



Remote Input and Output (RIO) Module



Hardware Introduction and Reference Manual

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Warning Labels

The following warning and caution labels are utilized throughout this manual to convey critical information required for the safe and proper operation of the hardware and software. It is extremely important that all such labels are carefully read and complied with in full to prevent personal injury and damage to the equipment.

There are four levels of special alert notation used in this manual. In descending order of importance, they are:



DANGER: This indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury.



WARNING: This indicates a potentially hazardous situation, which, if not avoided, could result in serious injury or major damage to the equipment.



CAUTION: This indicates a situation, which, if not avoided, could result in minor injury or damage to the equipment.

NOTE: This provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation

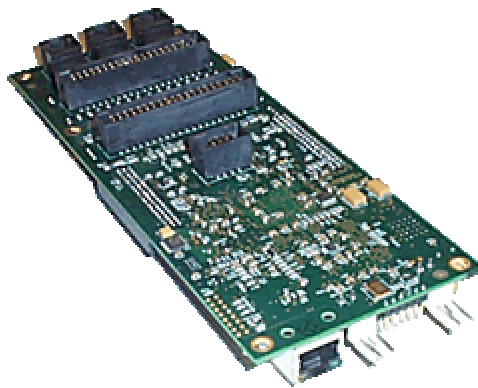
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Introduction to the Hardware

Remote Input and Output (RIO) Module Overview

The Remote Input and Output (RIO) module can add additional optically isolated digital input and output signals, analog inputs, and serial ports to any Guidance Controller. The RIO module connects to a controller via Ethernet and can be placed anywhere within the controller's local network. The RIO supports MODBUS/TCP and uses a variation of this to communicate with a Guidance Controller. MODBUS/TCP is a "open" standard that is widely used in the industrial manufacturing environment to interconnect intelligent devices and intelligent sensors and is compatible with all standard Ethernet TCP/IP networks. A RIO can also be utilized as a standard MODBUS/TCP slave device. This permits a PC that is executing MODBUS/TCP master software to directly connect to a RIO. (In this mode, the RIO cannot simultaneously communicate with a Guidance Controller.)



WARNING: The RIO contains unshielded 24 VDC signals and pins. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when power is turned on.

The Standard RIO module provides 32 optically isolated digital inputs and 32 optically isolated digital outputs and one RS-232 serial port. An enhanced version of the RIO adds 4 analog inputs, a second RS-232 port and one RS-422/485 port. In addition, up to two digital I/O Expansion Boards can be added to the Enhanced RIO for a maximum of 96 isolated digital inputs and 96 isolated digital outputs. Up to 4 RIO modules can be connected to a single controller.

All of the digital input lines can be jumpered as sinking or sourcing in blocks of 8 signals. Different versions of the RIO hardware must be purchased in order to obtain either all sinking or all sourcing digital output signals.

The RIO is an intelligent device and shares many of the software features available with the Guidance Controller. The software configuration is stored in the Configuration and Parameter Database that is

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accessed with pages viewed by a web browser. For detailed information on the web interface and the Parameter Database, please see the *Software Setup* and *Introduction to Software* sections of the *Controller Software* chapter of the *Precise Documentation Library*.

Software Reference

Ethernet Software Configuration

The RIO module and the Guidance Controller communicate over a standard 10/100 Mb Ethernet network. Input and output signal states are communicated in messages that are periodically sent between the two devices. To facilitate setting up the Ethernet communications link, the RIO includes a built-in web server that provides access to software configuration information.

Like most Ethernet devices, the RIO must have an Ethernet IP address/subnet mask assigned before it can be used. Initially, the RIO IP address/subnet is set to "192.168.0.101" and "255.255.255.0". If that information is acceptable on your network, no further network configuration is required. Otherwise, you can change the IP information by modifying the parameters shown in the table below.

