QRIO 984LL Example

Companion Manual

This manual provides more detail on the QRIO 984LL Video demonstrating a Quantum PLC controlling Allen-Bradley 1771 (PLC5) I/O.

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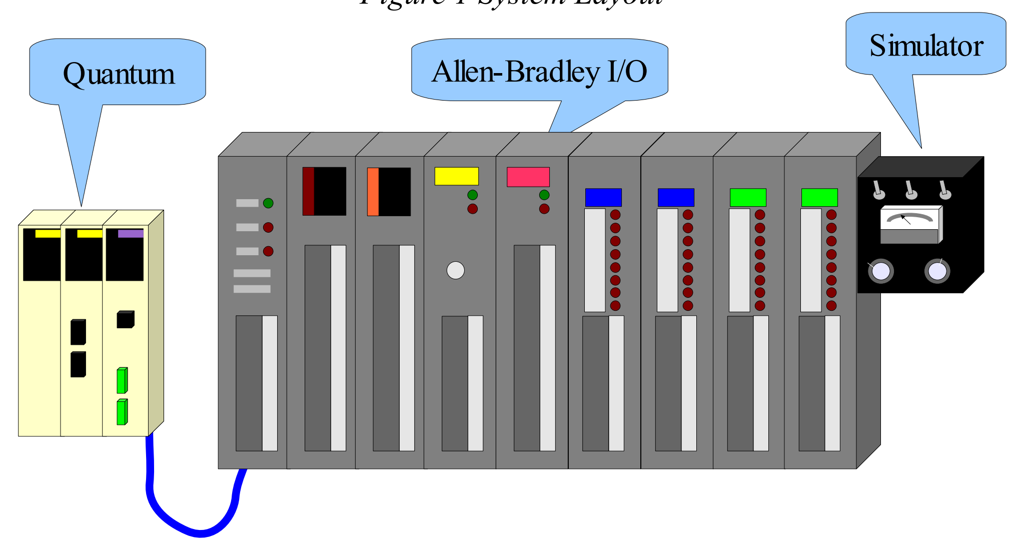
System Layout

Figure 1 System Layout

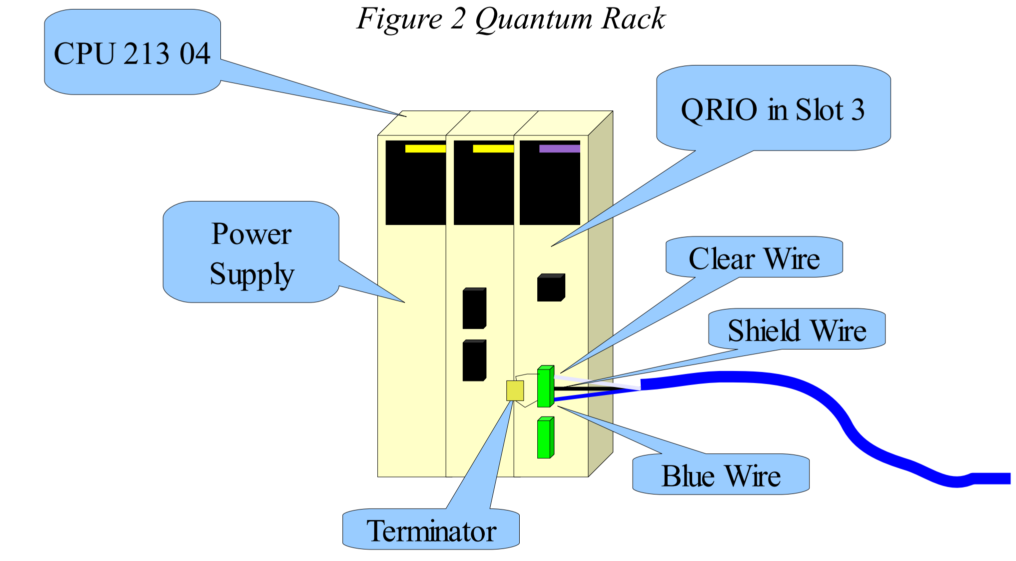


This demonstration video shows a simple Modicon Quantum PLC system controlling a remote rack of Allen-Bradley 1771 Series I/O using the Niobrara QRIO-002. The Quantum rack consists of a power supply, CPU, and the QRIO. The A-B rack consists of an ASB, a 16-bit discrete input card, a 16-bit output card, a 16 channel analog input card, a 4 channel analog output card, two 8-bit discrete input cards, and two 8-bit discrete output cards. A small simulator box is also attached that provides three toggle switches connected to inputs on the 24VDC 8-bit input cards, two 0-10Vdc potentiometers connected to two of the analog inputs, and a DC voltmeter connected to one of the analog outputs.

Quantum Rack

The Quantum system is a simple 3-slot rack with a CPS111 power supply in slot 1, a CPU 213 04A in slot 2, and the QRIO-002 in slot 3. RIO Port 1 of the QRIO is connected with the standard “Blue Hose” twin-axial cable to the A-B ASB. The standard 82 ohm terminator is installed across the clear and blue wires at the removable connector.

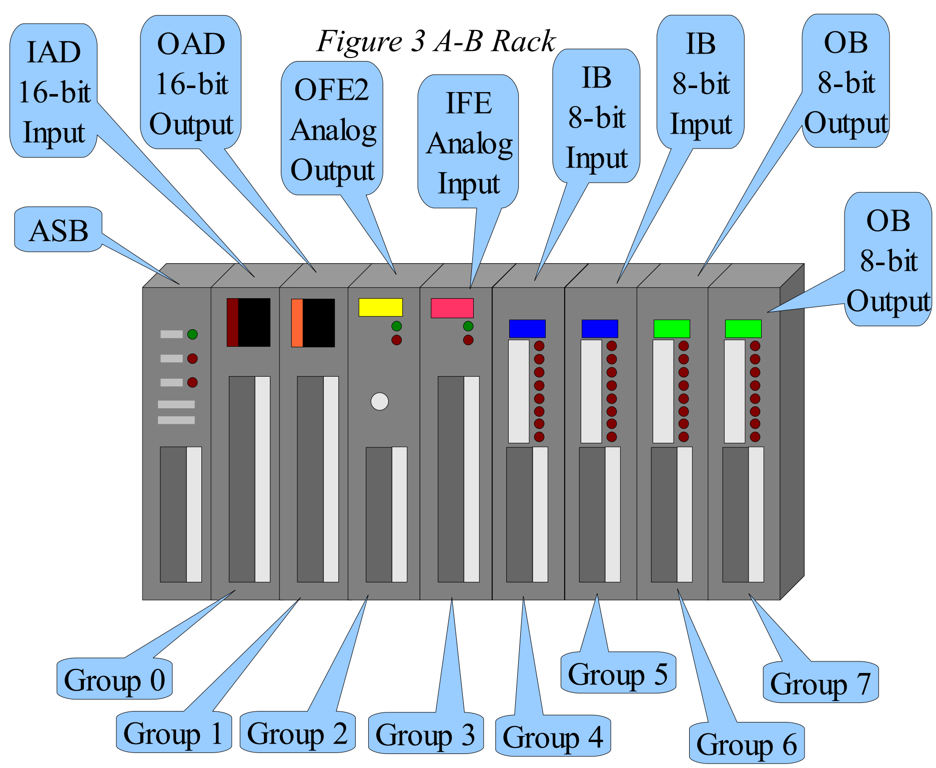
Figure 2 Quantum Rack



A-B Rack

The Allen-Bradley rack is an 8-slot chassis. Removing the ASB allow the examining of the DIP switch on the rack backplane (See Figure 4). Consult the ASB user manual for

