ProSoft TECHNOLOGY

Where Automation Connects.

inRAx®

3100-3150 MCM

SLC / PLC Platform

Modbus Master/Slave Communications Module for PLC / SLC

April 7, 2014

USER MANUAL

Your Feedback Please

We always want you to feel that you made the right decision to use our products. If you have suggestions, comments, compliments or complaints about our products, documentation, or support, please write or call us.

How to Contact Us

ProSoft Technology
5201 Truxtun Ave., 3rd Floor
Bakersfield, CA 93309
+1 (661) 716-5100
+1 (661) 716-5101 (Fax)
www.prosoft-technology.com
support@prosoft-technology.com

3100-3150 MCM User Manual

April 7, 2014

ProSoft Technology® Product Documentation

In an effort to conserve paper, ProSoft Technology no longer includes printed manuals with our product shipments. User Manuals, Datasheets, Sample Ladder Files, and Configuration Files are provided on the enclosed CD-ROM, and are available at no charge from our web site: www.prosoft-technology.com

Printed documentation is available for purchase. Contact ProSoft Technology for pricing and availability.

North America: +1.661.716.5100

Asia Pacific: +603.7724.2080

Europe, Middle East, Africa: +33 (0) 5.3436.87.20

Latin America: +1.281.298.9109

Important Installation Instructions

Power, Input, and Output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods, Article 501-4 (b) of the National Electrical Code, NFPA 70 for installation in the U.S., or as specified in Section 18-1J2 of the Canadian Electrical Code for installations in Canada, and in accordance with the authority having jurisdiction. The following warnings must be heeded:

A WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIV. 2;
B WARNING - EXPLOSION HAZARD - WHEN IN HAZARDOUS LOCATIONS, TURN OFF POWER BEFORE REPLACING OR WIRING MODULES
C WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.
D THIS DEVICE SHALL BE POWERED BY CLASS 2 OUTPUTS ONLY.

MVI (Multi Vendor Interface) Modules

WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

AVERTISSEMENT - RISQUE D'EXPLOSION - AVANT DE DÉCONNECTER L'ÉQUIPEMENT, COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX.

Warnings

North America Warnings

A Warning - Explosion Hazard - Substitution of components may impair suitability for Class I, Division 2.
B Warning - Explosion Hazard - When in Hazardous Locations, turn off power before replacing or rewiring modules.
Warning - Explosion Hazard - Do not disconnect equipment unless power has been switched off or the area is known to be nonhazardous.
C Suitable for use in Class I, division 2 Groups A, B, C and D Hazardous Locations or Non-Hazardous Locations.

ATEX Warnings and Conditions of Safe Usage:

Power, Input, and Output (I/O) wiring must be in accordance with the authority having jurisdiction

A Warning - Explosion Hazard - When in hazardous locations, turn off power before replacing or wiring modules.
B Warning - Explosion Hazard - Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
C These products are intended to be mounted in an IP54 enclosure. The devices shall provide external means to prevent the rated voltage being exceeded by transient disturbances of more than 40%. This device must be used only with ATEX certified backplanes.
D DO NOT OPEN WHEN ENERGIZED.

Warning: This module is not hot-swappable! Always remove power from the rack before inserting or removing this module, or damage may result to the module, the processor, or other connected devices.

Battery Life Advisory

The batteries for the 3100/3150 are non-rechargable, replaceable, 3.6 volt lithium-thionyl-chloride, size 1/2AA, standardized part number (ER) 14250. This battery is easily user-replaceable and has a rated shelf life of 10 years @ 68 degrees F.

Markings

Electrical Ratings

- Backplane Current Load: 800 mA @ 5 Vdc
- Operating Temperature: 0°C to 60°C (32°F to 140°F)
- Storage Temperature: -40°C to 85°C (-40°F to 185°F)
- Shock: 30g Operational; 50g non-operational; Vibration: 5 g from 10 Hz to 150 Hz
- Relative Humidity 5% to 95% (without condensation)
- All phase conductor sizes must be at least 1.3 mm(squared) and all earth ground conductors must be at least 4mm(squared).

Label Markings

Agency Approvals and CertificationsANSI / ISA	ISA 12.12.01 Class I Division 2, GPs A, B, C, D
CSA CB Certified	IEC61010
ATEX	EN60079-0 Category 3, Zone 2 EN60079-15

243333

Contents

1 Quick Start Guide to the 3150-MCM

In This Chapter

Modbus Master/Slave Communication Module for the SLC platform

1. Open the sample ladder logic, MCM3EX1M.RSS in RSLogix500. The sample ladder is available on the inRAx product CD, or on the web site www.prosoft-technology.com
2. Double-click "Controller Properties" and choose the appropriate SLC processor. Click OK.
3. Do not clear I/O. Click OK.
4. Double-click "I/O Configuration".
5. Choose the appropriate rack size. The sample ladder is configured with a 1747-A4 four-slot rack.
6. The 3150-MCM module is defined as a "1746-BAS-5/02, BASIC module, M0/M1 capable."
7. Drag this module to the appropriate slot in the rack. The sample ladder is configured with the 3150-MCM module in slot 1.
8. Select all of the following options and click OK:
   - Move existing I:1/O:1 data and force data to I:x/O:x
   - Replace all ladder occurrences of I:1/O:1 with I:x/O:x
   - Replace all ladder occurrences of M0:1/M1:1 with M0:x/M1:x

   where x is the new slot for the 3150-MCM module.

Configuration complete.

The 3150-MCM is now configured with the following parameters:

- Data Flow as per the At-A-Glance diagram.
- Port 1: Modbus RTU Master, 1 stop bit, no parity, 9600bps baud rate

Parameter	Description
Command 1:	Slave Node #1, Function code 3, 10 registers starting from 4x0201, store in database address 0 to 9, paged to N7:0 to N7:9
Command 2:	Slave Node #1, Function code 4, 10 registers starting from 3x0211, store in database address 10 to 19, paged to N7:10 to N7:19
Command 3:	Slave Node #1, Function code 1, 16 coils starting from 0x3521, store in database address 20, paged to N7:20
Command 4:	Slave Node #1, Function code 2, 16 inputs starting from 0x3201, store in database address 30, paged to N7:30
Commands 5 to 8:	Disabled.

- Port 2: Modbus RTU Slave, node address #1. No offsets.

1.1 Implementation Guide

Integration of the MCM module into a PLC or SLC application is easier if a series of steps are followed. In order to assist the first time users of our products in getting operational quickly, we have come up with this step-by-step implementation guide.

First Time Users: Although the following steps are to assist you in implementing the module, we recommend that you attempt to experiment with the example logic provided on disk with the module or available off our www.prosoft-technology.com web site before laying out your application. This step will allow you to gain insight into how the module works prior to making decisions which will impact the long term success of the installation.

Start with one of the ladder logic programs provided on disk with the MCM, and then complete the following steps:

If you are entering the ladder logic by hand for the SLC, remember the following:

- Configure the slot as a 1746-BAS module in 5/02 mode
- Enter the Transfer Enable and Done bits as shown in the example logic

1 Edit the ladder logic (page 15) provided on disk as needed for the application
- Verify rack and slot location in program
- Modify ladder instruction addresses as needed

2 Setup the Communication Configuration (page 21) parameters
- Determine each port's communication configuration requirements: Master or Slave, Parity, Stop Bits, Baud Rate, RTS delay requirements
- Identify memory mapping requirements
- Set the Read Data, Write Data , and the Command Block Count parameters
- Set the Slave and Master Error Table pointers are needed for the application

3 Setup the Command List if configuring a Master
- Review register map of slave device to build most effective memory map

4 Identify the module jumper requirements (page 100)

5 Make up the communication cables. Make sure that no matter what type of connection is being made up that a jumper is in place to satisfy the CTS signal. Normally this signal will be jumpered to RTS.

6 Place processor into the run mode

7 Monitor the data table for the Master and Slave Error Status values (page 43)

1.2 "ProSoft Tested" Test Documents

Through the efforts of our "ProSoft Tested" Program, we maintain a growing list of devices which we know have been interfaced to our module. In addition, we also have documented several of the devices which we have tested.

You can find more information on "ProSoft Tested" devices at www.prosoft-tested.com

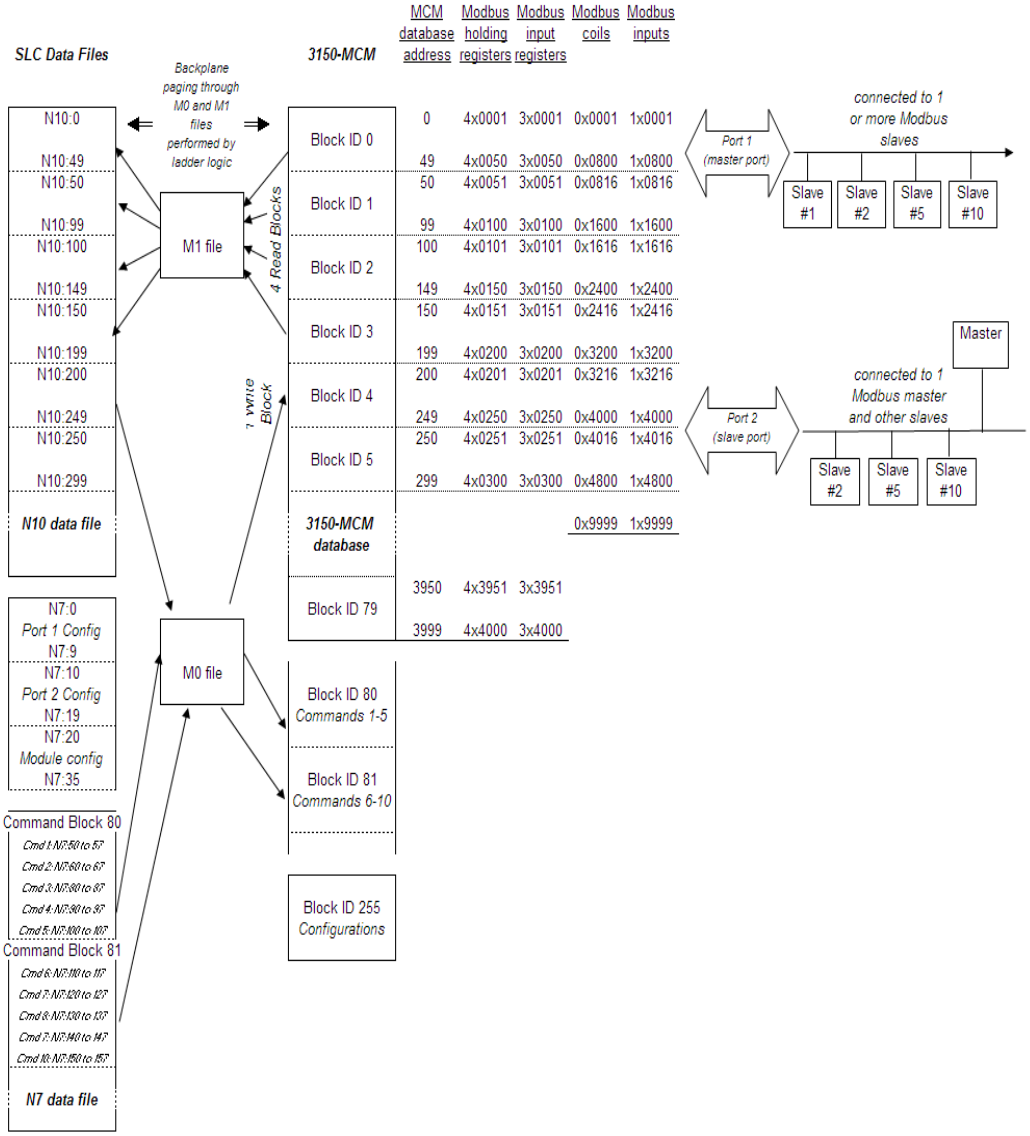
1.3 Quick Start Guide

Installation of the 3100/3150-MCM module is easily accomplished. Installation into a system requires only a few steps. Following is a step-by-step procedure for getting an application operational:

Step	Example	User Application
Identify Rack position	Rack 0 Group 2 Slot 0	Rack: ____ Group: _____ Slot: _____
Identify PLC Data Files usage	BT Buffers: N7 BT Control: N7 Config File: N7 Data File: N10	BT Buffers: N____ BT Control: N____ Config File: N____ Data File: N_____
Ladder Logic	Example on disk and in Reference (page 69) section (Several examples to choose from)	Select the example closest to your application and modify as needed
Modify Logic for rack position	PLC BTR: Rung 2:0 BTW: Rung 2:1 SLC I:x.0 addresses O:x.0 addresses M0:x addresses M1:x addresses	Modify these instructions as needed based on the required rack position. You must configure the slot in the SLC.
Modify Logic for Data file usage	N7 and N10 is used as data space for the module	Create files and change references from N7 and N10
Install card in rack	Power down rack and install module	Power down and install module
Connect a comm cable to the front of the module	Decide on cable type needed for application	
Apply power to system and place PLC in RUN	Monitor the status files and the LEDs on the front of the module	

When the hardware has been installed and the necessary programming has been downloaded to the processor, the system is ready (Presuming all other system components are safely ready).