For security purposes, you may wish to restrict access to the RIO module to certain Controllers or MODBUS masters. Only IP addresses found in the "MODBUS master IP address" (DataID 560) array are allowed to connect with the RIO module. The default value of "255.255.255.255" means that security is disabled and any address can connect.

To access these values via the web interface go to: **Setup > Parameter Database > Controller > Network.**

After these values are updated and saved to the flash disk, you must restart your RIO module to put your changes into effect.

Parameter Database ID	Parameter Name	Default Value	Description
420	Local IP address	192.168.0.101	IP address of the RIO module.
421	IP subnet mask	255.255.255.0	IP address mask for the RIO module.
422	IP gateway address	192.168.0.100	IP address of any network gateway.
560	MODBUS master IP address	255.255.255.255	Array of IP addresses specifying the Controller or MODBUS master that can connect to this module.

I/O Scanning Software Configuration

The RIO module scans its inputs signals at a fixed rate to check for any changes. If any input signal changes in value, a message is sent to the Guidance Controller notifying it of the new input values. The

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scan period determines the minimum input pulse width that can be detected by the RIO module, and also defines the delay between when an input changes and when the controller is notified of the change. The scan period must be set short enough to not miss input pulses, but must be long enough to not overwhelm the system with messages if the inputs change frequently. Normally the scan period is set to 10 milliseconds.

The RIO module also sends heartbeat messages at a slow rate, even if no inputs have changed. These messages permit the controller to confirm that the RIO is still connected and functioning. The heartbeat must occur often enough so that the Guidance Controller can detect failures in a timely manner, but slow enough to not waste too much of the controller's time.

The Guidance Controller also sends a heartbeat to the RIO module. If the RIO module does not receive a message within a specified time, it assumes that an error has occurred and closes its connection. In addition, it may freeze or clear its outputs.

The table below shows the scanning configuration parameters. To access these values via the web interface go to: **Setup > Parameter Database > Controller > System DIO**.

After these values are updated, they go into effect the next time the GPL controller connects to the RIO. Any current connection is not affected. To save these as the permanent values, the values must be written to the flash disk.

Parameter Database ID	Parameter Name	Default Value	Description
550	Remote IO scan period in sec	0.010	The time period used by the RIO to scan its inputs. If the input values have changed, the new values are sent to the Guidance Controller.
551	Remote IO heartbeat period in sec	0.500	The time period used by the RIO to send a heartbeat message to the controller, even if no inputs have changed.
552	Remote IO max input time in sec	2	If the Guidance Controller fails to send an update message within this time period, an error occurs.
553	Local IO error action	0	Determines the digital output state if a communications error occurs. 0 means freeze the outputs. 1 means clear the outputs. Only the first array element of this parameter is used by the RIO module.

Hardware Reference

Remote Input and Output Hardware Overview

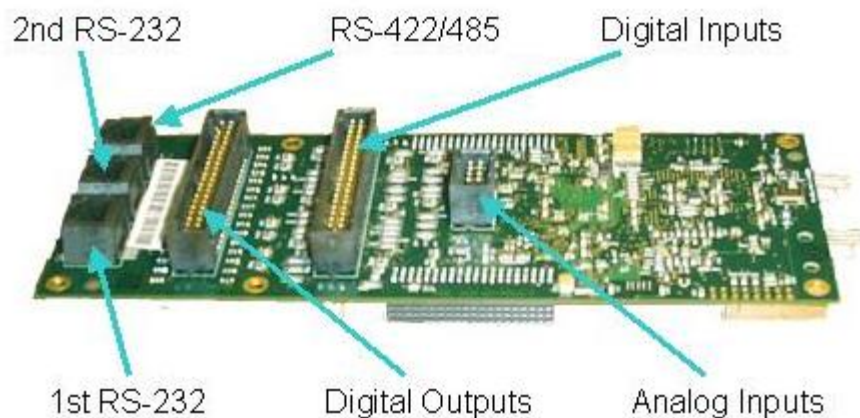
The Remote Input and Output module provides a number of hardware interfaces that further enhance a Guidance Controller's ability to connect to external equipment. The interfaces and configuration hardware for this module include the following:

