

Remote Input and Output (RIO) Module

Hardware Introduction and Reference Manual

P/N: RIO1-DI-00010, Rev 5.0.0, April 9, 2022

Brooks Automation

Information provided within this document is subject to change without notice, and although believed to be accurate, Brooks Automation assumes no responsibility for any errors, omissions, or inaccuracies.

AcuLigner™, Advan Tag™, AutoTeach™, ATR™, AXM™, BiSymmetrik™, CenterSmart™, Crate to Operate™, CrossingConnect™, DARTS™, Enerta™, e-RMA™, e-Spares™, e-Volution™, Falcon™, FIXLOAD™, FrogLeg™, GuardianPro™, Independent Twin Linear Exchange™, InCooler™, InLigner™, Isoport™, ITLX™, Jet™, Jet Engine™, LEAP™, LeapFrog™, LowProfile™, LPT™, M2 Nano™, Marathon 2, Marathon Express, PASIV™, Pathway™, PowerPak™, PowerTools™, PuroMaxx™, QuadraFly™, Radius™, Radiant™, Radiant Express™, Reliance™, Reliance ATR™, RetroEase™, SCARA™, SmartPM™, SMIF-INX™, SMIF-LPT™, SPOTLevel™, The New Pathway to Productivity™, Time Optimized Trajectory™, Time Optimal Trajectory™, Time Optimized Path™, TopCooler™, TopLigner™, VacuTran™, VersaPort™, WaferEngine™, LEAP™, Pathway™, GIO, GSB, Guidance 6410, Guidance 6420, Guidance 6430, Guidance 6000, Guidance 6600, Guidance 3400, Guidance 3300, Guidance 3200, Guidance 2600, Guidance 2400, Guidance 2300, Guidance 2200, Guidance 1400, Guidance 1300, Guidance 1200, Guidance 0200 Slave Amplifier, Guidance 0006, Guidance 0004, Guidance Controller, Guidance Development Environment, GDE, Guidance Development Suite, GDS, Guidance Dispense, Guidance Input and Output Module, Guidance Programming Language, GPL, Guidance Slave Board, Guidance System, Guidance System D4/D6, PreciseFlex™ 300, PreciseFlex™ 400, PreciseFlex™ 3400, PreciseFlex™ 1300, PreciseFlex™ 1400, PreciseFlex™ DD4, PreciseFlex™ DD6, PreciseFlex™ DDR, PreciseFlex™ G5400, PreciseFlex™ G5600, PreciseFlex™ G6400, PreciseFlex™ G6410, PreciseFlex™ G6420, PreciseFlex™ G6430, PreciseFlex™ G6600, PreciseFlex™ GSBP Slave Amp, PreciseFlex™ PFD0, PrecisePlace 100, PrecisePlace 0130, PrecisePlace 0140, PrecisePlace 1300, PrecisePlace 1400, PrecisePlace 2300, PrecisePlace 2400, PrecisePower 300, PrecisePower 500, PrecisePower 1000, PrecisePower 2000, PreciseVision, and RIO logos are trademarks of Brooks Automation.

Fusion®, Guardian®, MagnaTran®, Marathon®, Razor®, Spartan®, Vision®, Zaris®, and the Brooks and design logo are registered U.S. trademarks of Brooks Automation.

All other trademarks are properties of their respective owners.

© 2021 Brooks Automation. All rights reserved. The information included in this manual is proprietary information of Brooks Automation, and is provided for the use of Brooks customers only and cannot be used for distribution, reproduction, or sale without the express written permission of Brooks Automation.

This technology is subject to United States export Administration Regulations and authorized to the destination only; diversion contrary to U.S. law is prohibited.

