

# QRIO

## Installation and Programming Manual

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This Manual describes the QRIO module for interfacing a Modicon Quantum<sup>®</sup> PLC system to an Allen-Bradley<sup>®</sup> RIO I/O network.

Effective: 16 October, 2007



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# Introduction

The Niobrara QRIO is a TSX Quantum<sup>®</sup> compatible module that acts as an Allen-Bradley Remote I/O Scanner. The QRIO connects A/B Remote I/O devices to a Modicon Quantum PLC, transparently placing the RIO devices' Discrete I/O into the Modicon PLC's 4x, 3x, 1x, or 0x memory. The QRIO also allows access to Block Transfer I/O and Block Transfer Messaging via the Quantum's MSTR instruction.

The QRIO has two RIO ports, referred to hereafter as Port 1 and Port 2. The RIO ports have detachable three-terminal connectors, included with the module. An RJ45 RS-232 port is also provided for debugging and firmware downloading.

The QRIO must be used in the local Quantum PLC processor rack. The module is configured as an NOE-771-00 in the PLC and the Ethernet I/O Scanner table is used to define operating parameters and configuration of the A-B Discrete I/O.

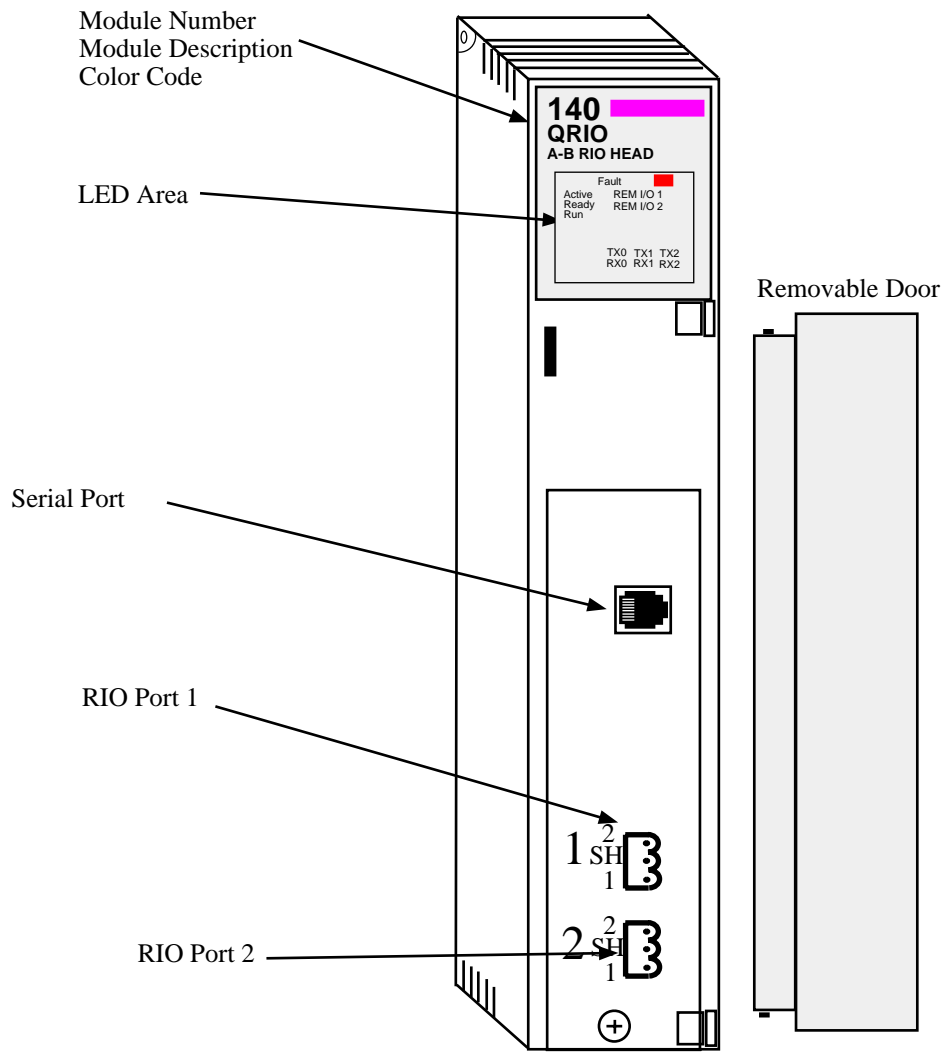


Figure 1-1 QRIO Front Pane