Figure 3 A-B Rack

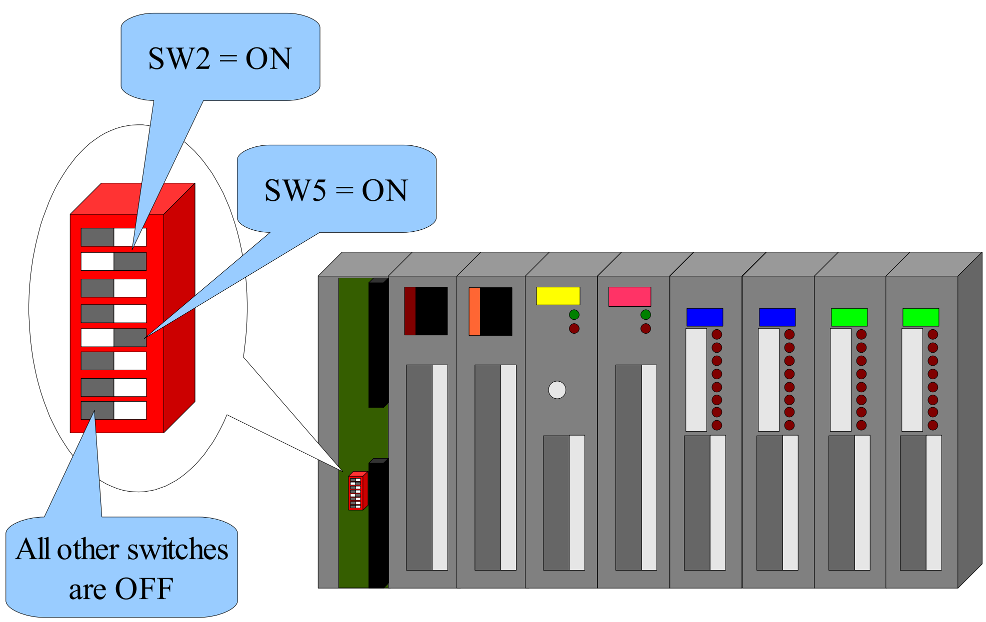


complete information about the chassis DIP switch. (The QRIO may be considered to be the same as a PLC-5 Family, SLC, or ControlLogix scanner.) The video shows that the chassis is configured for the following:

- SW1 = OFF (Outputs of the chassis are deenergized when a fault is detected.)
- SW2 = ON (Remote restart enabled)
- SW3 = OFF (Always OFF)
- SW4 = OFF (Always OFF)
- SW5 = ON
- SW6 = OFF (SW5 ON + SW6 OFF = 1-slot addressing)
- SW7 = OFF (Always OFF)
- SW8 = OFF (Always OFF)

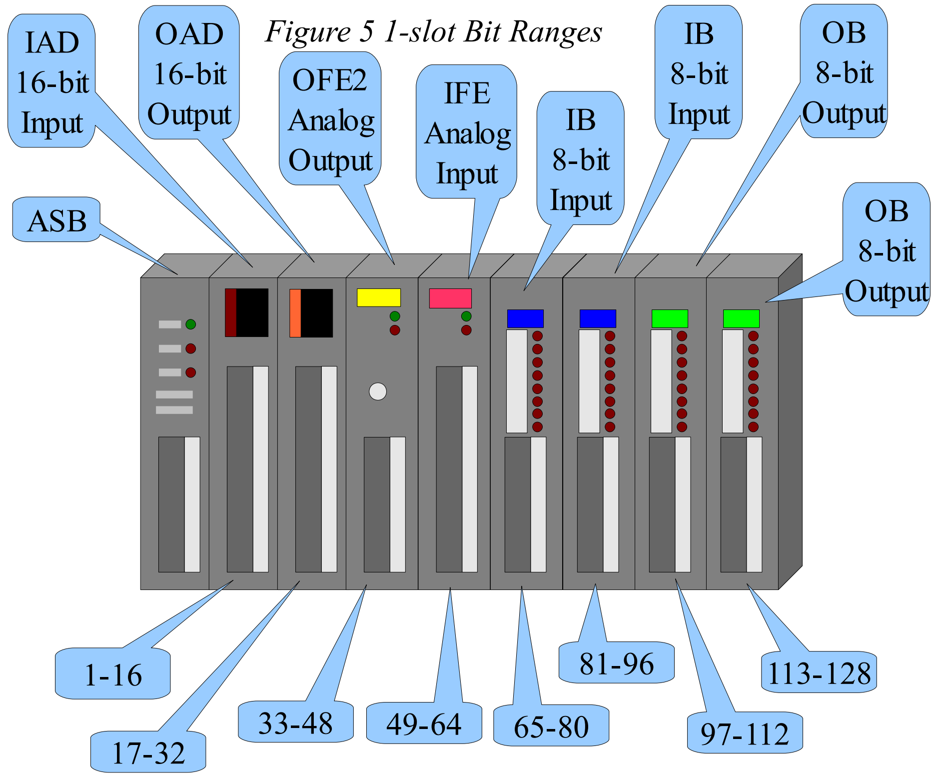
Switches 5 and 6 determine the addressing of the chassis. This rack is set for 1-slot addressing. The ASB user manual goes into great detail about ½-slot, 1-slot, and 2-slot addressing with various 8-bit, 16-bit, and 32-bit discrete cards.

Figure 4 A-B Rack DIP Switch



The implication of 1-slot addressing is that every slot in the rack has 16 input bits and 16 output bits assigned. This wastes a lot of bits, but it is the only way to make it work. Sixteen bit input only cards use all 16 input buts but waste the 16 output bits. Output

Figure 5 1-slot Bit Ranges



1-slot Address assigns 16 bits IN and 16 bits OUT to every slot. These input bits and output coils must be reserved.

cards only use the output bits and waste input bits. Eight bit cards only use the first 8 bits of the appropriate direction. Analog cards don't use the bits at all but they still must be assigned.

ASB Configuration

The QRIO supports ASB models of Series D and E. The ASB is configured by DIP switches. Consult the ASB user manual for complete information about the settings and consider the QRIO as a PLC-5, SLC, or ControlLogix Scanner.

NOTE: The ASB user manual table 2.C shows the Rack # in Octal. The settings shown in Figure 6 are octal 12 = decimal 10 (8+2).