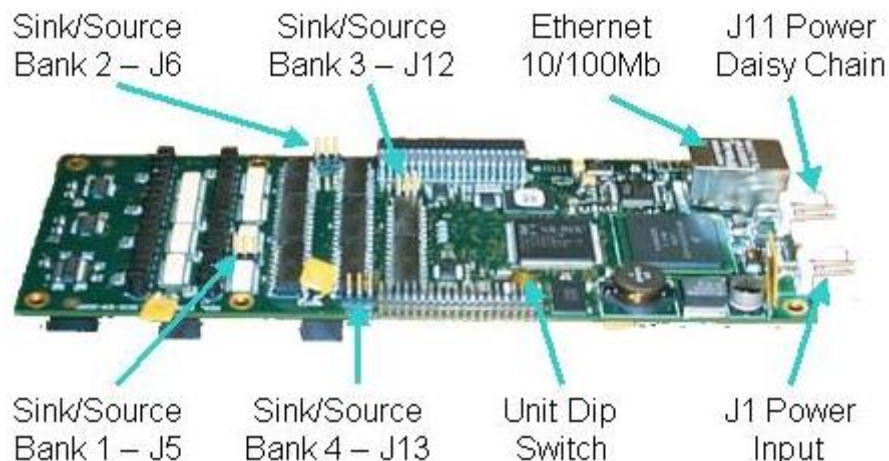
- [Analog Input Connector](#)
- [Digital Input Connector](#)
- [Digital Output Connector](#)
- [Ethernet Connector](#)
- [Power Connectors](#)
- [RS-232 Connectors](#)
- RS-422/485 Connector
- [Sinking Versus Sourcing Input Jumpers](#)
- [RIO Unit Number DIP Switch](#).

The pictures below illustrate the top and bottom surfaces of the RIO and identify each of the user connectors and configuration components. To jump to the detailed information for a specific connector, click on the connector interface name or the connector.



WARNING: The RIO contains unshielded 24 VDC signals and pins. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when power is turned on.



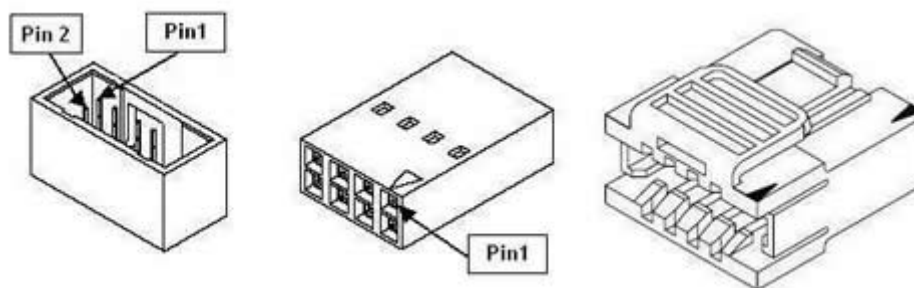


In the following sections, the software configuration of this module is described along with the pin outs for each of the connectors and the settings for the jumpers and switches.

Analog Input (Enhanced RIO only)

The enhanced version of the RIO contains 4 analog input channels on the base board. The Analog to Digital Converter accepts a ± 10 VDC signal and has a 12-bit resolution. The input impedance of the analog conversion circuit is 20,000 ohms. There is a 4 KHz noise filter on each input.

All of the inputs are read in from a single connector. The connector for these signals is a 8-pin Molex 71349-2002. The matching plug consists of a Molex plug together with a Molex clip that covers the plug and crimp pins that are inserted into the plug.



