



Niobrara Research & Development Corporation

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QRIO Instructions, *Preliminary*

Revised 1 April, 2004. Really.

The Niobrara QRIO module allows connection of A/B RIO 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 is configured in the Quantum rack as a Modicon NOE771 Ethernet Option module.

The QRIO has two RIO ports, referred to hereafter as Port 1 and Port 2; Port 2 is on bottom. The RIO ports have detachable three-terminal connectors, included with the module. The uppermost port (the RJ-45 connector) is an RS-232 port, which at this time is used only for debugging and firmware download. Though the module has capacitor-backed non-volatile RAM, this capability is NOT used in the current implementation, since all configuration is stored in the Quantum PLC. This is convenient for the user in that it allows quick and easy replacement of a faulty QRIO module.

Configuration

In order to configure a QRIO in the Quantum rack, add a NOE-771-00 to the I/O Map in the slot where the QRIO will be. The only configuration that is not slave-dependant is the network baud rate. Network baud rate is set with the "Internet Address" of the QRIO, as described below in Table 1.

Discrete I/O

Discrete I/O are I/O points that are continually shared between the master (QRIO/Quantum Rack) and the slave device (RIO device). The QRIO continually trades these data with the slave, and updates the input information in the Quantum PLC any time there is a change, and updates the output information to the RIO slave every rack scan.

Discrete I/O is configured in the Ethernet I/O Scanner configuration page. Open the Ethernet I/O Scanner window for the QRIO. In this window some fields are unused, but Concept may not allow some values to be entered (such as a zero byte in an IP address).

It is beneficial to group all your Discrete Outputs together in the PLC's memory. Since the QRIO must read these every PLC scan, it does optimize its reads to issue as few reads



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as possible to the PLC. Grouping the Discrete Outputs together will minimize the impact of the QRIO on your PLC's scan time.

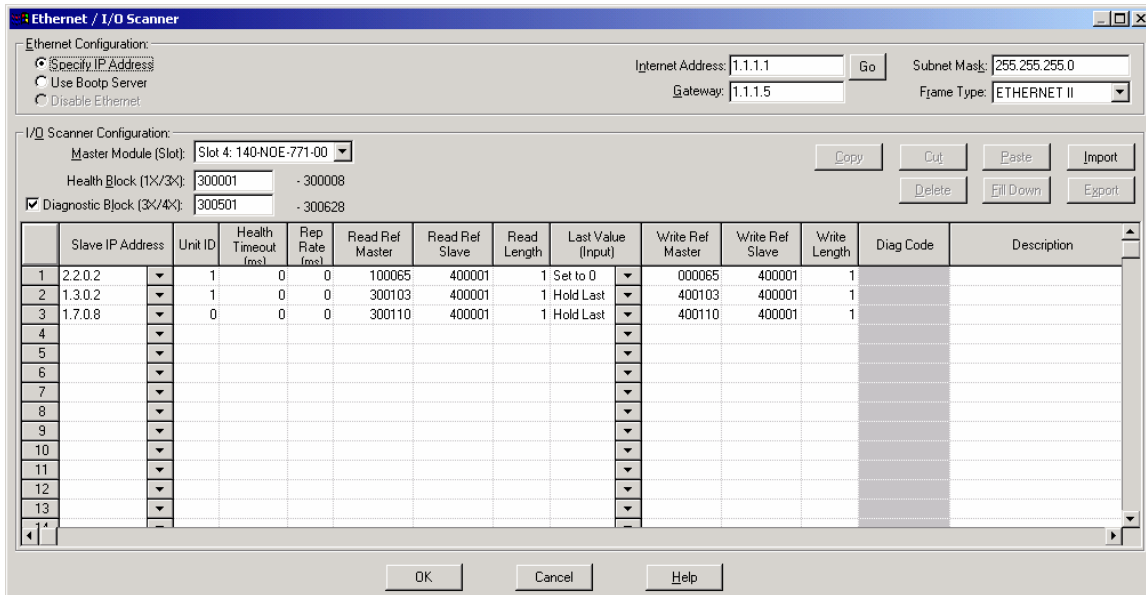


Figure 1: Offline view of I/O Scanner configuration

The “Internet Address” for the QRIO sets the bitrates for the two RIO ports. The ports may have different bitrates. Figure 1 above sets both ports to 57.6kBPS (see Table 1).