Figure 6 ASB DIP Switches

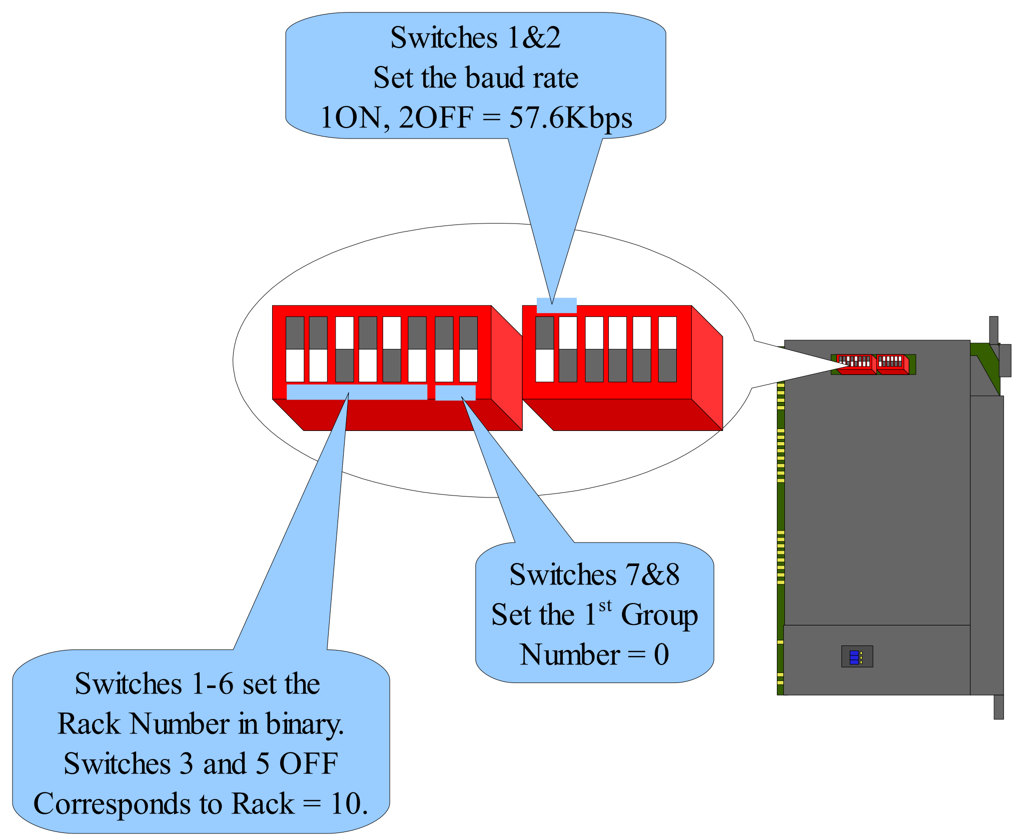
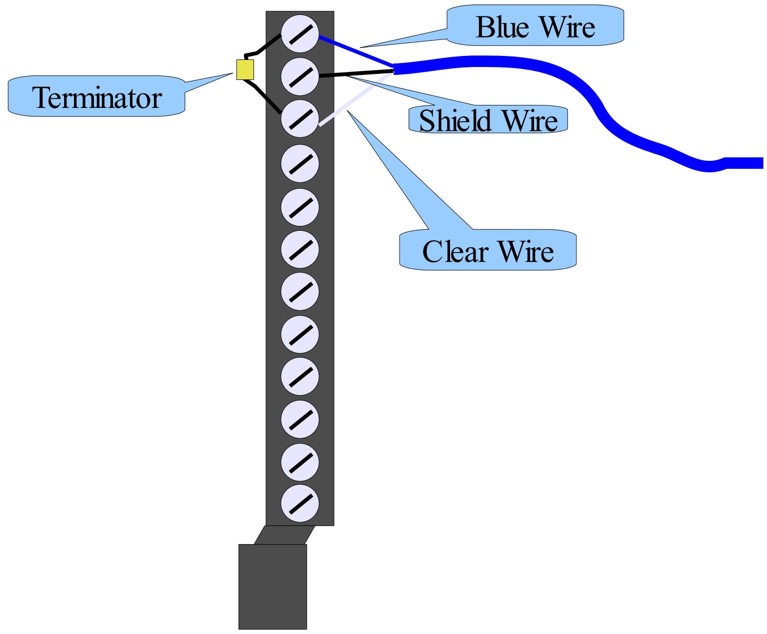


Figure 7 ASB Blue Hose Wiring



The wiring of the ASB card simply connects the “Blue Hose” cable to the proper screw terminals. Also notice that since this is the last node on the network the 82ohm terminator is also installed across the clear and blue wires.

1771-IAD (16-bit 120VAC Discrete Input Card)

Slot 0 holds a 16-bit discrete input card. It is difficult to see in the video, but three of the inputs on this card are hard-wired ON to 120VAC. Inputs 00, 15, and 17 (octal) are all ON. These inputs are not used in the sample ladder logic in the Quantum, but are there simply to assist the understanding of the bit mapping from the A-B system to the Modicon.

The QRIO's I/O Scanner maps these 16 inputs into bits 1x0001 through 1x00016.

NOTE: The A-B rack is configured for 1-slot addressing. This means that this slot consumes 16-1x input bits and 16-0x output coils. Therefore, coils 0x00001 through 0x000016 are assigned to this slot and may not be used elsewhere in the PLC program.

Quantum Address	Card Input (octal)	Notes
1x00001	00	Wired always ON
1x00002	01	
1x00003	02	
1x00004	03	
1x00005	04	
1x00006	05	
1x00007	06	
1x00008	07	
1x00009	10	
1x00010	11	
1x00011	12	
1x00012	13	
1x00013	14	
1x00014	15	Wired always ON
1x00015	16	
1x00016	17	Wired always ON

Table 1: 1771-IAD Mapping

1771-OAD (16-bit 120VAC Discrete Output Card)

Slot 1 holds a 16-bit discrete output card. Two of the outputs are controlled in the Quantum's ladder logic. Careful viewing of the video will show switch 3 changing the state of this card's Outputs 00 and 16 (octal) (Modicon coils 0x00017 and 0x00031).

The QRIO's I/O Scanner maps these 1 He6 outputs to coils 0x00017 through 0x00032.

NOTE: The A-B rack is configured for 1-slot addressing. This means that this slot consumes 16 0x coils as well as 16 1x input bits. These 1x bits will always be set to zero by the QRIO.

Quantum Address	Card Output (octal)	Notes
0x00017	00	Tied to Toggle Switch #3
0x00018	01	
0x00019	02	
0x00020	03	
0x00021	04	
0x00022	05	
0x00023	06	
0x00024	07	
0x00025	10	
0x00026	11	
0x00027	12	
0x00028	13	
0x00029	14	
0x00030	15	
0x00031	16	Tied to Toggle Switch #3
0x00032	17	

Table 2: 1771-OAD Mapping

1771-OFE2 (12-bit 4-channel Analog Output Card)

Slot 2 contains a 4-channel analog output card. This card is configured (internal jumpers) for 0-10VDC outputs. Output channel 1 is wired directly to the analog voltmeter. Output channels 2, 3, and 4 are not used in this example.

The 1-slot addressing of the A-B chassis ends up mapping discrete inputs 1x00033 through 1x00048 and outputs 0x00033 through 0x00048 to this card. These bits and coils are not used within the Quantum's ladder logic but their reservation is required.

Allen-Bradley systems control this card with a function called a block transfer write. The QRIO uses the standard Modicon MSTR function to achieve control. The MSTR requires two blocks of Holding Registers (4x), one for the control block, and one for the data to be written to the analog output card.

The ladder logic used to control the MSTR to write the data is shown on page 26. The control and data blocks are shown below:

Quantum Address	Value (hex)	Value (decimal)	Notes
4x0100	0001	1	1=MSTR Write Command
4x0101	0000	0	Error Code Returned by QRIO
4x0102	000D	13	13 words of data in the write
4x0103	0000	0	Always 0
4x0104	0301	769	High byte = QRIO Slot Number (3) Low byte = QRIO Port Number (1)
4x0105	000A	10	Logical Rack number of Write (10)
4x0106	0000	0	Interface Group Number of Target (0)
4x0107	0002	2	ASB Group Number of Target (2)
4x0108	0000	0	Always 0 for 1-slot addressing

Table 3: Analog Output MSTR Control Block

NOTE: The scaling for channel 1 was set to match the scaling of the analog input #1 so a simple ADD16 could be used to copy the analog input 1 to analog output 1.

NOTE: For more information about the data block written to the OFE, consult the OFE user manual.

Quantum Address	Value (hex)	Value (decimal)	Notes
4x0120	0669	1641	Channel 1 Data Value
4x0121	07D0	2000	Channel 2 Data Value
4x0122	07D0	2000	Channel 3 Data Value
4x0123	07D0	2000	Channel 4 Data Value
4x0124	8000	32768	Integer Data, positive scales, positive data
4x0125	0000	0	Channel 1 Min. Scale Value
4x0126	0FFF	4095	Channel 1 Max. Scale Value
4x0127	0000	0	Channel 2 Min. Scale Value
4x0128	0FFF	4095	Channel 2 Max. Scale Value
4x0129	0000	0	Channel 3 Min. Scale Value
4x0130	0FFF	4095	Channel 3 Max. Scale Value
4x0131	0000	0	Channel 4 Min. Scale Value
4x0132	0FFF	4095	Channel 4 Max. Scale Value

Table 4: Analog Output MSTR Data Block

1771-IFE (12-bit 16-channel Analog Input Card)

Slot 3 contains a 16-channel analog input card. This card is configured for -10 to +10VDC inputs. Input channel 1 is wired directly to potentiometer #1 which provides a 0-10VDC input. Input channel 16 is wired to potentiometer #2 which also provides a 0-10VDC input. Input channels 2 through 15 are floating.

Channel 1 is scaled to achieve a 0-4095 value for the 0-10VDC range. This range was chosen to allow a simple ADD16 command to copy the data from this analog input to the analog output card. Just for fun, Channel 16 is scaled to achieve a 0-1000 value for the 0-10VDC range.

