RIO128 Installation and Operation Manual

NOTICE

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Open Control Solutions also reserves the right to make changes to the specifications of the RIO128 and to the information contained in this document at any time without notice.

Table of Contents

Chapter 1: Specifications & Pinouts

DIGITAL INPUTS (INPUTS)

Quantity of digital inputs (inputs): 40
Input type: Closure-to-ground for on; biased with 10-15 VDC raw power via onboard 5.6 Kohm resistor
On/Off threshold: 1.5 VDC
Input current: 2.5mA @ 0 VDC
Conversion rate: 120 samples-per-second with 100 mSec debouncing for on/off status
DI pulse counting rate: Sampled at raw 120 samples-per-second; maximum input pulse rate of 30 Hz (See "Pulse points" on page 39 in Chapter 6: Communications for more information on pulse points.)

Pin #	Name	User-defined Name	Description	Modbus Register		
				Normal	Packed	Pulse
P1-1	digital input 1 (DI-1)			10001	40012/0	40055
P1-2	digital input 2 (DI-2)			10002	40012/1	40056
P1-3	digital input 3 (DI-3)			10003	40012/2	40057
P1-4	digital input 4 (DI-4)			10004	40012/3	40058
P1-5	digital input 5 (DI-5)			10005	40012/4	40059
P1-6	digital input 6 (DI-6)			10006	40012/5	40060
P1-7	digital input 7 (DI-7)			10007	40012/6	40061
P1-8	digital input 8 (DI-8)			10008	40012/7	40062
P1-9	digital ground (DI-▽)					
P2-1	digital input 9 (DI-9)			10009	40012/8	40063
P2-2	digital input 10 (DI-10)			10010	40012/9	40064
P2-3	digital input 11 (DI-11)			10011	40012/10	40065
P2-4	digital input 12 (DI-12)			10012	40012/11	40066
P2-5	digital input 13 (DI-13)			10013	40012/12	40067
P2-6	digital input 14 (DI-14)			10014	40012/13	40068
P2-7	digital input 15 (DI-15)			10015	40012/14	40069
P2-8	digital input 16 (DI-16)			10016	40012/15	40070
P2-9	digital ground (DI-▽)					
P3-1	digital input 17 (DI-17)			10017	40013/0	40071
P3-2	digital input 18 (DI-18)			10018	40013/1	40072
P3-3	digital input 19 (DI-19)			10019	40013/2	40073
P3-4	digital input 20 (DI-20)			10020	40013/3	40074
P3-5	digital input 21 (DI-21)			10021	40013/4	40075
P3-6	digital input 22 (DI-22)			10022	40013/5	40076
P3-7	digital input 23 (DI-23)			10023	40013/6	40077

DIGITAL INPUTS (INPUTS)						
Pin #	Name	User-defined Name	Description	Modbus Register		
				Normal	Packed	Pulse
P3-8	digital input 24 (DI-24)			10024	40013/7	40078
P3-9	digital ground (DI-⏚)					
P4-1	digital input 25 (DI-25)			10025	40013/8	40079
P4-2	digital input 26 (DI-26)			10026	40013/9	40080
P4-3	digital input 27 (DI-27)			10027	40013/10	40081
P4-4	digital input 28 (DI-28)			10028	40013/11	40082
P4-5	digital input 29 (DI-29)			10029	40013/12	40083
P4-6	digital input 30 (DI-30)			10030	40013/13	40084
P4-7	digital input 31 (DI-31)			10031	40013/14	40085
P4-8	digital input 32 (DI-32)			10032	40013/15	40086
P4-9	digital ground (DI-⏚)					
P5-1	digital input 33 (DI-33)			10033	40014/0	40087
P5-2	digital input 34 (DI-34)			10034	40014/1	40088
P5-3	digital input 35 (DI-35)			10035	40014/2	40089
P5-4	digital input 36 (DI-36)			10036	40014/3	40090
P5-5	digital input 37 (DI-37)			10037	40014/4	40091
P5-6	digital input 38 (DI-38)			10038	40014/5	40092
P5-7	digital input 39 (DI-39)			10039	40014/6	40093
P5-8	digital input 40 (DI-40)			10040	40014/7	40094
P5-9	digital ground (DI-⏚)					

ANALOG INPUTS (INPUT REGISTERS)

Quantity of analog inputs (input registers): 40
Signal input levels, nominal: 0-5V; 4-20mA externally with external 249 ohm .02% resistor
Resolution: 12-bit
Maximum ratings: 0-5V +/- .2V
Input impedance: 511 Kohms
Overload / transient protection: None
Conversion rate: 10-samples-per-second
Noise rejection (50/60Hz): -30dB
Note: See "Analog inputs repeated as analog outputs" on page 40 in Chapter 6: Communications for more information on repeating analog inputs as holding registers (analog outputs).

ANALOG INPUTS (INPUT REGISTERS)					
Pin #	Name	User-defined Name	Description	Modbus Register	
				Normal	Repeated as holding register
P6-1	analog input 1 (AI-1)			30001	40015
P6-2	analog input 2 (AI-2)			30002	40016
P6-3	analog input 3 (AI-3)			30003	40017
P6-4	analog input 4 (AI-4)			30004	40018
P6-5	analog input 5 (AI-5)			30005	40019
P6-6	analog input 6 (AI-6)			30006	40020
P6-7	analog input 7 (AI-7)			30007	40021
P6-8	analog input 8 (AI-8)			30008	40022
P6-9	analog ground (AI-⏚)				
P7-1	analog input 9 (AI-9)			30009	40023
P7-2	analog input 10 (AI-10)			30010	40024
P7-3	analog input 11 (AI-11)			30011	40025
P7-4	analog input 12 (AI-12)			30012	40026
P7-5	analog input 13 (AI-13)			30013	40027
P7-6	analog input 14 (AI-14)			30014	40028
P7-7	analog input 15 (AI-15)			30015	40029
P7-8	analog input 16 (AI-16)			30016	40030
P7-9	analog ground (AI-⏚)				
P8-1	analog input 17 (AI-17)			30017	40031
P8-2	analog input 18 (AI-18)			30018	40032
P8-3	analog input 19 (AI-19)			30019	40033
P8-4	analog input 20 (AI-20)			30020	40034
P8-5	analog input 21 (AI-21)			30021	40035
P8-6	analog input 22 (AI-22)			30022	40036

ANALOG INPUTS (INPUT REGISTERS)					
Pin #	Name	User-defined Name	Description	Modbus Register	
				Normal	Repeated as holding register
P8-7	analog input 23 (AI-23)			30023	40037
P8-8	analog input 24 (AI-24)			30024	40038
P8-9	analog ground (AI-⏚)				
P9-1	analog input 25 (AI-25)			30025	40039
P9-2	analog input 26 (AI-26)			30026	40040
P9-3	analog input 27 (AI-27)			30027	40041
P9-4	analog input 28 (AI-28)			30028	40042
P9-5	analog input 29 (AI-29)			30029	40043
P9-6	analog input 30 (AI-30)			30030	40044
P9-7	analog input 31 (AI-31)			30031	40045
P9-8	analog input 32 (AI-32)			30032	40046
P9-9	analog ground (AI-⏚)				
P10-1	analog input 33 (AI-33)			30033	40047
P10-2	analog input 34 (AI-34)			30034	40048
P10-3	analog input 35 (AI-35)			30035	40049
P10-4	analog input 36 (AI-36)			30036	40050
P10-5	analog input 37 (AI-37)			30037	40051
P10-6	analog input 38 (AI-38)			30038	40052
P10-7	analog input 39 (AI-39)			30039	40053
P10-8	analog input 40 (AI-40)			30040	40054
P10-9	analog ground (AI-⏚)				

DIGITAL OUTPUTS (COILS)

Quantity of digital outputs (coils): 40
Output type, configuration: Darlington array sinking to common
Output switch current rating: Current capability to drive 12 or 24 VDC, 80 mA constant duty, 300mA in-rush current, ice cube-type relays

DIGITAL OUTPUTS (COILS)					
Pin #	Name	User-defined Name	Description	Modbus Register	
				Normal	Packed
P11-9	digital ground (DO-↓)				
P11-8	digital output 1 (DO-1)			00001	40009/0
P11-7	digital output 2 (DO-2)			00002	40009/1
P11-6	digital output 3 (DO-3)			00003	40009/2
P11-5	digital output 4 (DO-4)			00004	40009/3
P11-4	digital output 5 (DO-5)			00005	40009/4
P11-3	digital output 6 (DO-6)			00006	40009/5
P11-2	digital output 7 (DO-7)			00007	40009/6
P11-1	digital output 8 (DO-8)			00008	40009/7
P12-9	digital ground (DO-↓)				
P12-8	digital output 9 (DO-9)			00009	40009/8
P12-7	digital output 10 (DO-10)			00010	40009/9
P12-6	digital output 11 (DO-11)			00011	40009/10
P12-5	digital output 12 (DO-12)			00012	40009/11
P12-4	digital output 13 (DO-13)			00013	40009/12
P12-3	digital output 14 (DO-14)			00014	40009/13
P12-2	digital output 15 (DO-15)			00015	40009/14
P12-1	digital output 16 (DO-16)			00016	40009/15
P13-9	digital ground (DO-↓)				
P13-8	digital output 17 (DO-17)			00017	40010/0
P13-7	digital output 18 (DO-18)			00018	40010/1
P13-6	digital output 19 (DO-19)			00019	40010/2
P13-5	digital output 20 (DO-20)			00020	40010/3
P13-4	digital output 21 (DO-21)			00021	40010/4
P13-3	digital output 22 (DO-22)			00022	40010/5
P13-2	digital output 23 (DO-23)			00023	40010/6
P13-1	digital output 24 (DO-24)			00024	40010/7
P14-9	digital ground (DO-↓)				
P14-8	digital output 25 (DO-25)			00025	40010/8
P14-7	digital output 26 (DO-26)			00026	40010/9

DIGITAL OUTPUTS (COILS)					
Pin #	**Name**	**User-defined Name**	**Description**	**Modbus Register**	
				Normal	Packed
P14-6	digital output 27 (DO-27)			00027	40010/10
P14-5	digital output 28 (DO-28)			00028	40010/11
P14-4	digital output 29 (DO-29)			00029	40010/12
P14-3	digital output 30 (DO-30)			00030	40010/13
P14-2	digital output 31 (DO-31)			00031	40010/14
P14-1	digital output 32 (DO-32)			00032	40010/15
P15-9	digital ground (DO-⏚)				
P15-8	digital output 33 (DO-33)			00033	40011/0
P15-7	digital output 34 (DO-34)			00034	40011/1
P15-6	digital output 35 (DO-35)			00035	40011/2
P15-5	digital output 36 (DO-36)			00036	40011/3
P15-4	digital output 37 (DO-37)			00037	40011/4
P15-3	digital output 38 (DO-38)			00038	40011/5
P15-2	digital output 39 (DO-38)			00039	40011/6
P15-1	digital output 40 (DO-40)			00040	40011/7

ANALOG OUTPUTS (HOLDING REGISTERS)

Quantity of analog outputs (holding registers): 8
Output types: 0-5V into a 10Kohm load
Resolution: 12-bit
Overall accuracy: $^+/_-$ 1% of full scale

ANALOG OUPUTS (HOLDING REGISTERS)				
Pin #	**Name**	**User-defined Name**	**Description**	**Modbus Register**
P19-9	analog ground (AO-⏚)			
P19-8	analog output 1 (AO-1)			40001
P19-7	analog output 2 (AO-2)			40002
P19-6	analog output 3 (AO-3)			40003
P19-5	analog output 4 (AO-4)			40004
P19-4	analog output 5 (AO-5)			40005
P19-3	analog output 6 (AO-6)			40006
P19-2	analog output 7 (AO-7)			40007
P19-1	analog output 8 (AO-8)			40008

POWER

Pin #	Name	Description	Electrical rating
P16-1	+V IN	Incoming power	10-15 VDC; less than 12 watts
P16-2	⏚	Incoming power return	
P16-3	⏚	Regulated 5V out return	
P16-4	+5V OUT	Regulated 5V out	½ amp maximum

RS-485

Pin #	Name	Description
P17-1	A	RS-485 serial interface A
P17-2	B	RS-485 serial interface B
P17-3	GROUND	RS-485 ground (optional; as required)

DTE CONNECTION (RS-232)

Pin #	Name	Description
J1-1	NC	
J1-2	RXD	Receive data input
J1-3	TXD	Transmit data output
J1-4	NC	
J1-5	SIGNAL GROUND	
J1-6	NC	
J1-7	RTS	Hardware flow control output
J1-8	CTS	Hardware flow control input
J1-9	NC	

ADDRESS BOARD

Pin #	Name	Description
P18-1	ADDR0	Station address bit 0 (value=1 bit)
P18-2	ADDR1	Station address bit 1 (value=2 bit)
P18-3	ADDR2	Station address bit 2 (value=4 bit)
P18-4	ADDR3	Station address bit 3 (value=8 bit)
P18-5	ADDR4	Station address bit 4 (value=16 bit)
P18-6	ADDR5	Station address bit 5 (value=32 bit)
P18-7	ADDR6	Station address bit 6 (value=64 bit)
P18-8	ADDR7	Station address bit 7 (value=128 bit)
P18-9	GROUND	Station address ground

COMMUNICATION CONFIGURATION

The position of each communication configuration switch – Up (Off) or Down (On) – determines if it is recognized logically (value of TRUE or FALSE) by the RIO032's onboard microprocessor.