Brooks Automation Precise Collaborative Robotics 201 Lindbergh Avenue Livermore, CA 94551 Tel: +1-510-498-1130	Brooks Automation 15 Elizabeth Drive Chelmsford, MA 01824-2400 Tel: +1 978-262-2400 Fax: +1 978-262-2500	Brooks Automation (Germany) GmbH Daimler-Straße 7 78256 Steißlingen, Germany Tel: +49-7732-9409-0 Fax: +49-7732-9409-200	Brooks Automation 46702 Bayside Pkwy Fremont, CA 94538 Tel: +1-510-661-5000 Fax: +1-510-661-5166
--	--	--	---





Corporate Headquarters

15 Elizabeth Drive
Chelmsford, MA 01824 U.S.A.

Brooks Automation

Precise Collaborative Robotics

201 Lindbergh Avenue
Livermore, CA 94551 U.S.A

For Technical Support:

Location	Contact Number	Website
North America	+1-510-498-1130 (Precise) +1-800-447-5007 (Toll Free) +1-978-262-2900 (Local)	http://www.preciseautomation.com
Europe	+49 800 000 9347 (Toll Free Germany) +49 364 176 9999 6 (Has Toll)	
Japan	+81 120-255-390 (Toll Free) +81 45-330-9005 (Local)	
China	+86 21-5131-7066	
Taiwan	+886 080-003-5556 (Toll Free) +886 3-5525258 (Local)	
Korea	1800-5116 (Toll Free)	
Singapore	+65 1-800-4-276657 (Toll Free) +65 6309 0701 (Local)	

Revision History

Revision	ECO Number	Date	Explanation of Changes
Rev 5.0.0	TBD	April 9, 2022	First version as Brooks

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

Table Of Contents

Introduction to the Hardware	7
Remote Input and Output (RIO) Module Overview	7
Installation, Configuration and Software	9
Mounting and Installation	9
RIO Ethernet Configuration	9
RIO and Guidance Controller Configuration	10
Hardware Reference	15
Remote Input and Output Hardware Overview	15
Analog Input (Enhanced RIO only)	16
Digital Input Signals	17
Digital Output Signals	20
Ethernet Interface	22
Power Connectors	22
RS-232 Serial Interfaces	23
Sinking Versus Sourcing Inputs Jumpers	24
Unit Number DIP Switch	24
Appendix A: Product Specifications	26
Remote Input and Output (RIO) Module Specifications	26

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 the MODBUS/TCP communications protocol and uses a variation of this to interface with a Guidance Controller. MODBUS/TCP is a "open" standard that is widely employed in industrial manufacturing environments to interconnect intelligent devices and intelligent sensors and is compatible with all standard Ethernet TCP/IP networks. A RIO can also be configured as a standalone controller or as a standard MODBUS/TCP slave device. The latter capability permits a PC that is executing MODBUS/TCP master software to directly connect to a RIO.



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 Remote Input and Output (RIO) module can operate in one of two primary modes. It can act as a remote I/O expansion module for a Guidance Controller or a PC, or it can operate as an independent master controller that runs GPL programs in the same manner as a standard Guidance Controller.

As a remote I/O expansion module, the RIO executes its I/O Scanning Software and sends a MODBUS/TCP message to the master whenever an input changes. It also responds to any requests it receives from a master to access the RIO's various I/O ports. This mode of operation is selected by setting DataID 211 "GPL MODBUS/TCP master" to False.

As an independent master controller, the RIO can execute GPL programs that can control its local IO. These programs can also access other RIO boards or MODBUS/TCP slaves since, in this configuration, the RIO can function as a MODBUS/TCP master. In this mode of operation, the RIO can still be accessed as a MODBUS/TCP slave in the same manner as a Guidance Controller. This configuration is selected by setting DataID 211 "GPL MODBUS/TCP master" to True.

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. Up to 4 RIO modules can be connected to a single controller.

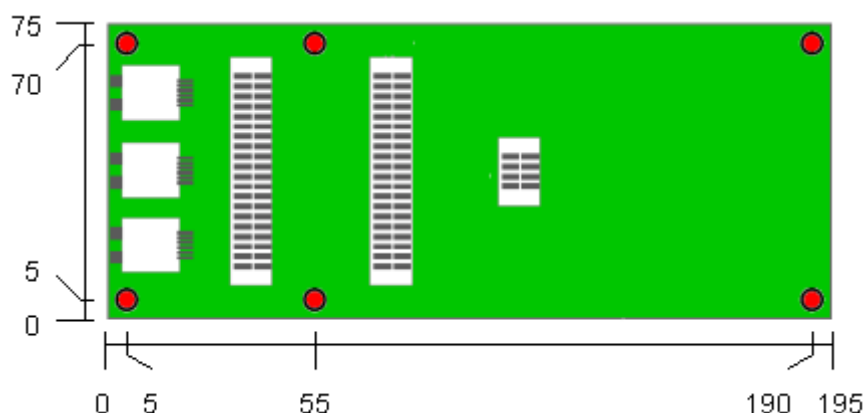
All of the digital input lines can be jumpered as sinking or sourcing in blocks of 8 signals. Different versions of the RIO hardware must be purchased in order to obtain either all sinking or all sourcing digital output signals.