1.4 The 3150-MCM At A Glance



2 Ladder Logic Overview

In This Chapter

Data transfers between the processor and the ProSoft Technology module occur using the Block Transfer commands, in the case of the PLC, and M0/M1 data transfer commands, in the case of the SLC. These commands transfer up to 64 physical registers per transfer. The logical data length changes depending on the data transfer function.

The following discussions and Sections describes the data structures used to transfer the different types of data between the ProSoft Technology module and the processor. The term "Block Transfer" is used generically in the following discussion to depict the transfer of data blocks between the processor and the ProSoft Technology module. Although a true Block Transfer function does not exist in the SLC, we have implemented a pseudo-block transfer command in order to assure data integrity at the block level. Examples of the PLC and SLC ladder logic are included in the Reference (page 69) section.

Important: In order for the ProSoft Technology module to function, the PLC/SLC must be in the RUN mode, or in the REM RUN mode. If in any other mode (Fault/PGM), the module will stop all communications until block transfers resume.

2.1 Operational Overview

On power up the module moves a 255 into Word 1 of the BTR data file. This is a signal that the module needs to receive configuration data before proceeding any further. When the configuration is received the module will begin transferring data to and from the processor depending upon how many Read and Write block counts have been configured. When these are completed, the module will then transfer the command blocks if any have been configured.

2.2 Ladder Logic

The flow of the ladder logic is somewhat predefined by the way the module has been programmed. The expected flow of the ladder logic should be as follows:

2.2.1 Read Rung

1 Read Data from the Module. In the case of the PLC the module data will be transferred into the BTR Buffer. In the case of the SLC the module data will be accessed directly out of the M1 file
2 Decode the BTR Block ID number. Depending on the value of the BTR Block ID, copy the module data into the correct location in the ladder logic data table
3 Move the BTW Block ID Number from Word 1 of the BTR Buffer into Word 0 of the BTW Buffer. In the case of the SLC the transfer will actually be from Word 1 of the M1 file to Word 0 of the M0 file. The BTW Block ID number should be manipulated if necessary to assure that data is not overwritten in the module (The LIM test branch does this in the example logic)
4 Test for Event Initiated Commands and module configuration

2.2.2 Write Rung

1 Decode the BTW Block ID number and depending on the value move either data values, Command List values or Configuration values to the BTW buffer (M0 file in the SLC / PLC)
2 If the configuration transfer is enabled, then clear the configuration enable bit
3 In an Event Initiated Command is enabled, then clear the enable bit
4 Execute the BTW transfer. In the PLC this will be done by enabling the BTW instruction. In the SLC / PLC, this will be done by setting the Transfer Done bit (an Output bit has been assigned to this function in the design of the module)

3 Writing to the Module

In This Chapter

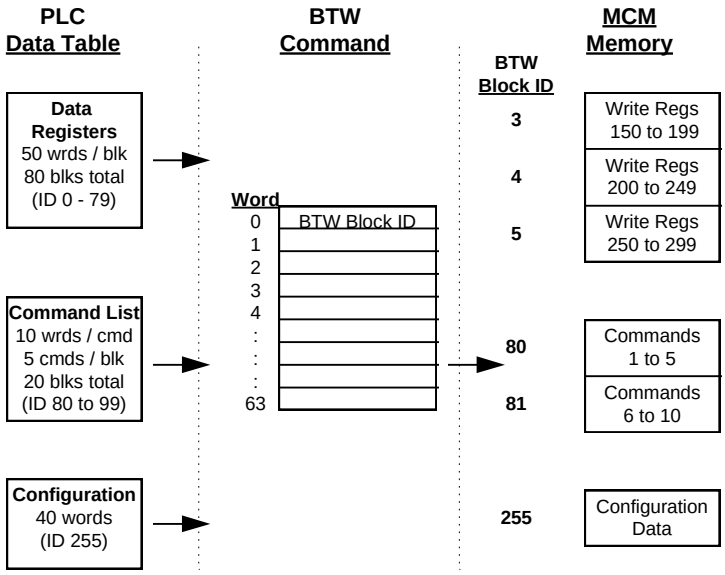
This section provides reference level information on the transfer of data from the PLC/SLC processor to the MCM module. This type of transfer allows the ladder logic to send configuration , command list and data to the module.

3.1 Block Transferring to the Module

Data transfer to the module from the processor is executed through the Block Transfer Write function. The different types of data which are transferred require slightly different data block structures, but the basic data structure is:

Word	Name	Description
0	BTW Block ID	A block page identifier code. This code is used by the ProSoft module to determine what to do with the data block. Valid codes are: BTW Code: Description 0 to 79: Module Data Memory 80 to 99: Command List 100 to 120: Event Driven Writes 255: Module Communication Configuration
1 to 63	Data	The data to be written to the module. The structure of the data depends on the Block ID code. The following topics provide information on the different structures.

Important: Although the full physical 64 words of the data buffer may not be used, the BTW and M0 lengths must be configured for 64 words, otherwise module operation will be unpredictable.



Data transfer from PLC to MCM: Data values and Command List entries are "paged" into the MCM module. The data type and location being written into corresponds to the BTW Block ID number. The BTW Block ID number is controlled by the MCM module, as discussed later in this section.

3.2 Communications Configuration [BTW Block ID 255]

The ProSoft Technology firmware communication parameters must be configured at least once when the card is first powered up, and any time thereafter when the parameters must be changed.

3.2.1 Power Up

On power up, the module enters into a logical loop waiting to receive configuration data from the processor. While waiting, the module sets the second word of the BTR buffer (the BTW Block ID) to 255, telling the processor that the module must be configured before anything else will be done. The module will continuously perform block transfers until the communications configuration parameters block is received. Upon receipt, the module will begin execution of the command list if present, or begin looking for the command list from the processor.

3.2.2 Changing parameters during operation

Changing values in the configuration table can be done at any time. The module does not accept any of the changes until the "re-configuration" process is initiated. This can be accomplished in several ways, including:

1 Cycle power to the rack
2 Press the **RESET** pushbutton on the module (3100 only)
3 Move 255 into BTW Block ID position (See example logic when B3/0 is set)

During this process, the "CFG" LED will toggle, giving a visual indication that the module has received the configuration block.

Important: Transferring the Communication Configuration Parameters to the module will force a reset of the communication port, as well as dropping DTR for 200 ms pulses to reset any attached hardware.

The configuration data block structure which must be transferred from the processor to the module is as follows:

BTW Buffer	Data Addr	Name	Example Value
0		BTW Block ID	255
		Port 1 Config	
1	N[ ]:0	Port Configuration Word	0 - Master 1 - Slave
2	N[ ]:1	Port Slave Addr	1
3	N[ ]:2	Baud Rate	5
4	N[ ]:3	RTS to TxD Delay	0
5	N[ ]:4	RTS Off Delay	0
6	N[ ]:5	Response Timeout	0
7	N[ ]:6	Intercharacter Delay	0
8	N[ ]:7	Setup Parm #1	0
9	N[ ]:8	Setup Parm #2	0
10	N[ ]:9	Setup Parm #3	0
		Port 2 Config	
11	N[ ]:10	Port Configuration Word	0 - Master 1 - Slave
12	N[ ]:11	Port Slave Addr	1
13	N[ ]:12	Baud Rate	5
14	N[ ]:13	RTS to TxD Delay	0
15	N[ ]:14	RTS Off Delay	0
16	N[ ]:15	Response Timeout	0
17	N[ ]:16	Intercharacter Delay	0
18	N[ ]:17	Setup Parm #1	0
19	N[ ]:18	Setup Parm #2	0
20	N[ ]:19	Setup Parm #3	0
21	N[ ]:20	Read Block Cnt	3
22	N[ ]:21	Write Block Cnt	1
23	N[ ]:22	Cmd Block Cnt	2
24	N[ ]:23	Slave Err Ptr	100
25	N[ ]:24	Master Error Ptr	120
26	N[ ]:25	BT Delay Cntr	0
27	N[ ]:26	Floating Point Offset	0
28	N[ ]:27	Read Block ID Start	0
29	N[ ]:28	Write Block ID Start	0
30	N[ ]:29	Spare	0
31 to 36	N[ ] :30 to N[ ] :35	Route Mode Slaves 1 to 6	0

3.2.3 Port 1 and 2 Configuration

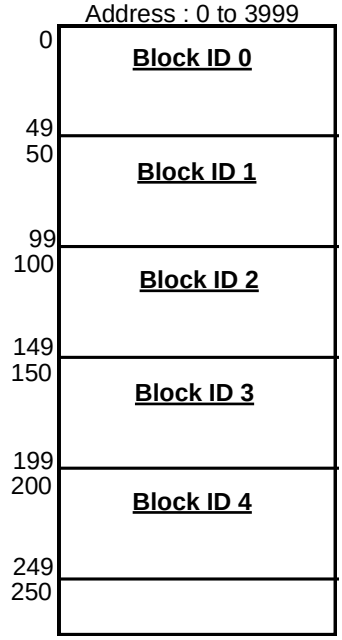
<table>
<tr><th>Data Addr</th><th>Name</th><th>Description</th></tr>
<tr><td>N[ ]:0
N[ ]:10</td><td>Port Configuration Word</td><td>This register contains several communication configuration parameters encoded into the word. These are as follows:
Protocol Mode: The port's protocol mode is selected by these bits:
Bits 210
<table>
<tr><td>000</td><td>Modbus Master - RTU Mode</td></tr>
<tr><td>001</td><td>Modbus Slave - RTU Mode</td></tr>
<tr><td>010</td><td>Modbus Master - ASCII Mode 7 bit</td></tr>
<tr><td>011</td><td>Modbus Slave - ASCII Mode 7 bit</td></tr>
<tr><td>100</td><td>Modbus Master - ASCII Mode 8 bit</td></tr>
<tr><td>101</td><td>Modbus Slave - ASCII Mode 8 bit</td></tr>
</table>
Pass Through Mode: The Slave Port operating mode is selected by this bit:
Bit 3
<table>
<tr><td>0</td><td>Pass Through Disabled</td></tr>
<tr><td>1</td><td>Pass Through Enabled</td></tr>
</table>
Routing Mode: Enable the Slave to Master Routing mode:
Bit 4
<table>
<tr><td>0</td><td>Routing Mode Disabled</td></tr>
<tr><td>1</td><td>Routing Mode Enabled</td></tr>
</table>
Stop Bits: The number of stop bits to be used is defined as follows:
Bits 13 12
<table>
<tr><td>0 0</td><td>One stop bit</td></tr>
<tr><td>0 1</td><td>Two stop bits</td></tr>
<tr><td>1 x</td><td>Invalid Port Configuration</td></tr>
</table>
Parity: The parity mode to be used by the module is defined by this word as follows:
Bits 15 14
<table>
<tr><td>0 0</td><td>No parity</td></tr>
<tr><td>0 1</td><td>Odd parity</td></tr>
<tr><td>1 0</td><td>Even parity</td></tr>
<tr><td>1 1</td><td>Invalid Port Configuration</td></tr>
</table></td></tr>
<tr><td>N[ ]:1
N[ ]:11</td><td>Slave Address</td><td>When the port is configured to operate in the Slave mode, the value entered in this register is used as the Modbus Slave address. Valid values range from 1 to 247.</td></tr>
</table>