- A switch that is Up (Off) has a logical value = 1 / TRUE.
- A switch that is Down (On) has a logical value = 0 / FALSE.

For Learn (auto configuration) mode, leave *all* communication configuration switches in the Off (Up) position (value = 1 / TRUE).

Refer to the example photo and illustration on page 38 when setting dip switches for communication parameters.

Pin #	Name	Description
SW2-1	BPS BIT 0	Baud rate settings (see BPS truth table below)
SW2-2	BPS BIT 1	Baud rate settings (see BPS truth table below)
SW2-3	BPS BIT 2	Baud rate settings (see BPS truth table below)
SW2-4	PROTOCOL BIT 0	Protocol settings (see Protocol truth table below)
SW2-5	PROTOCOL BIT 1	Protocol settings (see Protocol truth table below)
SW2-6	8/7 DATA BITS	switch is Off (Up) = 8; switch is On (Down) = 7 (see "Manual configuration: Data bits and parity" on page 36 for more information on configuring this option)
SW2-7	E/O PARITY	switch is Off (Up) = EVEN; switch is On (Down) = ODD (see "Manual configuration: Data bits and parity" on page 36 for more information on configuring this option)
SW2-8	1 / 2 STOP BITS	switch is Off (Up) = 1 stop bit; switch is On (Down) = 2 stop bits
SW2-9	GROUND	Station address ground

BPS Truth Table

Baud Rate	BPS Bit 0 Value (switch position)	BPS Bit 1 Value (switch position)	BPS Bit 2 Value (switch position)
1200	0 (down)	0 (down)	0 (down)
2400	1 (up)	0 (down)	0 (down)
4800	0 (down)	1 (up)	0 (down)
9600	1 (up)	1 (up)	0 (down)
19200	0 (down)	0 (down)	1 (up)
38400	1 (up)	0 (down)	1 (up)
Reserved	0 (down)	1 (up)	1 (up)
Learn	1 (up)	1 (up)	1 (up)

Protocol Truth Table

Protocol	Protocol Bit 0 Value (switch position)	Protocol Bit 2 Value (switch position)
ASCII	0 (down)	0 (down)
TCP	1 (up)	0 (down)
RTU	0 (down)	1 (up)
Learn / RTU Radio*	1 (down)	1 (up)

* The RIO128 will only enter Learn mode if *all* of the communication configuration switches are in the Off (Up) position (value = 1 / TRUE). RTU Radio Protocol is identical to RTU Protocol except that the RIO128 expects a CTS to occur whenever it asserts an RTS and will wait for the RTS signal before transmitting any data.

SPECIAL FUNCTION REGISTERS

Register	Function
49000	Dip Switch Bus Address - Current dip switch setting. Overrides Flash Bus Address
49001	Dip Switch Configuration Bits - Current dip switch setting. Overrides Flash Configuration Bits
49002	Flash Bus Address - Bus address stored in flash. Used only if dip switch = 255
49003	Flash Configuration Bits- Configuration Bits stored in flash. Used only if dip switch = 255
49104	Hardware Version - Factory
49105	Software Version Year
49106	Software Version Month
49107	Software Version Day
49108	Patch Version Year
49109	Patch Version Month
49110	Patch Version Day
49111	Serial Number Hi
49112	Serial Number Lo
49113	Product Model Number
49114	Product Dash Number (Optional)
49200	Remote Reset (data must be oxA5A5)
49201	Jump to Boot Loader (data must be 0xAA55)
49202	Last Fault Condition (Last non-255 byte in Fault Log)

Notes:

The RIO128 is a unique "open architecture" high density rail-mounted input/output device. Ideal for use in all industries, the RIO128 supports industry-standard Modbus ASCII, TCP, RTU, and RTU Radio protocols and may be used for local and remote monitoring and control over wide-area Radio and Ethernet networks. A built-in RS-232 serial connector is available for interface with third-party radios and an optional network adaptor is available for networking.

Featuring 128 I/O points, the RIO128 is suitable for just about any application. The built-in RS-485 serial connector provides the ability to connect up to thirty-two RIO-128 devices for a total expansion to 4,096 I/O points. This open architecture device not only ensures interoperability with other devices, it also provides compatibility with hundreds of popular SCADA / DCS software packages, PLCs, process controllers and instrumentation.

128 I/O POINTS

High density I/O count

The RIO128 has a total of 128 non-isolated I/O points:

- 40 digital input, or monitor, points (inputs)
- 40 digital output, or control, points (coils)
- 40 analog input, or monitor, points (input registers) with 12 bit resolution
- 8 analog output, or control, points (holding registers) with 12 bit resolution

Analog points

All of the RIO128's analog I/O have 12-bit resolution and are processed at a rate of 10-samples-per-second. When not being used as analog I/O, the RIO128's analog points may be used as digital I/O.

Digital points

The RIO128's digital inputs are closure-to-ground for on and are biased with 10-15 VDC raw power through an onboard 5.6 Kohm resistor. Digital inputs are processed at a rate of 120-samples-per-second with 100 mSec debouncing for on/off status. For pulse input accumulation, digital inputs are sampled at the raw 120 sample rate. The maximum input pulse rate is 30 Hz.

Digital outputs are open collector with current capability to drive 12 or 24 VDC, 80mA constant duty, 300mA in-rush current, ice cube-type DC relays.

COMMUNICATIONS

Three modes

The RIO128 is capable of three methods of communication: Radio, Modem, and Network. Radio and modem communications take place through the RIO128's RS-232 and RS-485 serial interfaces. Network communications require the use of an optional serial-to-network converter such as the RAIL Network Adapter, or RNA), available from Open Control Solutions.

Scan and control rate

The RIO128 features a 10 Hz scan and control rate (93 Modbus status registers and five Modbus control registers). This rate may vary depending on variables including message length, baud rate, Modbus master processing time, and transmission errors.

Serial interfaces

The RIO128 includes one RS-485 serial interface and one RS-232 serial interface, as well as an onboard RS-232 to RS-485 converter. The RIO128's serial interfaces have several uses:

1. The RS-485 and RS-232 serial interfaces may be used for connecting to polling devices and controllers.
2. The RS-232 serial interface may be used for connecting the RIO128 to a communication device such as a radio or to a serial-to-network converter.
3. The RS-485 serial interface may be used for bussing multiple RIO128 units.

Communication speed

The RIO128 is capable of communicating at speeds of 1200-38400 baud.

Communication protocols

The RIO128 supports the following communication protocols:

1. Modbus ASCII
2. Modbus RTU
3. Modbus RTU Radio*
4. Modbus TCP (requires RAIL Network Adapter or other serial-to-network converter)

* Modbus RTU Radio protocol is identical to RTU protocol except that the RIO128 expects a CTS (clear to send) to occur whenever it asserts an RTS (request to send) and will wait for it before transmitting any data. This protocol allows the RIO128 to be connected to an RDR (Rail Data Radio) or other manufacturer radio without special cabling.

LED STATUS INDICATORS

The RIO128 features four LED's (TXD, Status, RXD, and Power) that provide quick status information.

RIO128 power status

The RIO128's Power LED illuminates when either DC voltage or battery power is applied to the device. If the voltage being applied drops below 7V, the Power LED begins to dim.

When the device is initially powered up, all LED's come on (TXD, Status, RXD, and Power) and then all but the Power LED go off.

Start up status

After power is applied, the RIO128 enters start up mode. The RXD LED flashes when the microprocessor has been started and polling has begun. The TXD LED will flash if the device is communicating properly (i.e., replying to a poll).

Lamp test status

Once the microprocessor has started, the RIO128 performs a power on self test. During the self test, the TXD, RXD, and Status LEDs come on solid and then go off.

Communication status

The RIO128's RXD and TXD LED's flash to indicate communications are taking place. The RXD flashes when a message is received. The TXD flashes when the RIO128 is transmitting information.

Learn (program) mode

The RIO128 features an auto configuration, or learn, mode that enables it to automatically detect baud rate and protocol parameters and begin communicating using these parameters. When all of the communication configuration switches are placed in the OFF position (set to 1) and the RIO128's configuration button is held down during power up, the RIO128 enters learn mode and it attempts to determine baud rate and protocol settings within three polling loops (may take up to ten polling loops depending on your settings, such as baud rate) .

When the device is powered up with the configuration button held down, all of the RIO128's LED's come on. When the RXD, TXD, and Status LED's go off, the configuration button can be released. The TXD will flash rapidly and then the TXD, RXD and Status LED's will blink. After a minimum of three polls are received (may take up to ten polls), the RXD will blink three times. The TXD, RXD and Status LED's will turn on and then off indicating that Learn (auto configuration) is complete.

During the Learn process, the RIO128 uses the CTS (clear to send) signal to determine if it is connected to a radio. Radios, unlike other devices, don't activate the CTS signal until an RTS (request to send) is asserted. Once the RIO128 determines it is connected to a radio, it will begin communicating with it using the RTU Radio Protocol. RTU Radio Protocol is identical to RTU Protocol except that the RIO128 expects a CTS to occur whenever it asserts an RTS and will wait for the RTS signal before transmitting any data. This protocol allows the RIO128 to be connected to an RDR (Rail Data Radio) or other manufacturer radio without special cabling.

Firmware fault trap indication

The RXD, TXD, and Status LED's blink together to indicate that a firmware fault condition has occurred. If the RIO128 experiences a firmware fault, the microprocessor shuts down and then restarts. The RIO128 will perform a power on self test and will attempt to begin communicating again.

NO PROGRAMMING REQUIRED

The RIO128 requires no special programming to be used as a simple I/O component. It can easily interface with Open Control Solutions' Hyper SCADA Server, or with off-the-shelf, third-party software such as Wonderware, Intellution, etc.

PLUG & PLAY FUNCTIONALITY

The RIO128 has a removable address strap that enables one RIO128 to be exchanged with another without readdressing.

The RIO128's learn mode enables it to automatically determine and learn communication parameters (e.g., baud rate, parity, stop bits, and protocol) when *all* of the communication configuration switches are placed in the OFF position (set to 1) and the Config button is held down on power up. After being placed in Learn mode, the RIO128 attempts to determine baud and protocol settings within three polling loops (may take up to ten polling loops depending on your settings, such as baud rate).

RAIL NETWORK ADAPTER

The RAIL Network Adapter (RNA) is a small-sized serial-to-network converter that enables the RIO128 to communicate via Modbus TCP protocol. The RNA features an RJ-45 10Base-T Ethernet interface and 9-pin DSUB (D-subminiature) male Serial interface to allow 1200-38400 baud RS-232 communications. The RNA, which is configurable over the network interface via ARP protocol, is capable of TCP communications and can be configured to require no TCP authentication.

SAFETY PRECAUTIONS

Review the following statements before installing, servicing, or replacing the RIO128 or any of its components.

GENERAL PRECAUTIONS

Only trained and qualified personnel should install, service, or replace this equipment.

Carefully read the installation and wiring instructions before connecting the RIO128 to its power source.

Do not work on the RIO128, or connect or disconnect any of its cables, during periods of lightning activity.

To prevent overheating the RIO128, do not operate it in an area that exceeds the maximum recommended temperature of -10°C (14°F) to 60°C (140°F).

Ensure that the unit is connected to earth ground during normal use.

Precautionary measures must be observed when installing, operating, and servicing the RIO128 in order to prevent shock from voltages present.

If the RIO128 is to be installed into an existing control panel, make sure that all breakers are shut off before starting the installation.

All wiring should conform to federal, state, and local electrical codes.

WORKING WITH THE RIO128

Before working with the RIO128 where the removal of components is necessary, perform the following steps in the sequence indicated:

1. Power down the unit.
2. Turn off all circuit breakers to the RIO128.
3. Ensure that any cables connected to the RIO128 will not become entangled in or caught on anything in the surrounding area.

