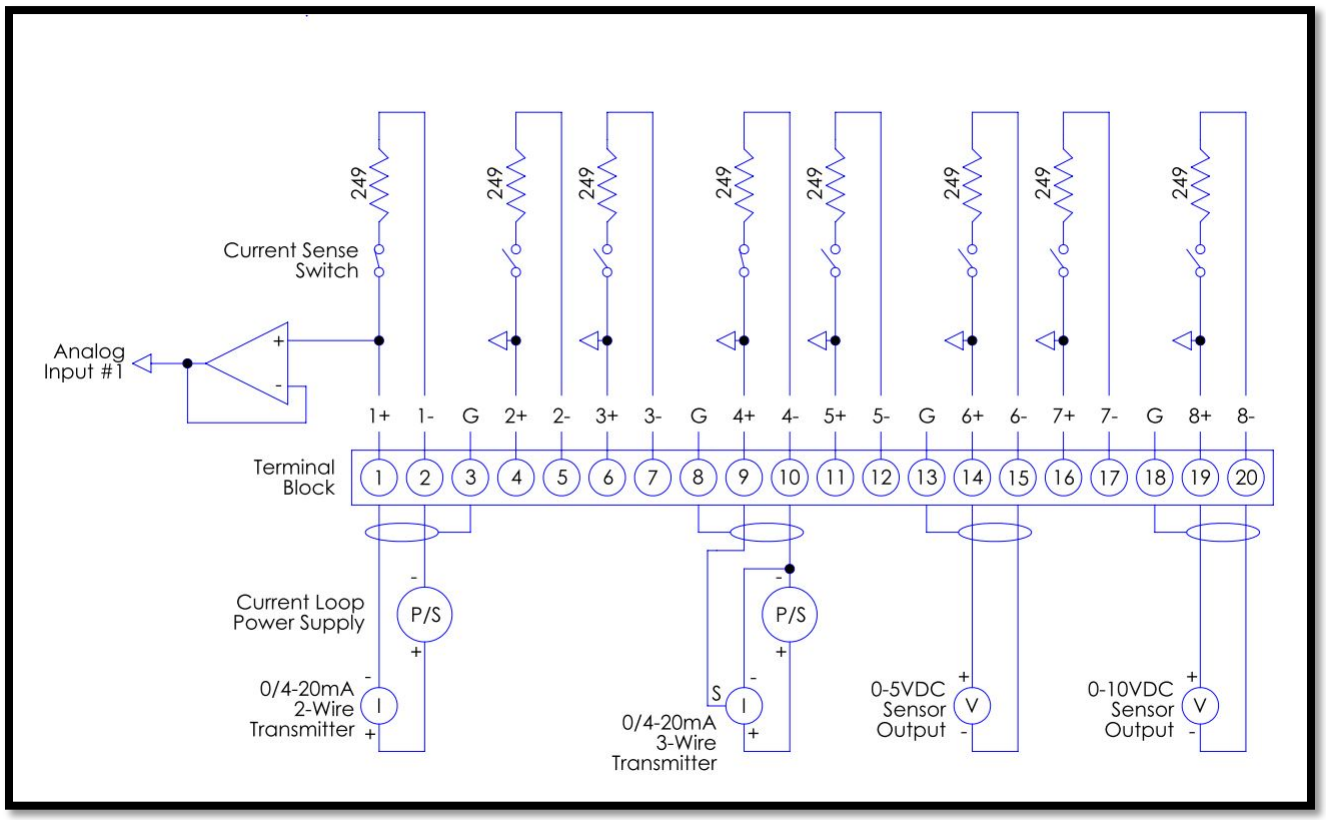
Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x04	Read Input Registers
2	0x10	Byte count of returned values
3	?	High Byte of Register 0
4	?	Low Byte of Register 0
5	?	High Byte of Register 1
6	?	Low Byte of Register 1
7	?	High Byte of Register 2
8	?	Low Byte of Register 2
9	?	High Byte of Register 3
10	?	Low Byte of Register 3
11	?	High Byte of Register 4
12	?	Low Byte of Register 4

13	?	High Byte of Register 5
14	?	Low Byte of Register 5
15	?	High Byte of Register 6
16	?	Low Byte of Register 6
17	?	High Byte of Register 7
18	?	Low Byte of Register 7
19	CRC	Low Byte of CRC
20	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

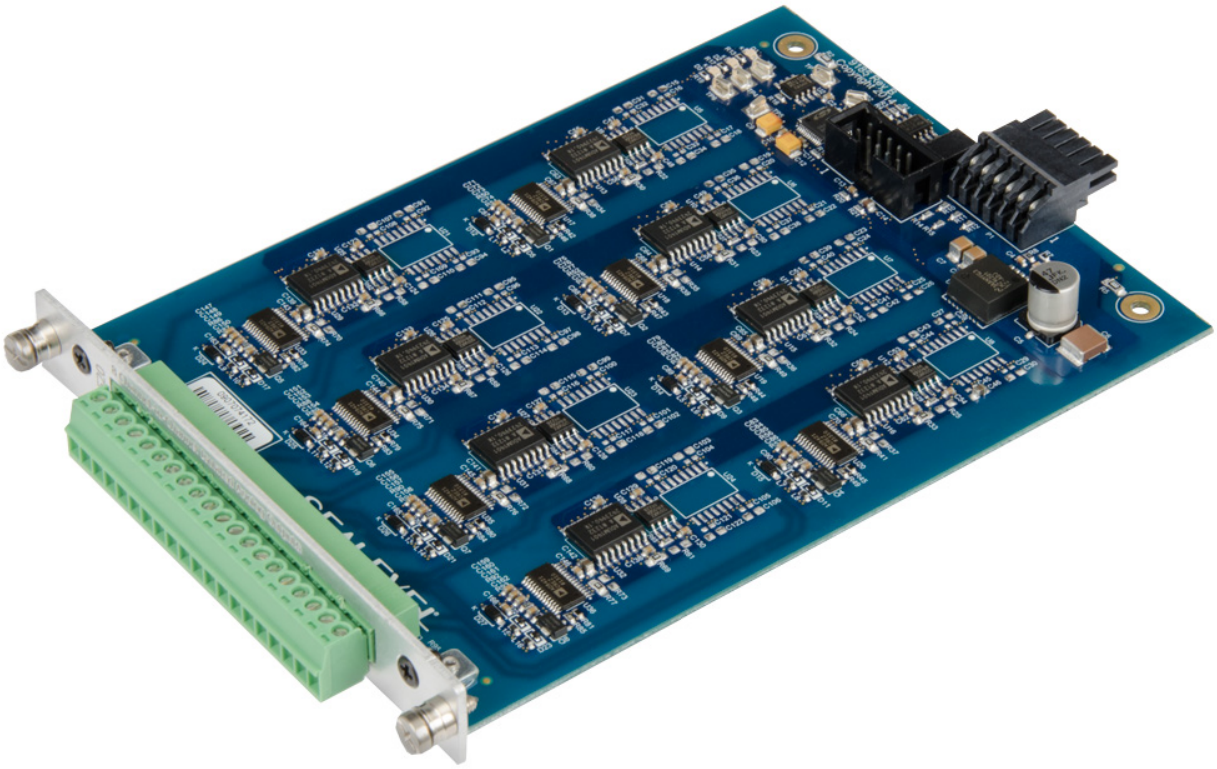
- **SeaMAX v3.3.6 or later required to function properly (note: INLINE_RESISTOR_249 has been changed to INLINE_RESISTOR_200 to match rev B hardware configuration).**
- SM_ReadAnalogInputs(): Read analog-to-digital inputs
- SM_GetAnalogInputConfig() & SM_GetAnalogInputRanges(): Query the analog-to-digital interface configuration
- SM_SetAnalogInputRanges(): Set analog-to-digital conversion range configuration
- SM_Open():Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity (for serial SeaI/O modules only).
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX handle

WIRING DIAGRAM



6520 - 8 Channel-to-Channel Isolated Analog Outputs

The SeaRAQ™ 6520 is an 8 channel-to-channel isolated 4-20 mA loop-powered analog output card. Input voltage range is 5.5V to 52V. User data is scaled so that 4.0 mA output corresponds to a raw digital count of 0 and 20.0 mA corresponds to a count of 65535 (full 16-bit resolution). When a fault is detected (DAC communications, Vloop tolerance, etc.) the output is automatically driven to the alarm current of 3.2 mA.