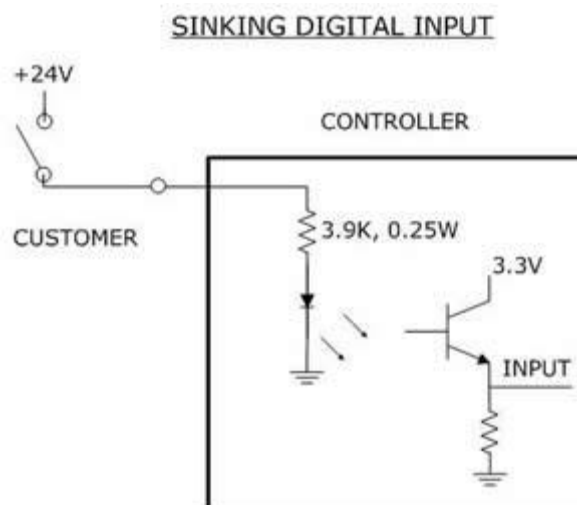
Pin	Description
1	GND
2	± 10 VDC input signal 1
3	GND
4	± 10 VDC input signal 2
5	GND
6	± 10 VDC input signal 3

7	GND
8	+/- 10 VDC input signal 4
User Plug Part No	Molex 22-55-2081 with Molex 15-04-5084 cover clip. The pins for this plug are 16-02-0103 and the Molex crimp tool is a 63811-1000.

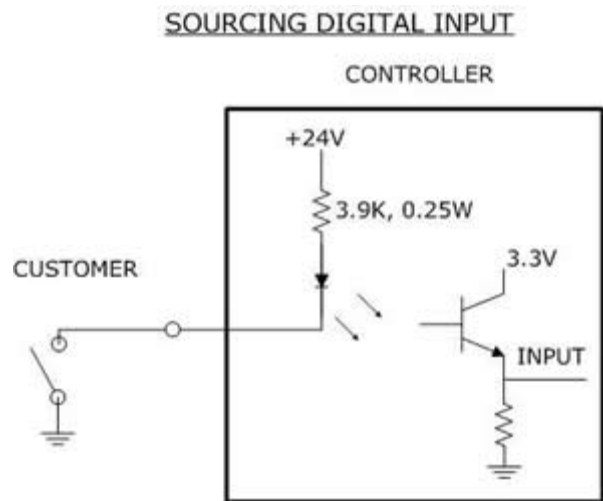
Digital Input Signals

The RIO boards and the Expansion RIO boards each support 32 optically isolated digital input signals. Depending upon the setting of the [Sinking Versus Sourcing Inputs Jumpers](#), the inputs are configured as "sinking" or "sourcing" in groups of 8 signals.

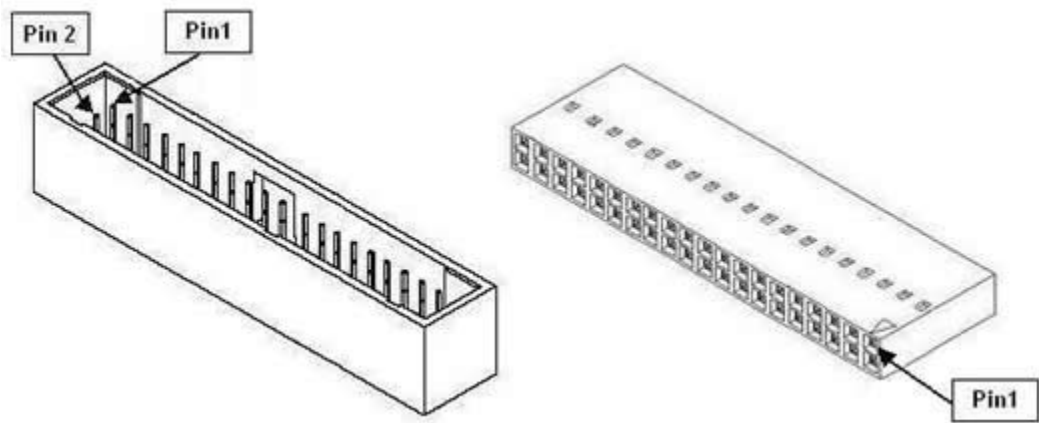
If an input signal is configured as "sinking", the external equipment must pull the input high to 5VDC to 24VDC to indicate a logical high value or no voltage for a logical low. This configuration is compatible with "sourcing" (PNP) sensors.