The 1-slot addressing of the A-B chassis ends up mapping discrete inputs 1x00049 through 1x00064 and outputs 0x00049 through 0x00064 to this card. These bits and coils are not used within the Quantum's ladder logic but their reservation is required.

Allen-Bradley systems control this card using both a block transfer read and write. The QRIO uses the standard Modicon MSTR functions to achieve control. Each MSTR requires two blocks of Holding Registers (4x), one for the control block, and one for the data to be read from the card or the setup data written to the card.

This card needs to be configured each time power is cycled on the A-B rack. Fortunately, the card gives a status bit that may be used to trigger the configuration write. The NOBT block in Network 5 of the 984LL program is this trigger.

The ladder logic used to control the MSTR to read the data is shown on page 27. The control and data blocks are shown below:

Quantum Address	Value (hex)	Value (decimal)	Notes
4x0200	0002	2	2=MSTR Read Command
4x0201	0000	0	Error Code Returned by QRIO
4x0202	0014	20	20 words of data in the read
4x0203	0000	0	Always 0
4x0204	0301	769	High byte = QRIO Slot Number (3) Low byte = QRIO Port Number (1)
4x0205	000A	10	Logical Rack number of Write (10)
4x0206	0000	0	Interface Group Number of Target (0)
4x0207	0003	3	ASB Group Number of Target (3)
4x0208	0000	0	Always 0 for 1-slot addressing

Table 5: Analog Input READ MSTR Control Block

NOTE: For more information about the data block read from the IFE, consult the IFE user manual.

Quantum Address	Value (hex)	Value (decimal)	Notes
4x0220	0002	2	Diagnostics Bits (data out of range)
4x0221	0000	0	Underrange Bitmap
4x0222	8000	-32768	Overrange Bitmap
4x0223	7FFF	32750	Data Polarity Bitmap
4x0224	05E7	1511	Channel 1 Data
4x0225	FDED	-531	Channel 2 Data
4x0226	FE6C	-404	Channel 3 Data
4x0227	FECB	-309	Channel 4 Data
4x0228	0345	837	Channel 5 Data
4x0229	FD4F	-689	Channel 6 Data
4x0230	FE6C	-404	Channel 7 Data
4x0231	FE5E	-418	Channel 8 Data
4x0232	FEC7	-313	Channel 9 Data
4x0233	FE60	-416	Channel 10 Data
4x0234	FE6A	-406	Channel 11 Data
4x0235	FED1	-303	Channel 12 Data
4x0236	FD9D	-611	Channel 13 Data
4x0237	FD9F	-609	Channel 14 Data
4x0238	FE9C	-356	Channel 15 Data
4x0239	03E8	1000	Channel 16 Data

Table 6: Analog Input READ MSTR Data Block

The ladder logic used to control the MSTR to read the data is shown on page 28. The control and data blocks are shown below:

Quantum Address	Value (hex)	Value (decimal)	Notes
4x0300	0001	1	1=MSTR Write Command
4x0301	0000	0	Error Code Returned by QRIO
4x0302	0025	37	37 words of data in the write
4x0303	0000	0	Always 0
4x0304	0301	769	High byte = QRIO Slot Number (3) Low byte = QRIO Port Number (1)
4x0305	000A	10	Logical Rack number of Write (10)
4x0306	0000	0	Interface Group Number of Target (0)
4x0307	0003	3	ASB Group Number of Target (3)
4x0308	0000	0	Always 0 for 1-slot addressing

Table 7: Analog Input WRITE MSTR Control Block

NOTE: For more information about the data block read from the IFE, consult the IFE user manual.

NOTE: The IFE requires the scale values to be entered in BCD (hex) instead of decimal.

The range for input 1 is set for -4095 to +4095 for -10 to +10VDC inputs. This gives a range of 0 to 4095 for a 0-10VDC input.

Quantum Address	Value (hex)	Value (decimal)	Notes
4x0320	FFFF	-1	Range Selection Channels 1 to 8
4x0321	FFFF	-1	Range Selection Channels 9 to 16
4x0322	0400	1024	Data Format = Two's Complement Range = 0 to +10V
4x0323	FFFF	-1	Sign Bits, Min. Scaling
4x0324	0000	0	Sign Bits, Max. Scaling
4x0325	4095	16533	Channel 1 Min. Scaling
4x0326	4095	16533	Channel 1 Max. Scaling
4x0327	4095	16533	Channel 2 Min. Scaling
4x0328	4095	16533	Channel 2 Max. Scaling
4x0329	4095	16533	Channel 3 Min. Scaling
4x0330	4095	16533	Channel 3 Max. Scaling
4x0331	4095	16533	Channel 4 Min. Scaling
4x0332	4095	16533	Channel 4 Max. Scaling
4x0333	4095	16533	Channel 5 Min. Scaling
4x0334	4095	16533	Channel 5 Max. Scaling
4x0335	4095	16533	Channel 6 Min. Scaling
4x0336	4095	16533	Channel 6 Max. Scaling
4x0337	4095	16533	Channel 7 Min. Scaling
4x0338	4095	16533	Channel 7 Max. Scaling
4x0339	4095	16533	Channel 8 Min. Scaling
4x0340	4095	16533	Channel 8 Max. Scaling
4x0341	4095	16533	Channel 9 Min. Scaling
4x0342	4095	16533	Channel 8 Max. Scaling
4x0343	4095	16533	Channel 10 Min. Scaling
4x0344	4095	16533	Channel 10 Max. Scaling
4x0345	4095	16533	Channel 11 Min. Scaling
4x0346	4095	16533	Channel 11 Max. Scaling
4x0347	4095	16533	Channel 12 Min. Scaling
4x0348	4095	16533	Channel 12 Max. Scaling

4x0349	4095	16533	Channel 13 Min. Scaling
4x0350	4095	16533	Channel 13 Max. Scaling
4x0351	4095	16533	Channel 14 Min. Scaling
4x0352	4095	16533	Channel 14 Max. Scaling
4x0353	4095	16533	Channel 15 Min. Scaling
4x0354	4095	16533	Channel 15 Max. Scaling
4x0355	1000	4096	Channel 16 Min. Scaling
4x0356	1000	4096	Channel 16 Max. Scaling

Table 8: Analog Input READ MSTR Data Block

1771-IB (8-bit 24VDC Discrete Input Cards)

Slots 4 and 5 contain 8-bit 24VDC input cards. Each card is assigned 16 bits in and out but only the first 8 input bits are used.

Quantum Address	Card Input (octal)	Notes
1x00065	00	Toggle Switch #1
1x00066	01	
1x00067	02	
1x00068	03	
1x00069	04	
1x00070	05	
1x00071	06	
1x00072	07	Toggle Switch #2
1x00073		Not Used
1x00074		Not Used
1x00075		Not Used
1x00076		Not Used
1x00077		Not Used
1x00078		Not Used
1x00079		Not Used
1x00080		Not Used

Table 9: 1771-IB Slot 4 Mapping

Quantum Address	Card Input (octal)	Notes
1x00081	00	Toggle Switch #3
1x00082	01	
1x00083	02	
1x00084	03	
1x00085	04	
1x00086	05	
1x00087	06	
1x00088	07	
1x00089		Not Used
1x00090		Not Used
1x00091		Not Used
1x00092		Not Used
1x00093		Not Used
1x00094		Not Used
1x00095		Not Used
1x00096		Not Used

Table 10: 1771-IB Slot 5 Mapping

1771-OB (8-bit 24VDC Discrete Output Cards)

Slots 6 and 7 contain 8-bit 24VDC output cards. Each card is assigned 16 bits in and out but only the first 8 output bits are used.