## Installation

### QRIO Installation

Mount the QRIO in an available slot in the PLC's register rack. Secure the screw at the bottom of the module. Like all Quantum modules, the QRIO may be hot-swapped. The QRIO operates as an "OPTION" communication module and thus must be installed in the PLC's rack and not in a Remote or DIO rack. The maximum number of supported "OPTION" modules varies with the PLC model (2 to 6) so the user should check the Modicon specifications to see how many QRIOs may be used in a single PLC system.

### Serial Connections to the QRIO

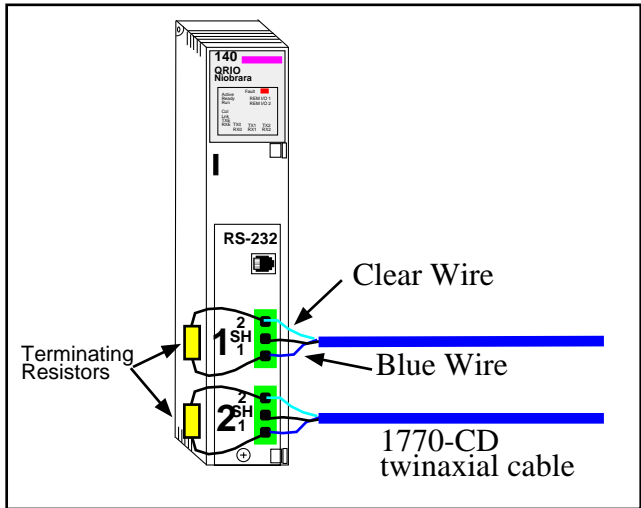
#### Ports 1 and 2 RIO

The Remote I/O networks are connected to Ports 1 and/or 2 of the QRIO. The standard A/B 1770-CD cable (Belden 9463) connects with the blue wire to Pin 1, White (Clear) wire to pin 2, and the bare shield to the SH. Standard A/B wiring conventions should be followed including the proper terminating resistors at each end of the daisy-chain. (See Table 2-1) The QRIO supports the "Expanded Node Capability" which allows up to 32 adapters on the RIO link using the 82 ohm terminators.

**Table 2-1 Remote I/O Specifications**

Communication Rate	Maximum Distance (feet)	Termination Resistor Value (Standard Node Capability)	Termination Resistor Value (Expanded Node Capability)
57.6 kbits/sec	10,000	150 ohm 1/2W	82 ohm 1/2W
115.2 kbits/sec	5,000	150 ohm 1/2W	82 ohm 1/2W
230.4 kbits/sec	2,500	82 ohm 1/2W	82 ohm 1/2W

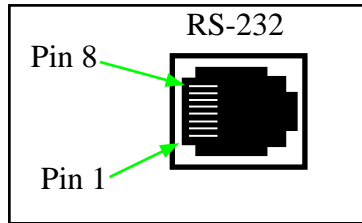
**NOTE:** Extended node capability can only be used if all adapters on the RIO daisy-chain support the feature. If any node fails to support the extended node capability then the maximum number of physical nodes is limited to 16.