If an input signal is configured as "sourcing", the external equipment must pull the signal input pin to ground to indicate a logical high and must let the line float high to 24VDC to signal a logical low value. This configuration is compatible with "sinking" (NPN) sensors.



The connector for these signals is a 40-pin Molex 71349-2086. The matching plug consists of a Molex plug together with a Molex clip that covers the plug and crimp pins that are inserted into the plug. Alternately, an IDC type plug can be used. The part numbers for these components are presented in the table below.



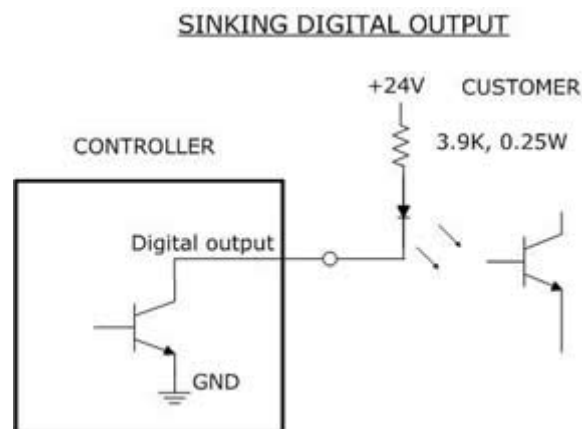
Signal	Pin	Pin	Signal
Input 1	1	2	Input 17
Input 2	3	4	Input 18
Input 3	5	6	Input 19
Input 4	7	8	Input 20
24VDC	9	10	GND
Input 5	11	12	Input 21
Input 6	13	14	Input 22
Input 7	15	16	Input 23
Input 8	17	18	Input 24
24VDC	19	20	GND
Input 9	21	22	Input 25

Input 10	23	24	Input 26
Input 11	25	26	Input 27
Input 12	27	28	Input 28
24VDC	29	30	GND
Input 13	31	32	Input 29
Input 14	33	34	Input 30
Input 15	35	36	Input 31
Input 16	37	38	Input 32
24VDC	39	40	GND
User Plug Parts	Molex 22-55-2401 with Molex 15-04-5404 cover clip. The pins for this plug are 16-02-0103 and the Molex crimp tool is a 63811-1000. Alternately, an IDC plug can be used, part # 746285-9.		

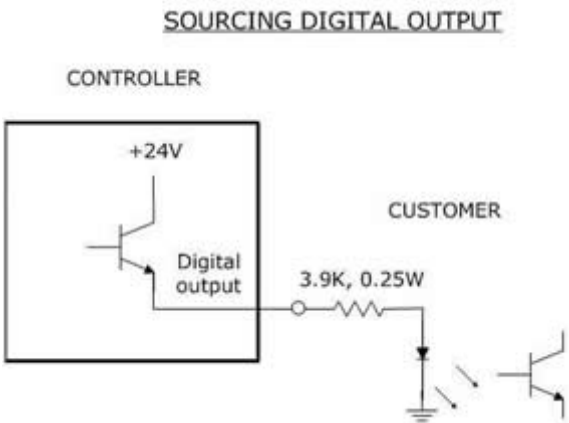
Digital Output Signals

The RIO boards and the Expansion RIO board each support 32 optically isolated digital output signals. Depending the type of RIO module purchased, all of the outputs are either "sinking" or "sourcing".