<table>
<tr><th>Data Addr</th><th>Name</th><th>Description</th></tr>
<tr><td>N[ ]:2
N[ ]:12</td><td>Baud Rate</td><td>The baud rate at which the port is to operate. The available configurations are as follows:
<table><tr><th>Value</th><th>Baud Rate</th></tr><tr><td>0</td><td>300 Baud</td></tr><tr><td>1</td><td>600 Baud</td></tr><tr><td>2</td><td>1200 Baud</td></tr><tr><td>3</td><td>2400 Baud</td></tr><tr><td>4</td><td>4800 Baud</td></tr><tr><td>5</td><td>9600 Baud</td></tr><tr><td>6</td><td>19200 Baud</td></tr><tr><td>7</td><td>38400 Baud</td></tr></table>The module’s two ports are limited to an upper baud rate of either 19200 or 38400 baud. The module cannot be configured with one port at 19200 and the other at 38400. If an attempt is made to configure the module in this fashion, a Port Configuration Error will be returned.</td></tr>
<tr><td>N[ ]:3
N[ ]:13</td><td>RTS to TXD Delay</td><td>This value represents the time in 1 ms increments to be inserted between asserting RTS, and the actual transmission of data. The delay, if greater in duration than the hardware time delay associated with CTS, will override the CTS line until the time-out is complete.
This configurable parameter is useful when interwith modem based devices, anytime line noise must be allowed to subside before data is transmitted, or if data transmissions must be slowed down.
Valid values range from 0 to 65535 (0xffff).</td></tr>
<tr><td>N[ ]:4
N[ ]:14</td><td>RTS Off Delay</td><td>The value in this word represents the number of 1 ms time delay increments inserted after the last character is transmitted and before RTS is dropped. The module automatically inserts a one character width Off Delay, assuring that RTS does not drop until after the last character has been completely sent. Unless working under unusual conditions, this value will normally be configured with a value of 0.
Valid value range from 0 to 65535 (0xffff).</td></tr>
<tr><td>N[ ]:5
N[ ]:15</td><td>Message Response Timeout</td><td>This register represents the message response timeout period in 1 ms increments. This is the time which a port configured as a Master will wait before re-transmitting a command if no response is received from the addressed slave. The value is set depending on the expected slave response times.
The allowable range of values is 0 to 65535(0xffff). If a zero value is entered, the module will default to a one second timeout value (1000 ms).</td></tr>
</table>

Data Addr	Name	Description
N[ ]:6 N[ ]:16	Inter-character Timeout	This register is used in situations where the end of message character timeout delay must be extended beyond the normal 3.5 character widths. The value entered represents the number of 1 ms intervals of 'no transmission' which will be counted prior to accepting a message. This parameter will be useful in satellite or packet radio installation where a data transmission may be split between two packets. Increasing this value beyond the system's packet handling time will eliminate timeout errors. Valid values range from 0 to 65535 (0xffff)
N[ ]:7 N[ ]:17	Setup Parameter #1 Master Mode : Not Used Slave Mode : Input Memory Start Address	**Modbus Slave Mode:** This value defines the offset address into the 4000 word data space that the MCM Slave port will use when responding to function code 2 and 4 commands. For example, to start the address space at word 150, enter a 150. A function 2 or 4 command with an address of zero (10001 or 30001) will then start reading at word 150. Valid values range from 0 to 3999.
N[ ]:8 N[ ]:18	Setup Parameter #2 Master Mode : Not Used Slave Mode : Output Memory Start Address	**Modbus Slave Mode** This value defines the offset address into the 4000 word data space that the MCM Slave port will use when responding to the function code 1, 5 or 15 commands. For example, to locate the output image at word 100, enter a 100. A function code 1 command with an address of zero (1) will then start reading at word 100. Valid values range from 0 to 3999.
N[ ]:9 N[ ]:19	Setup Parameter #3 Master Mode : Not Used Slave Mode : Holding Register Start Address	**Modbus Slave Mode** This value defines the offset address into the 4000 word data space that the MCM Slave port will use when responding to the function code 3, 6, or 16 commands. For example, to locate address 40001 at word 100 in the module, enter a 100. A function code 3 command with an address of zero (40001) will then start reading at word 100. Valid values range from 0 to 3999.

3.2.4 System Configuration

Data Addr	Name	Description
N[ ]:20	Read Data Block Count	This value represents the number of 50 word data blocks which are to be transferred from the MCM Module to the processor. The blocks returned from the module start at block 0 and increment from there. The maximum block count is 80. For example, a value of 5 will return BTR Block ID data blocks 0, 1, 2, 3, and 4, or module registers 0 to 249. If a value greater than 80 is entered, a System Configuration Error is activated
N[ ]:21	Write Data Block Count	This value represents the number of 50 word data blocks which are to be transferred from the processor to the MCM Module. The module will use this value to return a BTW Block ID Number to the processor. The ladder logic can use this value to determine which data to move to the MCM via the Block Transfer Write. The maximum block count is 80. For example, if a value of 5 is entered, the MCM will return BTW Block ID numbers 0, 1, 2, 3, and 4 to the ladder logic (Communications Configuration (page 21)). If a value greater than 80 is entered, a System Configuration Error is activated
N[ ]:22	Command Block Count	This value represents the number of 50 word Command Blocks which are to be transferred from the processor to the MCM Module. This value will be 0 if the module will not be configured with a Master port. The maximum block count is 20. If a value greater than 20 is entered, a System Configuration Error is activated
N[ ]:23	Slave Error Block Pointer	This value represents the relative starting position in the module's data table within which the Modbus Slave Error Data Block is placed. The Slave Error Table is a 20 word block containing Slave port status and several communication counters. The error data can be placed anywhere in the module's data space (0 to 3999). The contents of the Error Table can then be obtained as part of the regular Register Data. If a value greater than 3980 is entered, a System Configuration Error is activated

Data Addr	Name	Description
		MCM Module Memory Block ID 0 to 79 Address : 0 to 3999  Slave Error Table Pointer= 100 Slave Error Table The data registers 100 to 119 will contain the Slave Error Table.
N[ ]:24	Master Error Block Pointer	This value represents the relative starting position in the module's data register table within which the Master Error Data Block is placed. The error block (120 words in length) can be placed anywhere in the module's data space (0 to 3999). The contents of the Error Table can then be obtained as part of the regular Register Data. If a value greater than 3880 is entered, a System Configuration Error is activated

Data Addr	Name	Description
		MCM Module Memory Block ID 0 to 79 Address : 0 to 3999 0 **Block ID 0** 49 50 **Block ID 1** 99 100 **Block ID 2** 149 150 **Block ID 3** 199 200 **Block ID 4** 249 250 Master Error Table Pointer= 120 Master Error Table Data registers 120 to 240 will contain the Master Error Table.
N[ ]:25	Block Transfer Delay Counter	This is an empirical value used by the module to balance the amount of time the module spends block transferring and the amount spent handling port communications. The value entered is used as a loop counter in the module, where each time through the loop the count is incremented. When the count equals the Block Transfer Delay Counter a Block Transfer sequence is initiated. The range on this value is 0 to 255. **Example:** In Master Mode applications with the module in a remote rack, the frequency of command execution can be improved by entering a value of 75 to 150. The value must be determined empirically.
N[ ]:26	Floating Point Offset	This value is used by the module's Slave port driver to support the read and write addressing of Floating Point registers when addressing registers > 7000 (Commonly called the Enron version of the Modbus protocol). The offset value is used as follows by the module: MCM Reg Address = Floating Point Offset + (Reg Addr - 7000) * 2 The Floating Point Offset is not used on Pass Through Mode addressing. In the Pass Through mode, the address passed to the ladder logic is calculated as follows: Address = Reg Addr - 7000

Data Addr	Name	Description
N[ ]:27	Read Block ID Start	This value determines the starting BTR Block ID number which will be returned from the module. For example, if the ladder logic needs to receive Blocks 2 through 5 from the module, the parameter should be configured with a '2' and the Read Block Count should be set to '4'. Valid values range from 0 to 79.
N[ ]:28	Write Block ID Start	This value determines the starting BTW Block ID number which the module will return to the ladder logic. For example, if the ladder logic needs to write into Blocks 4 through 5 in the module, this parameter should be set to '4' and the Write Block Count should be set to '2'. Valid values range from 0 to 79.
N[ ]:30 to N[ ]:35	Route Mode Slave Address #1 to #6	These six addresses are provided for when the MCM module is configured with the Routing Mode Enabled. In this mode, any command which comes in the Slave port which matches one of the Route Mode Addresses will be re-transmitted out the Master port. The response from this slave will be routed back to the host via the slave port.

3.3 Writing Into Module Data Memory [BTW Block ID Codes 0 to 79]

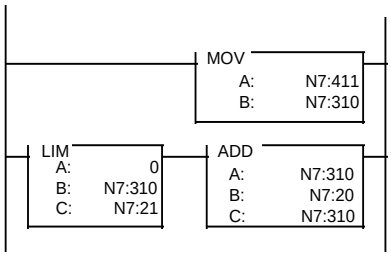
Writing into the MCM register data space is accomplished using a Block Transfer Write with BTW Block ID codes from 0 to 79 followed by 50 words of data.

Caution: Care must be exercised with memory layout to assure that MCM read and write commands do not overwrite data being moved in from the processor ladder logic. Modbus data **cannot** be moved into a 50 word block that is also updated by the processor. The ladder logic examples in the Reference (page 69) section address this concern.

3.3.1 Ladder Logic to Write Data to Module

The ladder logic required to move data to the module is a simple series of EQU-COP branches, or it can be implemented using indirect addressing. The way that we have implemented the transfer to the module in all of our example ladder logic is through a two step process, where:

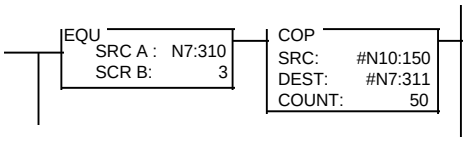
Step 1: During the BTR process, the module will "feed" the ladder logic a BTW Block ID Number in the second word of the BTR Data Buffer. Ladder logic is implemented to accept this value, condition it if needed, and then to move the value to the actual BTW Block ID location. The ladder logic to do this is shown below:



Setting up the BTW Block ID Number

Located at the bottom of the BTR rung (Rung 0), this logic moves the BTW Block ID Number being received from the module and offsets it by the Read Block Count (N7:20) in order to assure that PLC data does not overwrite the data being returned from the module to the PLC.

Step 2: During the processing of the BTW rung, the ladder logic will test for the value in the BTW Block ID register and based on the value, copy data from the data table into the BTW Block Transfer buffer. This process requires that every BTW Block ID which will be processes be accounted for with a branch of logic. An example of the ladder logic required follows:



Test BTW Block ID and move data to BTW Buffer

This branch, located in the BTW rung (rung 1) is an example of the logic that must be implemented for each data block to be move to the module.