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 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*.

Installation, Configuration and Software

Mounting and Installation

The Remote Input and Output module is an open frame device with exposed 24VDC and must be mounted inside of a cabinet or other enclosure. The mounting holes are shown in **Red** in the following drawing with all dimensions in millimeters. The mounting holes are 4.2mm in diameter and are designed for M3 screws. When the RIO is mounted with the Ethernet connector on the bottom and the DIO connectors on the top, a M3 standoff that is at least 16mm in length should be used between the RIO and the mounting surface. There should be sufficient airflow across the top and bottom of this board to ensure that the components do not become excessively hot.



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.

RIO Ethernet 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 the RIO's 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 of the RIO, 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.

RIO and Guidance Controller Configuration

RIO Slave Operation: Remote I/O Scanning

RIO modules are typically configured as slaves to provide additional remote digital I/O, analog inputs, and serial ports to a Guidance Controller. This mode of operation is specified by setting DataID 211 "GPL MODBUS/TCP master" on the RIO to True (the default setting).

When the RIO is configured as a slave, its built-in system software periodically scans the module's input signals at a fixed rate to check for any changes. If a change occurs, a message is sent to the master Controller, notifying it of the new input values. The scan period determines the minimum input pulse width

that can be detected and also adds to the latency 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 does not poll output commands from the Controller, but relies on the Controller to notify the RIO whenever an output changes. The rate at which the Controller scans its outputs and sends messages to the RIO is configured on the Controller.

The RIO module also sends heartbeats to the Controller. If the Controller does not receive a message within a specified time, it assumes that an error has occurred and closes its connection. In this case the I/O points associated with the RIO become unavailable for I/O, and robot power is optionally disabled until communication with the RIO is reestablished.

The Controller also sends heartbeat messages at a slow rate to each RIO module, even if no outputs have changed. These messages allow the RIO modules to detect that the Controller is still connected and functioning. The heartbeat must occur often enough so the RIOs can detect failures in a timely manner, but slow enough to not waste too much time on the master Controller.

The table below shows the scanning parameters. **To access these values on the RIO or the Controller as appropriate, go to the web interface for the proper device and select: *Setup > Parameter Database > Controller > System DIO*.** After these values are updated, you should save them to the flash disk. If decide to use the default scanning parameters on all your RIO modules, you can simply use the defaults on the Controller.

Parameter Database ID	Parameter Name	Default Value	Description
550	Remote IO scan period in sec	0.010	(Set on Controller and RIO) The time period used by the local board to scan its local I/O. If any changed I/O values are detected during a scan, the new values are sent to the remote board (either a RIO module or the master Controller). The scan period determines the minimum input pulse width that can be detected by the local board, and also adds to the time between when an input changes and when the remote node 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.
551	Remote IO heartbeat period in sec	0.500	(Set on Controller and RIO) The time period used by the local board to send its I/O state to the remote board (either a RIO module or the master Controller), even if no I/O have changed. Receiving this message notifies the remote node that this local board is alive. Typically set to less than one-half the value of

			"Remote IO max input time in sec" (DataID 552) on the remote module.
552	Remote IO max input time in sec	2	(Set on Controller and RIO) If the remote board (either a RIO module or master Controller) fails to send an update message within this time period, an error occurs. Typically set to > 2 times the value of "Remote DIO output heartbeat time in sec" (DataID 551) on the remote module.
553	Local IO error action	0 or 2	(Set on Controller and RIO) Determines the action taken if a communications error occurs. On the RIO module, 0 means freeze the outputs, 1 means clear the outputs. On a Controller, 0 and 1 are ignored. 2 means disable robot power and do not permit it to be enabled until communication with the RIO module is established.