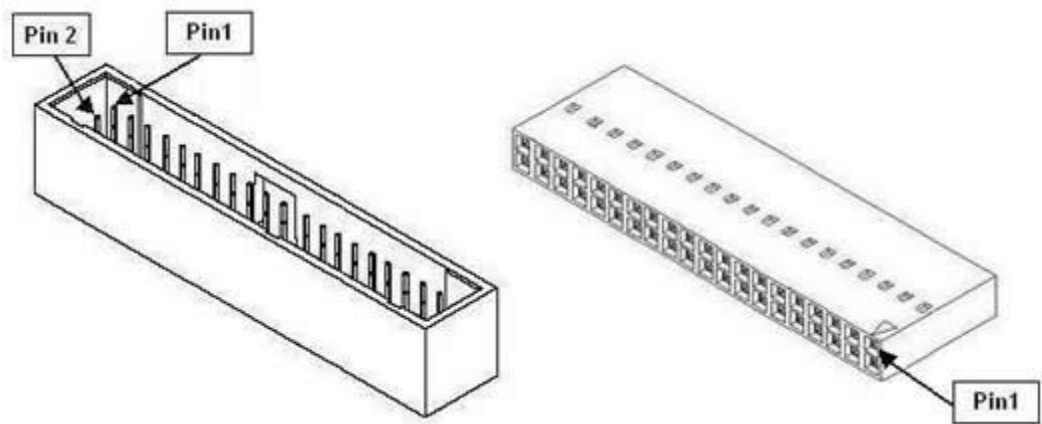
If an output signal is "sinking", the external equipment must provide a 5VDC to 24VDC pull up voltage on the output pin and the RIO pulls this pin to ground when the signal is asserted as true. This configuration is compatible with "sourcing" (PNP) devices.



If an output signal is "sourcing", the external equipment must pull down the output pin to ground and the RIO pulls this pin to 24VDC when the signal is asserted as true. This configuration is compatible with "sinking" (NPN) devices.



The connector for these signals is a 40-pin Molex 71349-2086. The matching plug consists of a Molex plug together with a Molex clip that covers the plug and crimp pins that are inserted into the plug. Alternately, an IDC type plug can be used. The part numbers for these components are presented in the table below.



Signal	Pin	Pin	Signal
Output 1	1	2	Output 17
Output 2	3	4	Output 18
Output 3	5	6	Output 19
Output 4	7	8	Output 20
24VDC	9	10	GND
Output 5	11	12	Output 21
Output 6	13	14	Output 22
Output 7	15	16	Output 23
Output 8	17	18	Output 24
24VDC	19	20	GND
Output 9	21	22	Output 25
Output 10	23	24	Output 26
Output 11	25	26	Output 27

Output 12	27	28	Output 28
24VDC	29	30	GND
Output 13	31	32	Output 29
Output 14	33	34	Output 30
Output 15	35	36	Output 31
Output 16	37	38	Output 32
24VDC	39	40	GND
User Plug Parts	Molex 22-55-2401 with Molex 15-04-5404 cover clip. The pins for this plug are 16-02-0103 and the Molex crimp tool is a 63811-1000. Alternately, an IDC plug can be used, part # 746285-9.		

Ethernet Interface

A Guidance Controller communicates with a RIO by means of a 10/100 Mbit Ethernet port. This high-speed and robust means of communication ensures that the RIO data can be quickly and reliably accessed by a controller on the same Ethernet network.

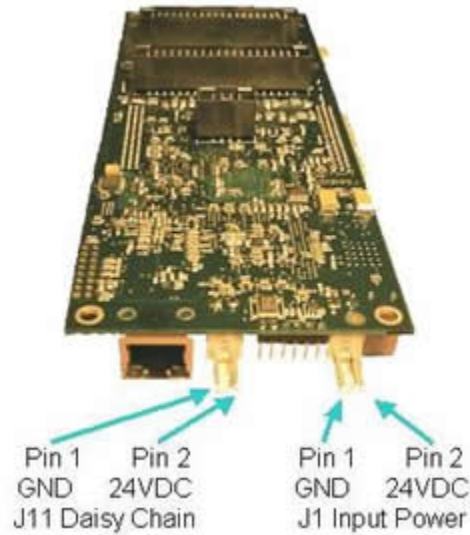


See the *Software Reference* section of this manual for information on configuring the IP address of the RIO and for setting other key communication parameters.