Quantum Address	Card Input (octal)	Notes
1x00097	00	Tied to Toggle Switch #1
1x00098	01	Not of Toggle Switch #2
1x00099	02	
1x00100	03	
1x00101	04	
1x00102	05	
1x00103	06	
1x00104	07	
1x00105		Not Used
1x00106		Not Used
1x00107		Not Used
1x00108		Not Used
1x00109		Not Used
1x00110		Not Used
1x00111		Not Used
1x00112		Not Used

Table 11: 1771-OB Slot 6 Mapping

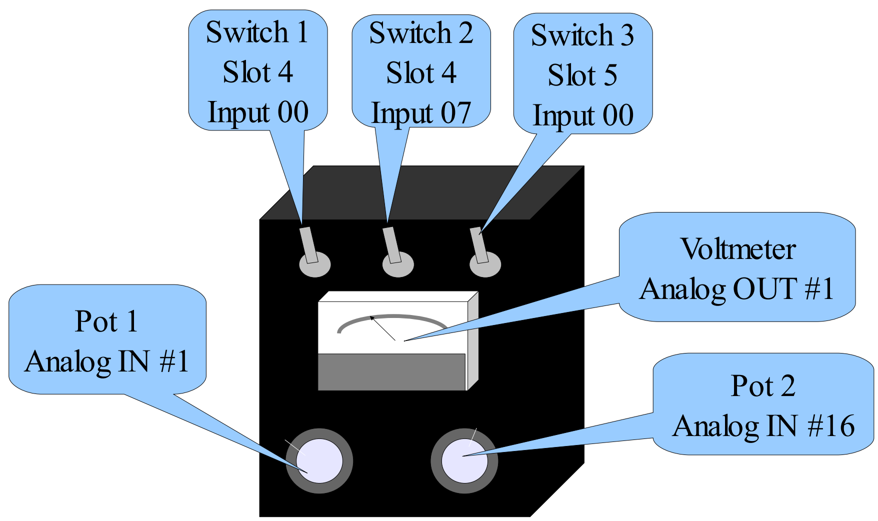
Quantum Address	Card Input (octal)	Notes
1x00113	00	Tied to Toggle Switch #3
1x00114	01	Tied to Toggle Switch #3
1x00115	02	Tied to Toggle Switch #3
1x00116	03	
1x00117	04	
1x00118	05	
1x00119	06	
1x00120	07	
1x00121		Not Used
1x00122		Not Used
1x00123		Not Used
1x00124		Not Used
1x00125		Not Used
1x00126		Not Used
1x00127		Not Used
1x00128		Not Used

Table 12: 1771-OB Slot 7 Mapping

Simulator Box

The Simulator box attached to the A-B chassis has three toggle switches wired to the 24VDC input cards, two 0-10VDC potentiometers wired to the analog input card, and a 0-10VDC voltmeter wired to the analog output card.

Figure 8 Simulator



ProWORX 32 Configuration

The configuration of the Quantum PLC is very simple. The only card in the traffic cop is the QRIO in slot 3. The QRIO pretends to be an NOE-771-00 network card and uses the I/O Scanner config extensions of the NOE to define its operation.

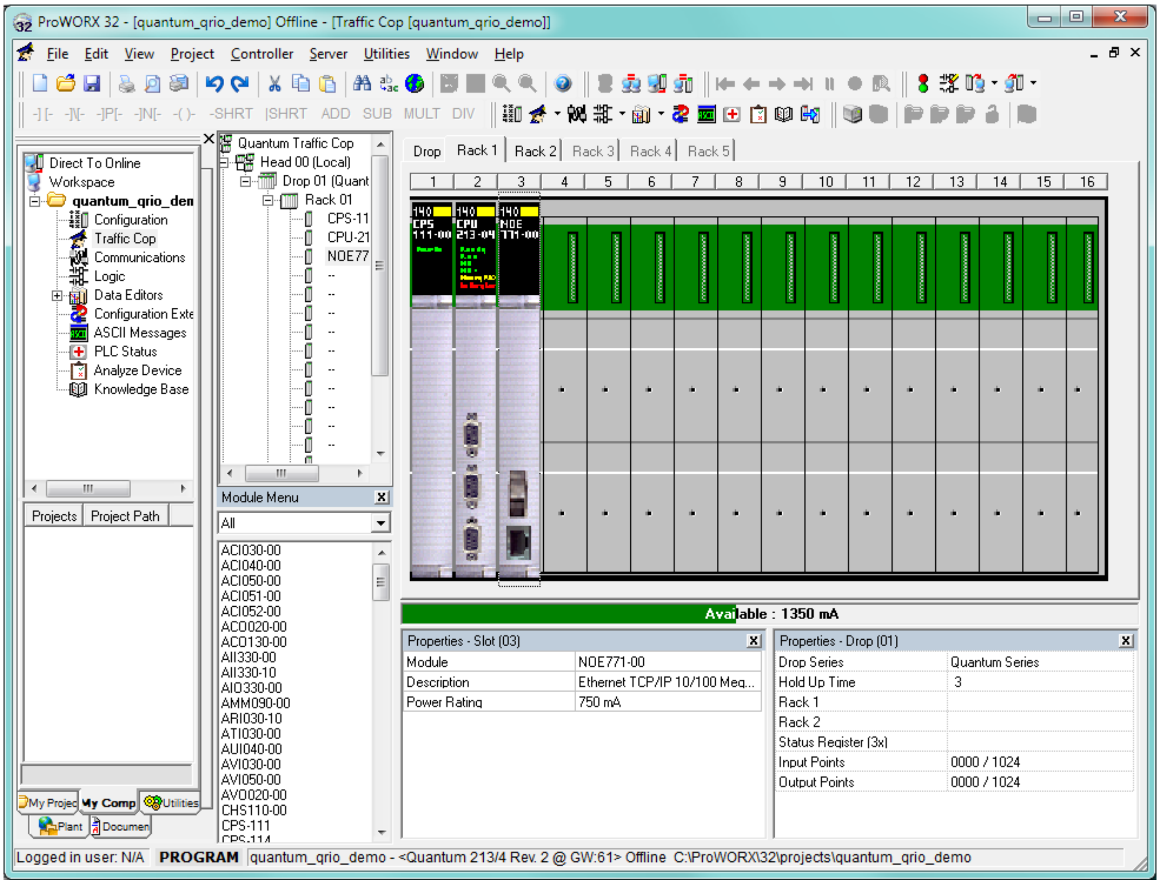


Figure 9: Traffic Cop

The I/O Scanner defines where the discrete data from the remote rack is placed within the Quantum. In this case, the inputs are placed into 8 words starting at 1x00001 and the outputs are placed into 8 words starting at 0x00001.

The A-B chassis is set to 1-slot addressing so each slot gets 16 bits of both 1x bits and 0x coils.