When disconnecting a cable, pull on its connector or on its strain-relief loop, not on the cable itself. Some cables have a connector with locking tabs; when disconnecting this type of cable, press in on the locking tabs before disconnecting the cable. When pulling connectors apart, keep them evenly aligned to avoid bending any connector pins. Also, before connecting a cable, make sure both connectors are correctly oriented and aligned.

PROTECTING AGAINST ELECTROSTATIC DISCHARGE

Static electricity can harm delicate, static-sensitive components inside the RIO128. To prevent static damage, observe proper ESD procedures during installation, such as putting on an electrostatic discharge wrist strap before touching any of the RIO128's electronic components. Additionally, the following steps can be taken to prevent damage from electrostatic discharge (ESD):

- When unpacking a static-sensitive component from its shipping carton, do not remove the component's antistatic packing material until ready to install the component in the RIO128. Be sure to put on an electrostatic discharge wrist strap before unwrapping the antistatic packaging.
- When transporting a sensitive component, first place it in an antistatic container or packaging.

- Handle all sensitive components in a static-safe area. Place the equipment on a grounded surface. If possible, use antistatic floor pads and workbench pads.

Note: Contact OCS if electrostatic discharge packaging is needed for return shipments. See "Return Authorization (RA) Procedure," p. 46 for more information on returning equipment.

USING THE RIO128

When using the RIO128, observe the following safety guidelines:

- To help prevent electric shock, wire the RIO128 and peripheral power cables into properly grounded power sources.
- Be sure nothing rests on the RIO128's cables and that the cables are not located where they can be stepped on or tripped over.

SITE SELECTION

When selecting a site for the RIO128, keep the following in mind:

- The RIO128 requires a power supply that provides 10-15 VDC.
- The RIO128 is designed to operate at the recommended temperature range of -10°C (14°F) to 60°C (140°F).
- The RIO128 is designed to be mounted in an industrial control panel with access limited to qualified personnel.
- Attention should be given to the location of the RIO128 to provide accessibility for wiring and servicing.

RECEIPT OF EQUIPMENT

When equipment is received, examine the outside of the carton for any damage incurred during shipment. Remove the packing list and the equipment from the shipping carton. Carefully inspect the equipment for damage. Resolve any damage with the local carrier. Report damages to Open Control Solutions (321-435-5010). Include the serial number of the unit and the extent of damage in your report.

⚠WARNING

This information is provided for qualified personnel only.

Improper installation, service, or maintenance can cause property damage, injury, or death.

Read the installation and operating instructions thoroughly before installing or servicing this equipment.

⚠WARNING

Precautionary measures must be observed when installing, operating, and servicing the RIO128 in order to prevent shock from voltages present.

If the RIO128 is to be installed into an existing control panel, make sure that all breakers are shut off before starting the installation.

All wiring must conform to federal, state, and local electrical codes.

IMPORTANT

A qualified technician should install the RIO128.

Precautionary measures must be observed when installing, operating, and servicing the RIO128 in order to prevent shock from voltages present.

The RIO128 is designed to be mounted in an industrial control panel with access limited to qualified personnel.

If the RIO128 is to be installed into an existing control panel, make sure that all breakers are shut off before starting the installation.

All wiring should conform to federal, state, and local electrical codes.

Attention should be given to the location of the RIO128 to provide accessibility for wiring and servicing. Allow room above and below the device to provide easy access.

SELECTING DIN-RAIL HARDWARE

When mounting the RIO128, either of the DIN-rail models listed below may be used.

- DIN EN 50025 (32mm asymmetrical)
- DIN EN 50022 (35mm symmetrical) (shown in drawing on the next page)

INSTALLING THE RIO128 ON THE DIN-RAIL

Hook the RIO128 on to the top of the DIN-rail and press down to snap it into place. Refer to the drawing on the next page when mounting the RIO128.
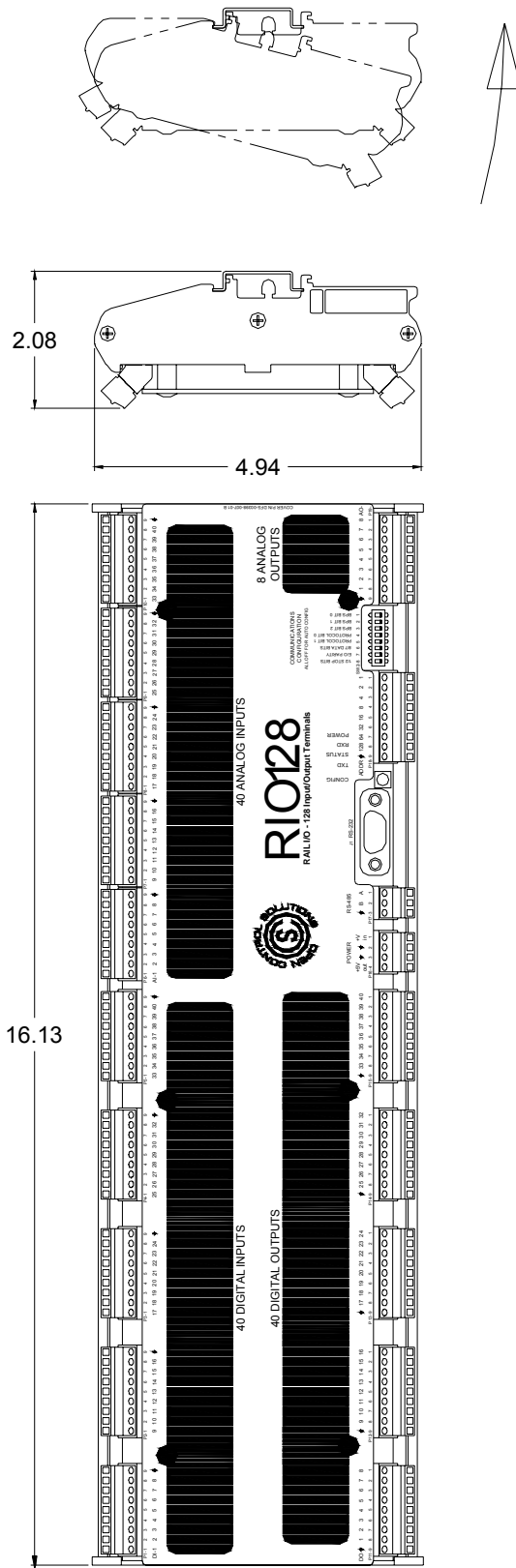
Figure 1, "Mounting the RIO128"

⚠WARNING

This information is provided for qualified personnel only.

Improper installation, service, or maintenance can cause property damage, injury, or death.

Read the installation and operating instructions thoroughly before installing or servicing this equipment.

⚠WARNING

Precautionary measures must be observed when installing, operating, and servicing the RIO128 in order to prevent shock from voltages present.

If the RIO128 is to be installed into an existing control panel, make sure that all breakers are shut off before starting the installation.

All wiring must conform to federal, state, and local electrical codes.

⚠CAUTION

Maximum wire size to RIO128 connectors is 16 AWG. Minimum wire size is 28 AWG.

Use copper conductors only with a minimum rating of 75°C.

When using connectors with screw-type terminals, tighten screw terminals to a maximum 7 in-lb (.79 Nm).

The electrical interface to the RIO128 is broken down into several groups of signals. Wiring of each group is detailed in the following paragraphs.

POWER

The RIO128 operates from 10-15 VDC and is compatible with other components of the RAIL system.

The RIO128 can be powered with a 13.8 V power supply and backed up with a 12 V lead-acid battery.

Four terminals are provided for wiring power:

- P16-1, *+V IN* (incoming power)
- P16-2, ⊽ (incoming power return)
- P16-3, ⊽ (regulated 5 volts out return)
- P16-4, *+5V OUT* (regulated 5 volts out)

Verify the input voltage on the RIO128's connector label before wiring. Wire in accordance with Federal, State, and Local Electrical Codes.
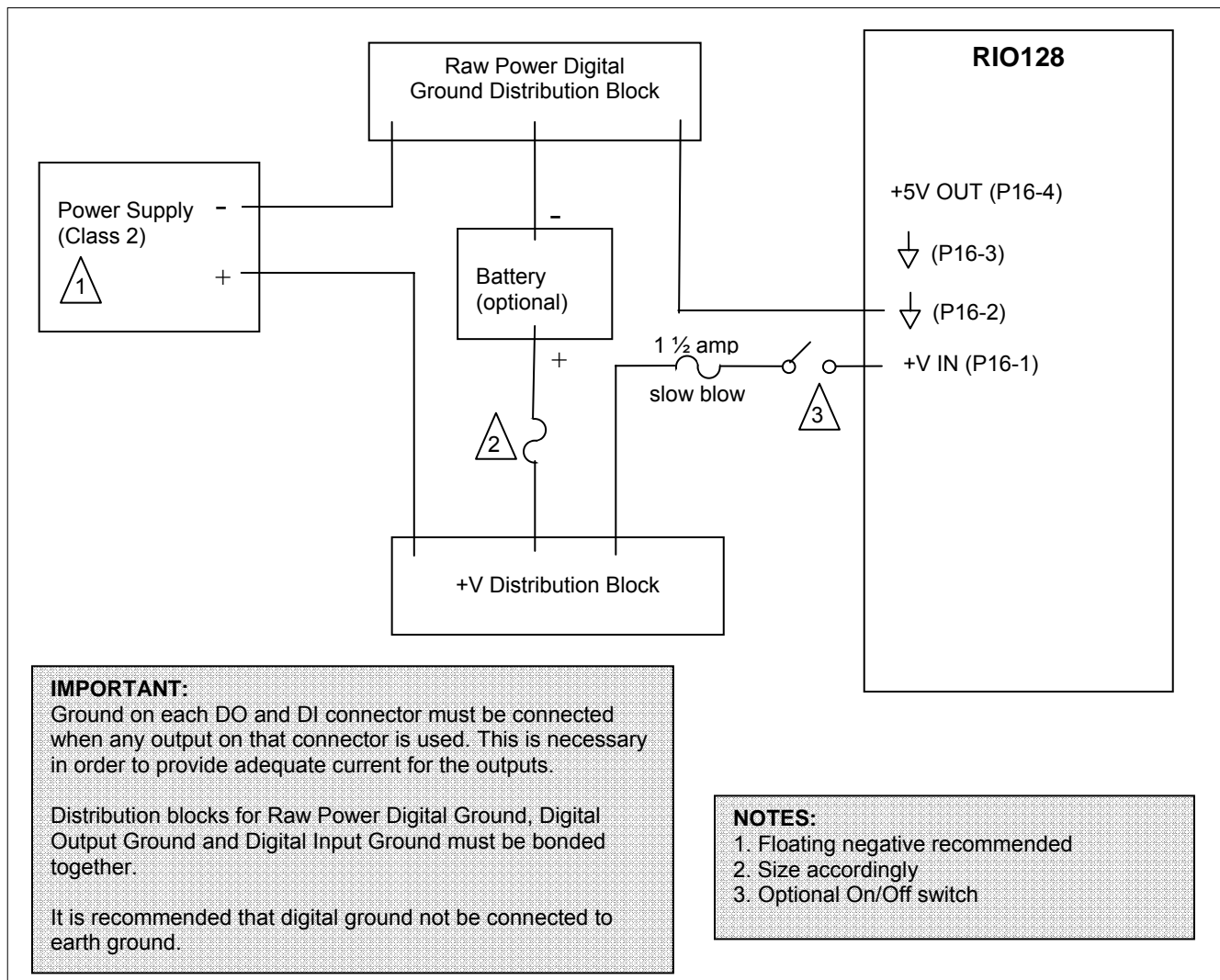
Figure 2, "Wiring DC Power"

DIGITAL INPUTS (INPUTS)

The RIO128 features 40 digital input, or monitor, points. The RIO128's digital inputs are closure-to-ground for on and are biased with 10-15 VDC raw power through an onboard 5.6 Kohm resistor. Digital inputs are processed at a rate of 120-samples-per-second with 100 mSec debouncing for on/off status. For pulse input accumulation, digital inputs are sampled at the raw 120 sample rate. The maximum input pulse rate is 30 Hz.

Pins for wiring digital inputs can be found at:

- P1-1 through P1-8
- P2-1 through P2-8
- P3-1 through P3-8
- P4-1 through P4-8
- P5-1 through P5-8

The corresponding ground pins are located at P1-9, P2-9, P3-9, P4-9 and P5-9.

IMPORTANT:
Ground on each DO and DI connector must be connected when any output on that connector is used. This is necessary in order to provide adequate current for the outputs.

Distribution blocks for Raw Power Digital Ground, Digital Output Ground and Digital Input Ground must be bonded together.

It is recommended that digital ground not be connected to earth ground.

Figure 3, "Digital Input Wiring"

DIGITAL OUTPUTS (COILS)

The RIO128 features 40 digital output, or control, points. The RIO128's digital outputs are open collector with current capability to drive 12 or 24 VDC, 80mA constant duty, 300mA in-rush current, ice cube-type DC relays.