Power Connectors

The RIO requires 24VDC to power its logic and I/O functions. The Standard or Enhanced RIO requires 0.4 amps for logic power and a maximum of 3.2 amps if the outputs are sourcing, for a total of 3.6 amps. In addition, each Expansion Board requires 0.2A for logic and up to 3.2A for sourcing outputs, for a total of 3.4 amps.

There are two sets of 24VDC pins labeled J1 and J11. Power to the module should be provided on J1. J11 is used to daisy chain the 24VDC to any attached RIO Expansion Boards. These sets of power pins are shown below as seen from the side of the module with the Ethernet connector.



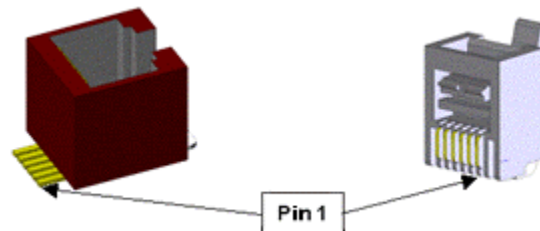
Connector	Pin	Description
J1 - Power input for the RIO module	Pin 1	GND
	Pin 2	24VDC input
J11 - Daisy chain power output to RIO Expansion Modules	Pin 1	GND
	Pin 2	24VDC output
User Plug Parts	Molex 09-50-3021 or 09-50-3081. In either case, the required pins are 08-50-0106 and the Molex crimp tool is a 63811-2200.	

RS-232 Serial Interfaces

The standard RIO has a single RS-232 serial port and the enhanced RIO module has two ports. Both ports support hardware as well as software flow control and use a RJ-11 modular jack, CablesNMor T23750. The matching plug is a standard RJ-11 phone plug, such as an Jameco 115617CH.

In addition to serving as a general serial application channel, the first port can also be configured as the serial console port for the RIO.

When used as remote serial ports on the Guidance Controller connected to the RIO, these serial ports are named `"/dev/comrx"` where "x" is the RIO unit number and "y" is the number of the RIO serial port.



Pin	Description
1	CTS - clear to send
2	RTS - ready to receive
3	Ground
4	RXD - controller receive data
5	TXD - controller transmit data
6	Not Connected
User Plug Part No	RJ-11 phone plug

Sinking Versus Sourcing Inputs Jumpers

When referring to digital input signals, "sinking" and "sourcing" indicate whether the external equipment must connect the input signal to a voltage to indicate a logical high value (RIO is "sinking" the current) or the external equipment must connect the input signal to ground to indicate a logical high value (RIO is "sourcing" the current). While different versions of the RIO module must be purchased to support sinking versus sourcing digital output signals, the digital input signals can be configured as sinking or sourcing in blocks of 8 signals. This configuration is performed using four sets of three jumper posts.



The location of these posts is illustrated at the start of this section and the sets of posts are identified by stenciled labels on the surface of the RIO. The posts are located on the surface of the RIO that includes the Ethernet connector.

The following table indicates how the pins of each set of posts that must be shorted ("jumped") in order to achieve the specified configuration. ***As shipped from the factory, all digital inputs are set to "sinking" by default.***

Digital Input Signals	For Sinking Inputs	For Sourcing Inputs
Inputs 1 to 8	J5-3 TO J5-2	J5-2 TO J5-1 (*)
Inputs 9 to 16	J6-3 TO J6-2	J6-2 TO J6-1 (*)
Inputs 17 to 24	J12-3 TO J12-2 (*)	J12-2 TO J12-1
Inputs 25 to 32	J13-3 TO J13-2	J13-2 TO J13-1 (*)

(*) in the table above indicates the setting when the jumper is positioned so it is closer to the Ethernet connector. For example, to set Inputs 1 to 8 to sourcing, the J5 jumper should be positioned so it connects the two pins that are closest to the edge of the board that contains the Ethernet connector.