3.3.2 Block Transfer Data Structure

The structure of the block transfer buffer when writing data to the module is shown below:

Word	Name	Description
0	BTW Block ID	The block identifier number allows the MCM Module to decode which "50 word page" in the module's 4000 word data space the data is to be written. The data space to be written into can be determined by multiplying the BTW Block ID by 50. The result is the first word of the "page". As an example: **BTW Block ID** / **Data Space** 0 / 0 to 49 1 / 50 to 99 10 / 500 to 549 20 / 1000 to 1049 By paging the different data blocks into the module the processor can control the module data memory contents.
1 to 50	Data	The data to be written to the module.

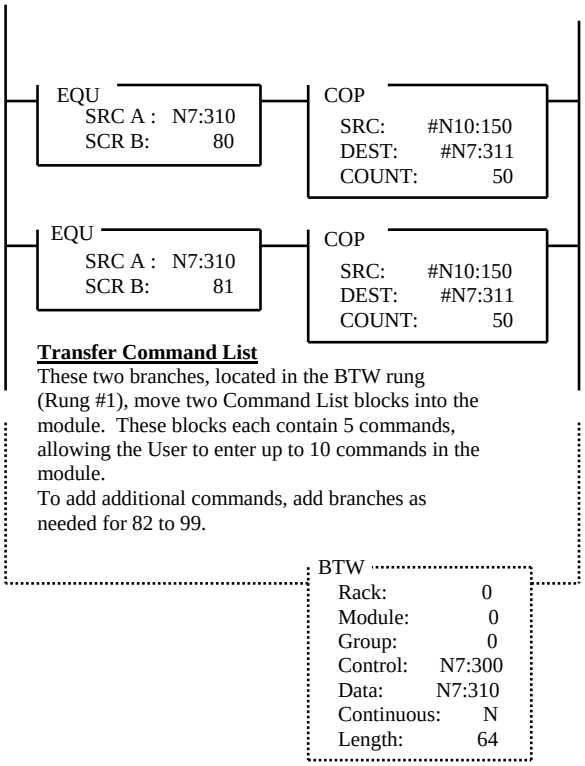
3.4 Command List Configuration - Master Mode [BTW Block ID Codes 80 to 99]

An MCM Modbus Master port establishes communications and performs various communications functions based on the data which the user has placed in the command list. The command list consists of up to 100 individually configured command data blocks (10 words reserved per command) which are shared between the two available ports (in the case when the module is configured with two Master ports).

3.4.1 Command List Ladder Logic

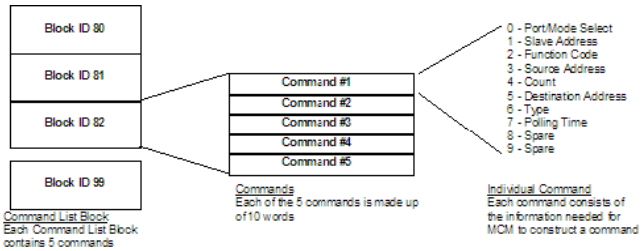
This list, entered into the processor Data Table, is transferred to the module's memory using BTW Block ID codes 80 to 99 with each code representing a 50 word block, or 5 commands.

An example of the ladder logic to move the commands to the module is as follows:



3.4.2 Command List Structure

The structure of the block containing the Command List is shown in the diagram below:



Name	Description
Port/Mode Select	The Port/Mode Select parameter allows the application to select which port the MCM Module will use to execute the command, and whether the command will be performed continuously or only when a change in data is detected (Conditional), or under direct ladder logic control (Control). Valid values are:

Port/Mode	Description
0	Disable Command
1	Port 1 Continuous Command
2	Port 2 Continuous Command
5	Port 1 Conditional Command
6	Port 2 Conditional Command
9	Port 1 Control Command
10	Port 2 Control Command

Continuous vs. Conditional : Function Codes 5, 6, 15, and 16

When configuring write commands in the Command List, the MCM Master driver can support two types of data write commands; Continuous and Conditional. The difference between the two are:

Continuous : Commands entered as in this fashion will be executed every time the module's Command List is scanned.

Conditional: Conditional commands are executed only when a change in the block of data to be written is detected. Every time the Command List is scanned, the module will compare the data to be written against the data last written. If a change is detected in any value, bit or word, the entire data block controlled by the command is written.

Control Command Mode

In the Control Command Mode, the command will only be executed when the Command Enable Bit (Command Control Mode) transitions from 0 to 1. The command is executed once per transition (that is, the module performs some one-shot logic to assure that the command only executes one). To clear the one-shot in the module, the Command Enable Bit must change state from 1 back to 0.

Slave Address	The slave address represents the Modbus slave address of the slave station to which the command is directed. Addresses should be entered in the decimal form.

<table>
<tr><th>Name</th><th>Description</th></tr>
<tr><td>Function Code</td><td>The function code entered in the table tells the MCM Module what command to execute.
<table>
<tr><th>Function Code</th><th>Description</th></tr>
<tr><td>1</td><td>Read Output Status</td></tr>
<tr><td>2</td><td>Read Input Status</td></tr>
<tr><td>3</td><td>Read Multiple Data Registers</td></tr>
<tr><td>4</td><td>Read Input Registers</td></tr>
<tr><td>5</td><td>Force Single Coil (Latch/Unlatch)</td></tr>
<tr><td>6</td><td>Preset (Write) Single Data Register</td></tr>
<tr><td>15</td><td>Multiple Coil Latch/Unlatch</td></tr>
<tr><td>16</td><td>Preset (Write) Multiple Data Register</td></tr>
</table></td></tr>
<tr><td>Source Address</td><td>The value represents the register or bit address, for both read and write commands, from which data will be obtained. The distinction between the two is as follows:
When issuing a read command, the Source Register Address is the register location in the slave where the command will begin getting data
When issuing a write command, the Source Register Address is register in the module where the command will begin obtaining the data to be written to the slave.</td></tr>
<tr><td>Count</td><td>The number of words or bits the Modbus command is to read or write. Modbus Command Configuration for a detailed discussion on the word and bit lengths to be specified for the different commands.</td></tr>
<tr><td>Destination Address</td><td>The value represents the register or bit address, for both read and write commands, to which data will be written. The distinction between the two is as follows:
▪ When issuing a read command, the Destination Address is the register location in the module where the command will begin placing the data from the slave
▪ When issuing a write command, the Destination Address is register in the slave where the command will begin placing the data to be written to the slave.</td></tr>
</table>

<table>
<tr><th>Name</th><th>Description</th></tr>
<tr><td>Type</td><td>The Type field is relevant only during a Function Code 3 command (Multiple Register Read). The Type field tells the module to execute word swapping on the data being received by that particular command.
This is extremely useful and important when reading floating point data (two words per value) from some instruments (Some instruments store the words of their floating point data in the opposite orientation to that of the processor. In these case, swapping the words allows a ladder logic COP command to copy the data straight from an Integer file to a Floating Point file). The available options at this time are:
<table>
<tr><th>Type</th><th>Description</th></tr>
<tr><td>0</td><td>Default value. Performs no swapping.</td></tr>
<tr><td>1</td><td>Swap words in each word pair received</td></tr>
<tr><td></td><td>from the slave during this command</td></tr>
<tr><td>2</td><td>Swap words in each word pair received</td></tr>
<tr><td></td><td>then swap the bytes within the words</td></tr>
<tr><td>3</td><td>Swap bytes within each word (no word swapping)</td></tr>
</table>
If using a function 6 or 16 and the destination register is greater than 47000, use a 1 in this field to disable the Enron Extension.</td></tr>
<tr><td>Polling Time Preset</td><td>The Polling Time Preset value allows each command to have a configurable execution frequency. In the module, a timer is maintained for each command. Once per second the timer is decremented, until it reaches zero. When the timer reaches zero, the command is enabled for execution, and the timer is reset to the Polling Timer Preset value. The resolution of the polling timer is 1 second. Valid values are 0 to 65535 (0xffff).</td></tr>
</table>

3.4.3 Editing the Command List

Entering the Command List is a matter of entering the correct values into the PLC data table. Using the ladder logic programming software, enter the values necessary to set up one or more valid commands.

Tip: When first setting up the Command List we recommend that you start out with one command. This one command will allow the module to begin transmitting if all else is OK (that is, ladder logic, cable is connected, and so on). When the module is transmitting, then attempt to communicate with the slave, then enter any other commands needed.

An example of a command list is shown below. Note that the commands can be entered in rows and that When the column definitions are understood, reviewing the Command List is very easy.

Example Command List

An example of multiple message configuration data blocks is shown in the following table (Columns 8 to 9 not shown for clarity).

	0	1	2	3	4	5	6	7
	Port Num	**Slv Add**	**Func Code**	**Src Add**	**Cnt**	**Dest Addr**	**Type**	**Poll Time**
N7:50	1	3	1	0	10	100	0	0
N7:60	1	3	4	50	20	100	0	0
N7:70	2	2	16	200	10	137	0	6
N7:80	6	2	16	210	10	150	0	0

3.5 Command Control Mode - Master Mode

Under some special operating conditions, it may be necessary for the ladder logic to be able to closely coordinate and control the execution of commands in the Command List. To accommodate this requirement, the MCM module supports something called the Command Control Mode.

When configured in the Command Control Mode, the ladder logic is able to provide Command Enable control on a per Command List entry basis. In addition, when used in conjunction with the Command Done Bits (page 55), the ladder logic is able to effectively one-shot each command if desired.

3.5.1 The BTW Block Structure

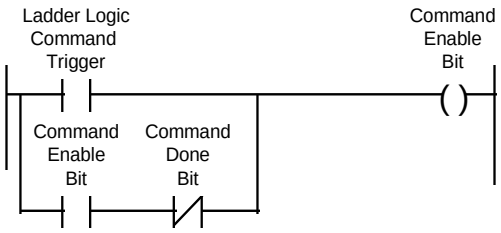
The structure of the Enable bits as they are written to the module in the BTW Block Transfer buffer is as follows:

<table>
<tr><th>Word</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>BTW Block ID</td><td>The Command Enable bits are moved to the module during every BTW transaction. Therefore, all valid BTW Block ID numbers can be used here</td></tr>
<tr><td>1 to 50</td><td>Data</td><td>Module data and Command List, as outlined above</td></tr>
<tr><td>51 to 56</td><td>Cmd Enable Bits</td><td>These registers contain Command Enable Bits for each command in the command list, up to the first 96 commands. The Enable Bits are bit mapped into the words depending on their relative position in the Command List. The mapping within the words is as follows:
<table>
<tr><th>Word</th><th>Cmds</th></tr>
<tr><td>51</td><td>1 to 16</td></tr>
<tr><td>52</td><td>17 to 32</td></tr>
<tr><td>53</td><td>33 to 48</td></tr>
<tr><td>54</td><td>49 to 64</td></tr>
<tr><td>55</td><td>65 to 80</td></tr>
<tr><td>56</td><td>81 to 96</td></tr>
</table>
Example: Word 51 bit 0 is Command #1 Enable</td></tr>
</table>

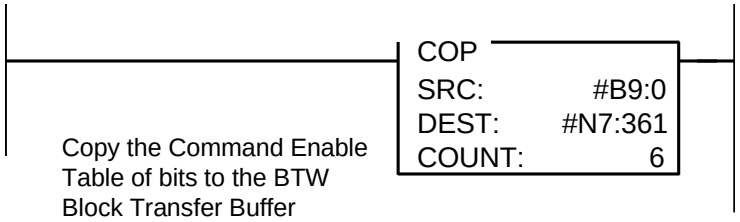
3.5.2 Controlling the Commands

When a command is configured in the Command Control Mode, and when the module detects the Command Enable bit changing state from 0 to 1, the module will attempt to execute the command (Three attempts will be made to execute the command). If the command is successfully sent, the Command Done bit will be set. If an error occurs during the sending process, the Command Error bit will be set.