RIO modules occupying multiple logical racks

It is possible to have an RIO device (such as an ASB module in a 16-slot rack) that occupies multiple logical racks. For instance, an ASB in a 16-slot rack configured for 1/2-slot addressing would occupy FOUR logical racks—if the ASB were addressed at rack 4, it would take up logical racks 4, 5, 6, and 7. In this case, FOUR entries must be made in the I/O table, one for each logical rack. The same rack, configured for 1-slot addressing would occupy two logical racks, and would require two entries in the I/O table.

If one logical rack occupied by an ASB module is omitted from the I/O table, the rack will show communications, but none of its output modules will show “Active”, until ALL logical racks are included in the I/O table.



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Table 1: Meaning of Ethernet I/O Scanner table entries

Field	Subfield	Meaning
Internet Address	First	Bitrate for RIO Port 1: 1=57.6, 2=115.2, 3=230.4 kbps
	Second	Reserved (set to 1)
	Third	Bitrate for RIO Port 2: 1=57.6, 2=115.2, 3=230.4 kbps
	Fourth	Reserved (set to 1)
Subnet Mask		Reserved
Gateway		Reserved (set to 1s)
Health Block		Used exactly as in an NOE.
Diagnostic Block		Used as in an NOE. See Table 2 for codes.
Slave IP Add.	First	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 Quantum for Input data to appear
Read Ref Slave		Reserved
Read Length		Unused, but must be non-zero if Input data are used.
Last Value (Input)		Same function as in NOE
Write Ref Master		Location in Quantum to read Output data
Write Ref Slave		Reserved
Write Length		Unused, but must be non-zero if Outputs data are used.
Diag Code		Displays Diagnostic code for entry, if enabled and Online.

When the Ethernet I/O Scanner table is viewed while Concept is online with the PLC, OFFLINE slave devices are shown in RED (see Figure 2, below) and each device's Diagnostic code is shown in its row, if Diagnostic codes are enabled. Figure 2 shows the first device as offline (not responding) and devices 2 and 3 as online and functioning normally.



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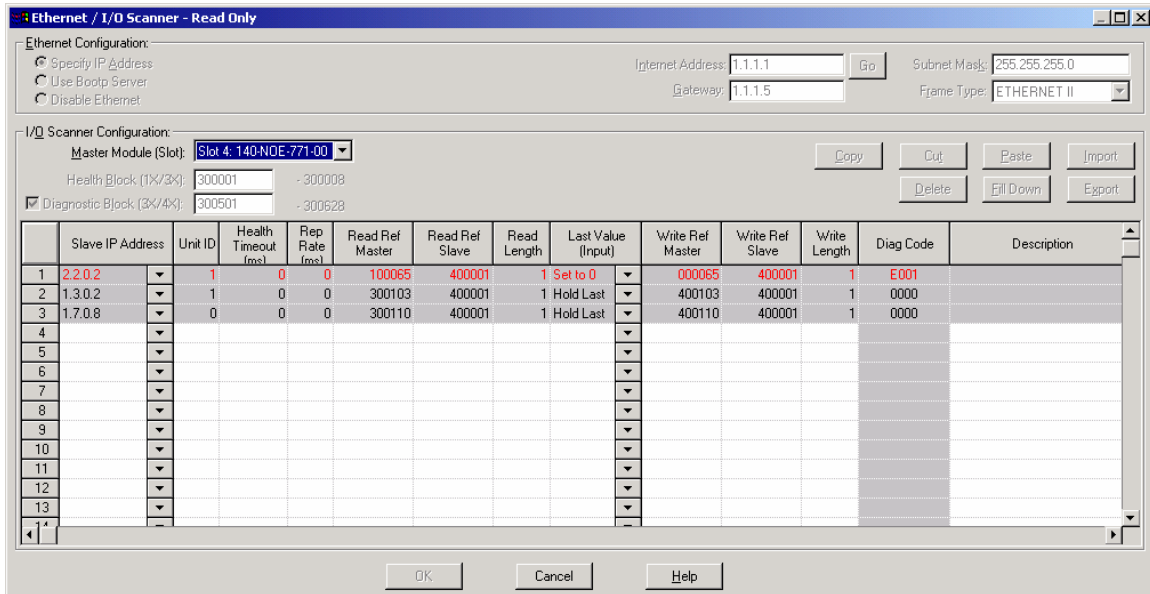