Ideal Transfer Function

Iloop = (16.0 mA / 216) * DATA + 4.0mA

SPECIFICATIONS

Output Range	4-20ma
User Loop Power Voltage Range	18-32 VDC
User Load	850 Ohms (Minimum load resistance)
Update Rate	<0.1 Seconds (all points on card)
Resolution	2 µA
Load Impedance	< 1100 Ohms @ 24 VDC Loop Power
Maximum Error (Accuracy)	0.05% Full scale
Linearity	0.02% Full Scale
Isolation (Field Side to Logic)	1500 VAC RMS

6520 PIN OUT

1	Channel 1 +	11	Channel 5 +
2	Channel 1 -	12	Channel 5 -
3	Shield	13	Shield
4	Channel 2 +	14	Channel 6 +
5	Channel 2 -	15	Channel 6 -
6	Channel 3 +	16	Channel 7 +
7	Channel 3 -	17	Channel 7 -
8	Shield	18	Shield
9	Channel 4 +	19	Channel 8 +
10	Channel 4 -	20	Channel 8 -

CONFIGURATION

There are no software configurable options with this card.

MESSAGE FORMAT – SET ANALOG OUTPUTS

16-bit analog values are written to the card starting at Modbus location 0. The 16-bit values are stored in Holding Registers 0 through 7 (corresponding to channels 1 – 8 respectively). To write all 8 analog values, use the following Modbus message.

Offset (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x10	Write Multiple Registers
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Registers to Write
5	0x08	Low Byte of Number of Registers to Write
6	0x10	Byte count of register data
7	?	High Byte of Register 0
8	?	Low Byte of Register 0
9	?	High Byte of Register 1
10	?	Low Byte of Register 1
11	?	High Byte of Register 2
12	?	Low Byte of Register 2
13	?	High Byte of Register 3
14	?	Low Byte of Register 3
15	?	High Byte of Register 4
16	?	Low Byte of Register 4
17	?	High Byte of Register 5
18	?	Low Byte of Register 5
19	?	High Byte of Register 6
20	?	Low Byte of Register 6
21	?	High Byte of Register 7
22	?	Low Byte of Register 7
23	CRC	Low Byte of CRC
24	CRC	High Byte of CRC

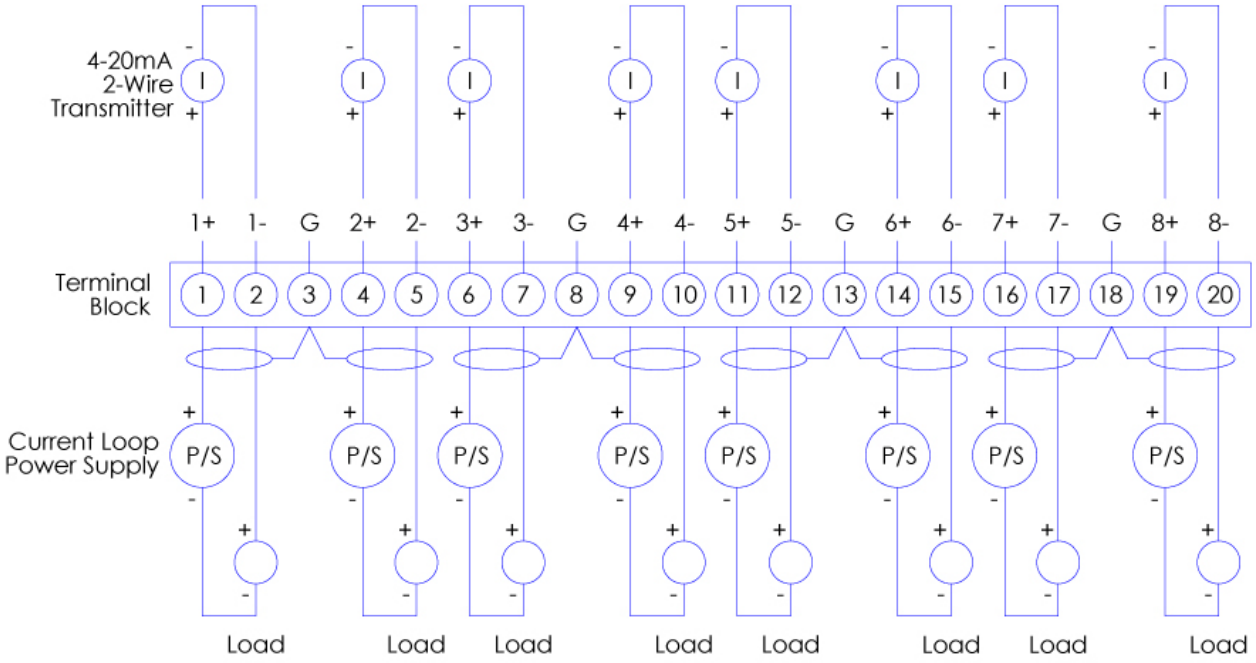
Upon successful completion of the command, the unit will respond with:

Offset (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x10	Write Multiple Registers
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Registers to Write
5	0x08	Low Byte of Number of Registers to Write
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

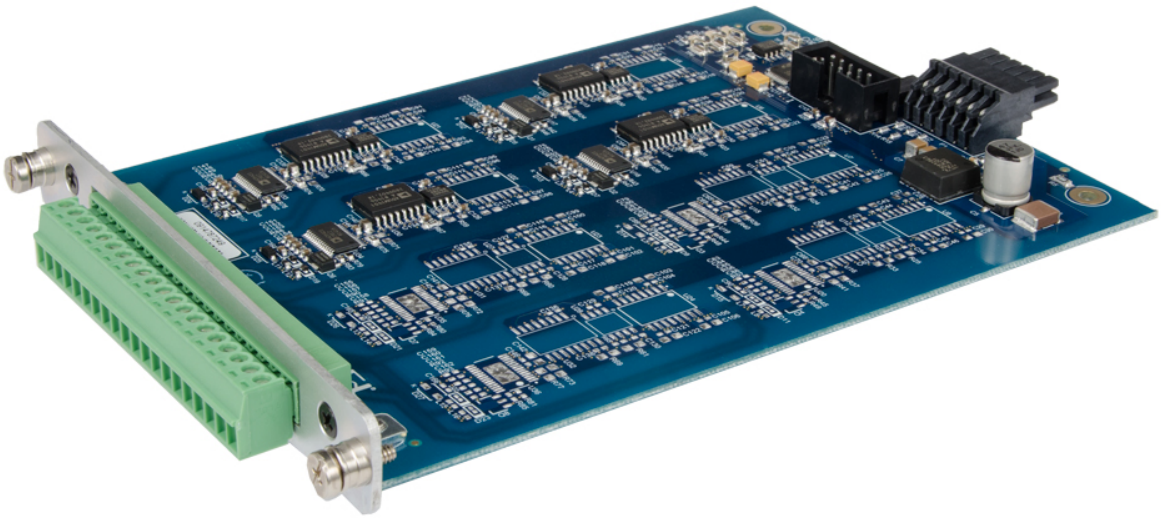
- SM_Open(): Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity (for serial SeaI/O modules only).
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX™ handle
- SM_WriteAnalogOutputs(): Write digital-to-analog outputs

WIRING DIAGRAM



6525 - 4 Channel-to-Channel Isolated Analog Outputs

The SeaRAQ™ 6520 is a 4 channel-to-channel isolated 4-20 mA loop-powered analog output card. Input voltage range is 5.5V to 52V. User data is scaled so that 4.0 mA output corresponds to a raw digital count of 0 and 20.0 mA corresponds to a count of 65535 (full 16-bit resolution). When a fault is detected (DAC communications, Vloop tolerance, etc.) the output is automatically driven to the alarm current of 3.2 mA.