Pins for wiring digital outputs can be found at:

- P11-1 through P11-8
- P12-1 through P12-8
- P13-1 through P13-8
- P14-1 through P14-8
- P15-1 through P15-8

The corresponding ground pins are located at P11-9, P12-9, P13-9, P14-9 and P15-9.

IMPORTANT:
Ground on each DO and DI connector must be connected when any output on that connector is used. This is necessary in order to provide adequate current for the outputs.

Distribution blocks for Raw Power Digital Ground, Digital Output Ground and Digital Input Ground must be bonded together.

It is recommended that digital ground not be connected to earth ground.

NOTES:
1. DC relay voltage rating to match power supply.
2. Recommend use of a floating power supply (i.e., DO-▽) not earth grounded.

Figure 4, "Digital Output Wiring"

ANALOG INPUTS (INPUT REGISTERS)

The RIO128 features 40 analog input, or monitor, points. All of the RIO128's analog I/O have 12-bit resolution and are processed at a rate of 10-samples-per-second. When not being used as analog I/O, the RIO128's analog points may be used as digital I/O. See "Using Analog I/O as Digital I/O" beginning on page 26 for wiring instructions.

Information on the bit format for the RIO's 12-bit analog I/O can be found in the section titled "Analog Bit Format" on page 40.

Pins for wiring analog inputs can be found at:

- P6-1 through P6-8
- P7-1 through P7-8
- P8-1 through P8-8
- P9-1 through P9-8
- P10-1 through P10-8

The corresponding ground pins are located at P6-9, P7-9, P8-9, P9-9 and P10-9.

4-20mA / 0-20mA Current Loop

IMPORTANT:
1. Because AI-1 through AI-40 are tied to a common isolated ground (AI-▽), the RIO128 must be the last device in a multiple device analog loop.
2. Do not exceed 5.5 volts on analog inputs.
3. Loop isolators (not shown) are recommended for circuit protection.
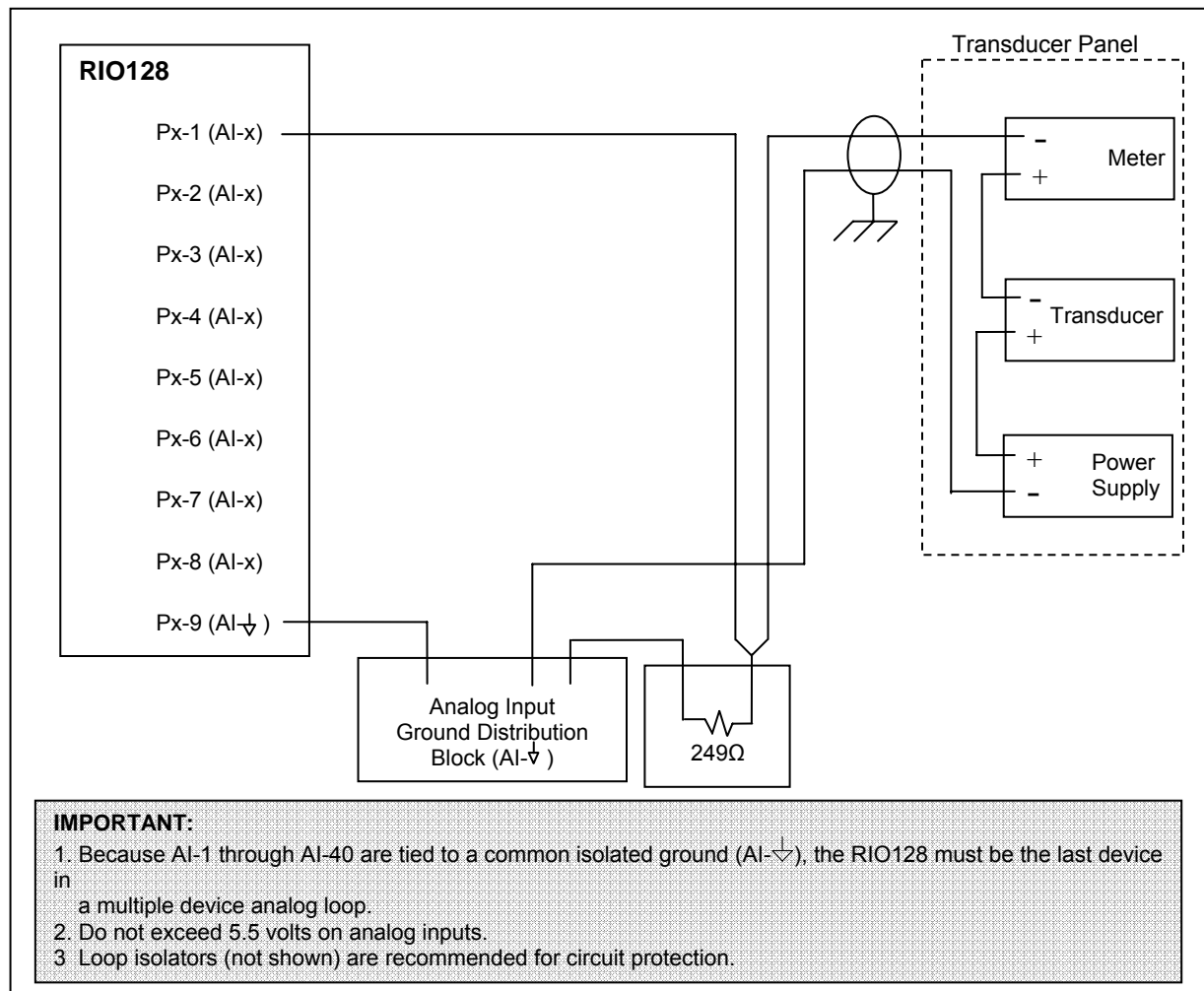
Figure 5, "4-20mA / 0-20mA Current Loop"

1-5V / 0-5V Voltage Source

RIO128

Px-1 (AI-x)

Px-2 (AI-x)

Px-3 (AI-x)

Px-4 (AI-x)

Px-5 (AI-x)

Px-6 (AI-x)

Px-7 (AI-x)

Px-8 (AI-x)

Px-9 (AI-⏚)

+ Transducer
−
+ V

+ Power
− Supply

Analog Input Ground
Distribution Block
(AI-⏚)

IMPORTANT:
1. Do not exceed 5.5 volts on analog inputs.
2. Loop isolators (not shown) are recommended for circuit protection.
3. Static sensitive devices; observe proper ESD procedures during installation.
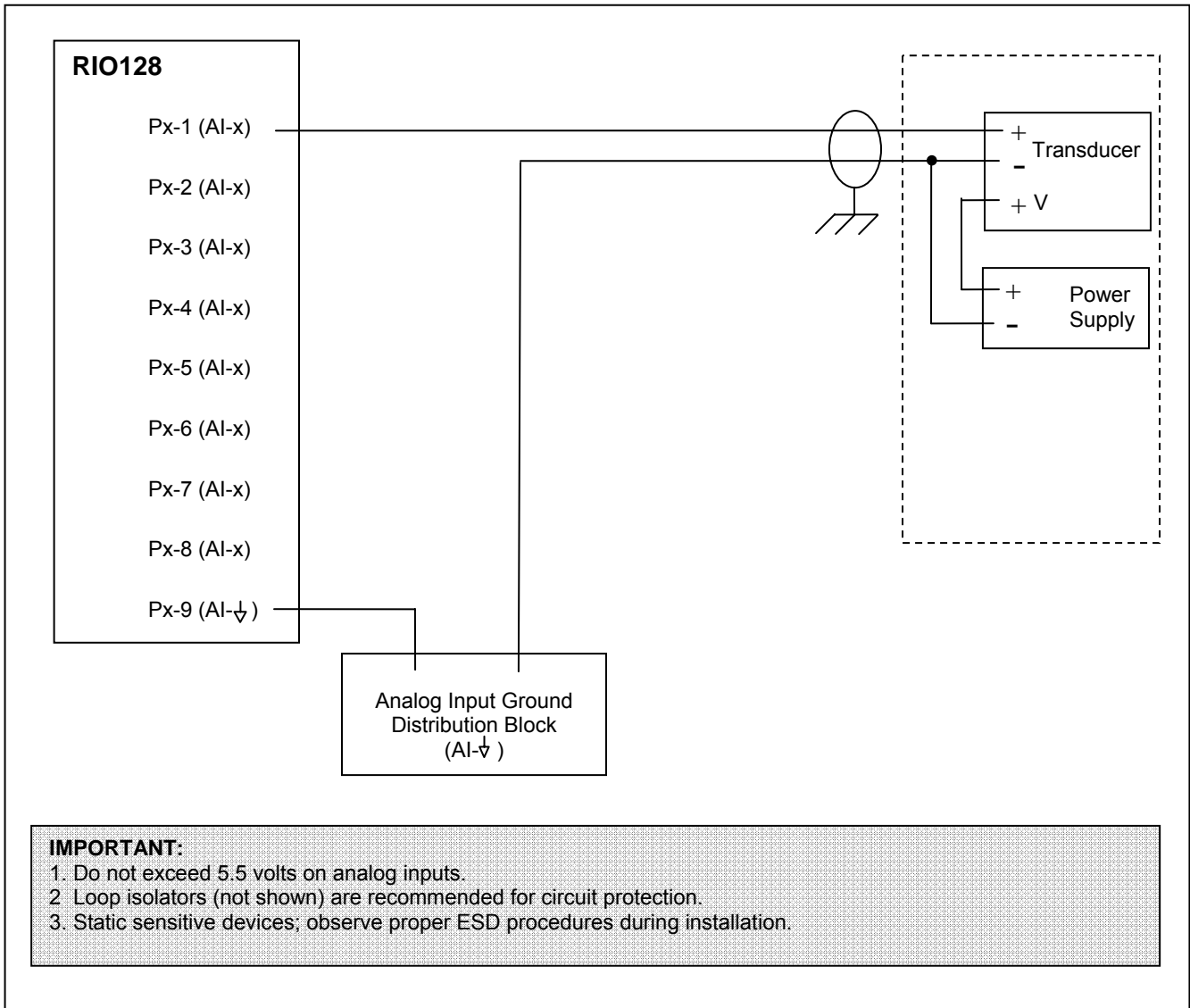
Figure 6, "1-5V / 0-5V Voltage Source"

ANALOG OUTPUTS (HOLDING REGISTERS)

The RIO128 features 8 analog output, or control, points. All of the RIO128's analog I/O have 12-bit resolution and are processed at a rate of 10-samples-per-second, and have an overall accuracy of $^+/_.$ 1% of full scale. When not being used as analog I/O, the RIO128's analog points may be used as digital I/O. See "Using Analog I/O as Digital I/O" beginning on page 26 for wiring instructions.

Information on the bit format for the RIO's 12-bit analog I/O can be found in the section titled "Analog Bit Format" on page 40.

Pins for wiring analog outputs can be found at:

- P19-1 through P19-8

The corresponding ground pin is located at P19-9.