Figure 2: Online view of Ethernet I/O Scanner page

Diagnostic Codes

Below is a list of Diagnostic codes that may be reported by the QRIO (in hexadecimal), and their meanings:

Table 2: Diagnostic Codes reported by QRIO

Code	Meaning
0000	All's well
F001	Device not yet polled
E001	No reply from Device at Rack/Group
E02x	Device Rack Size does not match IOScan configuration. Device configured for X words
E03x	Bitmask of problems with IOScan entry (more than one bit may be set):
E031	Entry is invalid: Read Ref Master address invalid
E032	Entry is invalid: Write Ref Master address invalid
E034	Size out of range (last byte of IP)
E044	Port number (first drop in IP) 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



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Block Transfer

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 use the Quantum’s MSTR function block. As before the MSTR’s Control block is nine words long, and the Data block is the area in the PLC where data will be read from or written to.

The QRIO will only service four MSTR function blocks simultaneously, at this point. As such, if many Block Transfer operations are required, care must be taken to sequence them properly, and to properly latch their Enable inputs. When the fifth simultaneous MSTR is activated, none of its outputs will be active until one of the first four MSTRs completes its transaction. Thereafter the Active output will be on until the MSTR completes its transaction. This is why the MSTRs in the examples here have a coil latching their Enable inputs, regardless the state of their Active output (such as coil 0x1001 in Figure 3).

The meaning of the fields within the Control Block are different from an Ethernet or MB+ MSTR instruction, of course:

Table 3: MSTR Control Block

Word	Use	Description
Named in top node of MSTR block	Operation Code	1 = Write 2 = Read
1 st implied	Error / Status	Feedback from Option: Nonzero indicates error. See Table 4
2 nd implied	Length	Number of Words to Transmit/Receive
3 rd implied	Reserved	Set to zero.
4 th implied	Option Slot number/ RIO Port number	High byte indicates slot number of QRIO, Low byte is 1 or 2 to indicate which RIO network to transmit message onto.
5 th implied	Interface Rack	Rack number of slave RIO device
6 th implied	Interface Group	Group of slave (0, 2, 4, or 6)
7 th implied	[Module Group]	For Block Transfer with modules in an ASB rack, Group # of <i>Module</i> . Set to zero otherwise.
8 th implied	[Module Number]	For Block Transfer with modules in an ASB rack with 2-slot addressing (0 or 1). Set to zero otherwise.

The 7th and 8th implied words will only be used when communicating to a module in a rack connected through an ASB interface. In other cases, these words should be set to zero. For messaging a module in an ASB rack, “Interface Rack” will be set to the Rack



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number into which the module in question would be mapped. In other words, this could be different from the rack number of the ASB module, if the rack is configured for 1-slot or 1/2-slot, making the physical rack occupy more than one logical rack. For Example, an ASB in a 16-slot rack configured for 1-slot addressing will occupy two logical racks. If the ASB is configured as Rack 4, comms 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 as 1/2-slot addressing would use numbers (4, 0, 7, 1).

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

Table 4: MSTR Error codes

Code	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 Block Transfer.

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

Block Transfer I/O

Block Transfer I/O are supported by some RIO devices. To share Block Transfer I/O, the MSTR instruction must be used (this is very similar to how it's done in an A/B PLC). A



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“Read” MSTR fetches Block transfer Inputs from the slave, and the “write” MSTR writes block transfer outputs to the slave.

Figure 3 shows a Block Transfer I/O write of 2 words of data (written from 4x1010) to Network 1, Rack 3, Group 0 (which is a Powerflex 70 drive in this application). It is being triggered every ten milliseconds, but it would also be reasonable in some cases to trigger it on its own completion.