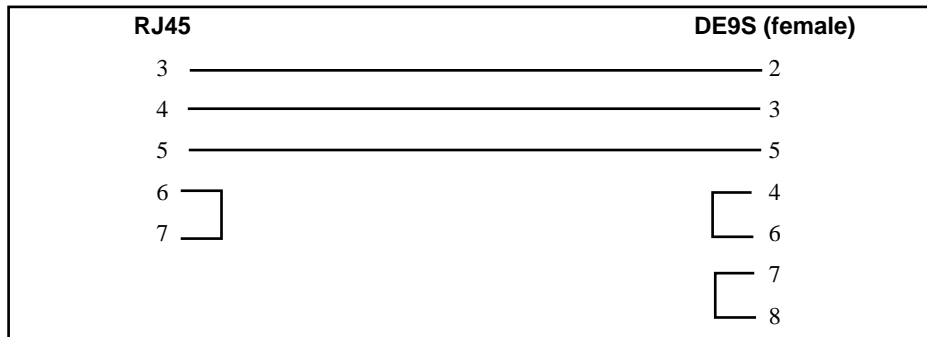
**Figure 2-1 Remote I/O Connections**

### RS-232 to the Personal Computer

The RS-232 port of the QRIO is used to load new firmware into the module. The Niobrara MM1 cable is used for this connection. This cable pinout is shown in Figure 2-3. Pin 1 is the bottom pin of the RJ-45 socket (See Figure 2-2).



**Figure 2-2 RS-232 Socket**



**Figure 2-3 QRIO to RS-232 PC Port (9-pin) (MM1 Cable)**

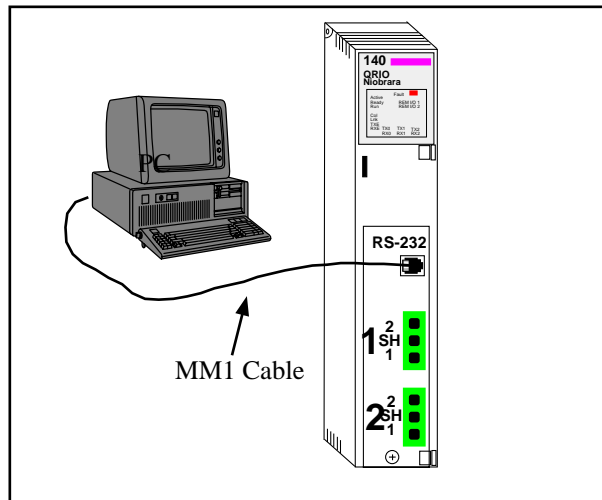


Figure 2-4 FWLOAD serial connection

## Loading Firmware into the QRIO

Niobrara may release new firmware for the QRIO from time to time. This section covers the procedure for upgrading the module.

The QRIO must use the qrio.fwl firmware included in the QRIO\_SETUP.EXE file. Run this setup file from the Niobrara CD or from [www.niobrara.com](http://www.niobrara.com) before starting the download process.

Firmware download is as follows:

- 1 Remove the module from the rack.
- 2 Move the RUN/LOAD switch on the back of the module to LOAD.
- 3 Replace the module in the rack and apply power.
- 4 Only the 3 light should be on.
- 5 Connect the PC to QRIO RS-232 with a MM1 cable.
- 6 From the Windows' Start button select:  
     "Start, Programs, Niobrara, QRIO, FWLOAD QRIO Firmware"  
     Verify that the file to load is qrio.fwl.  
     Also verify that the proper PC serial port is selected.
- 7 Press the "Start Download" button. The download will only take a few minutes and it will notify the user when finished.
- 8 Remove the module from the rack and change the switch back to RUN.

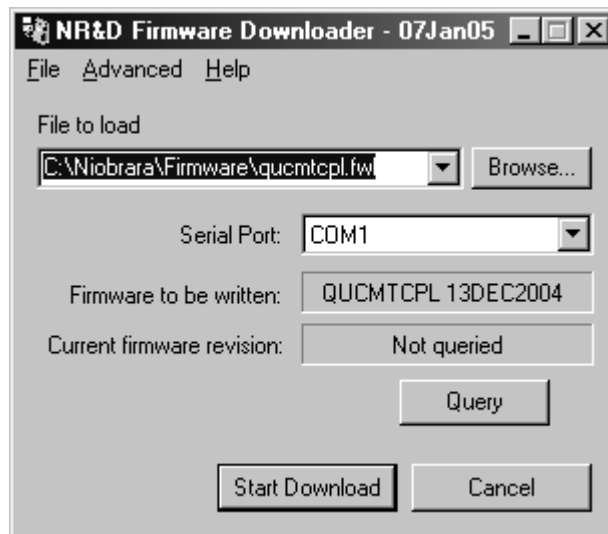


Figure 2-5 FWLOAD of QRIO Firmware

## RIO Discrete Operation

### Discrete

A-B Remote I/O is divided into groups and logical racks. A group consists of a pair of input and output words (16-bit). A collection of groups forms a logical rack. A full logical rack is 8 groups numbered 0-7. RIO Adapters are configured in even numbers of groups. If an adapter's size is greater than 8 groups, then it also takes up the next logical rack address.