RIO Slave Operation: Digital I/O Number Mapping

When a properly configured RIO module is connected to the local Ethernet network and enabled, additional general digital inputs and outputs become available on the master Controller. The correspondence between the RIO module I/O and the Controller signal numbers depends on the unit number of the RIO, as selected by the DIP switch settings on the RIO, and are independent of the Ethernet IP addresses of the Controller and RIO.

RIO Unit	RIO DIP switch 1 2 3 4	Output Signals	Input Signals
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

A single RIO module contains 32 digital inputs and 32 digital outputs.

Guidance Controller Configuration

After the Ethernet IP address of the Remote I/O module has been configured, the Controller must be configured to recognize and connect to the RIO module.

1. Set the value of the "Remote IO module IP address" (DataID 555) database array to the IP address of the RIO module. The array index chosen is not important for operation of the RIO module, but is used when accessing other parameter values in the following steps. Likewise, the IP address for the RIO can be arbitrarily selected and does not effect how the IO on the RIO are

addressed from within application programs. By default, the first RIO address is set to "192.168.0.101".

2. Set the corresponding element of the "Remote IO module enable" (DataID 554) parameter array to "True", to enable scanning of the RIO device. If this value is True when the parameter database is saved, the scanning begins automatically when the Controller is restarted. Setting this value to False stops the scanning of the corresponding RIO, and setting it back to True attempts to restart scanning. If a RIO module is connected to the network after the Controller is started, the "Remote IO module enable" (DataID 554) value must be toggled to False then True to initiate scanning of the RIO.
3. Note the value of the corresponding element of the read-only parameter array "Remote IO module unit" (DataID 556). If the RIO device was detected and is being scanned, this parameter value is the unit number (from 1 to 15) of the RIO module. If no RIO module is detected or an error occurs, this value is zero.

The table below shows the Controller setup parameters. **To access these values, go to the web interface of the Controller and select: *Setup > Parameter Database > Controller > System DIO*.** After these values are updated, you should save them to the flash disk.

Parameter Database ID	Parameter Name	Default Value	Description
554	Remote IO module enable	False	(Set only on Controller) Determines if the corresponding RIO module specified by a "Remote IO module IP address" (DataID 555) entry should be scanned by this Controller. When changed from True to False, disables the RIO module. When changed from False to True, attempts to begin scanning for the RIO module.
555	Remote IO module IP address	192.168.0.101	(Set only on Controller) Each entry specifies the IP address of a RIO module to be scanned. Scanning only occurs if the corresponding entry in "Remote IO module enable" (DataID 554) is set to True. The order of IP addresses in this array is not important.
556	Remote IO module unit	0 to 15	(Read-only on Controller and RIO) Indicates the status of the corresponding RIO module specified by the "Remote IO module IP address" (DataID 555). If 0, the RIO module is not being scanned. If > 0, the value indicates the RIO unit number, from 1 to 15.

Guidance Controller Remote Digital I/O Simulation

As a software development aid, digital IO signals for networked IO modules (RIO's, MODBUS/TCP, EtherNet/IP) can be simulated in software. When an IO signal is simulated, its value can be read and

written using the standard GPL instructions even though the hardware is not connected to the Controller. To enable software IO simulation, see "I/O simulation map: count, signal" (DataID 579).

RIO Operation As An Independent Master Controller

RIO modules can be configured to execute as a standalone master controller. In this mode of operation, the RIO acts much like a Guidance Controller in that it can execute GPL programs that can access all of the board's communication resources. However, there are a few restrictions:

- RIO masters cannot generate robot motions.
- RIO masters cannot be part of a Precise Servo Network.

In addition, external MODBUS/TCP masters cannot directly access a master RIO's I/O ports. Instead, the RIO operates like a Guidance controller and is a MODBUS/TCP slave to other MODBUS/TCP masters and communicates through an array of holding registers. (See the MODBUS/TCP section of the *Precise Documentation Library* for more information on this feature.)

To configure a RIO as a master controller, the following DataID on the RIO must be set.