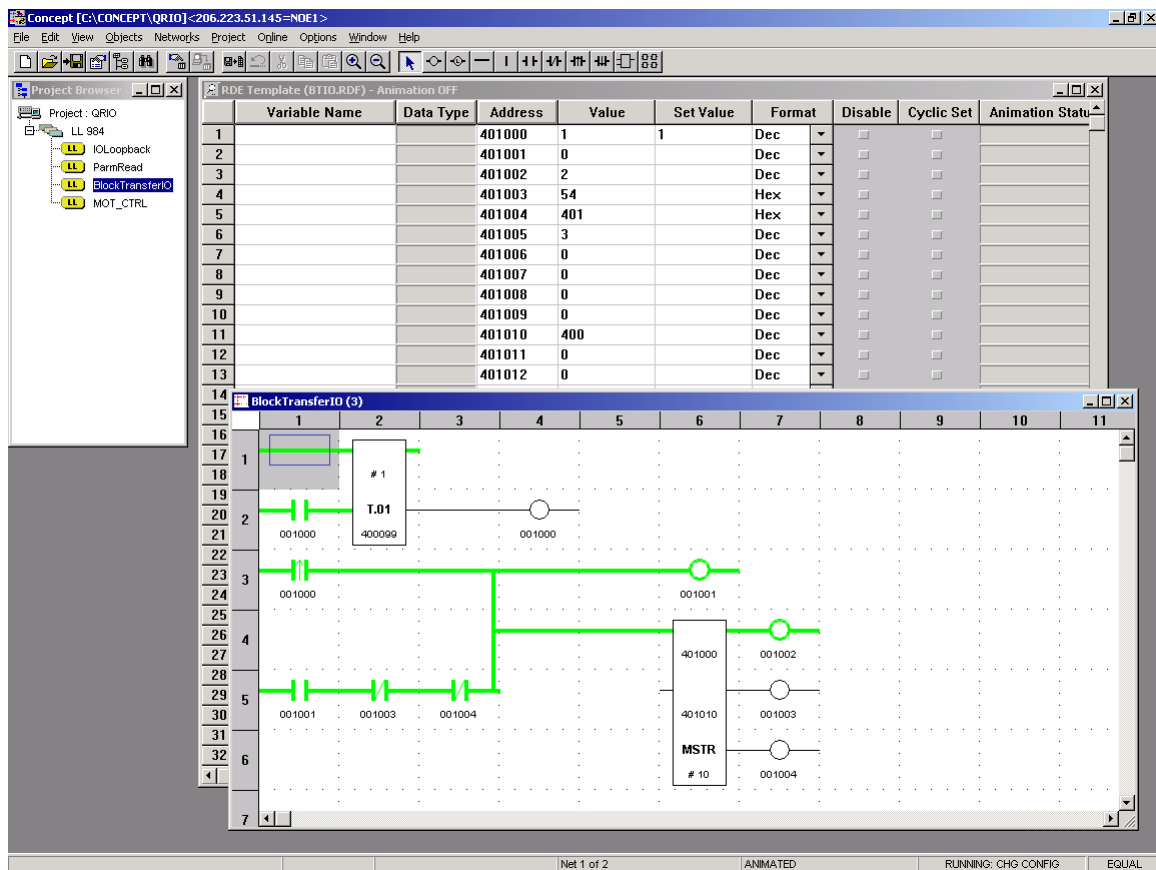
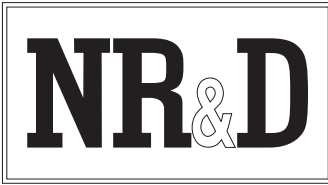


Figure 3: Block Transfer I/O Write

Figure 4 illustrates a Block Transfer I/O Read, of 2 words from the same device.