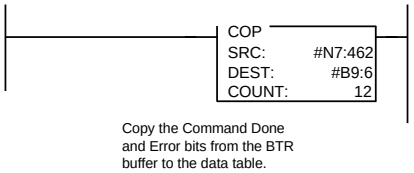
As example of the ladder logic which might be implemented to control a command would appear in structure as follows:



The simplest implementation would be to maintain a Binary table of Command Enable Bits which is copied to the BTW Buffer every transaction. The following branch of logic can be added to the BTW rung (transfer data to module):



The Command Done and Error bits could then be copied into the same Binary File and referenced in ladder logic after being transferred. The following instruction can be added to the BTR rung (read data from module) accomplish this:



3.5.3 Example Command List

Commands can be controlled through configuration of the Command Enable

	0	1	2	3	4	5	6	7
	port Num	**Slv Add**	**Func Code**	**Src Add**	**Cnt**	**Dest Addr**	**Type**	**Poll Time**
N7:50	9	3	1	0	10	100	0	0
N7:60	10	3	4	50	20	100	0	0

Example Command List

An example where the command in N7:50 is configured as a Control Command Mode for Port 1 while the N7:60 command is configured for Port 2.

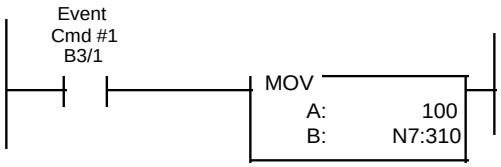
3.6 Event Initiated Commands - Master Mode [BTW Block ID Codes 100 to 119]

In addition to the continuously enabled commands which can be configured in the Command List, the MCM module also supports Event Initiated commands. These Event Commands can be used for reading/writing data conditionally with a slave. Example applications might include setting the time in a slave, resetting a batch counter, and so on.

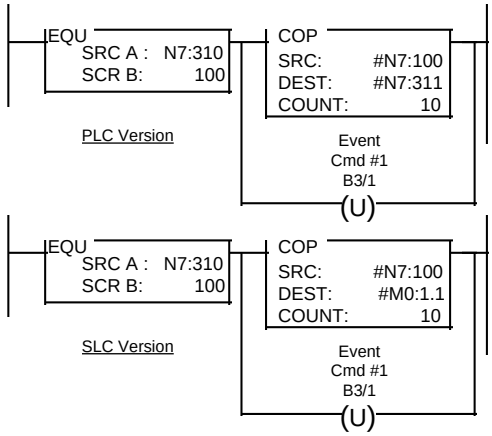
Tip: One of the benefits offered by an Event Initiated Write Command (FC 5, 6, 15, 16) is that the data contents written to the slave are guaranteed to be coordinated with the execution of the command. Note that this is not necessarily the case when executing the commands out of the Command List.

3.6.1 Ladder Logic

Executing an Event Initiated Command is performed by transferring data to the BTW Buffer while the Block ID number is between 100 and 119, inclusive. The data block which is transferred, described in the next section, contains the data necessary for the module to encode a valid command The additions to the ladder logic which must be made to support this functionality are as follows:



This branch is added to the Read rung, just above the MOV 255 to N7:310 branch. The B3/1 bit, selected here for example purposes only, is one-shot set in the ladder logic



This branch is added to the BTW rung, and serves to copy the Event Initiated Command block structure to the module and then Unlatches the command enable bit which was set in the ladder program.

3.6.2 BTW Block Structure

The structure of the block containing the Event Initiated Command is shown in the following table.

<table>
<tr><th>BTW Word</th><th>Data Offset</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td></td><td>BTW Block ID</td><td>The BTW Block ID is used by the module to determine that the Block Transfer buffer contains an Event Initiated Command. Valid values are between 100 and 119. The value determines the relative position in the Master Error Table.</td></tr>
<tr><td>1</td><td>N[ ]:0</td><td>Port Number</td><td>The Port Number parameter allows the application to select which port the module will use to execute the command. Expected values are:
<table>
<tr><th>Port/Mode</th><th>Description</th></tr>
<tr><td>1</td><td>Port 1</td></tr>
<tr><td>2</td><td>Port 2</td></tr>
</table></td></tr>
<tr><td>2</td><td>N[ ]:1</td><td>Slave Address</td><td>The slave address represents the Modbus slave address of the slave station to which the command is directed. Addresses should be entered in the decimal form.</td></tr>
<tr><td>3</td><td>N[ ]:2</td><td>Function Code</td><td>The function code entered in the table tells the MCM Module what command to execute.
<table>
<tr><th>Function Code</th><th>Description</th></tr>
<tr><td>1</td><td>Read Output Status</td></tr>
<tr><td>2</td><td>Read Input Status</td></tr>
<tr><td>3</td><td>Read Multiple Data Registers</td></tr>
<tr><td>4</td><td>Read Input Registers</td></tr>
<tr><td>5</td><td>Force Single Coil (Latch/Unlatch)</td></tr>
<tr><td>6</td><td>Preset (Write) Single Data Register</td></tr>
<tr><td>15</td><td>Multiple Coil Latch/Unlatch</td></tr>
<tr><td>16</td><td>Preset (Write) Multiple Data Register</td></tr>
</table></td></tr>
<tr><td>4</td><td>N[ ]:3</td><td>Source Address</td><td>The value represents the register or bit address, for read commands, from which data will be obtained.
▪ When issuing a read command, the Source Register Address is the register location in the slave where the command will begin getting data
When executing an Event Initiated Write command, this value has no meaning</td></tr>
<tr><td>5</td><td>N[ ]:4</td><td>Count</td><td>The number of words or bits the Modbus command is to read or write.</td></tr>
</table>

BTW Word	Data Offset	Name	Description
6	N[ ]:5	Destination Address	The value represents the register or bit address, for both read and write commands, to which data will be written. The distinction between the two is as follows: ▪ When issuing a read command, the Destination Address is the register location in the module where the command will begin placing the data from the slave ▪ When issuing a write command, the Destination Address is register in the slave where the command will begin placing the data to be written to the slave.
7	N[ ]:6	Type	The Type field is relevant only during a Function Code 3 command (Multiple Register Read). The Type field tells the module to execute word swapping on the data being received by that particular command. Command List Structure has a complete discussion of this parameter
8 to 51	N[ ]:7	Write Data	These register contain the write data values which will be sent to the address slave per the Function Code selection.

	0	1	2	3	4	5	6	7	8	9
	Port Num	Slv Add	Func Code	Src Add	Cnt	Dest Addr	Type	Data	Data	Data
N7:100	1	3	1	0	10	100	0	0	0	0
N7:110	1	3	6	0	1	1	0	1267		

Example Event Initiated Write Commands

The first command issues a FC 1 to Slave 3, reading 10 bits from bit 0 into register 100 in the module. The second commands writes the value 1267 to register 1 in the slave.

4 Reading from the Module

In This Chapter

This section provides reference level details on the transfer of data from the PLC/SLC processor to the MCM module. This type of transfer allows the ladder logic to send configuration , command list and data to the module.

4.1 Transferring data from the module [BTR Block ID 0 to 79]

When the Master port driver reads data from a slave or when a Host writes to the Slave port driver, the resulting data is placed into the ProSoft module's data space (Addresses 0 to 3999). This Module Data space is the same block of memory that the PLC/SLC can write into per the above discussion.

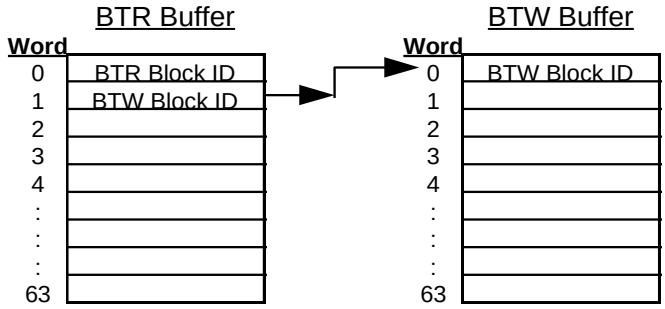
The transfer of data from the ProSoft Technology module to the processor is executed through the Block Transfer Read function. The following topics detail the handling of the read data.

Important: Although the full physical 64 words of the data buffer may not be used, the BTR and M1 lengths must be configured for a length of 64 words, otherwise module operation will be unpredictable

4.1.1 The Read Data Block Structure

The BTR buffer definition is:

Word	Name	Description
0	BTR Block ID	The ladder logic uses this value to determine the contents of the data portion of the BTR buffer. With some conditional testing in ladder logic, the data from the module can be placed into the PLC/SLC data table.



The relationship between the BTR Block ID number and the register table can be put into an equation:

Starting Register Address = Block ID Number * 50

Valid codes are between 0 and 79.

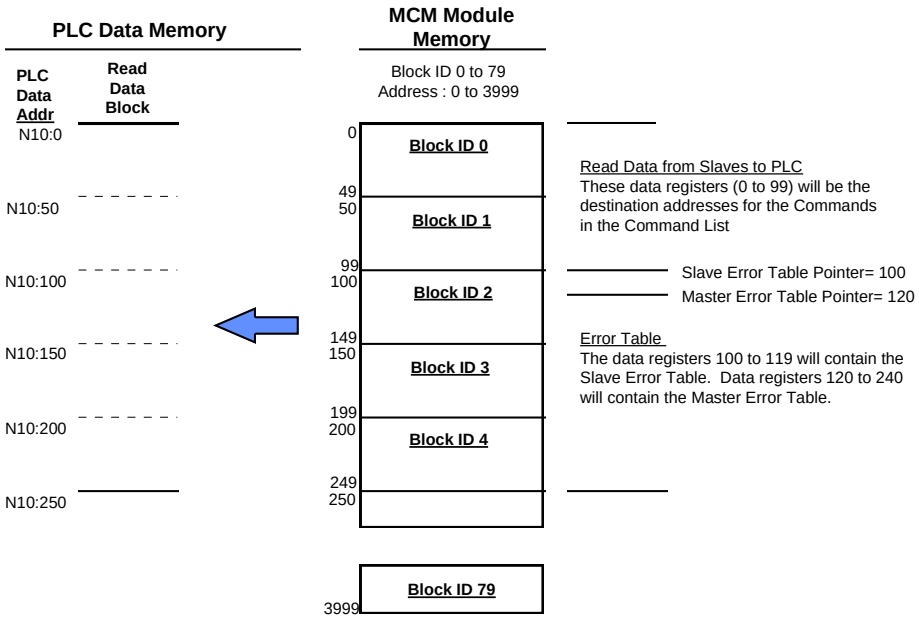
<table>
<tr><th>Word</th><th>Name</th><th>Description</th></tr>
<tr><td>1</td><td>BTW Block ID</td><td>The module returns this value to the processor to be used to enable the movement of register data and command list blocks to the module. The BTW Block ID number is developed by the module based on the parameters entered in parameters 21 and 22 of Block 255. This value is intended to only be a suggestion and to ease the ladder logic programming requirements. If it is desired to develop a different data transfer series, this may be easily accomplished in ladder logic.
Valid codes are:
<table>
<tr><th>BTW Code</th><th>Description</th></tr>
<tr><td>0 to 79</td><td>Module Data</td></tr>
<tr><td>80 to 99</td><td>Command List</td></tr>
<tr><td>100 to 119</td><td>Event Initiated Cmds</td></tr>
<tr><td>255</td><td>Module Configuration</td></tr>
</table>
</td></tr>
<tr><td>2 to 51</td><td>Data</td><td>The contents of the module’s Register Data space (0 to 3999). This data will contain data received from the slaves, data moved from the processor, and the Slave and Master Error Tables. The values will be 16 bit register values, and should be placed into integer files. Note that the user application ladder logic controls the placement and use of the data registers.</td></tr>
<tr><td>52 to 63</td><td>Command Done and Error Bits</td><td>Decoding Command Done and Command Error Bits - Master Mode</td></tr>
</table>

4.1.2 Moving the data from the module to the processor

Data which has been read from the slave devices (Master driver) or has been written from a host (Slave driver) is deposited into a 4000 word register table in the module. This table is addressed starting at 0 and going up to 3999.