Parameter Database ID	Parameter Name	Default Value	Description
211	GPL MODBUS/TCP master	TRUE for standard controllers, FALSE for RIO boards	<p>If TRUE, a RIO board operates like a Guidance Controller and can act as a MODBUS/TCP master to access other RIO boards.</p> <p>Always TRUE for Guidance controllers. For RIO boards, must be FALSE if the RIO is to act as a standard remote I/O board. May be set TRUE for RIO boards that act as intelligent controllers.</p> <p>If TRUE, this controller maps MODBUS/TCP slave requests to holding registers in DataID 561.</p> <p>If FALSE, this controller maps slave requests directly to I/O ports.</p> <p>The controller must be rebooted for changes to take effect.</p>

Hardware Reference

Remote Input and Output Hardware Overview

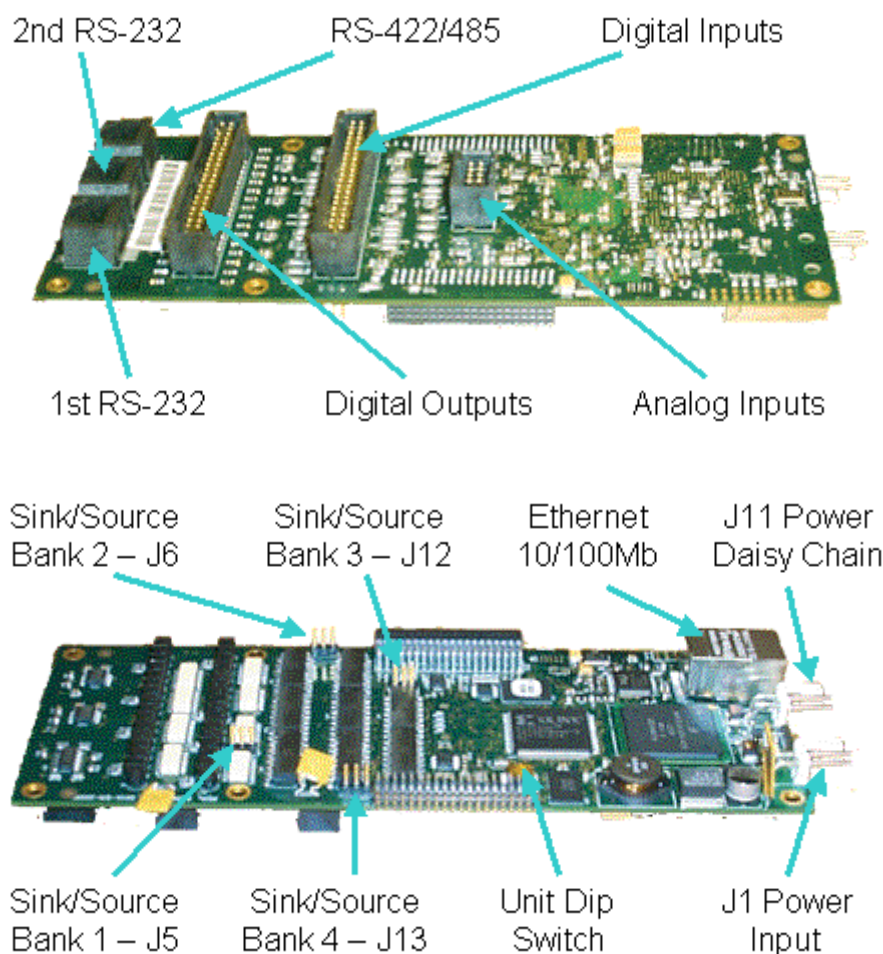
The Remote Input and Output module provides a number of hardware interfaces that further enhance a Guidance Controller's ability to connect to external equipment. The interfaces and configuration hardware for this module include the following:

- [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.

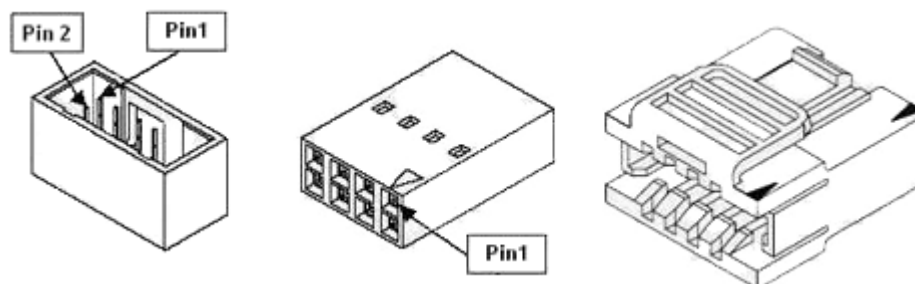


In the following sections, the software configuration of this module is described along with the pin outs for each of the connectors and the settings for the jumpers and switches.