### Logical Rack

The Rack Number defines the starting logical rack address of an adapter. An adapter will take up the declared rack number, and successive rack numbers to satisfy the number of groups assigned to that adapter.

## PLC I/O Scanner Configuration

The QRIO uses the NOE I/O Scanner configuration to set the baud rate of both RIO ports, the PLC location of the Health and Diagnostic Blocks, and the information for the A-B Discrete I/O. This setup may be done in Concept or Proworx. The QRIO must be added in the I/O Map as an NOE-771-00. The QRIO then may have its Ethernet I/O Scanner configured.

**Specify IP Address** - Check this box.

**IP Address** - Sets the baud rates of the two RIO ports. Table 3-1 describes the meanings of each byte. An IP Address of 3.1.2.1 would set port 1 = 230.4kbps and port 2 = 115.2 kbps.

**Table 3-1 QRIO IP Address Settings**

IP Address byte	Description	Meaning
First	Bitrate for Port 1	1 = 57.6 kbps 2 = 115.2 kbps 3 = 230.4 kbps
Second	Reserved	Set to 1
Third	Bitrate for Port 2	1 = 57.6 kbps 2 = 115.2 kbps 3 = 230.4 kbps
Fourth	Reserved	Set to 1

**Subnet Mask** - Reserved. Set the Subnet Mask to 255.255.255.0.

**Gateway** - Reserved. Set the default gateway to 1.1.1.1.

**Framing** - Reserved. Set to ETHERNET II.

**Health Block** - This is the starting 3x register or 1x coil of the 128 bits of status for the I/O Scanner. Used exactly as in the NOE I/O Scanner.

**Diagnostic Block** - This is the starting 3x or 4x register for the 128 register block of diagnostic codes. Each entry in the I/O Scanner has a matching diagnostic register. Table 3-2 gives the meanings of the diagnostic codes in hexadecimal.

**Table 3-2 Diagnostic Codes**

Diagnostic Code (Hex)	Meaning
0000	No Errors
F001	Device not yet polled.
E001	No reply from Device at Rack/Group.
E02x	Device Rack Size does not match I/O Scan configuration. Device configured for "x" words.
E031	I/O Scan Entry bad: Read Ref Master address invalid
E032	I/O Scan Entry bad: Write Ref Master address invalid
E033	I/O Scan Entry bad: Read and Write Ref Master addresses invalid
E034	I/O Scan Entry bad: Size out of Range (last byte of IP Address)
E035	I/O Scan Entry bad: Read Ref Master address invalid and Size out of Range
E036	I/O Scan Entry bad: Write Ref Master address invalid and Size out of Range
E037	I/O Scan Entry bad: Read and Write Ref Master addresses invalid and Size out of Range
E044	Port number (first drop in IP Address) is out of range (must be 1 or 2)
E045	Rack and/or Group is out of range
E1xx	Configuration duplicates device in line xx

**Slave IP Address** - The first byte sets the QRIO port number for the slave. The second byte is the logical rack number of the slave. The third byte is the group number of the slave. The fourth byte is the number of words of discrete I/O in the slave. For example, an IP Address of 1.10.4.2 would be a slave on QRIO port 1 set to logical rack 10, group 4, with 2 words of I/O.

**Table 3-3 Slave IP Address Settings**

IP Address byte	Description	Meaning
First	QRIO Port number of Slave	1 = Port 1 2 = Port 2
Second	Rack Number of Slave	
Third	Group Number of Slave	0, 2, 4, or 6
Fourth	Number of words of Discrete I/O in Slave	2, 4, 6, or 8

**Unit ID** - Reserved. Set to 0.

**Health Timeout** - Reserved. Set to 0.

**Rep Rate** - Reserved. Set to 0.

**Read Ref Master** - Location in PLC for Input data to appear. This will be a 4x register number or a 0x coil. The 0x Coil must be on a word boundary (a multiple of 16 plus 1).