The data register table is transferred from the module to the ladder logic through a paging mechanism designed to overcome the 64 physical word limit of the BTR instruction. The paging mechanism is outlined in the discussion above, but the important thing to understand is the relationship between the page numbers (BTR Block ID numbers) and the register addresses in the module.

The diagram also shows the layout for an example application. Note the number of blocks returned from the module to the ladder logic is determined by the value entered in the System Configuration "Read Block Cnt' register . In this example we have assumed a Read Block Count value of 5.

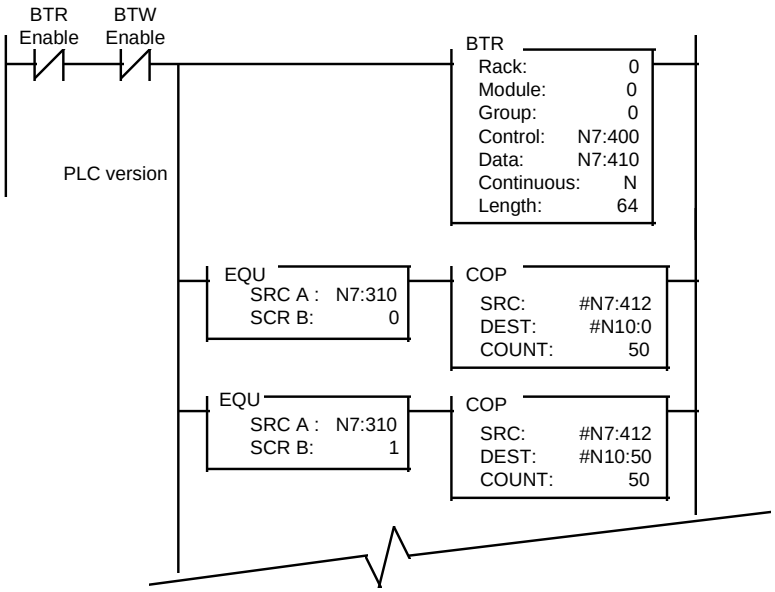


Read Data Blocks from MCM Module

Note that this diagram assumes a Read Block Count value of 5, therefore returning Registers 0 to 249 from the module. This value can be altered as needed depending on the application.

4.1.3 Ladder Logic to Read Module Data

The ladder logic must be programmed to look at the BTR buffer, decode several words, and then take action. The following is an example of such ladder logic:



Example ladder to transfer data from module

This logic shows a method for moving data from the module to the PLC data table.

4.1.4 Slave Error Code Table

The MCM Module monitors the status of all Slave port commands. This status is communicated to the processor in the form of a Slave Error Code Table.

Important: The Slave Error Code Table is initialized to zero on power up, and every time the module receives the 255 configuration data block.

The Slave Error Table is a 20 word block. The location of the Error Table is determined by the Slave Error Table Pointer parameter in the Configuration Block. The structure of the data block is as follows:

Port 1 Status Codes

Word	Example Addr	Name	Description
0	N10:100	Current Port Status	This value represents the current value of the error code for the port. This value will only be valid if the port is configured as a Slave. The possible values are described in the following section.
1	N10:101	Last Transmitted Error	This value is the last error code transmitted to the master by this slave port. Error codes which can be expected in this field are 0, 1, 2, 3, and 6. The field will only be cleared by re configuring the module (Block ID 255).
2	N10:102	Total Msgs to this slave	This value represents the total number of messages that have matched this slaves address on this port, whether the slave actually determined them to be good (worthy of response) or not.
3	N10:103	Total Responses from this slave	This value represents the number of good (non-error) responses that the slave has sent to the master on this port. The presumption is that if the slave is responding, the message was good.
4	N10:104	Total Msgs seen by this slave	This value represents the total number of commands seen by the slave on this port, regardless of the slave address.

Port 2 Status Codes

Word	Example Addr	Name	Description
5	N10:105	Current Port Status	Reference above for these descriptions
6	N10:106	Last Transmitted Error	Reference above for these descriptions
7	N10:107	Total Msgs to this slave	Reference above for these descriptions
8	N10:108	Total Responses from this slave	Reference above for these descriptions
9	N10:109	Total Msgs seen by this slave	Reference above for these descriptions

System Information

Word	Example Addr	Name	Description
10 to 11	N10:110 N10:111	Product Name (ASCII)	These two words represent the product name of the module in an ASCII representation. In the case of the MCM product, the letters ' MCM ' should be displayed when placing the programming software in the ASCII data representation mode.
12 to 13	N10:112 N10:113	Revision (ASCII)	These two words represent the product revision level of the firmware in an ASCII representation. An example of the data displayed would be '1.45' when placing the programming software in the ASCII data representation mode.
14 to 15	N10:114 N10:115	Operating System Rev (ASCII)	These two words represent the module's internal operating system revision level in an ASCII representation.
16 to 17	N10:116 N10:117	Production Run Number (ASCII)	This number represents the 'batch' number that your particular chip belongs to in an ASCII representation.
18 to 19	N10:118 N10:119	Spare	

All counters in the Slave Error Table will rollover to 0 after reaching 65535

4.1.5 Master Error Code Table

The MCM Module monitors the status of all Master port commands. This status is communicated to the processor in the form of a Master Error Code Table, the position of which is controlled by the Master Error Table Pointer in the Communication Configuration setup. Each Master command will generate an Error Code for use by the user.

The Master Error Code Table is initialized to zero on power up, and every time the module receives the 255 configuration data block.

The Error Code Table is a 120 word block. The relationship between the placement of the error codes within the Error Table and the commands is according to the command's relative position in the command list.

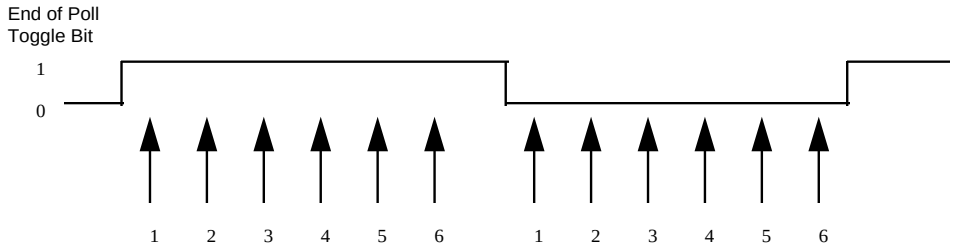
The simplest method for obtaining the Master Error Status Table is to locate it at the end of the application's data map and then read it back into the PLC/SLC data table as part of the regular data. The structure of the Master Error Table is as follows:

Word	Description
0	Command List End of Poll Status
1	Command #1 Error Status
2	Command #2 Error Status
-	
98	Command #98 Error Status
99	Command #99 Error Status
100-120	Future

Where:

Command List End Of Poll Status: This register provides an indication of when the Master has completed one cycle through the Command List. A bit in the word will be toggled each time the command list has been completed. The status is indicated for each master port as follows:

Bit	
0	Master Port 1
1	Master Port 2



The theoretical operation of the End of Poll Toggle Bit is that all of the commands which are to be executed for a port are execute within each state change of the bit.

Command Error Status: The Error Status Codes, either received from the slaves, or generated by the module, are placed in the table. Refer to the next section for the meaning of the error codes. The values will be 16 bit values, and should be placed into an integer file. Note that the user application ladder logic controls the placement and use of these registers.

Error Status Table Example

Master Error Table Pointer = 120										
	Wrd 0	Wrd 1	Wrd 2	Wrd 3	Wrd 4	Wrd 5	Wrd 6	Wrd 7	Wrd 8	Wrd 9
N10:120	0	0	8	0	0	0	0	0	0	0
N10:130	0	0	0	0	0	0	0	0	0	0
N10:140	0	0	0	0	0	0	0	0	0	0
N10:150	0	0	0	0	0	0	0	0	0	0
N10:160	0	0	0	0	0	0	0	0	0	0
N10:170	0	0	0	0	0	0	0	0	0	0
N10:180	0	0	0	0	0	0	0	0	0	0
N10:190	0	0	0	0	0	0	0	0	0	0
N10:200	0	0	0	0	0	0	0	0	0	0
N10:210	0	0	0	0	0	0	0	0	0	0
N10:220	0	0	0	0	0	0	0	0	0	0
N10:230	0	0	0	0	0	0	0	0	0	0

These registers correspond to the registers used in the sample program for PLC-5 in the back of this manual. Your application may require your own specific program. In this case an error code of 8 was generated for command 2 - all other commands were executed without any errors. Column 0 identifies that a master port has reached the end of the command list, and is starting at the top of the Command List.

4.1.6 Error Status Codes

The Error Codes returned in the Slave and Master Error Code Tables reflect the outcome of the commands and responses executed by the module. Note that in all cases, if a zero is returned, there was not an error. Valid Error Status Codes are as follows:

Code	Name	Description
0	All OK	The module is operating as desired
1	Illegal Function	An illegal function code request is being attempted
2	Bad Data Address	The address, or the range of addresses, covered by a request from the master are not within allowed limits
3	Bad Data Value	The value in the data field of the command is not allowed.
4	Incomplete Response Detected	This error indicates that an incomplete response was received to a master query. Often this will indicate that the slave device may be responding too quickly or that there may be excessive noise on the line.
6	Module Busy	The module busy status code is returned when a write command from the master has not yet been completed when a second write command is received
8	Timeout Error	Communications with the addressed slave have been unsuccessful due to a lack of response from the slave. The Master port will attempt a command three times before moving onto the next command.
10	Buffer Overflow	The receive buffer has overflowed and reset the character count to 0. If this condition occurs try reading fewer parameters at one time
16	Port Configuration Error	If this value is returned from the module, one or both of the serial ports have been mis-configured. To determine the exact source of the problem, verify the following: ▪ Parity Configuration ▪ Stop Bit Configuration ▪ Baud Rate Configuration ▪ Start Input Register Address ▪ Start Output Register Address
18	System Configuration Error	If this error is returned from the module, one of the system configuration parameters has been detected out of range. To determine the source, verify the following: ▪ Read Block Count <= 80 ▪ Write Block Count <=80 ▪ Command Block Count <= 20 ▪ Slave Error Pointer <= 3850 ▪ Master Error Pointer <= 3880
254	Checksum Error	The slave determined that the message checksum was in error, and therefore discarded the message

Code	Name	Description
255	TX Hardware Timeout	A transmit timeout condition has occurred indicating that the module was not able to transmit the command. Verify that the RTS-CTS jumper on the port is still connected

4.2 Pass-Through Mode: Slave Mode [BTR Block ID 256 to 259]

When a Slave port is configured to support the Pass-Through mode, any Modbus write commands which are addressed to the local slave address will be passed across the backplane for processing by the ladder logic. Ladder logic in the Reference (page 69) section provides an example of how the Pass-Through commands can be decoded.