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.

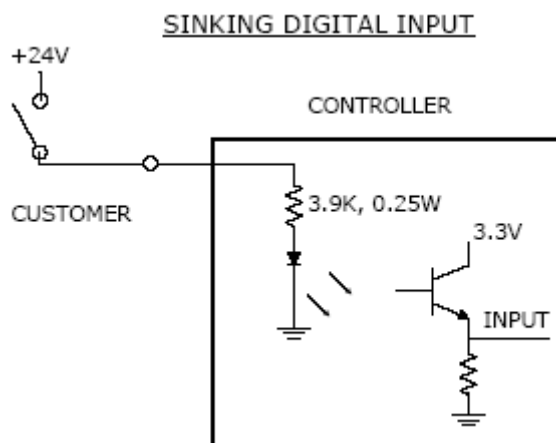


Pin	Description
1	GND
2	+/- 10 VDC input signal 1
3	GND
4	+/- 10 VDC input signal 2
5	GND
6	+/- 10 VDC input signal 3
7	GND
8	+/- 10 VDC input signal 4
User Plug Part No	Molex 22-55-2081 with Molex 15-04-5084 cover clip. The pins for this plug are 16-02-0103 and the Molex crimp tool is a 63811-1000.

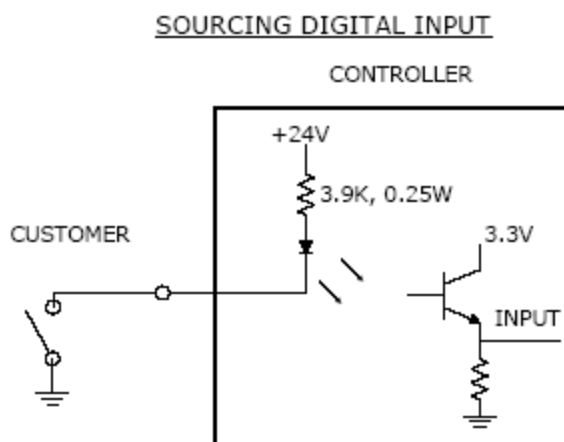
Digital Input Signals

The RIO boards 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.

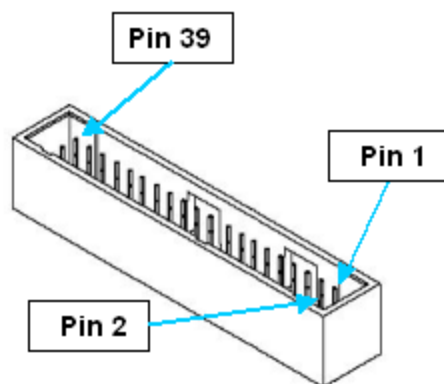
If an input signal is configured as "sinking", the external equipment must provide a 5VDC to 24VDC voltage to indicate a logical high value or no voltage for a logical low. This configuration is compatible with "sourcing" (PNP) sensors.



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.

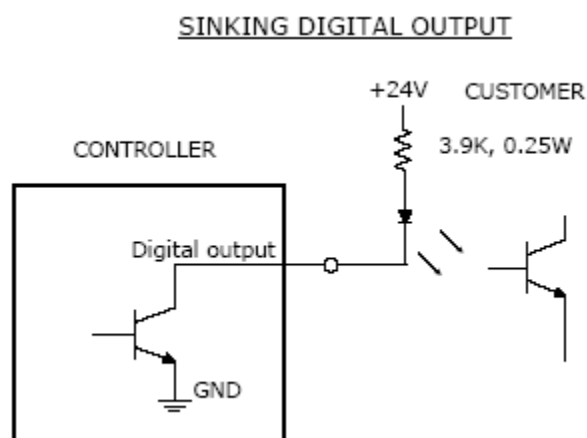


Signal	Pin	Pin	Signal
Input 1	1	2	Input 17
Input 2	3	4	Input 18
Input 3	5	6	Input 19
Input 4	7	8	Input 20
24VDC	9	10	GND
Input 5	11	12	Input 21
Input 6	13	14	Input 22
Input 7	15	16	Input 23
Input 8	17	18	Input 24
24VDC	19	20	GND
Input 9	21	22	Input 25
Input 10	23	24	Input 26
Input 11	25	26	Input 27
Input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