**Read Ref Slave** - Reserved. Set to 400001.

**Read Length** - Reserved. Set to 1 if inputs are used otherwise set to 0.

**Last Value (Input)** - Input data either zeroed or frozen on loss of communication with slave. Same function as NOE.

**Write Ref Master** - This is the PLC location that holds the starting register for a given block of data and may be either a 4x register or 0x coil. The 0x coil must be on a word boundary (a multiple of 16 plus 1).

**Write Ref Slave** - Reserved. Set to 400001.

**Write Length** - Reserved. Set to 1 if outputs are used or 0 otherwise.

**Table 3-4 I/O Scanner Example**

X	Specify IP					IP Address		3.1.2.1	Subnet	255.255.255.0			
						Gateway		1.1.1.1	Framing	Ethernet II			
Master Module (slot)			Slot 5: 140-NOE-771-00										
Health Block			300123										
X	Diagnostic Block		300501										
	Slave IP Addr	Unit ID	Health Tout	Rep Rate	Read Ref Master	Read Ref Slave	Read Len	Last Value	Write Ref Master	Write Ref Slave	Write Len	Diag. Code	Description
1	2.2.0.2	1	0	0	100065	400001	1	Set to 0	000065	400001	1	E001	
2	1.3.0.2	2	0	0	300103	400001	1	Hold	400103	400001	1	0000	
3	1.7.0.8	3	0	0	300110	400001	1	Hold	400110	400001	1	0000	
4													
5													
6													
7													
8													
9													

The example in Table 3-4 shows a QRIO in Slot 5 with Port 1 set to 230.4kbps and Port 2 set to 115.2kbps. The Health Block is in input registers 300123-300???. The Diagnostic Block is in registers 300501-300628.

Slave 1 is connected to Port 2, Logical Rack 2, Group 0, with 2 words of I/O. The input bits should show up in 100065-10097 and the output coils are from 000065-00097. The slave is not responding to the QRIO as shown by the Diagnostic Code E001 and thus the input coils are zeroed.

Slave 2 is connected to Port 1, Logical Rack 3, Group 0, with 2 words of I/O. The input words are in 300103 and 3000104 while the output words are from 4000103 and 400104. The slave is online with a Diagnostic Code of 0000. When the device goes offline, the inputs will be held at their last value.

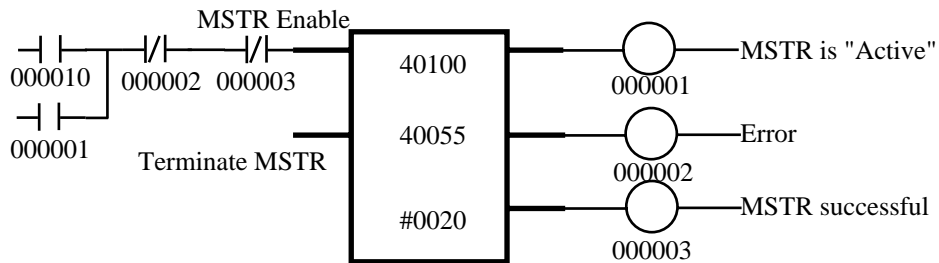
Slave 3 is connected to Port 1, Logical Rack 7, Group 0, with 8 words of I/O. The input words are in 300110 and 3000117 while the output words are from 4000110 and 400117. The slave is online with a Diagnostic Code of 0000. When the device goes offline, the inputs will be held at their last value.

**NOTE:** It is beneficial to group all Discrete Outputs together in the PLC's memory. The QRIO must read these outputs on every PLC scan. The module does optimize its reads to issues as few as possible to the PLC. Grouping the Discrete Outputs together will minimize the impact of the QRIO on the PLC's scan time.