4.2.1 The Block Structure

The BTR buffer definition for Pass-Through Mode transfers is:

Word	Name	Description
0	BTR Block ID	The value of the BTR Block ID register represents the type of write command which has been received from the host. Valid codes are: **BTR ID** / **Description** 256 / Register Write 257 / Register Write: Enron Float 258 / Single Bit Write 259 / Multiple Bit Write
1	BTW Block ID	Same as above description
2 to 62	Data	The contents of these registers are a function of the BTR Block ID number (that is, the command received from the host)

4.2.2 Receiving Register Writes [BTR Block ID 256 and 257]

The BTR buffer definition is:

Word	Name	Description
0	BTR Block ID	The value of the BTR Block ID register represents the type of write command which has been received from the host. Valid codes are: **BTR ID** / **Description** 256 / Register Write 257 / Register Write: Enron Float 258 / Single Bit Write 259 / Multiple Bit Write
1	BTW Block ID	Same as above description
2	Count	The number of registers being written by the Master. Valid numbers which will be received will range from 1 to 60
3	Destination Address	This value is used by the ladder logic to determine the address in the processor data table in which to start the data write
4 to 62	Data	The data values written from the master. The value will be 16 bit register value

4.2.3 Receiving Single Bit Writes [BTR Block ID 258]

The BTR buffer definition is:

Word	Name	Description
0	BTR Block ID	The value of the BTR Block ID register represents the type of write command which has been received from the host. Valid codes are: **BTR ID** | **Description** 258 | Single Bit Write
1	BTW Block ID	Same as above description
2	Bit Address	Represents the bit which will be acted on
3	Control Action	The action being commanded by the master. When the value is 0, the addressed bit is to be reset and when the value is 1 the addressed bit is set

4.2.4 Receiving Multiple Bit Writes [BTR Block ID 259]

The BTR buffer definition is:

Word	Name	Description
0	BTR Block ID	The value of the BTR Block ID register represents the type of write command which has been received from the host. Valid codes are: **BTR ID** | **Description** 259 | Multiple Bit Write
1	BTW Block ID	Same as above description
2	Word Count	Represents the number of words in the data block that contain valid bit data. Valid numbers range from 1 to 30 (This limits the number of bits which can be written in one command to 30 * 16).
3	Word Start Address	Represents the offset word address into which the bit write data block will start to be written. When the master addresses a bit write, it sends the starting bit address. The starting bit address is used by the module to generate this word start address (Bit address/ 16)
4 to 33	Data	These registers contain the bit write data received from the master. Note that partial work length bit writes are acceptable. The mask bits and some ladder logic protects un-addressed bits within a common word.
34 to 63	Mask	These words mask off the un-addressed bits. This allows for starting addresses which are not on a word boundary and lengths which do not end on a word boundary. Refer to the example ladder logic in the Reference section.

4.3 Decoding Command Done and Command Error Bits - Master Mode

The Command Done and Command Error bits are returned for use in the ladder logic program during every data block transfer (BTR Block ID 0 to 79). These bits can be used by the ladder logic to keep track of command execution or to disable commands when a command is configured in the Command Control Mode (page 73, page 37).

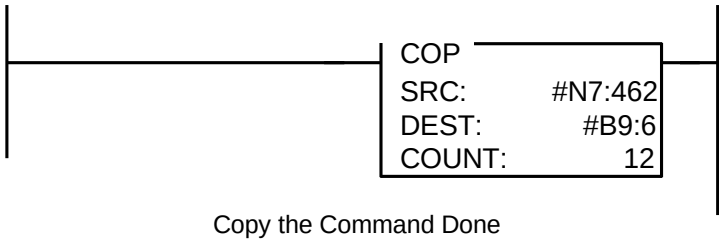
4.3.1 The Block Structure

The structure of the Done and Error bits as they are returned in the BTR Block Transfer buffer is as follows:

Word	Name	Description
0	BTR Block ID	When the BTR Block ID value is between 0 and 79 the BT Buffer contains Command Done and Command Error bits, as outlined below
1	BTW Block ID	Same as above description
2 to 51	Data	Module data, as outlined above
52 to 57	Cmd Done Bits	These registers contain Done Bit flags for each command in the command list, up to the first 96 commands. The Done Bits are bit mapped into the words depending on their relative position in the Command List. The mapping within the Done Bits is as follows: Word Cmds 52 1 to 16 53 17 to 32 54 33 to 48 55 49 to 64 56 65 to 80 57 81 to 96 Example: Word 52 bit 0 is Command #1
58 to 63	Cmd Error Bits	These registers contain Error Bit flags for each command in the command list, up to the first 96 commands. The Error Bits are bit mapped into the words depending on their relative position in the Command List. The mapping within the Done Bits is as follows: Word Cmds 58 1 to 16 59 17 to 32 60 33 to 48 61 49 to 64 62 65 to 80 63 81 to 96 Example: Word 52 bit 0 is Command #1

4.3.2 Ladder Logic

A simple rung of logic can be entered to move the Done and Error bits from the BTR buffer to the PLC/SLC data table. An example follows:



Copy the Command Done and Error bits from the BTR buffer to the data table.

5 MODBUS Command Configuration

In This Chapter

The ProSoft Technology MCM Modbus Master and Slave communication drivers support several data read and write commands. When configuring a Master port, the decision on which command to use is made depending on the type of data being addressed, and the level of Modbus support in the slave equipment. When configuring as a slave, it may be important to understand how the Modbus commands function in order to determine how to structure the application data.

5.1 MCM Commands

The MCM module supports a command subset of the MODBUS Specification consisting primarily of the Function Codes required to read and write data. The following topics detail the different commands supported by the module. The perspective is given mainly from that of a Master port, but much of the discussion will assist those implementing Slave ports.

Function Code	Cmd	Address Range	Slave Driver Comments	Master Driver Comments
1	Read Coil Status	Coil 0001 to 9999	Module returns binary data from the 'Output Status' register space. The module will support up to 125 words of data in one command.	**Device Address:** Starting bit address in the slave from which data should be read. Enter a 0 to address coil 0001 **Count:** Number of bits to be read (up to 125 words in length) **Internal Address:** Starting word address in the module's Register Memory in which the data should be placed, starting with bit 0.
2	Read Input Status	Bit 10001 to 29999	Module returns binary data from the 'Input Status' register space. The module will support up to 125 words of data in one command.	**Device Address:** Starting bit address in the slave from which data should be read. Enter a 0 to address bit 10001 **Count:** Number of bits to be read (up to 125 words in length) **Internal Address:** Starting word address in the module's Register Memory in which the data should be placed, starting with bit 0.
3	Read Holding Registers	Registers 40001 to 47999	The module returns word data from the register space. The entire 5000 words in the module make up the register space addressable by a host. Word 0 in the module corresponds to MODBUS Address 40001. The module will support up to 125 words of data in one command.	**Device Address:** Starting register address in the slave from which data should be read. Enter a 0 to address 40001 in the slave **Count:** Number of words or values to be read (up to 125 words in length) **Internal Address:** Starting word address in the module's Register Memory in which the data should be placed. **Type:** Controls byte and word swapping for floating point read (Writing data to the module (page 19)).

Function Code	Cmd	Address Range	Slave Driver Comments	Master Driver Comments
4	Read Input Registers	Registers 30001 to 39999	The module returns data from the 'Input Register' space in the module. The module will support up to 125 words of data in one command.	**Device Address:** Starting register address in the slave from which data should be read. Enter a 0 to address 30001 in the slave **Count:** Number of words or values to be read (up to 125 words in length) **Internal Address:** Starting word address in the module's Register Memory in which the data should be placed.
5	Force (Write) Single Coil	Coil 0001 to 9999	**Normal Mode:** The bit written will be placed in the module's data space **Pass-Through Mode:** The bit written will be passed to the PLC/SLC for handling in ladder logic	**Internal Address:** Starting bit address in the MCM which should be used to determine the bit set/reset action of the command **Count:** Not used, defaults to one **Device Address:** The bit address in the slave which is to be set or reset. Enter an address of 0 to address coil 0001 in the slave
6	Preset (Write) Single Register	Registers 40001 to 47999	**Normal Mode:** The bit written will be placed in the module's data space **Pass-Through Mode:** The bit written will be passed to the PLC/SLC for handling in ladder logic	**Internal Address:** Starting register address in the MCM which should be used to determine the source of the data to be written **Count:** Not used, defaults to one **Device Address:** The register address in the slave in which the data is to be written. Enter an address of 0 to address register 40001 in the slave
15	Force Multiple Coils		**Normal Mode:** The bit written will be placed in the module's data space. Up to 125 words of bit data max. **Pass-Through Mode:** The bit written will be passed to the PLC/SLC for handling in ladder logic. Up to 30 words of bit data max.	**Internal Address:** Starting bit address in the MCM which should be used to determine the source of the data to be written **Count:** The number of bits to be written (up to 125 words total) **Device Address:** The starting bit address in the slave in which the data is to be written. Enter an address of 0 to address coil 0001 in the slave

Function Code	Cmd	Address Range	Slave Driver Comments	Master Driver Comments
16	Preset Multiple Registers		**Normal Mode:** The register value written will be placed in the module's data space. Up to 125 words max **Pass-Through Mode:** The bit written will be passed to the PLC/SLC for handling in ladder logic. Up to 60 words max.	**Internal Address:** Starting register address in the MCM which should be used to determine the source of the data to be written **Count:** The number of words or values to be written (up to 125 words total) **Dest Addr:** The starting address in the slave in which the data is to be written. Enter an address of 0 to address register 40001 in the slave

6 Diagnostics and Troubleshooting

In This Chapter

The module provides information on diagnostics and troubleshooting in the following forms:

- LED status indicators on the front of the module provide general information on the module's status.
- Status data values can be transferred from the module to processor memory and can be monitored there manually or by customer-created logic.

Several hardware diagnostics capabilities have been implemented using the LED indicator lights on the front of the module. The following topics explain the meaning of the individual LEDs for both the PLC and the SLC platforms.

6.1 3100 PLC Platform LED Indicators

The PLC platform MCM product is based on the ProSoft CIM hardware platform. The following table documents the LEDs on the 3100-MCM hardware and explains the operation of the LEDs.

ProSoft CIM Card

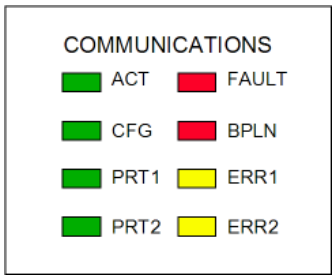
ACTIVE	○ ○	FLT
CFG	○ ○	BPLN
ERR1	○ ○	ERR2
TXD1	○ ○	TXD2
RXD1	○ ○	RXD2

LED	Color	Status	Indication
ACT	Green	Blink (Fast)	Normal state: The module is operating normally and successfully Block Transferring with the PLC
		On	The module is receiving power from the backplane, but there may be some other problem
		Off	The module is attempting to Block Transfer with the PLC and has failed. The PLC may be in the PGM mode or may be faulted
FLT	Red	Off	Normal State: No system problems are detected during background diagnostics
		On	A system problem was detected during background diagnostics.
CFG	Green	Off	Normal state: No configuration related activity is occurring at this time
		Blink	This light blinks every time a Module Configuration block (ID = 255) is received from the processor ladder logic
		On	The light is on continuously whenever a configuration error is detected. The error could be in the Port Configuration data or in the System Configuration data. Writing to the Module (page 19) has more information.
BPLN	Red	Off	Normal State: When this light is off and the ACT light is blinking quickly, the module is actively Block Transferring data with the PLC
		On	Indicates that Block Transfers between the PLC and the module have failed (Not activated in the initial release of the product)
ERR1 ERR2	Amber	Off	Normal State: When the error LED is off and the related port is actively transferring data, there are no communication errors
		Blink	Periodic communication errors are occurring during data communications. Writing to the Module (page 19) has more information on how to determine the error condition
		On	This LED will stay on under several conditions: ▪ CTS input is not being satisfied ▪ Port Configuration Error ▪ System Configuration Error ▪ Unsuccessful comm on MCM slave ▪ Recurring error condition on MCM master
Tx1 Tx2	Green	Blink	The port is transmitting data.