Ideal Transfer Function

Iloop = (16.0 mA / 216) * DATA + 4.0mA

SPECIFICATIONS

Output Range	4-20ma
User Loop Power Voltage Range	18-32 VDC
User Load	850 Ohms (Minimum load resistance)
Update Rate	<0.1 Seconds (all points on card)
Resolution	2 µA
Load Impedance	< 1100 Ohms @ 24 VDC Loop Power
Maximum Error (Accuracy)	0.05% Full scale
Linearity	0.02% Full Scale
Isolation (Field Side to Logic)	1500 VAC RMS

6525 PIN OUT

1	Channel 1 +	11	No Connect
2	Channel 1 -	12	No Connect
3	Shield	13	No Connect
4	Channel 2 +	14	No Connect
5	Channel 2 -	15	No Connect
6	Channel 3 +	16	No Connect
7	Channel 3 -	17	No Connect
8	Shield	18	No Connect
9	Channel 4 +	19	No Connect
10	Channel 4 -	20	No Connect

CONFIGURATION

There are no software configurable options with this card.

MESSAGE FORMAT – SET ANALOG OUTPUTS

16-bit analog values are written to the card starting at Modbus location 0. The 16-bit values are stored in Holding Registers 0 through 3 (corresponding to channels 1 – 4 respectively). To write all 4 analog values, use the following Modbus message.

Offset (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x10	Write Multiple Registers
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Registers to Write
5	0x04	Low Byte of Number of Registers to Write
6	0x10	Byte count of register data
7	?	High Byte of Register 0
8	?	Low Byte of Register 0
9	?	High Byte of Register 1
10	?	Low Byte of Register 1
11	?	High Byte of Register 2
12	?	Low Byte of Register 2
13	?	High Byte of Register 3
14	?	Low Byte of Register 3
15	CRC	Low Byte of CRC
16	CRC	High Byte of CRC

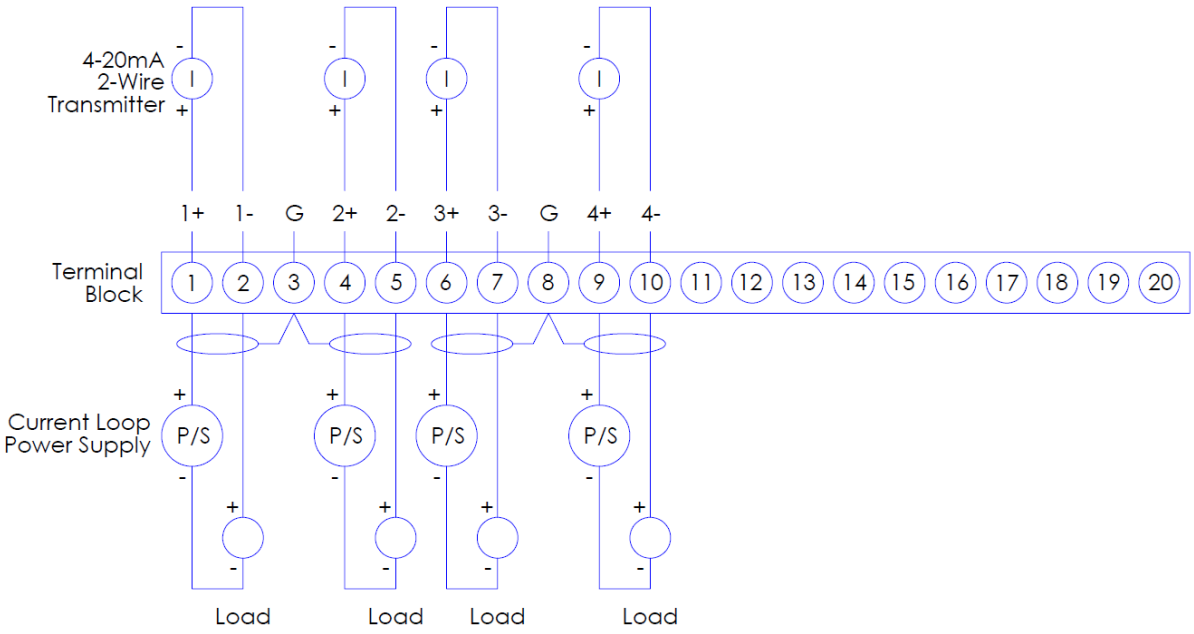
Upon successful completion of the command, the unit will respond with:

Offset (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x10	Write Multiple Registers
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Registers to Write
5	0x04	Low Byte of Number of Registers to Write
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

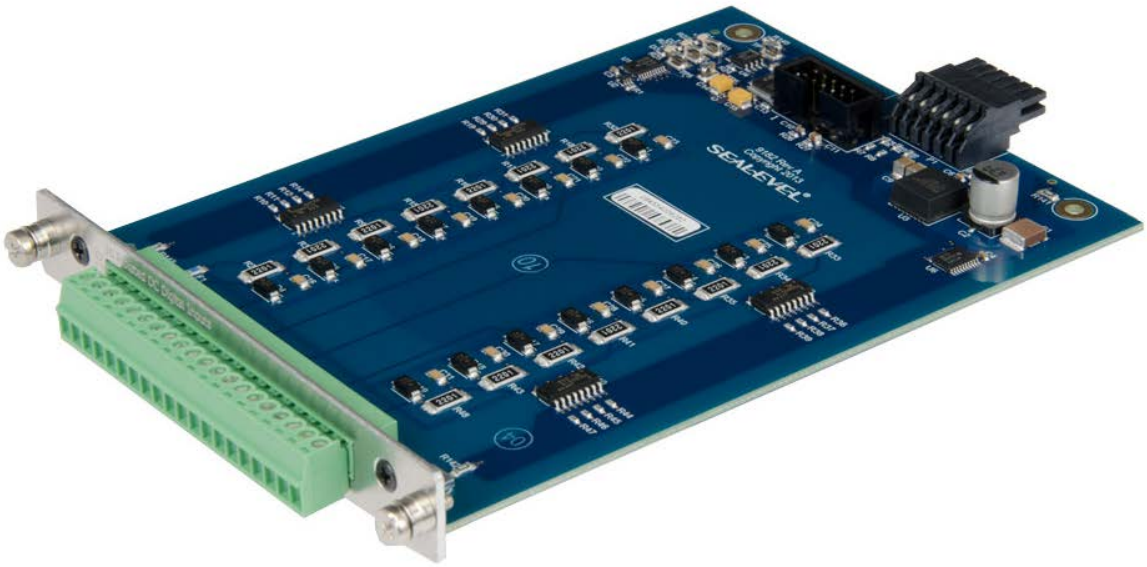
- SM_Open(): Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity (for serial SeaI/O modules only).
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX handle
- SM_WriteAnalogOutputs(): Write digital-to-analog outputs

WIRING DIAGRAM



8510 – 16 Channel Isolated Digital Inputs

The SeaRAQ™ 8510 provides 16 optically isolated digital input channels that allow you to input the logic signal from 3 to 30VDC.