## RIO Analog Operation

Block Transfer can be used to pass additional I/O ("Block Transfer I/O") or to read and write parameters from an intelligent RIO slave device. Both operations are accomplished using the MSTR function block. The MSTR's Control Block is nine words long, and is described in Table 3-5.

At this writing, the QUCM will only support four simultaneous MSTR blocks. Therefore, care must be taken to properly sequence the MSTR blocks if more than four are required. Each MSTR should be latched in until success or failure breaks the connection to power, and initiates the next MSTR. An example of latching in the MSTR is provided in Figure 3-1.



**Figure 3-1 Sample MSTR**

**Table 3-5 MSTR Control Block**

Register	Use	Description
Displayed	Opcode	1 = Read, 2 = Write
First implied	Error Status	Feedback from Option.
Second implied	Length	Number of words transferred
Third implied	Reserved	Set to zero.
Fourth implied	Slot Number/ RIO Port Number	High byte = Option Slot # Low byte = 1 or 2 to indicate QRIO port number.
Fifth implied	Interface Rack	Logical Rack number of Slave device.
Sixth implied	Interface Group	Group number of slave device. (0, 2, 4, or 6)
Seventh implied	[Module Group]	For Block Transfer with modules in an ASB rack, Group # of module. Otherwise, always set to zero.
Eighth implied	[Module Number]	For Block Transfer with modules in an ASB with 2-slot addressing (0 or 1). Otherwise, always set to zero.

The 7th and 8th implied words are only used when the intelligent module is in a rack connected to the RIO network by an ASB interface. In all other cases, both words

should be set to zero. For messaging to a module in an ASB rack, "Interface Rack" will be set to the Logical Rack number into which the module in question is mapped. This may differ from the Logical Rack number with which the ASB rack starts, as the rack may occupy more than one logical rack. For example, an ASB in a 16-slot rack that is configured for 1-slot addressing will occupy two logical racks. If the ASB were configured as rack 4, messaging to an Analog Input module in slot 16 would use values (5, 0, 7, 0) for (Interface Rack, Interface Group, Module Group, and Module Number). The same hardware configured for 1/2-slot addressing would use numbers (4, 0, 7, 1).

The following errors may be reported by an MSTR function block:

**Table 3-6 MSTR Error Codes**

Diagnostic Code (Hex)	Meaning
0000	Successful
1001	Abort
2002	Control Block changed while MSTR Active
2013	Data Block outside 4x Registers
7001	Timeout
701x	Bad Control Block word x
7011	Unsupported Opcode
7012	Data Block too long
7014	Incorrect Port number
7016	Invalid Group number
7017	Invalid Module Group number
7018	Invalid Module number
7021	No such device on network
7022	Drop number too large
7025	Reply's internal checksum incorrect
7030	Command word for target device is nonzero*
7040	Buffer shortage**

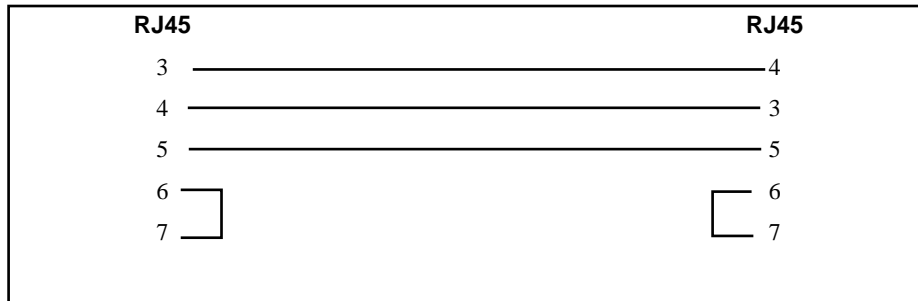
\*The Least significant byte of the first output word of Discrete I/O assigned to the slave device must remain zero; it is reserved for handshaking for the Block Transfer.

\*\*A Buffer shortage is caused by rapidly enabling MSTR's directed to a non-existent RIO slave device, or devices that are not responding. The error condition may be caused by a different MSTR than the one receiving this error.