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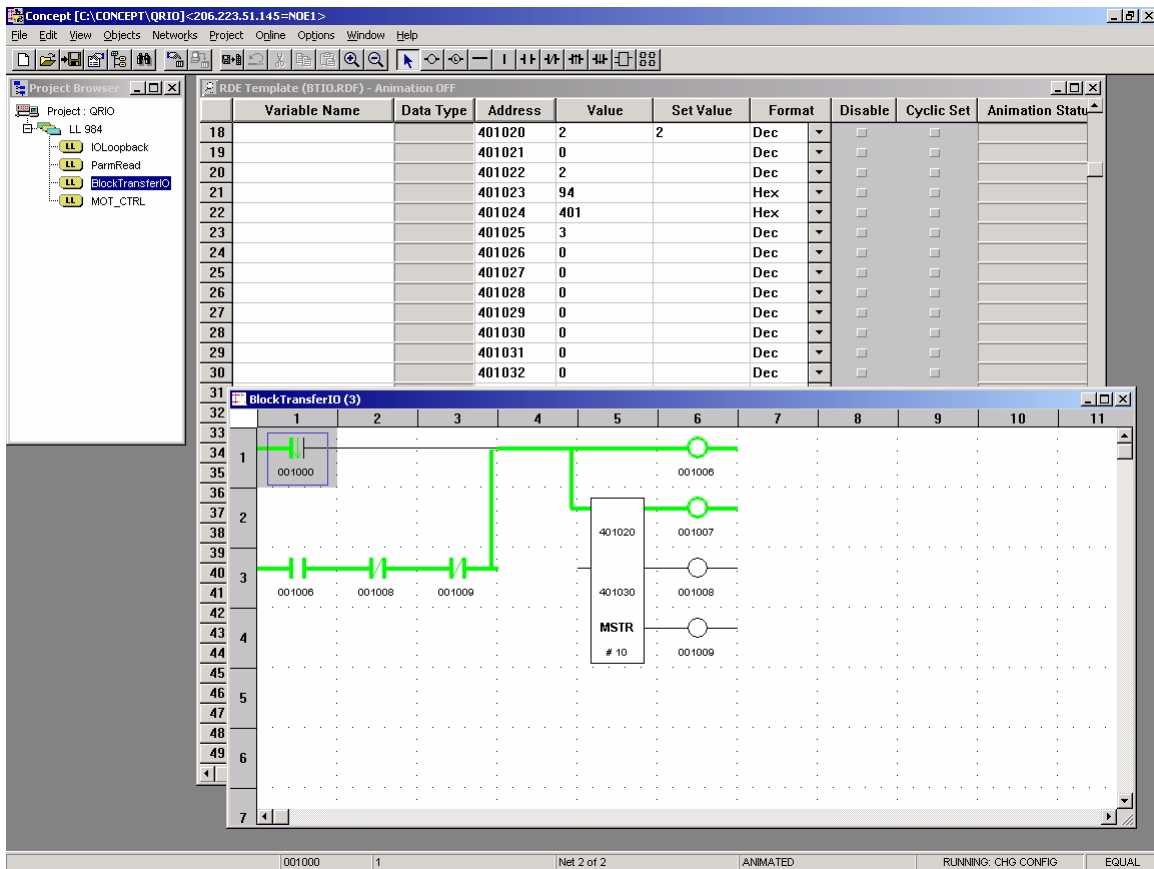


Figure 4: Block Transfer I/O Read

Parameter Block Transfers

Parameter reads and writes use the same MSTR function blocks as the Block Transfer I/O, but are subtly different. The differences between Parameter block transfers and Block Transfer I/O seem to vary between slave devices, so it is out of the scope of these instructions to describe them fully.

In the case of the Powerflex drive, a Parameter Read or Write is distinguished by the length of the Read or Write (must be 20, 30, or 60 words, whereas block transfer I/O are 18 or fewer words), and special handshaking must be used to ensure a parameter read or write is not triggered when the slave is not ready to handle it.

Figure 5 shows the ladder code to begin a Parameter read from the Powerflex 70 drive; it is the same read as is described in the 20-COMM-R manual, page 5-9. Note that this is the *first step* of a two step read process, and is actually writing to the slave device.



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The NOBT and NCBT function blocks are used to extract bits from input registers from the slave device. These bits are handshaking from the slave (part of the drive's Discrete I/O) that indicate whether it's ready to receive a Block Transfer Write, and whether it's got a Block Transfer Read ready for the master. The arrangement and meaning of these bits differs between different slave devices; refer to your RIO device's manual for specifics of these bits' meaning. Beware that in some instances the bit numbers in A/B manuals and software are represented in Octal, with the LSB of the word being numbered zero, whereas in Modicon, the LSB is numbered 16.