NOTES:
1. Loop isolators (not shown) are recommended for circuit protection.
2. Static sensitive devices; observe proper ESD procedures during installation.
3. Do not short output to ground. 10KΩ load typical.
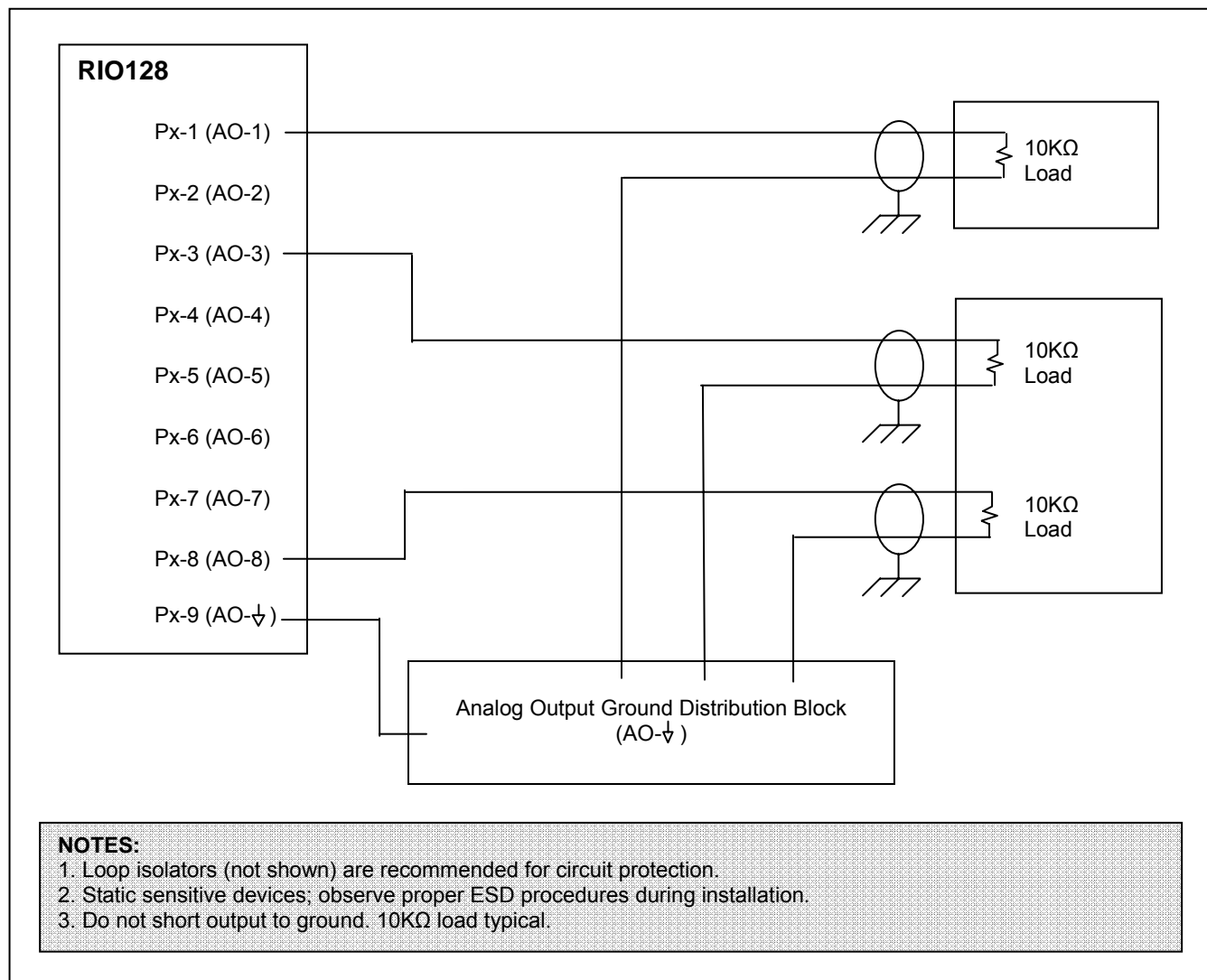
Figure 7, "0-5V Analog Output"

USING ANALOG I/O AS DIGITAL I/O

The RIO128's analog I/O can be used as digital I/O if more digital inputs and/or outputs are required. However, it is good practice to use all of the RIO128's digital I/O before using analog for digital because analog I/O points do not make ideal digital I/O. Using the RIO128's analog inputs and outputs in this way introduces to each analog point an error equal to the amount of ripple on the power supply (1 LSB per 1.2 milivolts of power supply ripple). Refer to the drawings below and on the next page when wiring analog points to be used as digital points. Information on how the RIO128 packs digital information into analog points can be found on page 39 in the section titled "Packing digital information into analog points."

Analog Inputs as Digital Inputs
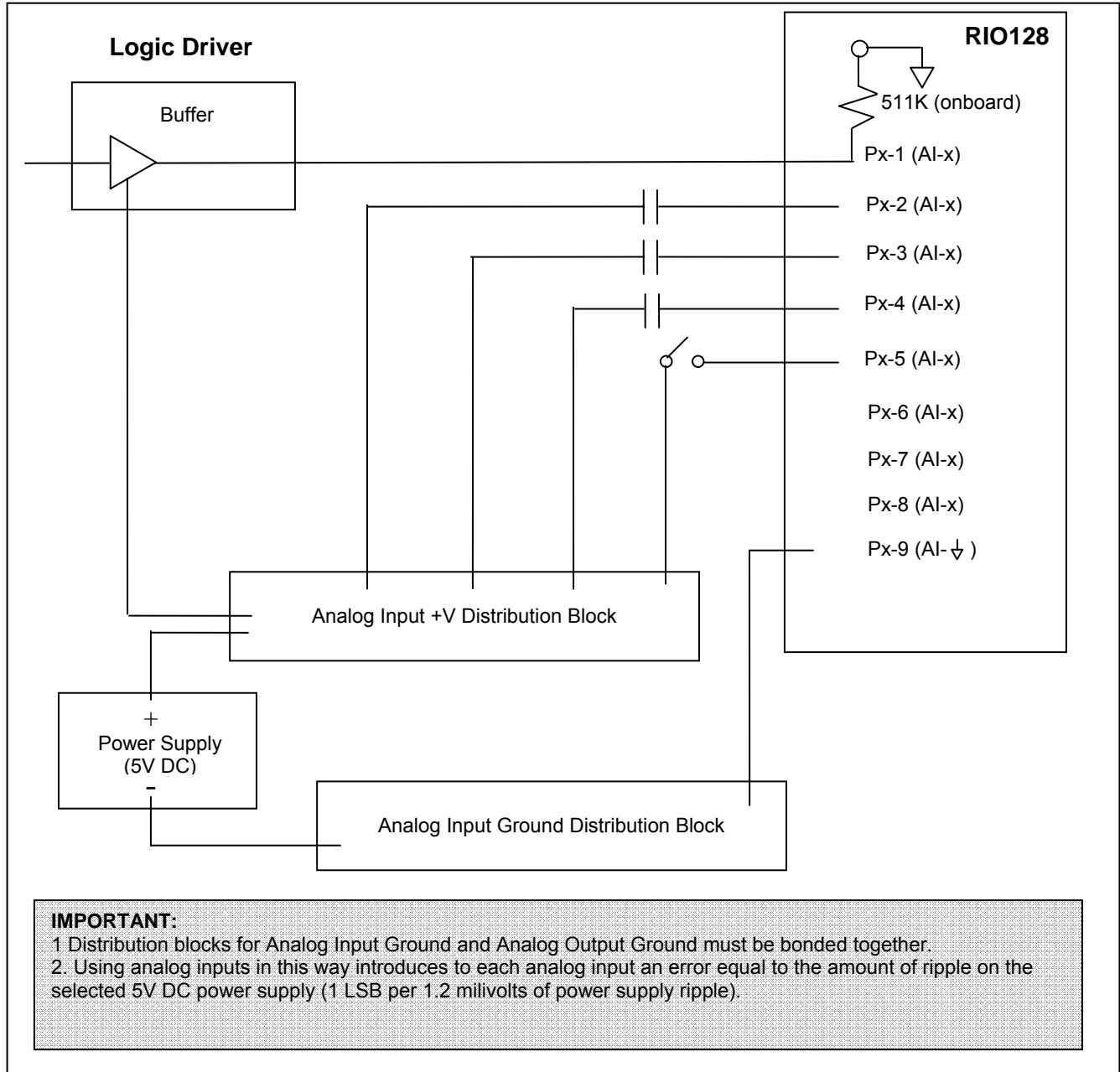
Figure 8, "Wiring Analog Inputs as Digital Inputs"

Analog Outputs as Digital Outputs
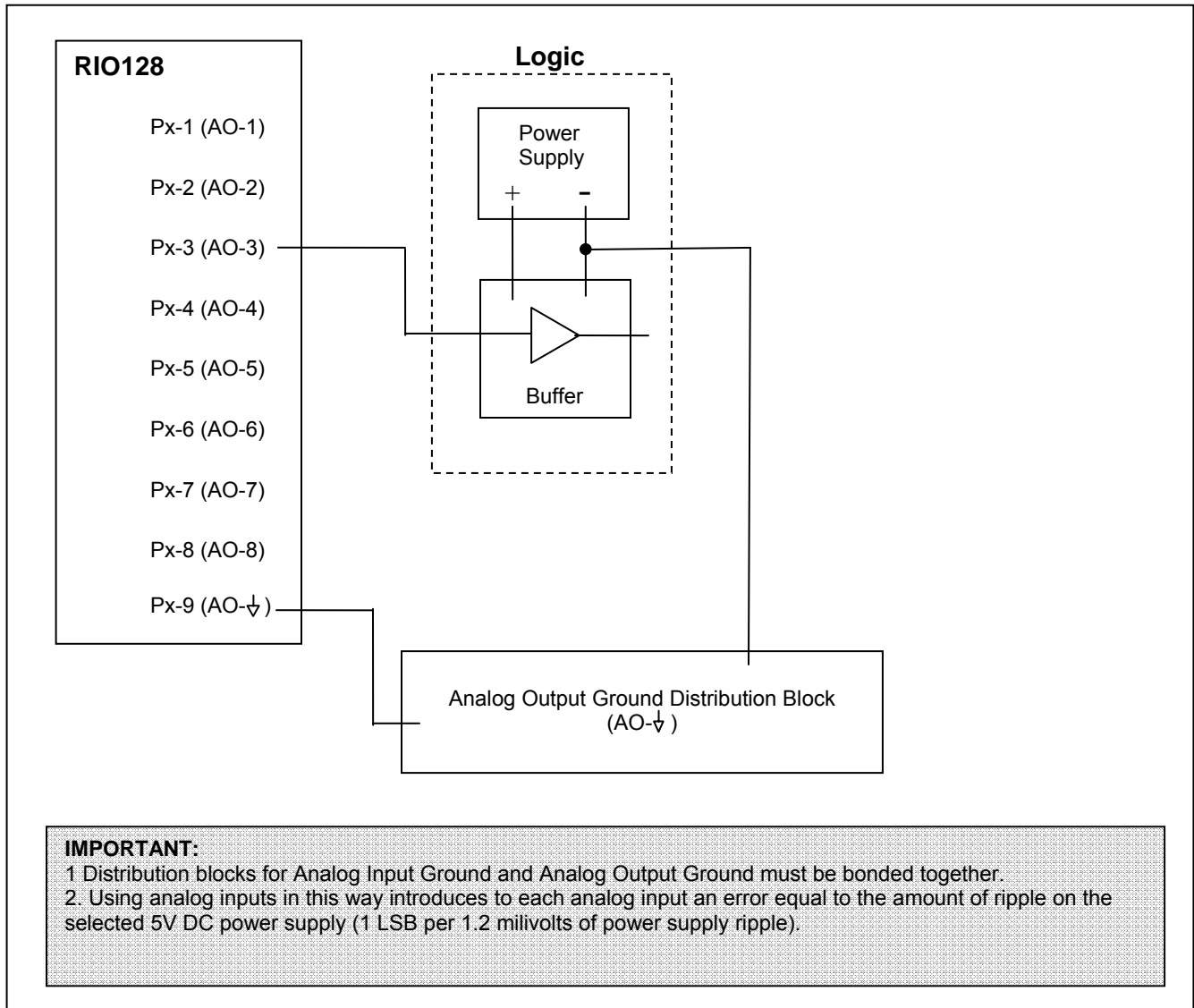
Figure 9, "Wiring Analog Outputs as Digital Outputs"

Inside the figure:

RIO128

Px-1 (AO-1)

Px-2 (AO-2)

Px-3 (AO-3)

Px-4 (AO-4)

Px-5 (AO-5)

Px-6 (AO-6)

Px-7 (AO-7)

Px-8 (AO-8)

Px-9 (AO-⏚)

Logic

Power Supply

+   −

Buffer

Analog Output Ground Distribution Block
(AO-⏚)

IMPORTANT:
1 Distribution blocks for Analog Input Ground and Analog Output Ground must be bonded together.
2. Using analog inputs in this way introduces to each analog input an error equal to the amount of ripple on the selected 5V DC power supply (1 LSB per 1.2 milivolts of power supply ripple).