Unit Number DIP Switch

When a RIO module is connected to a Controller, its unit number determines how its digital input and output signals are mapped into the DIO signal numbers on the Guidance Controller. The Guidance signal numbers are used to access these I/O points in a GPL program, from MotionBlocks and on web pages.

The unit number is selected by the DIP switch settings on the RIO base board. The DIP switch settings on the expansion board are ignored. If the DIP switch is set to the "MODBUS/TCP" setting, the RIO will respond as a standard MODBUS/TCP slave device rather than a RIO peripheral to a Guidance Controller.



In the following table, when a switch is in the "ON" position, it reads a value of "0". *As shipped from the factory, all of the switches are in the "ON" position, which indicates RIO unit #1.* If the MODBUS/TCP configuration is selected, the RIO operates as a standard MODBUS/TCP slave device and can talk to any standard MODBUS/TCP master. In this mode, the RIO cannot communicate with a Guidance Controller.

RIO Unit	RIO DIP switch 1 2 3 4	Controller Output Signal Numbers	Controller Input Signal Numbers
1	0 0 0 0	101 - 196	10101 - 10196
2	1 0 0 0	201 - 296	10201 - 10296
3	0 1 0 0	301 - 396	10301 - 10396
4	1 1 0 0	401 - 496	10401 - 10496
MODBUS/TCP	1 1 1 1	None	None

Appendix A: Product Specifications

Remote Input and Output (RIO) Module Specifications

General Specification	Range & Features
Interface to Guidance Controller	
Communications Interface	Interfaces via 10/100 Mbps Ethernet. Can be located anywhere within the local network of the Guidance Controller.
Communications Protocol	Supports the MODBUS/TCP communications protocol. Uses a variation of this protocol to interface to Guidance Controllers. Protocol is compatible with all standard Ethernet TCP/IP networks. Can be configured as a slave to standard MODBUS/TCP masters (cannot communicate with Guidance Controllers in this mode).
Scanning Rate	Scanning rate for changes in inputs configurable. New input data sent to controller when values changed. New output data received from controller when values changed. Typical scanning rates are 5-10msec.
Number of units	Up to 4 RIO's can be simultaneously interfaced to a Guidance Controller
Input and Output Interfaces	
Ethernet Port	Standard and Enhanced RIO: One 10/100 Mbps Ethernet port Expansion Board: None
Serial Ports	Standard RIO: One RS-232 port with hardware flow control
	Enhanced RIO: Two RS-232 ports with hardware flow control, one RS-422/485 port
	Expansion Board: None
Digital Input Channels	Standard RIO, Enhanced RIO, each Expansion Board: 32 optically isolated digital inputs Configurable in banks of 8 as sinking or sourcing 5VDC to 24VDC for logic high if sinking 24VDC supplied for logic high if sourcing
Digital Output Channels	Standard RIO, Enhanced RIO, each Expansion Board: 32 optically isolated digital outputs Must be purchased as sinking or sourcing 24VDC maximum pull up if sinking 24VDC supplied if sourcing, 100mA maximum per channel
Analog I/O Channels	Standard RIO & Expansion Boards: None
	Enhanced RIO: 4 analog input channels, +/-10VDC, 12 bit ADC
Expansion Boards	Up to 2 Expansion Boards can be added to either a Standard or

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	Enhanced RIO
General	
Size and Weight	75mm (W) x 195mm (L) x 28mm (H), 0.142 kg
Low Voltage Logic Power	<p>24VDC required for logic and input/output functions</p> <p>Standard RIO: 0.4A minimum for logic plus 3.2A maximum if sourcing all digital outputs for a total of 3.6A.</p> <p>Enhanced RIO: 0.4A minimum for logic plus 3.2A maximum if sourcing all digital outputs for a total of 3.6A.</p> <p>Each expansion board: 0.2A minimum for logic plus 3.2A maximum if sourcing all digital outputs for a total of 3.4A.</p>