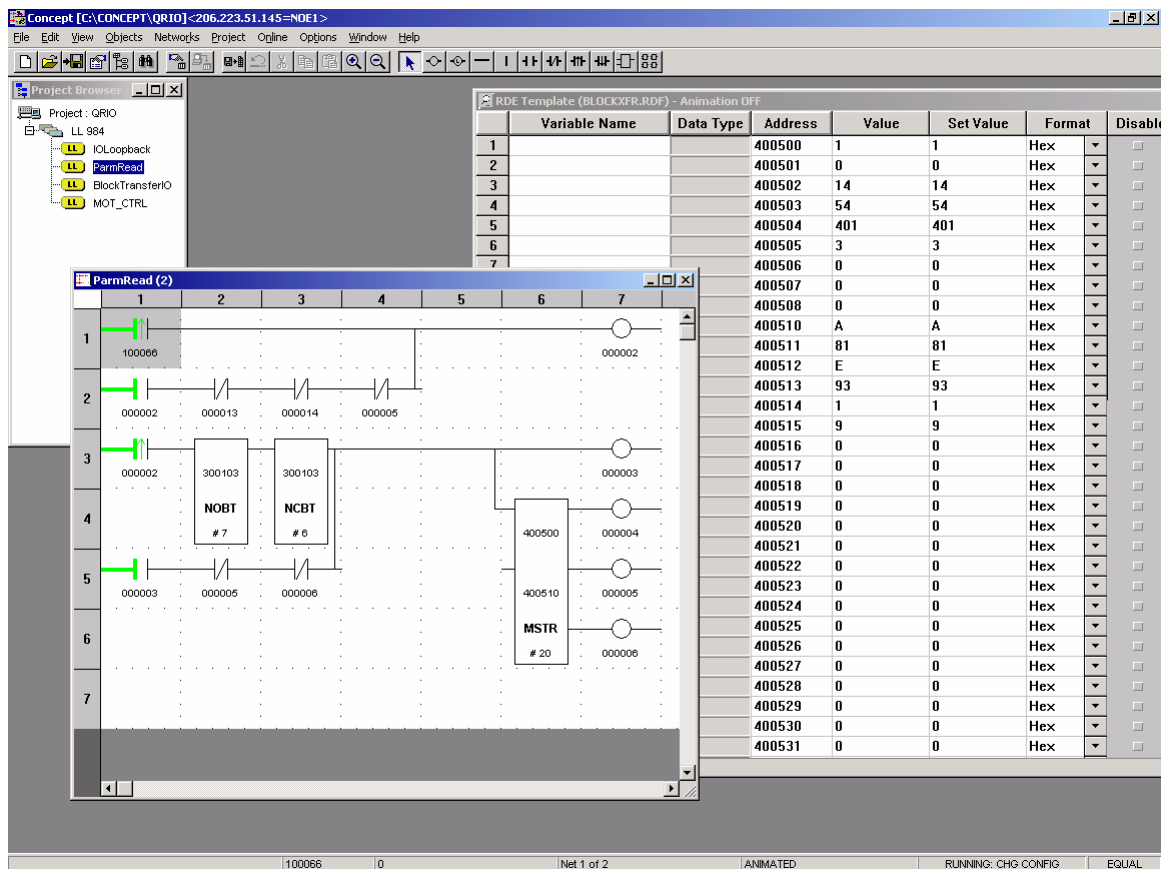


Figure 5: Parameter Block Transfer Write

Figure 6 shows the read that actually fetches the data back from the drive which was requested in the previous step. This also is directly from the example in the same manual. The NOBT function block in this ladder code triggers the read when the slave reports having a response ready.