SPECIFICATIONS

Input Voltage Range	3-30 VDC (24 VDC Rated Voltage) Will handle TTL inputs.
Input Current	7 mA @ Rated Voltage
Isolation (Field Side to Logic)	1500 VAC RMS
Response time	7 Milliseconds (On or Off) Maximum
On-stage Voltage	+3 to +30 VDC
Off-state Voltage	0 to +0.8 VDC
On-state Current	0.72 mA Minimum
Off-state Current	0 mA

8510 PIN OUT

1	DC Input COM	11	Channel 10
2	Channel 1	12	Channel 11
3	Channel 2	13	Channel 12
4	Channel 3	14	Channel 13
5	Channel 4	15	Channel 14
6	Channel 5	16	Channel 15
7	Channel 6	17	Channel 16
8	Channel 7	18	No Connect
9	Channel 8	19	No Connect
10	Channel 9	20	No Connect

CONFIGURATION

There are no software configurable options with this card.

MESSAGE FORMAT – READ DIGITAL INPUT STATES

16 bit digital values are read from the card starting at Modbus location 0. The 16 bit values are read as discrete inputs 0 through 15. To read all 16 digital states, use the following Modbus message.

Offsets (bytes)	Value	Description
0	n	Address based on which slot the card has been inserted
1	0x02	Read Discrete Inputs
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Inputs
5	0x10	Low Byte of Number of Inputs
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

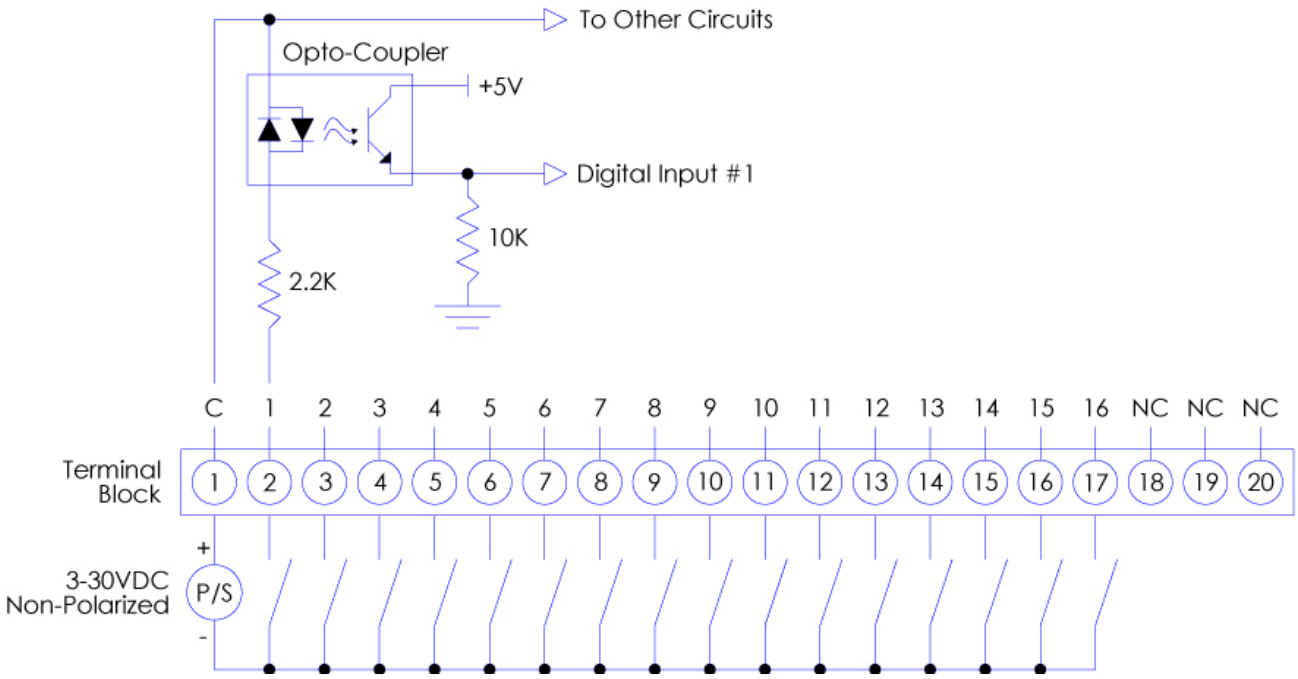
The response back from the unit containing the returned data will be:

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x02	Read Holding Registers
2	0x02	Byte count of returned values
3	?	8 bit pattern with the low order bit being the 1st input
4	?	8 bit pattern with the low order bit being the 9th input
5	CRC	Low Byte of CRC
6	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

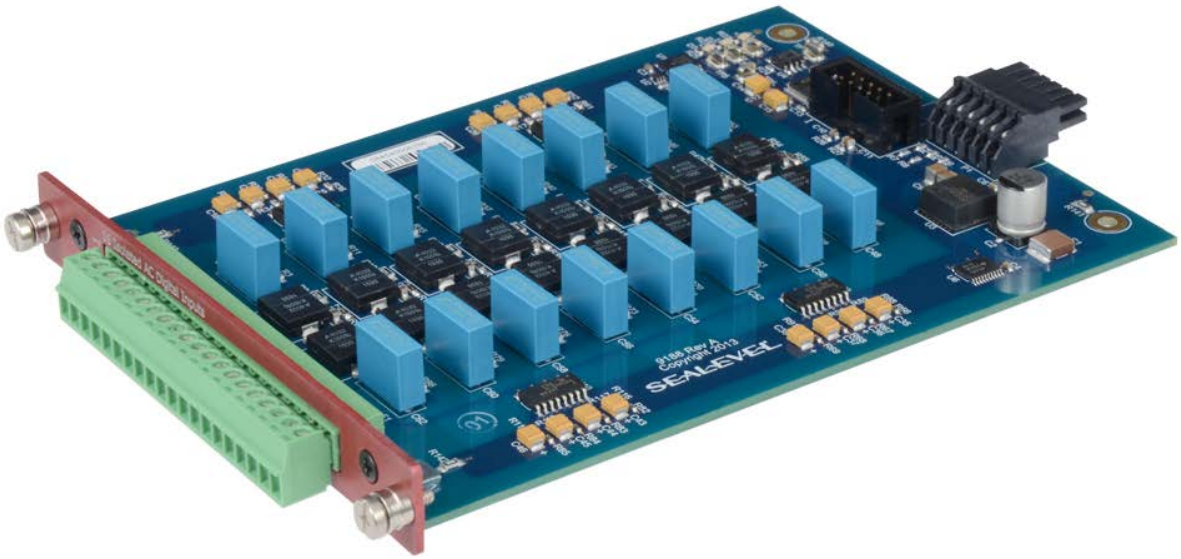
- SM_ReadDigitalInputs(): Read digital inputs
- SM_Open(): Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity.
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX™ handle

WIRING DIAGRAM



8511 - 16 Channel Isolated AC Digital Inputs

The SeaRAQ™ 8511 provides isolated AC digital input for AC voltages up to 132 VAC. You can use the board to isolate the computer from large common-mode voltages, ground loops, and voltage spikes that often occur in industrial environments.



SPECIFICATIONS

Input Voltage Range	0-132 VAC
Input Current	7 mA @ Rated Voltage
Isolation (Field Side to Logic)	1500 VAC RMS
Response time	30 ms (On or Off) Maximum
On-stage Voltage	74 to 132 VAC
Off-state Voltage	0 to 20 VAC
On-state Current	6 mA Minimum
Off-state Current	2.2 mA Maximum

USE EXTREME CAUTION!
High voltages will be present on the 8511 when high voltage is connected. Never handle the printed circuit board when high voltage signals are connected to the board. Note that the mounting bracket is colored red to indicate the possibility of dangerous voltages.

8511 PIN OUT

1	Channel 1	11	Channel 11
2	Channel 2	12	Channel 12
3	Channel 3	13	Channel 13
4	Channel 4	14	Channel 14
5	Channel 5	15	Channel 15
6	Channel 6	16	Channel 16
7	Channel 7	17	No Connect
8	Channel 8	18	No Connect
9	Channel 9	19	AC Input Neutral
10	Channel 10	20	No Connect

CONFIGURATION

There are no software configurable options with this card.