Notes

NETWORK

In order for the RIO128 to communicate with other devices via an Ethernet network, a serial-to-network converter, such as the RAIL Network Adapter (RNA110), must be utilized. Refer to "Serial Cable Wiring Diagrams" on page 32 for additional information on wiring this type of connection.
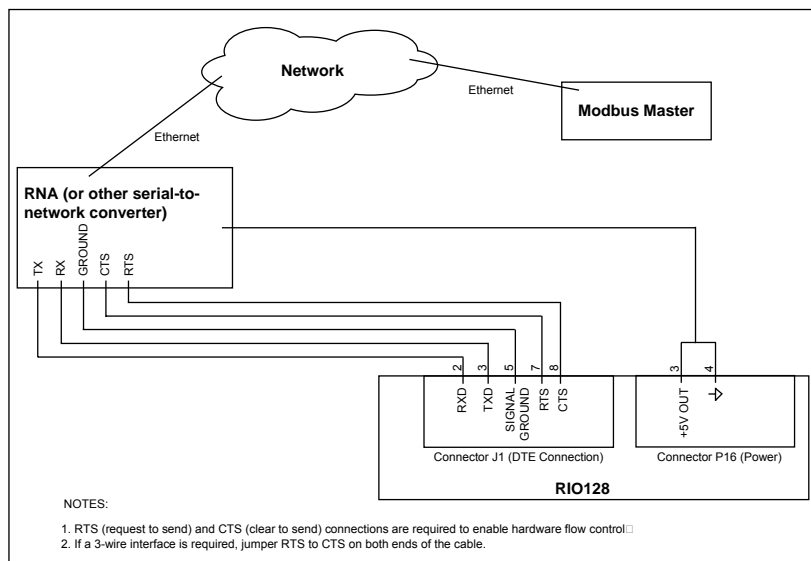
Figure 10, "Network Communication"

MODEM

Refer to "Serial Cable Wiring Diagrams" on page 32 for additional information on wiring this type of connection.
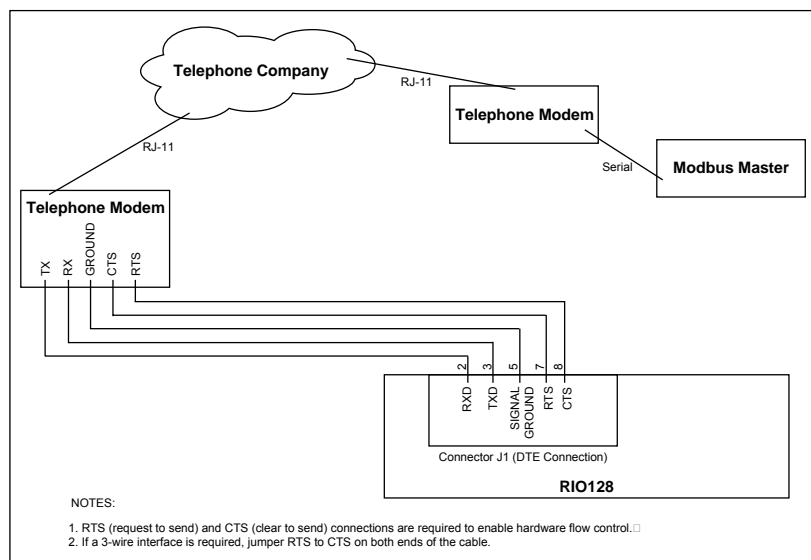
Figure 11, "Modem Communication"

RADIO

In order for the RIO128 to communicate with other devices via radio, a radio modem, such as the RAIL Data Radio (RDR200), must be utilized. Refer to "Serial Cable Wiring Diagrams" on page 32 for additional information on wiring this type of connection.
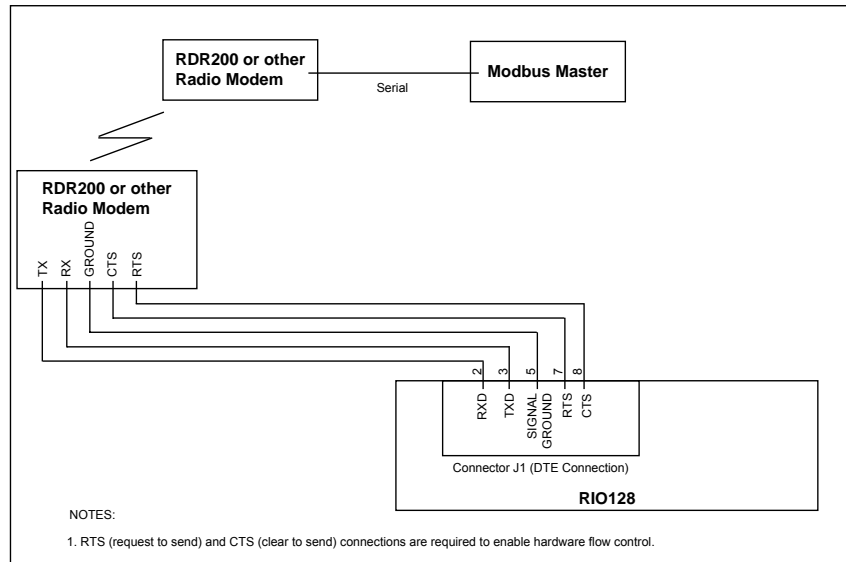
Figure 12, "Radio Communication"

DIRECT TO MODBUS MASTER
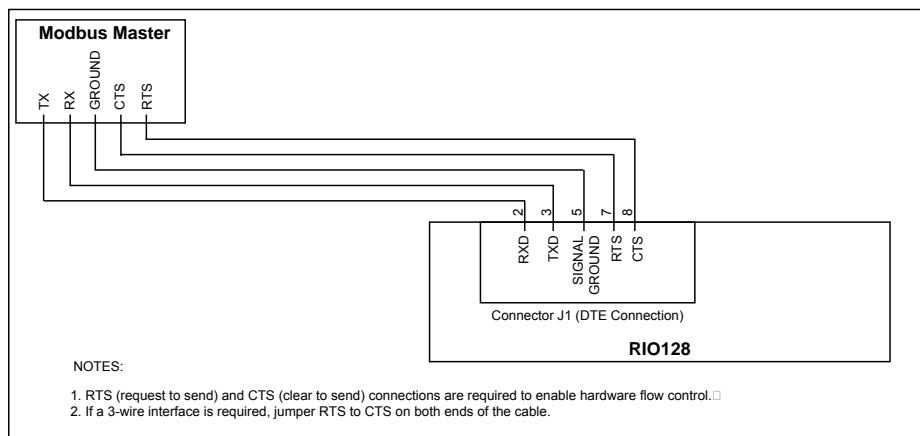
Via RS-232

Figure 13, "Direct Modbus Communication via RS-232"

Hardware flow control must be enabled on the serial port of the Modbus master when connecting via RS-232. The RIO128 features a DTE (data terminal equipment) connection and should be connected to a DTE connection on the Modbus master. A typical serial port on a computer is a DTE connection and can be connected to the RIO via a null modem cable. If the Modbus master has a DCE (data communication equipment) connection (for example, as a radio or modem would have), use a modem cable to connect to the RIO128. Pin outs for the RIO128's DTE Connection can be found on page 7. Refer to "Serial Cable Wiring Diagrams" on page 32 for additional information on wiring this type of connection.

Via RS-485

NOTES:

1. The cable shield wire must only be grounded at one end (as close as possible to the selected end).
2. Requires 150-200 ohm resistor (resistors should only be placed at the extreme ends of the RS-485 network).
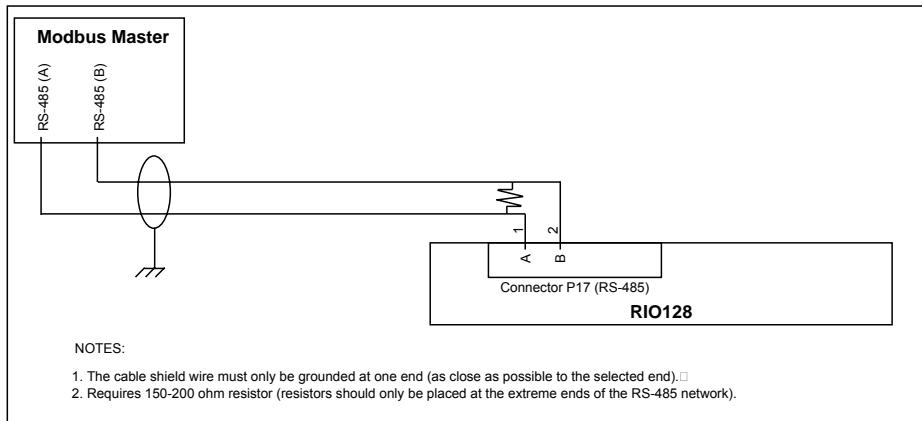
Figure 14, "Direct Modbus Communication via RS-485"

BUSSING MULTIPLE RIO128S
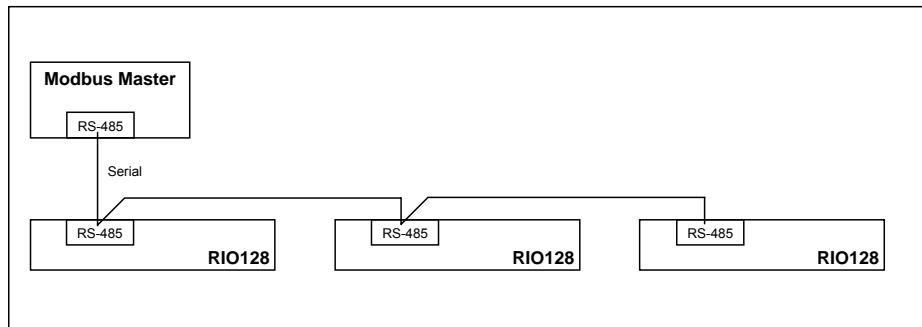
Figure 15, "Bussing Multiple RIO128's"

REDUNDANT MODBUS MASTER DEVICES
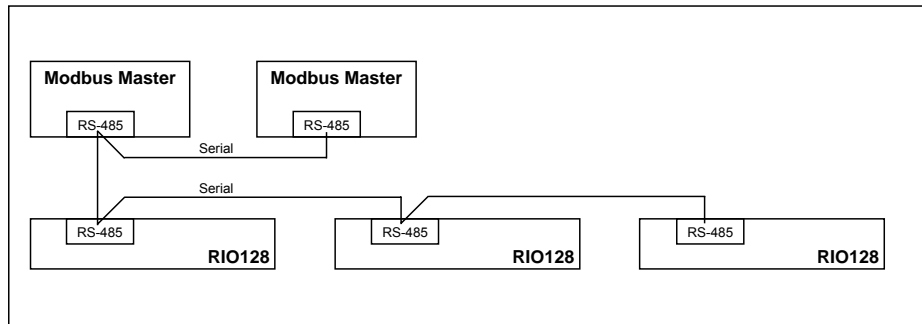
Figure 16, "Redundant Modbus Masters"

SERIAL CABLE WIRING DIAGRAMS

Pin #	Description
1	unused
2	RXD – receive data
3	TXD – transmit data
4	unused
5	SG – signal ground
6	unused
7	RTS – request to send
8	CTS – clear to send
9	unused

9-pin to 9-pin serial modem cable

```
        1                 1
RXD     2 ————————————— 2    RXD
TXD     3 ————————————— 3    TXD
        4 ————————————— 4
SG      5 ————————————— 5    SG
        6 ————————————— 6
RTS     7 ————————————— 7    RTS
CTS     8 ————————————— 8    CTS
        9                 9
```
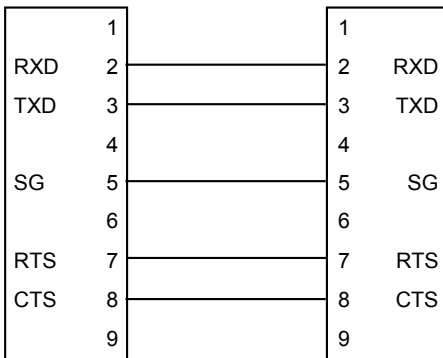
9-pin to 9-pin serial null modem cable

```
        1                 1
RXD     2      ╲ ╱      2    RXD
TXD     3      ╱ ╲      3    TXD
        4                 4
SG      5 ————————————— 5    SG
        6                 6
RTS     7      ╲ ╱      7    RTS
CTS     8      ╱ ╲      8    CTS
        9                 9
```
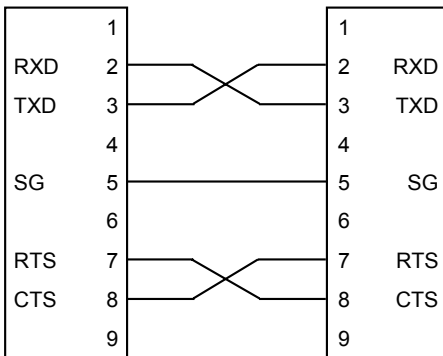
9-pin to 9-pin serial 3-wire modem connection
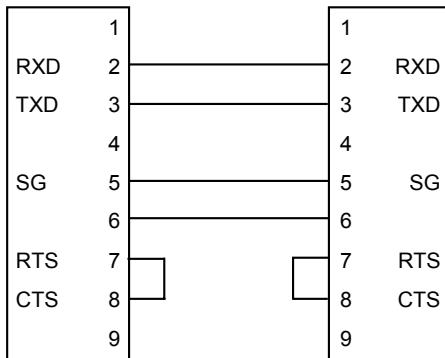
9-pin to 9-pin serial 3-wire null modem connection
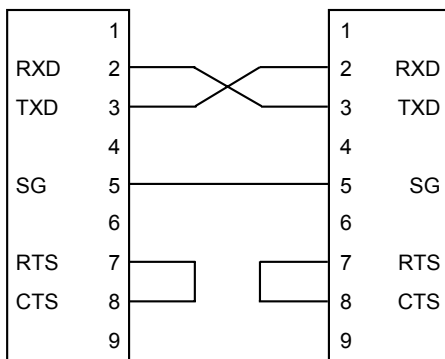
ADDRESSING THE RIO128

The RIO128 features a detachable address board used to configure the RIO128's station, or Modbus, address. The address board's screw-terminal lanyard enables you to tether it to the control panel (for example, to the panel's earth ground). In the event the RIO128 needs to be replaced, the address board can be disconnected from the RIO128 and attached to a new RIO128. This ensures that the station, or Modbus, address remains with the site; the new RIO128 doesn't have to be addressed.