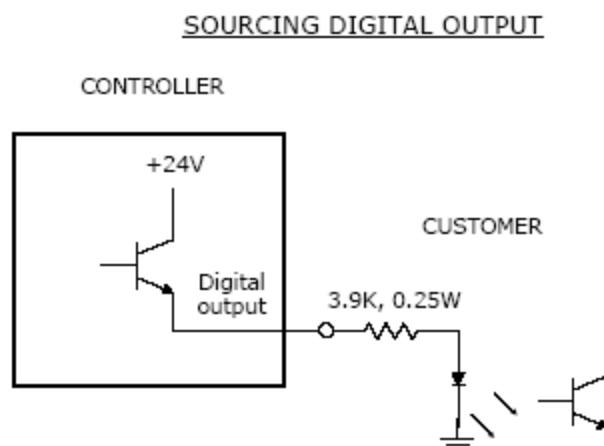
Digital Output Signals

The RIO boards each support 32 optically isolated digital output signals. Depending the type of RIO module purchased, all of the outputs are either "sinking" or "sourcing". [Note, Sourcing outputs is a special order configuration and the lead time might be very long.]

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.

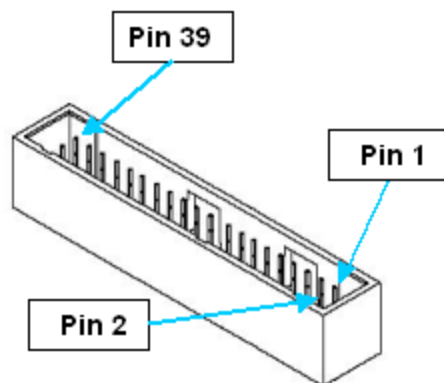


If an output signal is "sourcing", the external equipment must pull-down the output pin to ground and the RIO pulls this pin to 24VDC when the signal is asserted as true. This configuration is compatible with "sinking" (NPN) devices.



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.

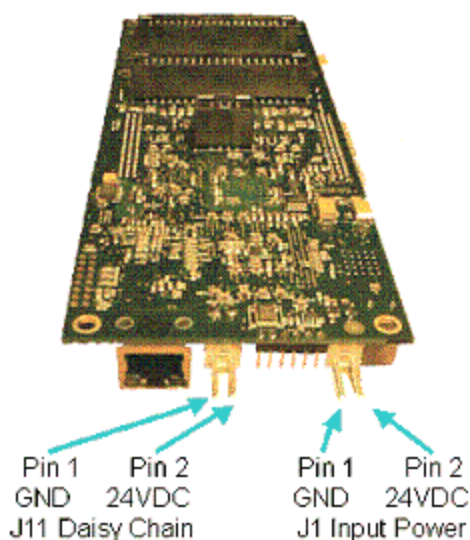


See the *Software Reference* section of this manual for information on configuring the IP address of the RIO and for setting other key communication parameters.

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.

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 additional RIO 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 additional RIO boards	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/comrxy" 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 ("jumpered") 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. 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
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
Digital Input Channels	Standard RIO, Enhanced RIO: 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: 32 optically isolated digital outputs Sinking outputs is standard. Sourcing are a special order item. 24VDC maximum pull up if sinking 24VDC supplied if sourcing, 100mA maximum per channel
Analog I/O Channels	Standard RIO: None

	Enhanced RIO: 4 analog input channels, +/-10VDC, 12 bit ADC
General	
Size and Weight	75mm (W) x 195mm (L) x 28mm (H), 0.142 kg
Low Voltage Logic Power	24VDC required for logic and input/output functions Standard RIO: 0.4A minimum for logic plus 3.2A maximum if sourcing all digital outputs for a total of 3.6A. Enhanced RIO: 0.4A minimum for logic plus 3.2A maximum if sourcing all digital outputs for a total of 3.6A.
Special Order Options	Both the Enhanced RIO and sourcing output signals are special order items. As such, the lead time for these options can be quite long and minimum order quantity requirements apply.