MESSAGE FORMAT – READ DIGITAL INPUT STATES

16-bit digital values are read from the card starting at Modbus location 0. The 16-bit values are read as discrete inputs 0 through 15. To read all 16 digital states, use the following Modbus message.

Offsets (bytes)	Value	Description
0	n	Address based on which slot the card has been inserted
1	0x02	Read Discrete Inputs
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Inputs
5	0x10	Low Byte of Number of Inputs
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

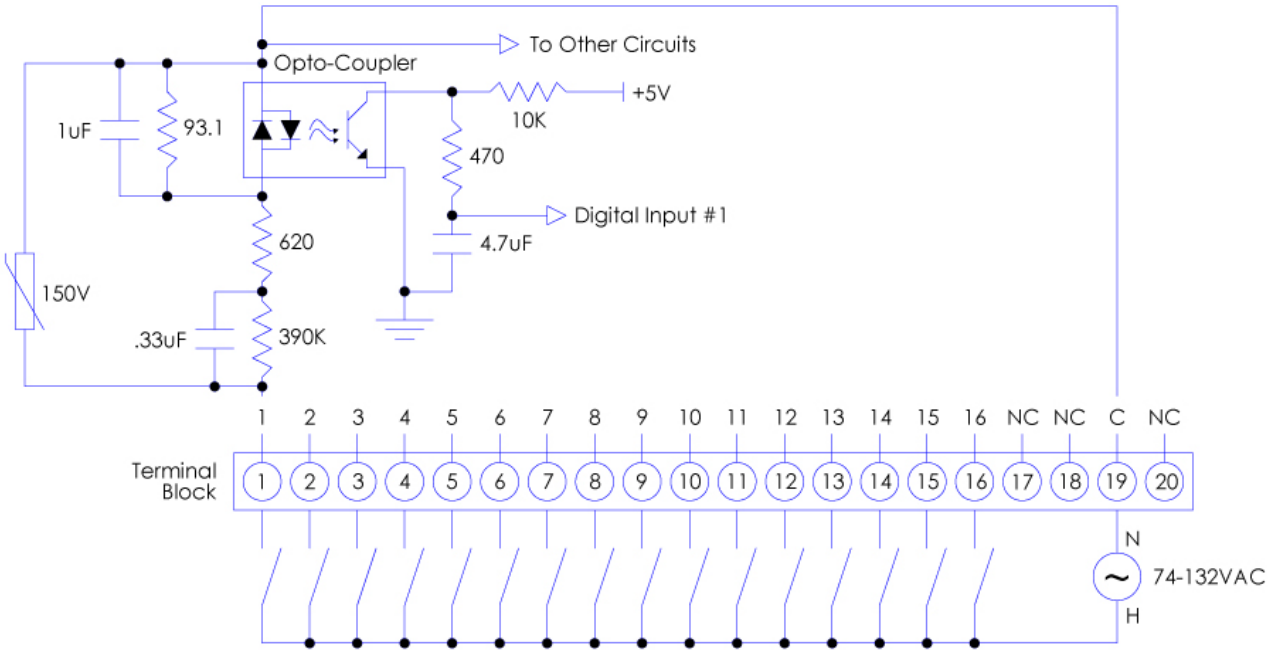
The response back from the unit containing the returned data will be:

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x02	Read Holding Registers
2	0x02	Byte count of returned values
3	?	8 bit pattern with the low order bit being the 1st input
4	?	8 bit pattern with the low order bit being the 9th input
5	CRC	Low Byte of CRC
6	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

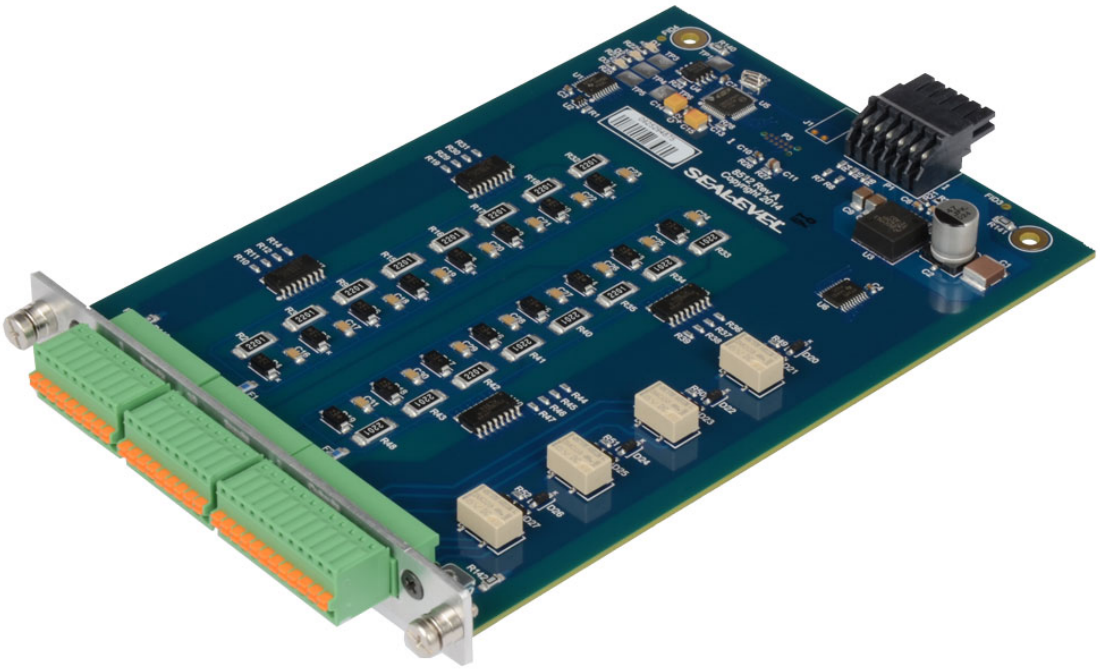
- SM_ReadDigitalInputs(): Read digital inputs
- SM_Open(): Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity.
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX handle

WIRING DIAGRAM



8512 - 16 Isolated Digital Inputs 4 Form C Relay Outputs

The SeaRAQ™ 8512 provides isolated digital input for DC voltages up to 30 VDC. You can use the board to isolate the computer from large common-mode voltages, ground loops, and voltage spikes that often occur in industrial environments.



SPECIFICATIONS

Digital Inputs

Input Voltage Range	3-30 VDC (24 VDC Rated Voltage) Will handle TTL inputs.
Input Current	7 mA @ Rated Voltage
Isolation (Field Side to Logic)	1500 VAC RMS
Response time	7 Milliseconds (On or Off) Maximum
On-stage Voltage	+3 to +30 VDC
Off-state Voltage	0 to +0.8 VDC
On-state Current	0.72 mA Minimum
Off-state Current	0 mA

Relay Outputs

Operating Voltage Range	0-60 VDC
Max. Switching Power	60 W
Isolation (Field Side to Logic)	1500 VAC RMS
Maximum Load	2 A
Minimum Load	10 mA
Maximum Inrush	5 A
Response Time	15 Milliseconds (On or Off) Maximum

8512 PIN OUT

DIGITAL INPUTS

1	Channel 1	10	Channel 9
2	Channel 2	11	Channel 10
3	Channel 3	12	Channel 11
4	Channel 4	13	Channel 12
5	Channel 5	14	Channel 13
6	Channel 6	15	Channel 14
7	Channel 7	16	Channel 15
8	Channel 8	17	Channel 16
9	CH1-CH8 Common	18	CH9-CH16 Common

FORM C RELAY OUTPUTS

1	Relay 1 - NC	7	Relay 3 - NC
2	Relay 1 - COM	8	Relay 3 - COM
3	Relay 1 - NO	9	Relay 3 - NO
4	Relay 2 - NC	10	Relay 4 - NC
5	Relay 2 - COM	11	Relay 4 - COM
6	Relay 2 - NO	12	Relay 4 - NO

CONFIGURATION

There are no software configurable options with this card.