The station, or Modbus, address is configured by turning off switch positions that add up to the desired station number. Each bit (pin on the separate address board – P18-1 through P18-8) has a corresponding value (see table on next page). The RIO128 is set to a specific station address by leaving particular pins on the address board's DIP switch ungrounded, or in the OFF position. The station address is calculated by totaling the bit values of the pins that are *not* grounded. The valid station address range for the RIO128 is 1-255.

Pin #	Name	Description
P18-1	ADDR0	Station address bit 0 (value=1 bit)
P18-2	ADDR1	Station address bit 1 (value=2 bit)
P18-3	ADDR2	Station address bit 2 (value=4 bit)
P18-4	ADDR3	Station address bit 3 (value=8 bit)
P18-5	ADDR4	Station address bit 4 (value=16 bit)
P18-6	ADDR5	Station address bit 5 (value=32 bit)
P18-7	ADDR6	Station address bit 6 (value=64 bit)
P18-8	ADDR7	Station address bit 7 (value=128 bit)
P18-9	GROUND	Station address ground

For example, to give the RIO128 a station address of 98, we would leave the bits for the following pins ungrounded (in the OFF position):

- pin P18-2 (bit value=2)
- pin P18-6 (bit value=32)
- pin P18-7 (bit value=64)

When we add the values of these bits together, we get a total value of 98 (2+32+64=98). The remaining bits would be left grounded (in the ON position). By removing the address board, we can give the station an address of 255, which is the sum of all of the bits. To address the station at 0 (zero), we would leave all of the bits grounded (all switches in the ON position).

IMPORTANT:

The RIO128 should not have a station address of 0 (zero). Station address 0 is reserved for troubleshooting purposes. When the Modbus master polls station 0, *all* RIO128's will respond.

If the RIO128 has a station address of 255, it will respond to *all* Modbus messages.

The RIO128 should be addressed at 255 when connected to a Rail Network Adapter (RNA110). This can be accomplished by simply removing the RIO128's detachable address board. Note that each RIO128 requires its own RNA110 (i.e., multiple, daisy-chained RIO128s cannot be connected to a single RNA).

CONFIGURING COMMUNICATION SETTINGS

Learn (program) mode

The RIO128 features an auto configuration, or learn, mode that enables it to automatically detect baud rate and protocol parameters and begin communicating using these parameters. When *all* of the communication configuration switches are left in the Off position and the RIO128's configuration button is held down during power up, the RIO128 enters learn mode and it attempts to determine baud and protocol settings within three to ten polling loops (depending on settings such as baud rate).

The position of each communication configuration switch – Up (Off) or Down (On) – determines if it is recognized logically (value of TRUE or FALSE) by the RIO032's onboard microprocessor.

- A switch that is Up (Off) has a logical value = 1 / TRUE.
- A switch that is Down (On) has a logical value = 0 / FALSE.

Refer to the example photo and illustration on page 38

Learn mode procedure

1. Place all the BPS and Protocol switches in the Up (Off) position (value = 1 / TRUE).
2. Hold down the configuration button while powering up the device. All of the RIO128's LED's come on.
3. Release the configuration button when the RXD, TXD, and Status LED's go off.
4. The TXD will flash rapidly and then the TXD, RXD and Status LED's will blink.
5. After a minimum of three polls are received (may take up to ten polls), the RXD will blink three times. The TXD, RXD and Status LED's will turn on and then off indicating that Learn (auto configuration) is complete.

During the Learn process, the RIO128 uses the CTS (clear to send) signal to determine if it is connected to a radio. Radios, unlike other devices, don't activate the CTS signal until an RTS (request to send) is asserted. If the RIO128 determines that is it connected to a radio, it will communicate using the RTU Radio protocol. This protocol is identical to RTU protocol except that the RIO expects a CTS to occur whenever it asserts an RTS, and it will wait for the CTS signal before it transmits any data. This protocol allows the RIO128 to be connected to an RDR (Rail Data Radio) or other manufacturer radio without using special cabling.

Information on manually setting the RIO128's communication parameters are provided in the next section.

Manual configuration

It is possible to manually configure the communication settings for the RIO128 using the SW2-1 through SW2-9 pins.

The position of each communication configuration switch – Up (Off) or Down (On) – determines if it is recognized logically (value of TRUE or FALSE) by the RIO032's onboard microprocessor.

- A switch that is Up (Off) has a logical value = 1 / TRUE.
- A switch that is Down (On) has a logical value = 0 / FALSE.

Refer to the example photo and illustration on page **Error! Bookmark not defined.**.

Baud rate

The RIO128's baud rate is set using pins SW2-1 through SW2-3.

Note: Refer to the table below and the example photo and illustration on page 38 when setting dip switches for baud rate.

Baud Rate	BPS Bit 0 (Pin SW2-1)	BPS Bit 1 (Pin SW2-2)	BPS Bit 2 (Pin SW2-3)
	Value (switch position)	Value (switch position)	Value (switch position)
1200	0 (down)	0 (down)	0 (down)
2400	1 (up)	0 (down)	0 (down)
4800	0 (down)	1 (up)	0 (down)
9600	1 (up)	1 (up)	0 (down)
19200	0 (down)	0 (down)	1 (up)
38400	1 (up)	0 (down)	1 (up)
Reserved	0 (down)	1 (up)	1 (up)
Learn	1 (up)	1 (up)	1 (up)

Protocol

The RIO128 is capable of using Modbus ASCII, Modbus TCP, Modbus RTU, or Modbus RTU Radio protocol [Modbus RTU Radio protocol is identical to Modbus RTU protocol except that the RIO128 expects a CTS (clear to send) to occur whenever it asserts an RTS (request to send).]

Protocol is set using pins SW2-4 and SW2-5.

Note: Refer to the table below and the example photo and illustration on page 38 when setting dip switches for protocol.

Protocol	Protocol Bit 0 (Pin SW2-4)	Protocol Bit 2 (Pin SW2-5)
	Value (switch position)	Value (switch position)
ASCII	0 (down)	0 (down)
TCP	1 (up)	0 (down)
RTU	0 (down)	1 (up)
Learn/RTU Radio*	1 (up)	1 (up)

* The RIO128 will only enter Learn mode, if *all* of the communication configuration switches are in the Off (Up) position.

Data bits and parity

The RIO128 can be configured with one of the following three data bits-parity formats using SW2-6 (8/7 data bits) and SW2-7 (E/O parity):

- 8 data bits, no parity
- 7 data bits, even parity
- 7 data bits, odd parity

Note: Refer to the table below and the example photo and illustration on page 38 when setting dip switches for data bits and parity.

Format	SW2-6 (Data Bits)	SW2-7 (Parity)
	Value (switch position)	**Value (switch position)**
8 data bits, no parity	0 (down)	0 (down) or 1 (up)
7 data bits, even parity	1 (up)	0 (down)
7 data bits, odd parity	1 (up)	1 (up)

Stop bits

The RIO128 can be configured with 1 (one) or 2 (two) stop bits using pin SW2-8.

Note: Refer to the table below and the example photo and illustration on page 38 when setting dip switches for data bits and parity.

Format	SW2-8
	Value (switch position)
1 Stop Bit	1 (up)
2 Stop Bits	0 (down)

Example: Communications Configuration

In the photo and illustration below, the RIO032 has been set for the following parameters:

- Baud rate: 9600 (pins 1 and 2 are Up/Off; pin 3 is Down/On)
- Protocol: ASCII (pins 4 and 5 are Down/On)
- Data Bits: 7 (pin 6 is Up/Off)
- Parity: Odd (pin 7 is Up/Off)
- Stop Bits: 2 (pin 8 is Up/Off)
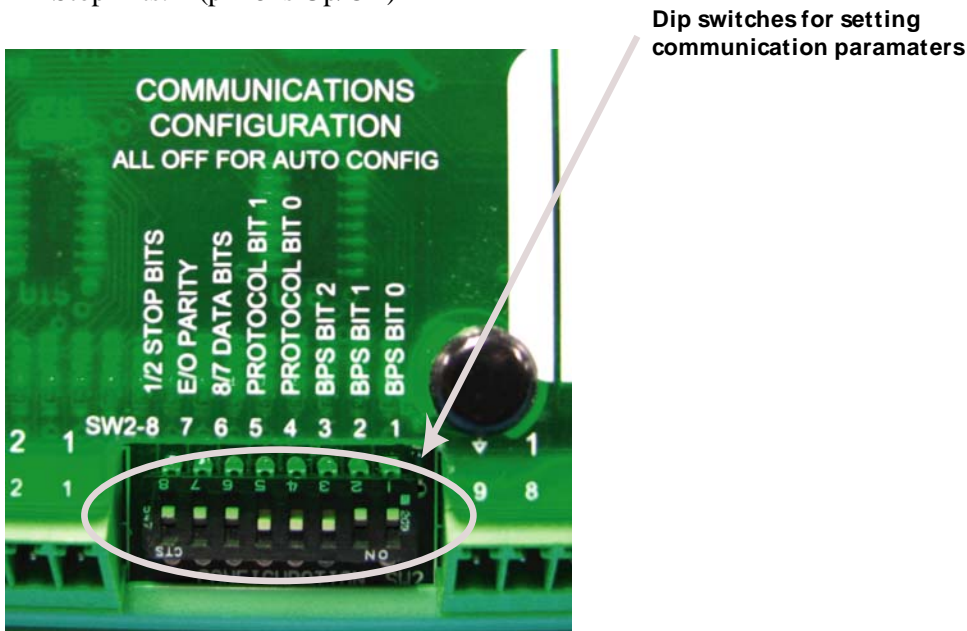
Figure 17, Communication Configuration (Dip Switch Positions)
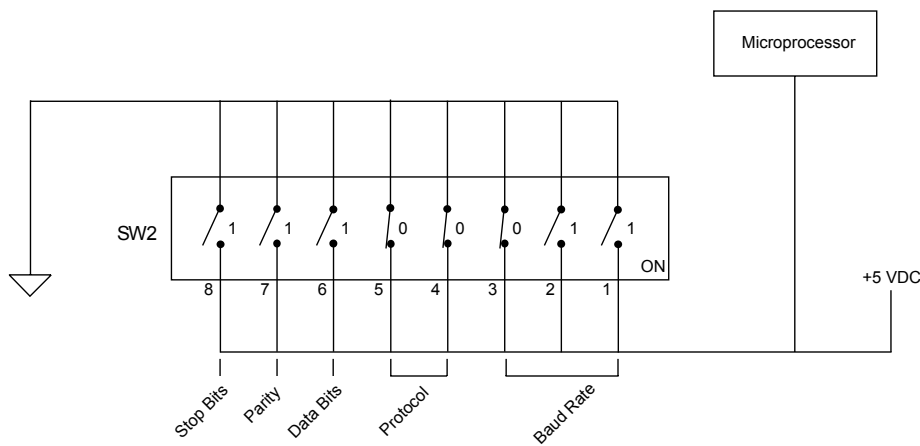
Figure 18, Communication Configuration Illustration

PACKING DIGITAL INFORMATION INTO ANALOG POINTS

The RIO128's analog I/O can be used as digital I/O if more digital inputs and/or outputs are required. The paragraphs below provides information on how the digital information is packed into the analog points. Refer to the section titled "Using Analog I/O as Digital I/O" beginning on page 26 for information on wiring these types of points.

An analog value is represented with 16 bits (each analog point is stored as a two byte value; each byte has eight bits). Each bit can have a binary value of 1 (one) or 0 (zero). When using analog inputs/outputs for digital I/O, 16 digital points can be packed (right to left) into one analog point.

- Digital outputs, or coils, (points 00001-00040) use Modbus addresses 40009 (bits 0-15), 40010 (bits 0-15), and 40011 (bits 0-7)
- Digital inputs (points 10001-10040) use Modbus addresses 40012 (bits 0-15), 40013 (bits 0-15), and 40014 (bits 0-7).