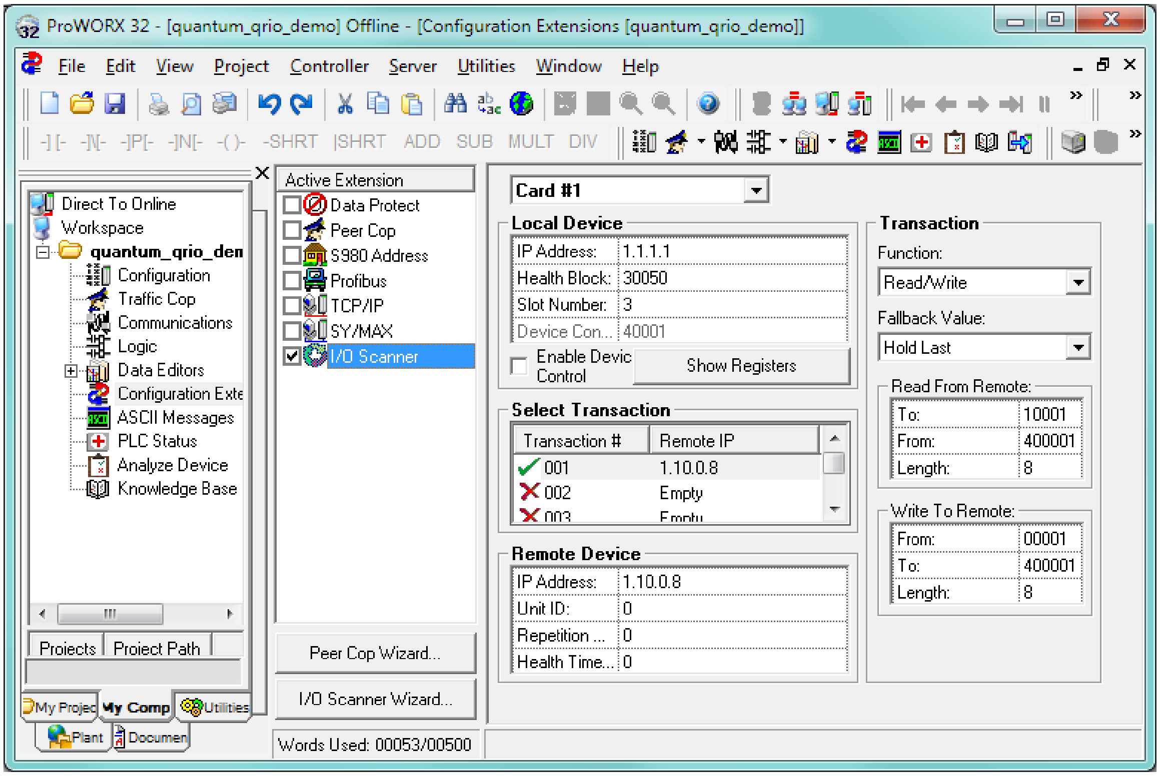


Figure 10: I/O Scanner

IP Address: The “Local Device” IP Address set the baud rates for QRIO ports 1 and 2. The decimal value of 1 in the first and third octets sets the baud rates of both ports to 57.6kbaud.

Health Block: The QRIO provides the normal 128 bit health block of an NOE's I/O Scanner. Each bit in the health block is set true if the I/O Scanner entry is successful.

Slot Number: This defines the Quantum rack slot number of the QRIO.

IP Address: The “Remote Device” IP Address sets the QRIO port number (1), target remote rack (10), starting group number (0), and word length (8).

The Unit ID, Repetition, and Health Timeout are ignored and may be left at 0.

This rack requires both inputs and outputs so the Read/Write function is selected.

The Fallback value may be set to Zero or Hold Last for the inputs to the Quantum.

The “Read From Remote To” field sets the starting location in the Quantum CPU for the discrete inputs from the remote rack. Selecting 1x bits allows for simple ladder logic sections. The “From” and “Length” fields are set to 4000001 and the length of the data segment (8 words).

The “Write To Remote From” field sets the starting location in the Quantum CPU for the discrete outputs. Selecting 0x coils simplifies the ladder logic segments. The “To” field is always set to 400001. The "Length" field should be set to the word size (8).

In this example, the 8 words of input bits m 1x0001 through 1x0128 are used by the QRIO. Output coils 0x0001 through 0x0128 are also reserved by the QRIO. Table 13 gives an overview of the bits and coils assigned to actual inputs and outputs.

I/O Label	**Slot 0**	**Slot 1**	**Slot 2**	**Slot 3**	**Slot 4**	**Slot 5**	**Slot 6**	**Slot 7**
(octal)	16-bit In	16-Bit Out	Analog Out	Analog In	8-bit In	8-bit In	8-bit Out	8-bit Out
00	1x1	0x17			1x65	1x81	0x97	0x113
01	1x2	0x18			1x66	1x82	0x98	0x114
02	1x3	0x19			1x67	1x83	0x99	0x115
03	1x4	0x20			1x68	1x84	0x100	0x116
04	1x5	0x21			1x69	1x85	0x101	0x117
05	1x6	0x22			1x70	1x86	0x102	0x118
06	1x7	0x23			1x71	1x87	0x103	0x119
07	1x8	0x24			1x72	1x88	0x104	0x120
10	1x9	0x25						
11	1x10	0x26						
12	1x11	0x27						
13	1x12	0x28						
14	1x13	0x29						
15	1x14	0x30						
16	1x15	0x31						
17	1x16	0x32						

Table 13: Bit and Coil Usage

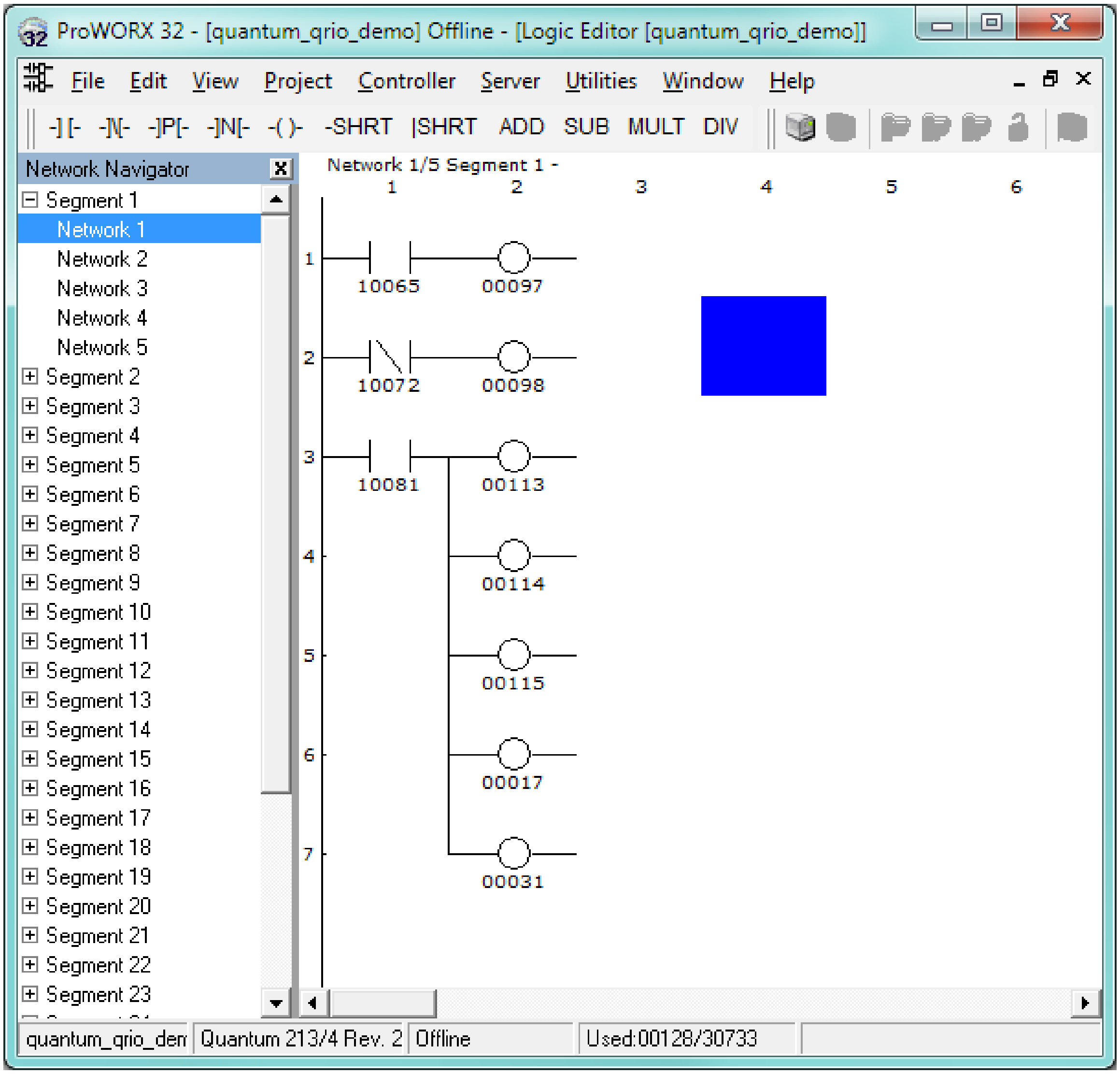


Figure 11: Simple Logic

Network 1 is some simple associations of outputs to the three input toggle switches. You can see the output lights change state on the video as the switches are moved.