MESSAGE FORMAT – READ DIGITAL INPUT STATES

16-bit digital values are read from the card starting at Modbus location 0. The 16-bit values are read as discrete inputs 0 through 15. To read all 16 digital states, use the following Modbus message.

Offsets (bytes)	Value	Description
0	n	Address based on which slot the card has been inserted
1	0x02	Read Discrete Inputs
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Inputs
5	0x10	Low Byte of Number of Inputs
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

The response back from the unit containing the returned data will be:

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x02	Read Holding Registers
2	0x02	Byte count of returned values
3	?	8 bit pattern with the low order bit being the 1st input
4	?	8 bit pattern with the low order bit being the 9th input

5	CRC	Low Byte of CRC
6	CRC	High Byte of CRC

MESSAGE FORMAT – SET RELAY STATES

4-bit digital values are sent to the card starting at Modbus location 0. The 4-bit values are set as coils 0 through 3. To set all 4 digital states, use the following Modbus message.

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x0F	Write Multiple Coils
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Outputs to Write
5	0x04	Low Byte of Number of Outputs to Write
6	0x01	Number of Bytes of Data
7	?	8 bit pattern with the low order bit being the 1st output. A high bit corresponds to an energized relay.
8	CRC	Low Byte of CRC
9	CRC	High Byte of CRC

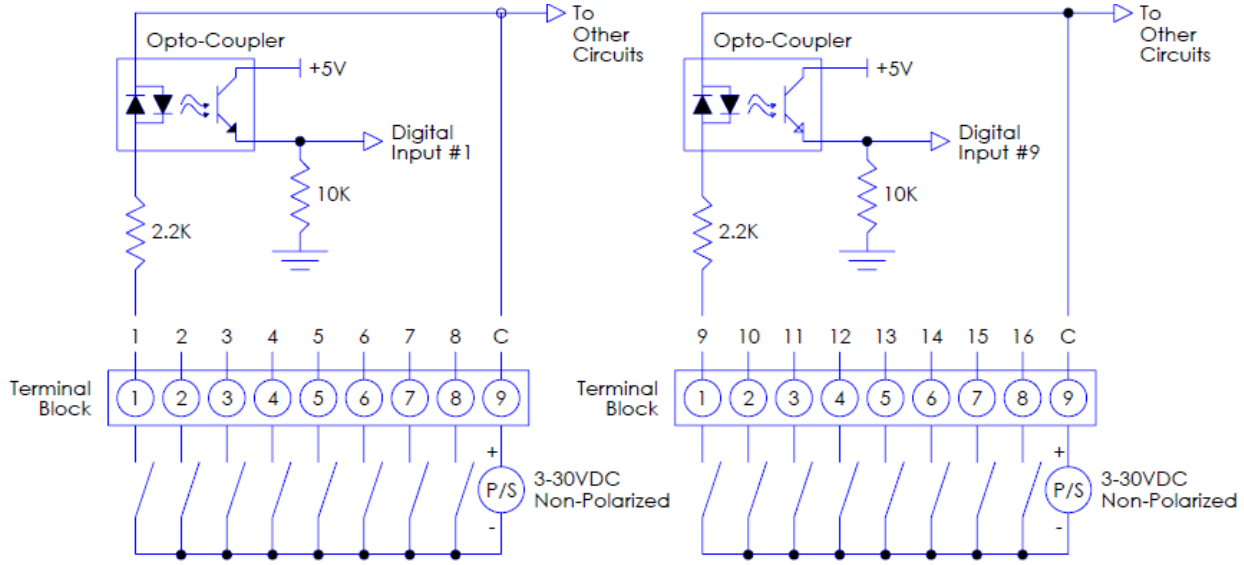
The response back from the unit containing the returned data will be:

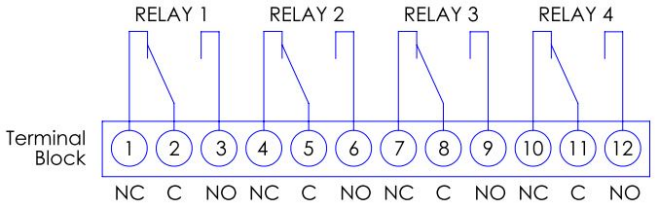
Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x0F	Write Multiple Coils
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Outputs Written
5	0x04	Low Byte of Number of Outputs Written
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

- SM_ReadDigitalOutputs(): Read the digital outputs
- SM_WriteDigitalOutputs(): Write the digital outputs
- SM_Open(): Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity.
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX™ handle

WIRING DIAGRAM





8520 – 16 Channel isolated Form A Relay Outputs

Control a variety of devices with the SeaRAQ™ 8520. The module's 16 channels of highly reliable SPST Form A relay outputs are rated for up to 30 VDC and 250 VAC. The 16 outputs are segmented into groups of 4 with a shared common for each group. Each of the 16 outputs offers normally open contact connections.

SPECIFICATIONS

Operating Voltage Range	5-250 VAC 50/60 Hz, 5-30 VDC
Isolation (Field Side to Logic)	1500 VAC RMS
Maximum Load	4 A Maximum, Resistive per group (shared common), 2 A pilot duty per output point.
Minimum Load	10 mA
Maximum Inrush	5 A
Response Time	15 Milliseconds (On or Off) Maximum

USE EXTREME CAUTION!
High voltages will be present on the 8520 when high voltage is connected. Never handle the printed circuit board when high voltage signals are connected to the board. Note that the mounting bracket is colored red to indicate the possibility of dangerous voltages.

8520 PIN OUT

1	Relay Common 1 - 4	11	Relay Common 9 - 12
2	Relay Output 1	12	Relay Output 9
3	Relay Output 2	13	Relay Output 10
4	Relay Output 3	14	Relay Output 11
5	Relay Output 4	15	Relay Output 12
6	Relay Common 5 - 8	16	Relay Common 13 - 16
7	Relay Output 5	17	Relay Output 13
8	Relay Output 6	18	Relay Output 14
9	Relay Output 7	19	Relay Output 15
10	Relay Output 8	20	Relay Output 16

CONFIGURATION

There are no software configurable options with this card.

MESSAGE FORMAT – SET RELAY STATES

16 bit digital values are sent to the card starting at Modbus location 0. The 16 bit values are set as coils 0 through 15. To set all 16 digital states, use the following Modbus message.

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x0F	Write Multiple Coils
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Outputs to Write
5	0x10	Low Byte of Number of Outputs to Write
6	0x02	Number of Bytes of Data
7	?	8 bit pattern with the low order bit being the 9th output. A high bit corresponds to an energized relay.
8	?	8 bit pattern with the low order bit being the 1st output. A high bit corresponds to an energized relay.
9	CRC	Low Byte of CRC
10	CRC	High Byte of CRC