Example: Modbus address 40009 mirrors digital points 00001-00016. In our example, points 00001-00016 have the following values:

00001 = 1
00002 = 0
00003 = 0
00004 = 1
00005 = 0
00006 = 0
00007 = 0
00008 = 0
00009 = 1
00010 = 1
00011 = 1
00012 = 1
00013 = 0
00014 = 0
00015 = 1
00016 = 1

To store these values in address 40009 in binary, hex or decimal formats:

- Binary: 40009 = 1100111100001001
- Hex: 40009 = CF09h
- Decimal: 53001

PULSE POINTS

Modbus addresses starting at 40055 have been set aside for polling digital inputs that are being used as pulse points. See Digital Inputs (Inputs) beginning on page 1 for a complete list of Modbus addresses used for pulse points.

When using pulse points, keep in mind that:

- Accumulated data rolls over at 4095.
- Data goes back to 0 (zero) when the RIO128 is reset.

Make the appropriate changes to your polling software to prevent loss of data.

ANALOG INPUTS REPEATED AS ANALOG OUTPUTS

Repeating analog inputs as analog outputs enables you to get the status of all inputs in one large message instead of individual messages.

Modbus addresses starting at 40015 have been set aside for polling analog inputs repeated as analog outputs. See Analog Inputs (Input Registers) beginning on page 3 for a complete list of Modbus addresses used for this purpose.

ANALOG BIT FORMAT

The RIO032 has a 12-bit resolution. The three least significant bits (LSB) are not taken into account. The table below explains the bit format.

Table 6-1: Analog Bit Format

		Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Value	32768 (sign)	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1
mA	**Raw**																	
0	7		X	0	0	0	0	0	0	0	0	0	0	0	0	X	X	X
4	6552		X	0	0	1	1	0	0	1	1	0	0	1	1	X	X	X
20	32767		X	1	1	1	1	1	1	1	1	1	1	1	1	X	X	X

I/O TROUBLESHOOTING

Digital Inputs:

Troubleshooting - All digital inputs rely on "dry" contact closure to the RIO128's logic ground, with each input biased from the RIO128's 10-15 VDC power supply. See "Digital Inputs", beginning on page 21 for input specs and correct wiring methods. The table below lists sections of the circuit that can possibly fail.

Problem	Possible Cause
Digital input will not turn on	Bias + is not present (power supply is faulty or current limiting)
	Logic ground is not present on Px-9 connector
	Open circuit – contact closure does not occur
	Input is damaged
Digital input will not turn off	Short circuit – contact closure does not release
	Input is damaged
Digital input does not reflect the correct state	Incorrect contacts on isolation relay
	Incorrect type of isolation relay
Digital input chatters	Incorrect voltage on isolation relay coil
	Incorrect type of isolation relay
Pulse input does not reflect correct count	Frequency of the input is greater than 30 Hz

Digital Outputs

Troubleshooting - All digital outputs source logic ground; each has the current capacity to drive a 12 or 24 VDC, 80mA constant duty, 300mA in-rush current, ice cube-type DC relay. See "Digital Outputs (Coils)," beginning on page 22 for correct wiring methods). The table below lists sections of the circuit that can possibly fail.

Problem	Possible Cause
Digital output does not turn on	Logic ground is not present on Px-9 connector
	Bias + is not present on DC + of relay coil
	Blown fuse
	Power supply is faulty or current limiting
	Output is damaged
Digital output does not turn off or reflects incorrect state	Incorrect contacts on isolation relay
	Incorrect type of isolation relay
	Isolation relay damaged
	Output damaged

Analog Inputs

Troubleshooting – All analog inputs range from 0 – 5 VDC at the input and reference logic ground as a return (Px-9). Current loop applications require a parallel 249 ohm resistor; current loop isolators are recommended.

See "Analog Inputs (Input Registers)," beginning on page 23 for input specs and correct wiring methods. The table below lists sections of the circuit that can possibly fail.

Problem	Possible Cause
Analog input has 0 value	Logic ground is not present on Px-9 connector
	Power supply is faulty or current limiting
	Loop isolator damaged
	Transducer damaged
	Input damaged
Analog input has maximum value	Power supply is faulty or incorrect voltage
	Loop isolator damaged
	Transducer damaged
	Input damaged
Analog input does not reflect correct value	Span incorrect
	Power supply is faulty or incorrect voltage
	Loop isolator damaged
	Input damaged
Analog input value erratic or unstable	Ground loop – no isolation between power supplies
	Noise – cable shield not grounded or grounded at both ends
	Input damaged
	Power supply is faulty

Analog Outputs

Troubleshooting – All analog outputs range from 0 – 5 VDC at the output and reference the same return (Px-9). Current loop applications require current loop isolators. See "Analog Outputs (Holding Registers)," beginning on page 25 for input specs and correct wiring methods. The table below lists sections of the circuit that can possibly fail

Problem	Possible Cause
Analog output does not reflect correct value	Span incorrect
	Device load < 2Kohm or > 8Kohm
	Loop isolator damaged
	Output damaged
	Power supply is faulty
Analog output value erratic or unstable	Ground loop – no isolation between power supplies
	Noise – cable shield not grounded or grounded at both ends
	Output damaged
	Power supply is faulty

COMMUNICATIONS TROUBLESHOOTING

Basic troubleshooting steps

If you are having problems communicating with your RIO128, check the following first:

- Are you using the RIO128's RS-485 connection and experiencing intermittent communications? If so:
  1. Verify that you are using twisted shielded pair wire. Make sure it is shielded only on one end with earth ground as close as possible to the selected end. (See "Direct to Modbus Master: Via RS-485" on page 31 for more information.)
  2. Check that terminating resistors are only placed at extreme ends of the RS-485 network. (See "Direct to Modbus Master: Via RS-485" on page 31 for more information.)
  3. Lower the baud rate. When communicating at 38400 baud over great distances, you may experience communication problems.
- Are the DIP switch settings (baud rate, parity, number of stop bits) required for the RS-232 port set correctly? (see "Configuring Communication " beginning on page 35 for more information).
- Is Learn Mode enabled? If so, keep in mind that Learn Mode requires at least three polls, and up to ten polls depending on settings such as baud rate, to "learn" correct communication settings (see "Configuring Communication " beginning on page 35 for more information on Learn Mode).
- Is the RIO128 configured for the correct Modbus station number? See "Addressing the RIO128" beginning on page 33 for more information.
- Is hardware flow control enabled on the RS-232 port of the Modbus master? (See "Direct to Modbus Master: Via RS-232" on page 30 for more information.)
- Check that the RIO128 has been configured with a unique station address (i.e., that no other system device has been assigned this station number). Check that the configuration at the Modbus master matches that of the RIO128. (See "Addressing the RIO128" beginning on page32 33 for more information.)
- Does the RS-485 have the correct A and B cabling? Try swapping the wires. (See "Direct to Modbus Master: Via RS-485" on page 31 for more information.)
- Is the Modbus master polling station 0 (zero)? If so, *all* RIO128's should respond. (See "Addressing the RIO128" beginning on page 33 for more information.)
- Does the RIO128 have a station address of 255? If so, it should respond to *all* Modbus messages. (See "Addressing the RIO128" beginning on page 33 for more information.)

Detailed troubleshooting steps

If you are still experiencing communications problems after reviewing the items in Basic troubleshooting, above, follow the procedure below:

1. Connect the primary communication cable to the correct port (either RS-232 or RS-485).
2. Power ON the RIO128 and start polling for status. The RX LED should blink when receiving communications. If the RX LED does not blink:
   1. Check the cabling and the pin out on the connectors (DTE Connection, page 7).
   2. Check the communication DIP switch settings. If you are using manual configuration settings, verify that the switches are in the correct position. If you are using the Learn Mode feature, repeat the steps outlined in the Learn mode procedure. Information on both manual and Learn Mode can be found in Configuring Communication beginning on page 35.
3. Check both the RIO128 and the Modbus master polling software for correct Modbus station address. (See "Addressing the RIO128" beginning on page 33 for instructions on how to set the RIO128's address). The TX LED will begin blinking once the RIO128 is responding to polling.

Notes:

Appendix B: Support, Service, And Warranty

SUPPORT AND SERVICE

Open Control Solutions offers support services nationwide from its home office and through authorized representatives. Contact your local Open Control Solutions representative for:

- Sales and order support
- Product technical training
- Warranty support
- Support service agreements

If you are unsure of who to contact, call OCS' Melbourne headquarters at 321-435-5010 and ask for the Sales Department. Alternatively, send email to sales@opencontrolsolutions.com.

TECHNICAL PRODUCT ASSISTANCE

Please review the information in Appendix A: Troubleshooting, before contacting Open Control Solutions. If you need further assistance, contact your local Open Control Solutions representative. If you are unsure of who to contact, call OCS' Melbourne headquarters at 321-435-5010 and ask for the Sales Department. Alternatively, send email to sales@opencontrolsolutions.com.

WARRANTY

Open Control Solutions (OCS) products carry a three (3) year return-to-factory warranty, from date of shipment, covering defects in material and workmanship.

REPAIRS - OCS will repair or replace at its option, F.O.B. Melbourne, Florida, any part or parts of its products, which become defective during this warranty period. When returning parts to OCS' factory, a Return Authorization (RA) may be obtained by contacting the Melbourne Factory Repair Center by telephone at 321-435-5010 or by email at RA@opencontrolsolutions.com.

FACTORY SUPPORT – Factory support is available to OCS product users during normal business hours. Normal business hours are weekdays, excluding holidays, 8:00 AM to 5:00 PM Eastern Time Zone. Factory support is available by telephone at 321-435-5010 or by email support@opencontrolsolutions.com.

OCS' liability under this warranty shall be limited to repairing or replacing any part(s) manufactured by OCS. In no event shall OCS be liable for any loss or damage, whether direct or indirect, arising out of or from the use or possession of any product supplied by OCS. OCS shall in no event be liable for any consequential damages.

RETURN AUTHORIZATION (RA) PROCEDURE

Open Control Solutions' products are designed to be robust and highly reliable. We back this performance with a 3-year full warranty (see our warranty statement for details). In the event that a product fails, during or after the warranty period, it may be returned to Open Control Solutions to be repaired or replaced.

All RA's will be subject to standard shipping and handling charges. Standard shipping and charges will be based on UPS ground, please advise if other arrangements are needed (UPS Red, FedEx, Pickup, Freight…). Standard cost of repairs and shipping charges can be obtained by contacting our Sales Department by phone or e-mail.

STEP 1:

Replace the failed product with a spare product of the same type, if one is available.

STEP 2:

Contact Open Control Solutions in one of the following ways to receive RA #.

E-mail – RA # can be obtained by e-mailing OCS at sales@opencontrolsolutions.com and must include the following information.

- Customer/Utility Name and Ship to Address
- Contact Name and Phone Number
- Products to be returned and Serial Numbers
- Detailed description of failure
- PO#

Phone – RA# will be issued over the phone by calling OCS at 321-435-5010 during normal operating hours. The following information will be needed.

- Customer/Utility Name and Ship to Address
- Contact Name and Phone Number
- Products to be returned and Serial Numbers
- Detailed description of failure
- PO#

Note: The lack of "Detailed description of failure" could result in the return of equipment due to the inability to properly determine the nature of the failure or testing resulting in "No Problem Found"

STEP 3:

Place the product in a sturdy box filled with popcorn-type or bubble wrap packing material. Include a packing slip with the following information:

- Model, serial number, probable cause of failure, and the RA number
- Shipping address
- Shipping instructions (shipping costs greater than UPS ground are charged to the customer)

STEP 4:

Address the box to:

RA Department # {the RA number you received here}
Open Control Solutions
605 N John Rodes Blvd.
Melbourne, FL 32934-9105

STEP 5:

Ship the box to OCS using any typical shipping carrier (for example, UPS, FedEx, etc.). If circumstances permit, have an OCS employee hand carry the package to the headquarters for you.

NOTE: OCS employees are not permitted to hand carry unpacked products.

Products are typically repaired and shipped back to the customer within a 2-week period starting at the time the product reaches the RA Department. If additional information is required during the repair of the product(s), the OCS RA department will contact you.

To get information on the progress of any of your equipment in for repair, contact the OCS Sales Department at sales@opencontrolsolutions.com or 321-435-5010.

Replacement of equipment may be necessary in the event that the equipment and/or parts are unrepairable. Warranty equipment will be replaced with out prior notification as warranty replacement.

The customer will be notified by phone, if equipment not under warranty cannot be repaired, with information of available options.

OCS reserve the right to return any material received without RA # or not conforming to the requirements of this RA process.

QUESTIONS OR COMMENTS ON THIS MANUAL

If you find a problem with any of the information in this manual or have suggestions on how it could be improved, please contact us at the address below:

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Documentation Department
605 N. John Rodes Blvd.
Melbourne, FL 32934

Alternatively, e-mail us at:

sales@opencontrolsolutions.com

Notes

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