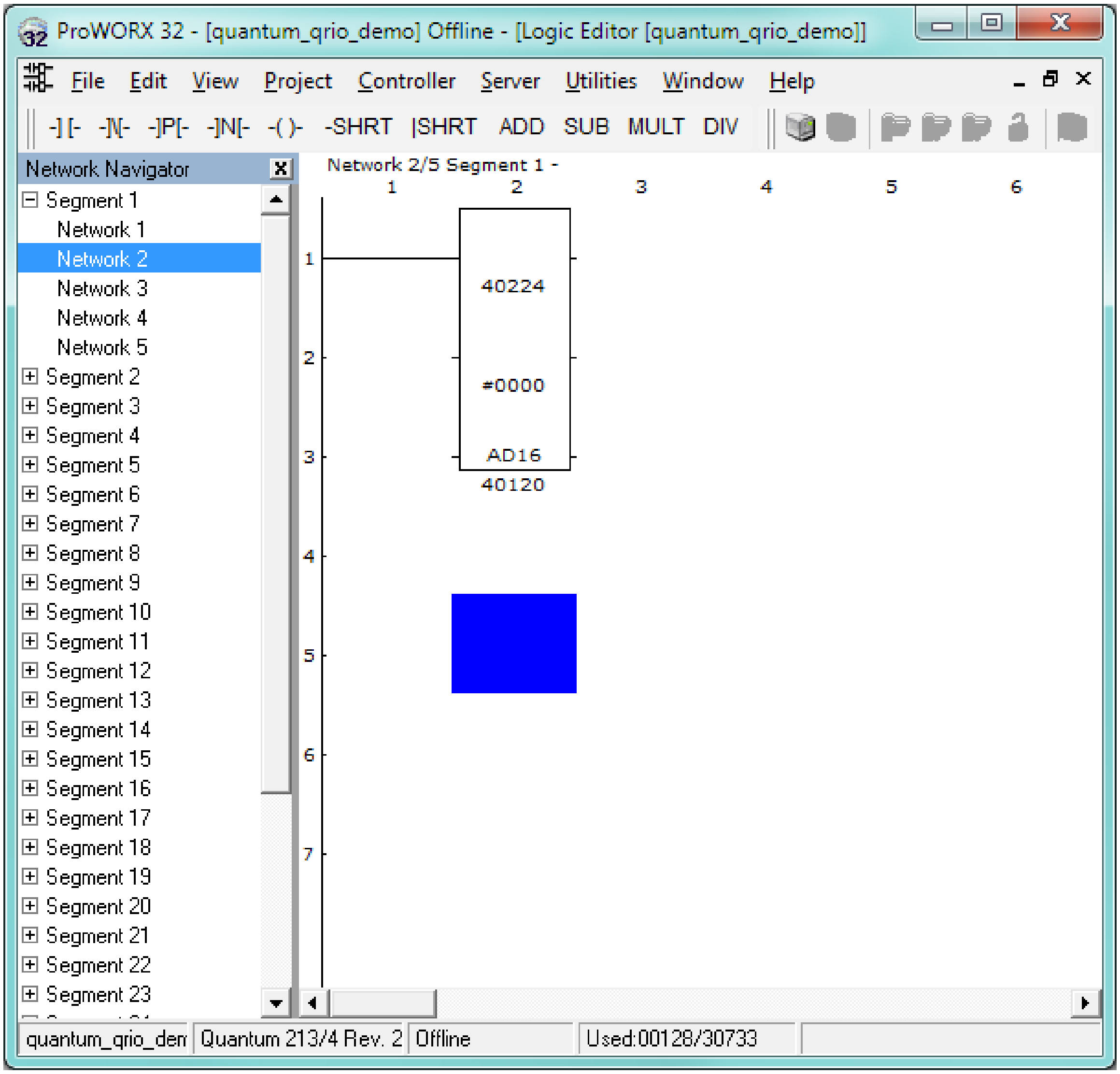


Figure 12: Copy Analog IN 1 Value to Analog OUT 1

Network 2 simply uses the ADD16 to copy the analog input #1 data (register 4x224) to the analog output #1 data (register 4x120).

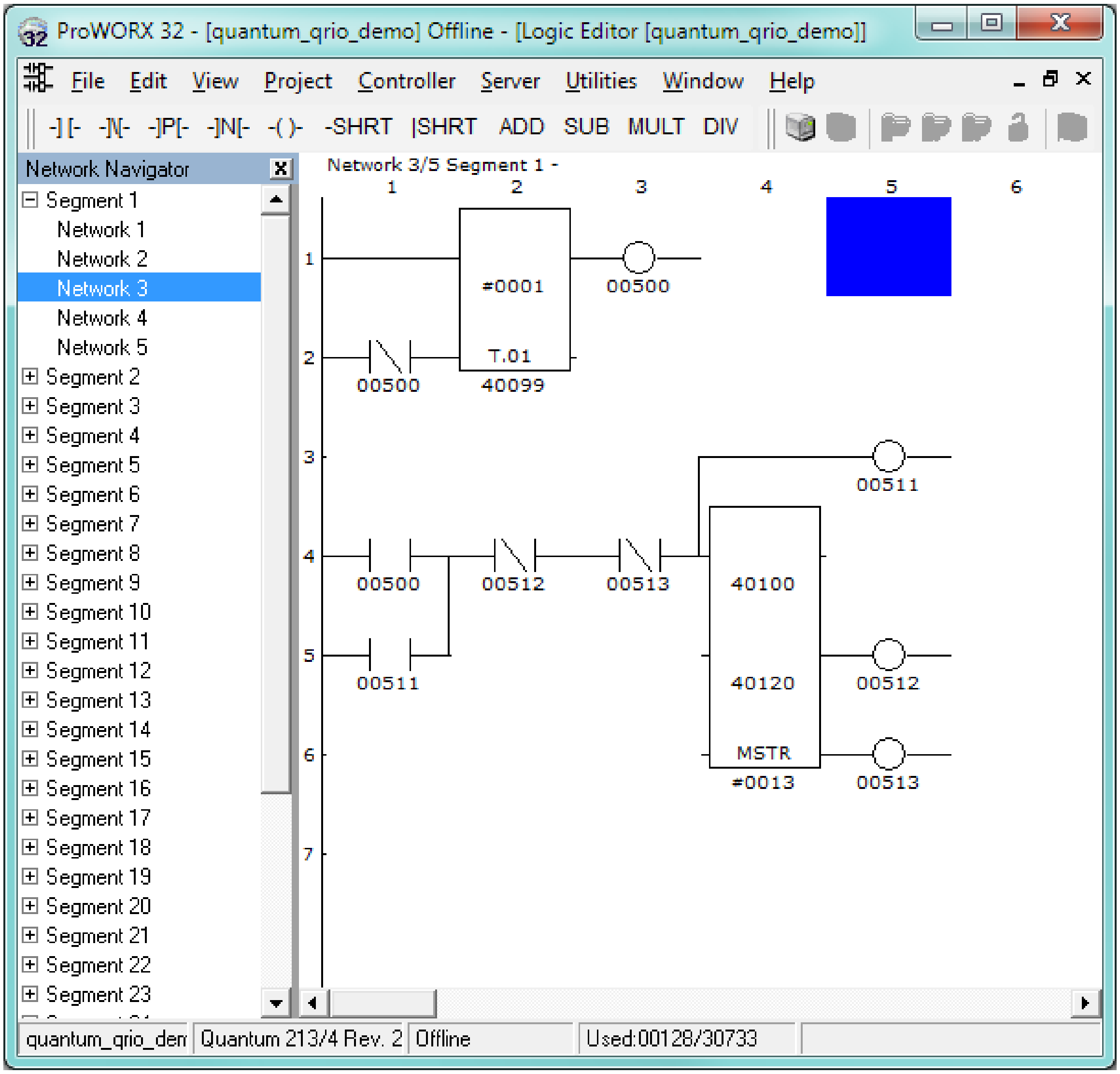


Figure 13: Analog OUT Write MSTR

Network 3 has the trigger timer for the analog out write and analog in read MSTRs. It also includes the analog out write MSTR. Note that the MSTR is latched on until it is successful (0x513) or errors (0x512).