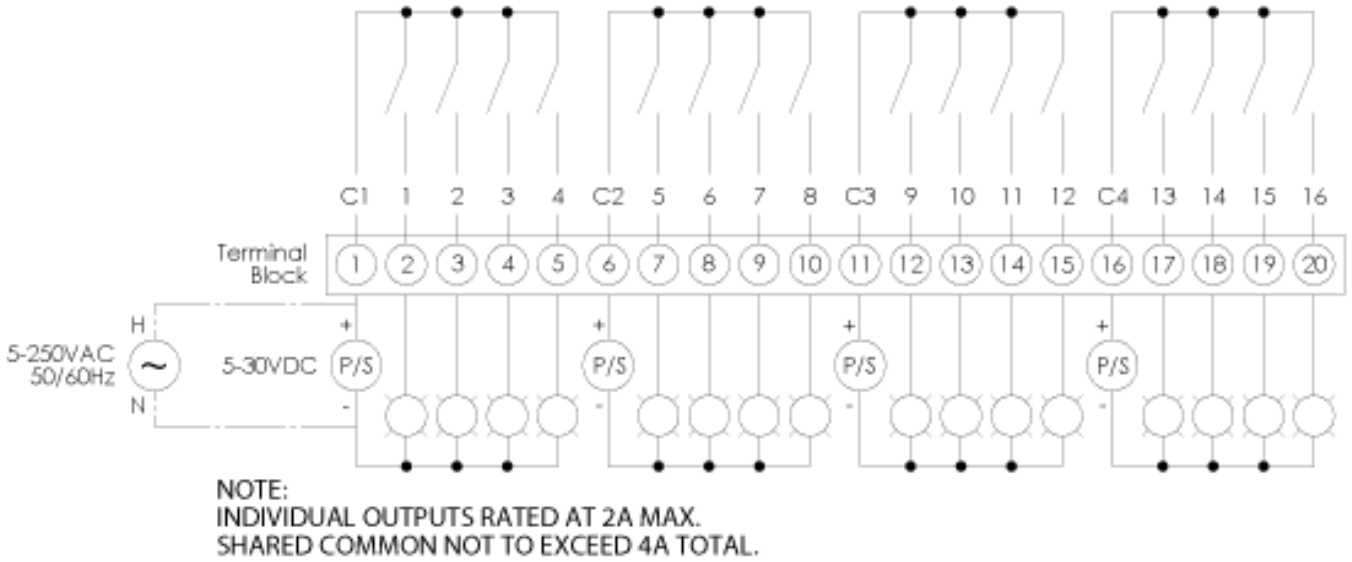
The response back from the unit containing the returned data will be:

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x0F	Write Multiple Coils
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Outputs Written
5	0x10	Low Byte of Number of Outputs Written
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

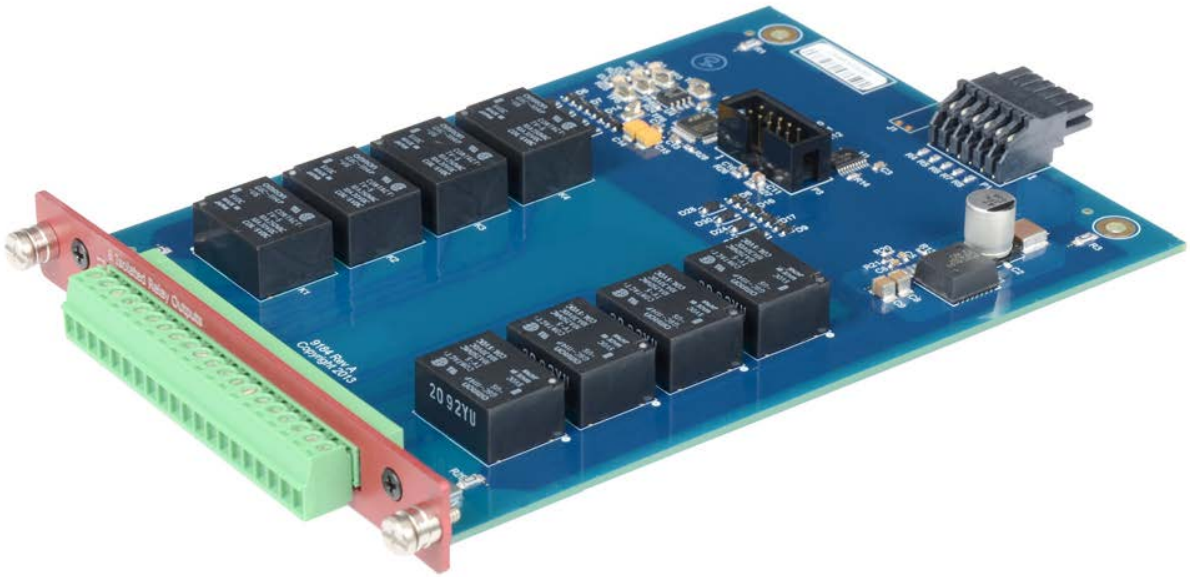
- SM_ReadDigitalOutputs(): Read the digital outputs
- SM_WriteDigitalOutputs(): Write the digital outputs
- SM_Open(): Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity.
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX™ handle

WIRING DIAGRAM



8521 - 8 Channel Isolated Form A Relay Outputs

The SeaRAQ™ 8521 module adds 8 isolated relay outputs rated for 5-250 VAC and 5-30 VDC. The Form A relays each have a discrete common and support a maximum 4A current load. The SPST relays are normally open and close when energized.



SPECIFICATIONS

Operating Voltage Range	5-250 VAC 50/60 Hz, 5-30 VDC
Isolation (Field Side to Logic)	1500 VAC RMS
Maximum Load	4 A Maximum, Resistive
Minimum Load	10 mA
Maximum Inrush	5 A
Response Time	15 Milliseconds (On or Off) Maximum

USE EXTREME CAUTION!
High voltages will be present on the 8521 when high voltage is connected. Never handle the printed circuit board when high voltage signals are connected to the board. Note that the mounting bracket is colored red to indicate the possibility of dangerous voltages.

8521 PIN OUT

1	No Connect	11	No Connect
2	Relay Output 1A	12	Relay Output 5A
3	Relay Output 1B	13	Relay Output 5B
4	Relay Output 2A	14	Relay Output 6A
5	Relay Output 2B	15	Relay Output 6B
6	Relay Output 3A	16	Relay Output 7A
7	Relay Output 3B	17	Relay Output 7B
8	Relay Output 4A	18	Relay Output 8A
9	Relay Output 4B	19	Relay Output 8B
10	No Connect	20	No Connect

CONFIGURATION

There are no software configurable options with this card.

MESSAGE FORMAT – SET RELAY STATES

8 bit digital values are sent to the card starting at Modbus location 0. The 8 bit values are set as coils 0 through 7. To set all 8 digital states, use the following Modbus message.

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x0F	Write Multiple Coils
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Outputs to Write
5	0x08	Low Byte of Number of Outputs to Write
6	0x01	Number of Bytes of Data
7	?	8 bit pattern with the low order bit being the 1st output. A high bit corresponds to an energized relay.
8	CRC	Low Byte of CRC
9	CRC	High Byte of CRC

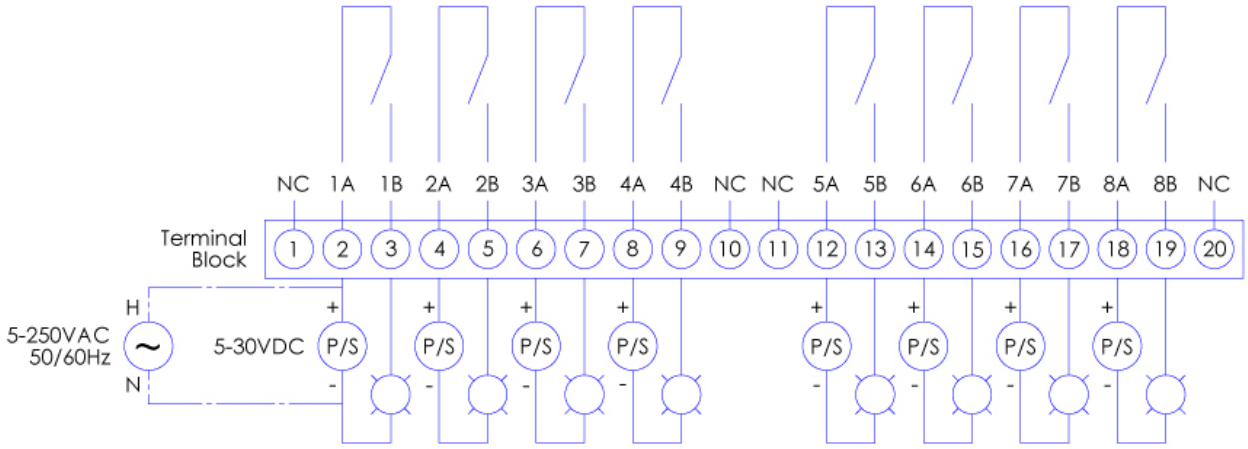
The response back from the unit containing the returned data will be:

Offsets (bytes)	Value	Description
0	N	Address based on which slot the card has been inserted
1	0x0F	Write Multiple Coils
2	0x00	High Byte of Starting Address
3	0x00	Low Byte of Starting Address
4	0x00	High Byte of Number of Outputs Written
5	0x08	Low Byte of Number of Outputs Written
6	CRC	Low Byte of CRC
7	CRC	High Byte of CRC

SEAMAX FUNCTIONS AVAILABLE

- SM_ReadDigitalOutputs(): Read the digital outputs
- SM_WriteDigitalOutputs(): Write the digital outputs
- SM_Open(): Open the Module
- SM_ConfigureSerialConnection(): Configures the local PC's serial port baud rate and parity.
- SM_SelectDevice(): Target a particular Modbus Slave ID
- SM_GetDeviceConfig(): Query the SeaI/O module for model and communications info
- SM_Close(): Close the SeaMAX™ handle

WIRING DIAGRAM



NOTE:
OUTPUTS RATED AT 4A MAX.