## Hot Standby Operation

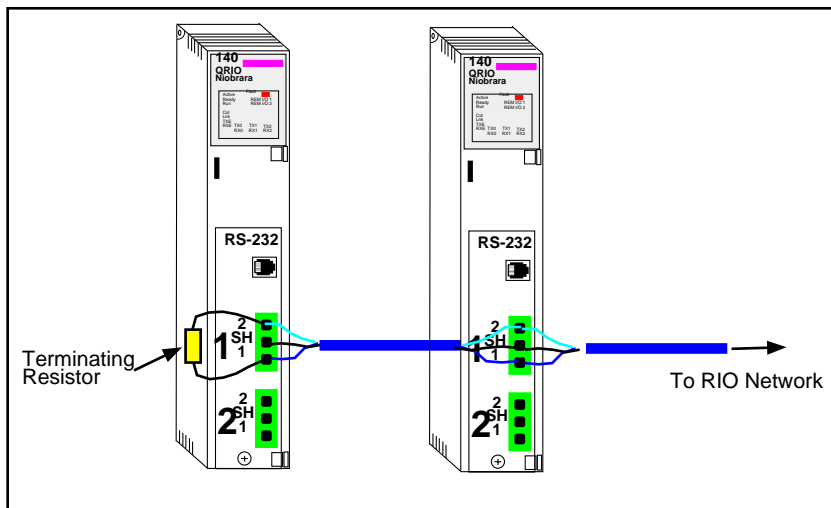
QRIO's with a firmware date of 26 September 2007 or later are capable of supporting Hot Standby operation under all programming software. This provides a means of controlling RIO networks redundantly. If the primary PLC or QRIO experience a failure, the secondary rack will take over operation of the process, and almost seamlessly take over operation. To accomplish this, the redundant QRIO's must be linked together by their serial ports, as well as linking the proper RIO Port of both modules to

each other. Figure 3-2 describes the cabling necessary to connect the two serial ports together. This is most easily accomplished by connecting a Niobrara MM1 to a Niobrara MM3, and connecting the RJ45 plugs to the QRIO jacks.



**Figure 3-2 QRIO RS-232 Crossover Cable (MM1 to MM3)**

Figure 3-3 shows the connection of the redundant RIO ports.



**Figure 3-3 Redundant Remote I/O Connections**

Note: In Hot Standby operation, it is still possible to control two completely different networks.



## Connector Pinouts

### RIO ports on QRIO (Screw Terminal)

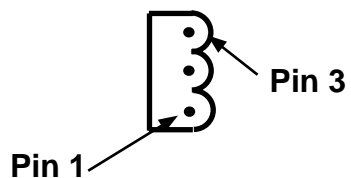


Figure 4-1 RS-232 Port RJ45

Table 4-1 RS-232 Pinout

Pin	Function	Notes
1	1	Connect Blue wire
2	SHLD	Connect shield wire
3	2	Connect White (Clear) wire

## RS-232 port on QRIO (RJ45 socket)

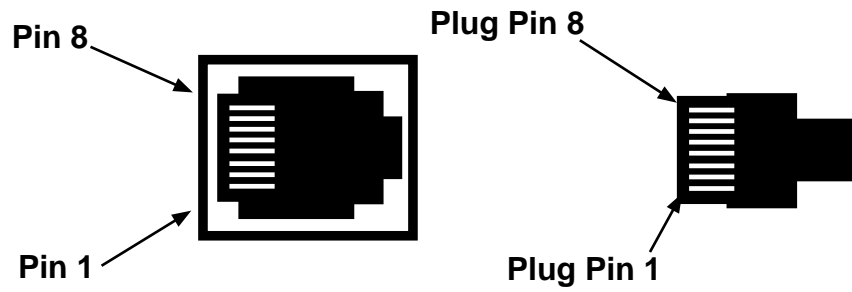


Figure 4-2 RS-232 Port RJ45

Table 4-2 RS-232 Pinout

Pin	Function	Notes
1	+5VDC	From Quantum Power Supply
2	DSR	Not used
3	TX	Transmit
4	RX	Receive
5	SG	Signal Ground
6	RTS	Push to Talk Request To Send
7	CTS	CTS must be high to transmit
8	Frame Ground	

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