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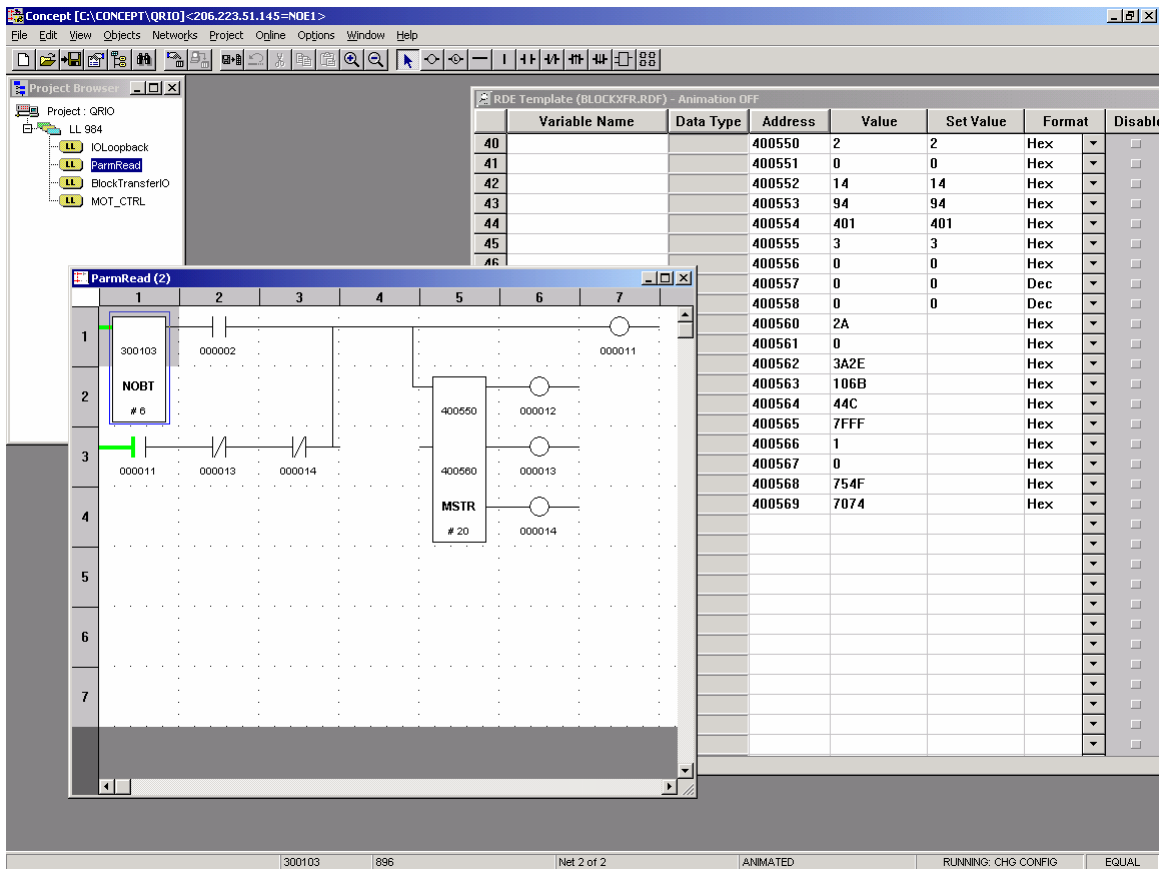


Figure 6: Parameter Block Transfer Read

If multiple MSTRs performing Parameter (Messaging) Block Transfer were directed to the same slave device, special care should be taken to ensure they're sequenced properly (only ONE should be active at any time). If sequencing failed, it would be possible for a MSTR to read the wrong response from the intended slave. This is no different than it would be in an A/B PLC system.

Block Transfer to Modules in ASB racks

In some cases, a rack controlled by an ASB module will contain other modules with more data to share than will fit into their Discrete I/O, such as an Analog Input module. Block Transfer messaging is slightly different when addressing these modules, because the message itself must be directed to the ASB module, while specifying which of the slaved I/O modules is to receive the message.

In order to message a device in an ASB rack, the 5th and 6th implied words in the Control Block indicate the Rack/Group of the ASB module. Rack will always be equal to the Rack number assigned to the target module's slot, which might be different from the



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ASB itself, if the ASB occupies multiple logical Racks. The 7th implied word indicates the Group of the target module, and the 8th implied word indicates the Module number; used only in the case where the ASB's rack is configured for 2-slot addressing, to specify which of the two modules in the Rack/Group you wish to address.

As an example, if you had an ASB module in a 16-slot rack, and an analog module were in the 16th slot of that rack and the ASB is configured to appear at Rack 8, you would specify (8, 0, 7, 1) for (Rack, Group, Module Group, Module) if the rack were configured as 2-slot addressing. With 1-slot addressing, use (9, 0, 7, 0), and with 1/2-slot addressing, use (11, 0, 6, 0)—in this case we'd want to specify the FIRST of the words that correspond to the Analog card.

The first (least-significant) byte assigned in Discrete I/O to any module supporting Block Transfer is used as handshaking for delivering Block Transfer messages. As such, this byte should be left at zero in the Quantum PLC. If it is found to be nonzero when an MSTR is initiated, an error 0x7030 will be returned.