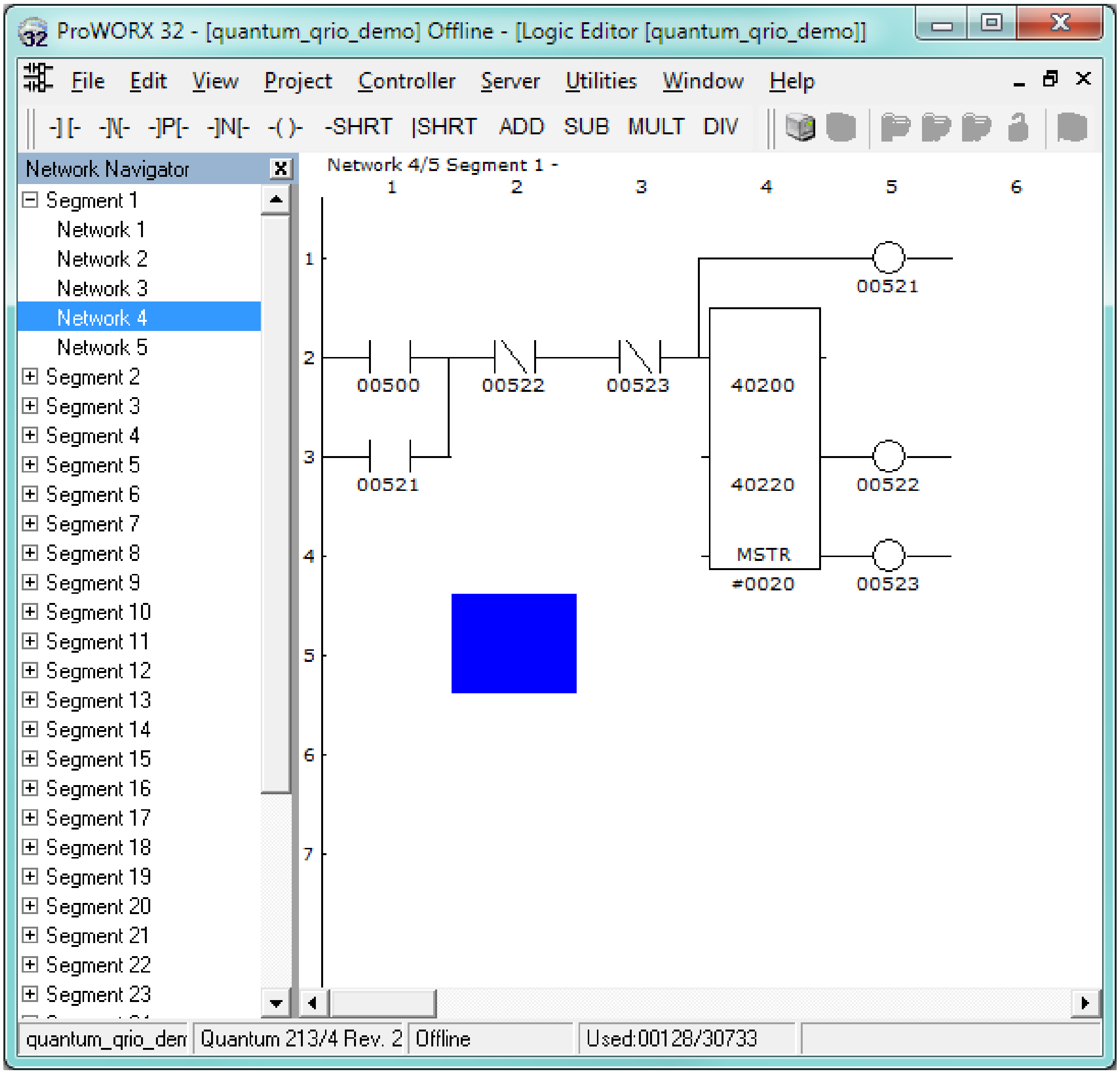


Figure 14: Analog IN Read MSTR

Network 4 is the analog in read MSTR.

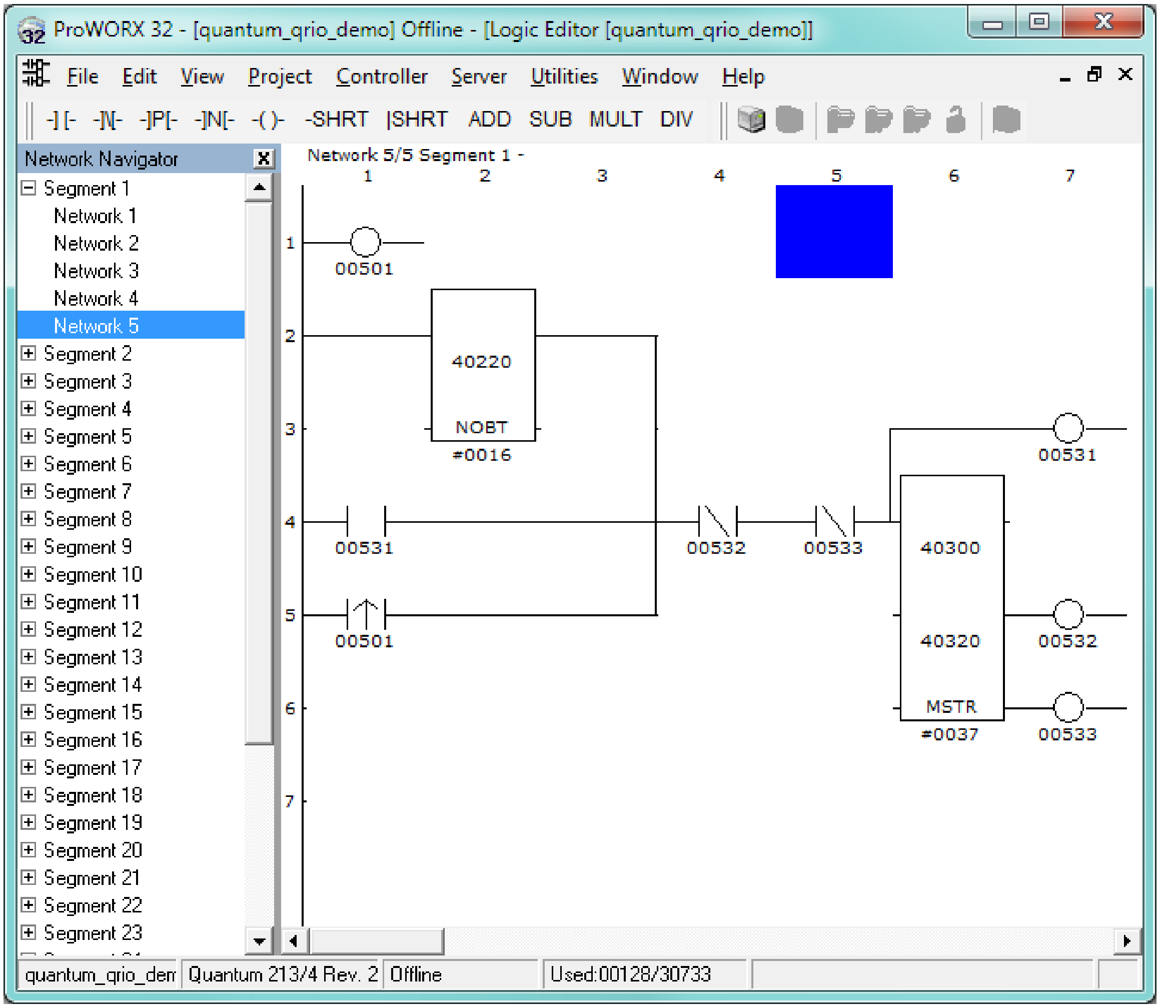


Figure 15: Analog IN Write MSTR

Network 4 is the configuration write MSTR for the analog input card. It is triggered on the first scan after loading the program from ProWORX32 (coil 0x501) and also triggered when the analog input card is unconfigured (bit 16 of 4x220).