Appendix A - Temperature Equations

This section provides the equations required for the software to calculate the measured temperature from the raw values provided by the cards.

6512 - Thermocouple input board

The SeaRAQ™ 6512 thermocouple input board provides 6 Thermocouple input channels supporting Type K, E and J thermocouple probes. Two cold junction compensation readings are available to adjust the measured temperature. A/D input number 7 (JC1) should be used with inputs 1-3, and input number 8 (JC2) with inputs 4-6.

Type J Measured Temperature from 0C to 500C:

$$T_J = a_0 + (a_1 * Tx) + (a_2 * Tx^2) + (a_3 * Tx^3) + (a_4 * Tx^4) + (a_5 * Tx^5) + T_{comp}$$

Type J Measured Temperature from -210C to 0C:

$$T_j = a_0 + (a_1 * Tx) + (a_2 * Tx^2) + (a_3 * Tx^3) + (a_4 * Tx^4) + (a_5 * Tx^5) + (a_6 * Tx^6) + (a_7 * Tx^7) + (a_8 * Tx^8) + T_{comp}$$

Type K Measured Temperature -200C to 500C:

$$T_K = a_0 + (a_1 * Tx) + (a_2 * Tx^2) + (a_3 * Tx^3) + (a_4 * Tx^4) + (a_5 * Tx^5) + (a_6 * Tx^6) + (a_7 * Tx^7) + (a_8 * Tx^8) + T_{comp}$$

Type E Measured Temperature from -100C to 500C:

$$T_E = a_0 + (a_1 * Tx) + (a_2 * Tx^2) + (a_3 * Tx^3) + (a_4 * Tx^4) + (a_5 * Tx^5) + (a_6 * Tx^6) + (a_7 * Tx^7) + (a_8 * Tx^8) + (a_9 * Tx^9) + T_{comp}$$

Where:
*Tx = (x (ch 1 to 6) input reading * 10/4096) / 48.575864368035*
T_{comp} = (comp (ch 7 or 8) * 10/4096) / 0.01

Measured Temperatures above 0C for J and K. -100C to 500C Type E			
Coefficient	Type E	Type J	Type K
a0	0.1049672	-0.04887	0.226585
a1	17189.453	19873.15	24152.11
a2	-282639.9	-218615	67233.42
a3	12695340	11569200	2210341
a4	-4.49E+08	-2.6E+08	-8.6E+08
a5	1.11E+10	2.02E+09	4.84E+10
a6	-1.77E+11		-1.18E+12
a7	1.72E+12		1.39E+13
a8	-9.19E+12		-6.34E+13
a9	2.06E+13		

Measured Temperatures Below 0C for J and K		
Coefficient	Type J	Type K
a0	0	0
a1	1.9528268E-2	2.5173462E-2
a2	-1.2286185E-6	-1.1662878E-6
a3	-1.0752178E-9	-1.0833638E-9
a4	-5.9086933E-13	-8.9773540E-13
a5	-1.7256713E-16	-3.7342377E-16
a6	-2.8131513E-20	-8.6632643E-20
a7	-2.3963370E-24	-1.0450598E-23
a8	-8.3823321E-29	-5.1920577E-28

Note: The internal temperature difference to the external ambient temperature will introduce an error in the T_{comp} variable. If this temperature difference is not acceptable, a more accurate way of measuring the junction temperature of the thermocouples will need to be implemented. More options for the cold junction temperature measurement will be added to the next revision of the board.

6511 - RTD input board

The SeaRAQ™ 6511 RTD input board provides 6 input channels supporting 2 or 3 wire Platinum 100 ohm RTD probes.

For $T_{RTD} \geq 0C$:

$T_{RTD} = (-b + \sqrt{(b\text{^}2 - 4ac)})/2a$

Where:
a = 0.00111082356 / x input reading (Ch1 to Ch6)
b = 7.5176306832 / x input reading (Ch1 to Ch6)
c = (1,923.504 / x input reading (Ch1 to Ch6)) – 1

Appendix B – Handling Instructions

ESD Warnings

ELECTROSTATIC DISCHARGES (ESD)

A sudden electrostatic discharge can destroy sensitive components. Proper packaging and grounding rules must therefore be observed. Always take the following precautions:

- Transport boards and cards in electrostatically secure containers or bags.
- Keep electrostatically sensitive components in their containers, until they arrive at an electrostatically protected workplace.
- Only touch electrostatically sensitive components when you are properly grounded.
- Store electrostatically sensitive components in protective packaging or on anti-static mats.

GROUNDING METHODS

The following measures help to avoid electrostatic damages to the device:

- Cover workstations with approved antistatic material. Always wear a wrist strap connected to a properly grounded workplace.
- Use antistatic mats, heel straps, and/or air ionizers for more protection.
- Always handle electrostatically sensitive components by their edge or by their casing.
- Avoid contact with pins, leads, or circuitry.
- Turn off power and input signals before inserting and removing connectors or connecting test equipment.
- Keep work area free of non-conductive materials such as ordinary plastic assembly aids and Styrofoam.
- Use field service tools such as cutters, screwdrivers, and vacuum cleaners that are conductive.

Appendix C – How to Get Assistance

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

The Sealevel website is an excellent resource located at www.sealevel.com. The most current software updates and user manuals are available via our homepage by clicking on the 'Drivers' or 'Manuals' links located under 'Technical Support.' Manuals and software can also be downloaded from the product page for your device.

The FAQ section of our website answers many common questions. Refer to this helpful resource by visiting www.sealevel.com/faq.asp.

Technical Support

Monday – Friday
8:00 am to 5:00 pm EST
Phone: +1 (864) 843-4343
Email: support@sealevel.com

Warranty

Sealevel's commitment to providing the best I/O solutions is reflected in the Lifetime Warranty that is standard on all Sealevel manufactured I/O products. Relio™ industrial computers are warranted for a period of two years and the R9 family is warranted for a five year period from date of purchase. 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 achieved ISO-9001:2000 certification in 2002.

Warranty Policy

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 the warranty period. 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, abuse, accidents, or acts of nature are not covered under this warranty.

Warranty service may be obtained by delivering the Product to Sealevel and providing proof of purchase. 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.

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

Non-Warranty Repair/Retest

Products returned due to damage or misuse and Products retested with no problem found are subject to repair/retest charges. A purchase order or credit card number and authorization must be provided in order to obtain an RMA (Return Merchandise Authorization) number prior to returning Product.

How to obtain an RMA (Return Merchandise Authorization)

If you need to return a product for warranty or non-warranty repair, you must first obtain an RMA number. Please contact Sealevel Systems, Inc. Technical Support for assistance:

Available	Monday – Friday, 8:00AM to 5:00PM EST
Phone	864-843-4343
Email	support@sealevel.com

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