LED	Color	Status	Indication
Rx1 Rx2	Green	Blink	The port is receiving data

6.2 3150 SLC Platform LED Indicators

The following table documents the LEDs on the 3150-MCM hardware and explains the operation of the LEDs.



LED	Color	Status	Indication
ACT	Green	Blink (Fast)	Normal state: The module is operating normally and successfully Block Transferring with the SLC
		On	The module is receiving power from the backplane, but there may be some other problem
		Off	The module is attempting to Block Transfer with the SLC and has failed. The SLC may be in the PGM mode or may be faulted
FLT	Red	Off	Normal State: No system problems are detected during background diagnostics
		On	A system problem was detected during background diagnostics. Please contact prosoft technology for technical support
CFG	Green	Off	Normal state: No configuration related activity is occurring at this time
		Blink	This light blinks every time a Module Configuration block (ID = 255) is received from the processor ladder logic
		On	The light is on continuously whenever a configuration error is detected. The error could be in the Port Configuration data or in the System Configuration data. Writing to the Module (page 19) has more information
BPLN	Red	Off	Normal State: When this light is off and the ACT light is blinking quickly, the module is actively Block Transferring data with the SLC
		On	Indicates that Block Transfers between the SLC and the module have failed
ERR1 ERR2	Amber	Off	Normal State: When the error LED is off and the related port is actively transferring data, there are no communication errors
		Blink	Periodic communication errors are occurring during data communications. Writing to the Module (page 19) has more information on how to determine the error condition
		On	This LED will stay on under several conditions: ▪ CTS input is not being satisfied ▪ Port Configuration Error ▪ System Configuration Error ▪ Unsuccessful comm on MCM slave ▪ Recurring error condition on MCM master

LED	Color	Status	Indication
PRT1 PRT2	Green	Blink	The port is communicating, either transmitting or receiving data

6.3 Troubleshooting: General

Use the following troubleshooting steps if you encounter problems when the module is powered up. If these steps do not resolve your problem, please contact ProSoft Technology Technical Support.

Problem Description	Steps to take
BPLN light is on (SLC)	The BPLN light comes on when the module does not think that the SLC is in the run mode (that is, SLC is in PGM or is Faulted). If the SLC is running then verify the following: ▪ Verify the SLC Status File to be sure the slot is enabled ▪ The Transfer Enable/Done Bits (I/O Bits 0 for the slot with the module) must be controlled by the ladder logic. Getting Going - A Step by Step Approach (page 12) has more information or the example ladder logic in the reference (page 69) section. ▪ If the ladder logic for the module is in a subroutine file verify that there is a JSR command calling the SBR
CFG light does not clear after power up (no ERR LED)	The 255 BTW Block ID number is not being detected by the module. This could be due to a Block Transfer failure (PLC) or to an error in the ladder logic preventing the 255 value from being moved to the BTW buffer
CFG light does not clear after power up (with ERR LED)	If the BPLN light has been cleared, then several of the Port and System configuration values are value checked by the module to be sure that legal entries have been entered in the data table. Verify the Error Status Table for an indication of a configuration error.
CFG light toggles	Under normal conditions, the CFG LED will clear immediately after receipt. If the CFG light toggles, this usually indicates that the logic condition which places the 255 Block ID value in the BTW buffer is not being cleared. Look at the ladder logic to be sure that the condition moving the 255 value is not held true.
Module is not transmitting	Presuming that the processor is in run, verify the following: ▪ CTS input is not satisfied (check RTS/CTS jumper) ▪ Check Error Status codes for 255 code. If so see next problem ▪ If in slave mode, verify the slave address being requested from the Host ▪ If in master mode, verify the command list configuration and that the Command List is being moved into the module (that is, look at the Command Block Cnt and associated ladder logic)
Error Code 255 in Status Table	This is caused by only one thing, a missing CTS input on the port. If a cable is connected to the port, then verify that a jumper has been installed between the RTS and CTS pins. If so then there may be a hardware problem.
Overwriting data blocks	This condition normally occurs when it is forgotten that the BTW Block ID value is being manipulated by the module, and that it always starts at 0. Please verify that the configuration of the module (Read and Write Block Counts) is not causing data from the PLC/SLC to overwrite data being returned from the module. A simple method for verifying this is to perform a histogram on the BTW Block ID register.
Data swapping is occurring (3100 only)	Under several circumstances data swapping in the module has occurred. This swapping has always been associated with the 8/16 pt jumper on the back of the card. Please verify that the jumper is in the 8pt position

Problem Description	Steps to take
New configuration values are not being accepted by the module	In order for new values to be moved to the module a Block Transfer Write with a Block ID of 255 must be transmitted to the module. The 'User Config Bit' in the example logic accomplishes this. In the example logic the bit must either be set in the data table manually or the module must be powered down/reset. In order to download the configuration upon transitioning from PGM to RUN, add a run to set the 'User Config Bit' based on the First Scan Status Bit (S1:1/15)
Error Codes being returned in locations with no commands (Master Configuration)	Verify that the Command Block Count configuration value is setup correctly. There should be one branch of logic in the Write Rung corresponding to each Command Block to be written (that is, a Command Block Count of 2 should have two branches of logic to handle BTW Block IDs 80 and 81. If the Command Block Count configuration value exceeds the number of branches in logic, the Command List is inadvertently being duplicated. To resolve the issue, either add more branches of logic or reduce the Command Block Count value to match the number of BTW logic branches.
RX1 or RX2 on continuously (3100 only)	The TX and RX LEDs on the module are tied to the hardware state of the ports (that is, are not controlled directly by firmware). When the RX LED is on continuously is normally indicates that the polarity of the cable connection to the port is swapped. This is particularly true in RS-485 and RS-422 modes.

7 Reference

In This Chapter

7.1 Product Specifications

The 3100/3150-MCM ("Modbus Communication Module") product family allows Rockwell Automation 1771 and 1746 I/O compatible processors to interface easily with other Modbus protocol compatible devices as either a Modus Master or a Modbus Slave.

The MCM product includes the following standard features:

7.1.1 General Specifications

- Two fully configurable serial ports, each capable of supporting Modbus Master or Modbus Slave. Available configurations include:

Port Configurations	Port 1	Port 2
Master-Master	Master	Master
Master-Slave	Master/Slave	Master/Slave
Slave-Slave	Slave	Slave

- Support for the storage and transfer of up to 4000 registers to the PLC /SLC data tables
- Support movement of binary, integer, ASCII, and floating point data types
- Memory mapping is completely user definable through data table configuration
- RS-232C handshaking for SCADA radio/modem applications
- RS-422/RS-485 compatible for multi-drop applications with up to 32 slaves per port
- Satellite and Packet Radio support with a configurable Inter-character Timeout available per port
- Software configuration (From processor ladder logic)

Slave Addr	1 to 247 (0 is broadcast)
Parity	None, odd, or even,
Stop Bit	1 or 2
Baud Rate	300 To 38,400
RTS to TxD	0 to 65535 milliseconds, 1 ms resolution
RTS Off	0 to 65535 milliseconds, 1 ms resolution
Timeout	0 to 65535 milliseconds, 1 ms resolution

- Response time

  The Modbus Master and Slave protocol drivers are written in Assembly and in a compiled higher level language. As such, the interrupt capabilities of the hardware are fully utilized to minimize delays, and to optimize the product's performance

Modbus Slave Specifications

- Protocol modes:

  RTU mode with CRC-16 error checking
  ASCII mode with LRC error checking (7 and 8 bit formats)

- Supported Modbus Function codes:

  1 Read Output Status
  2 Read Input Status
  3 Read Multiple Data Registers
  4 Read Input Registers
  5 Force Single Coil (Latch/Unlatch)
  6 Preset (Write) Single Data Register
  8 Loopback Test (Test 0 only)
  15 Multiple Coil Latch/Unlatch
  16 Preset (Write) Multiple Data Register

- Supports broadcast commands from host
- Error Status and Communication Statistics returned to the ladder processor
- Pass Through Mode: configurable selection

  Select to transfer write commands from host directly to ladder for processing. Allows conditional acceptance of write data by ladder logic

- Command Routing Mode

  Supports Slave to Master routing for up to six slave addresses. Allows a supervisor on slave port to access data from the routed slaves

Modbus Master Specifications

- Protocol modes:

  RTU mode with CRC-16 error checking
  ASCII mode with LRC error checking (7 and 8 bit formats)

- Supported Modbus Function codes:

  1 Read Output Status
  2 Read Input Status
  3 Read Multiple Data Registers
  4 Read Input Registers
  5 Force Single Coil (Latch/Unlatch)
  6 Preset (Write) Single Data Register
  15 Multiple Coil Latch/Unlatch
  16 Preset (Write) Multiple Data Register

- Supports up to 100 Command List entries, each individually configurable with the following parameters:

  Port/Mode Selection
  Slave Address
  Function Code
  Source/Destination data address
  Number of values to transfer
  Polling Time

- Command Control Mode

Allows individual command execution control to be done in ladder logic enabling a list of commands to be executed based on events in the PLC/SLC

- Individual command "Done' and "Error' bits available
- Support for "Event Driven' Writes initiated directly from ladder logic
- Individual Command Error Statue codes returned to the ladder processor
- Supports broadcast commands to slaves

Hardware Specifications

- Backplane Current Load:

  3100 0.65 A
  3150 0.15 A at 5 V
  0.04 A at 24 V

- Operating Temperature: 0 to 60 °C
- Storage Temperature: -40 to 85 °C
- Connections:

  3100 : 2 - DB25 Female Connectors
  3150 : 2 - DB-9 Male Connectors

7.2 New Features in Revision 2

3100 Module
1771 Platform

3150 Module
1746 Platform

Revision 2 of the MCM product represents the first major upgrade to the product. Incorporated in the product are many new features, some which have been suggested by our existing customers and some as the result us learning how our customers are using the product. A description of some of these new features follows:

7.2.1 Modbus Master Driver

Command Status Bits

Added to the information returned to the ladder logic are command "Done" and "Error" bits. These bits allow the ladder logic to track each Modbus Master command's execution and its success or failure. In conjunction with the new Command Control Mode (see below), the ladder program is now able to control the execution of each command.

Command Polling Time

Each command can now be configured with a "Polling Time" to effectively control the frequency of execution. The timer has a resolution of one second and each command can be configured up to 65535 seconds.

Command Control Mode

The Command Control Mode is most likely the most requested feature we have been asked for. In this mode, the Modbus Master driver only executes commands in the command list upon receiving an "Enable" bit from the ladder logic. The module returns "Done" and "Error" bits as part of the regular command status information returned to the ladder (See discussion above) allowing commands to be sent only once if desired.

Event Initiated Write Commands

The Modbus Master driver in the MCM module supports the execution of Event Driven Write Commands. This type of support provides the ladder logic program with another method beyond the Conditional Write Commands (documented in the manual) and the Command Control Mode to send Modbus Write commands to a slave (FC 5,6,15,16).

7.2.2 Modbus Slave Driver

Pass-through Mode

1. The Pass-Through Mode allows a Modbus Slave port to pass write commands received from a host directly across the backplane for handling by ladder logic. Although this feature requires more ladder logic in order to implement a solution, there are certain situations where this functionality can be useful. Some of these situations include:
2. When the slave needs to know when it has been written to
3. When the acceptance of data may require some conditioning
4. When the host's write data registers must overlap the read register space

Routing Mode

The Routing Mode allows a Modbus Slave port to 'route' commands received from a host to the master port. A list of up to six routed slave addresses can be entered in the configuration table. Whenever a host command (either read or write) is received on the slave port which matches one of the six addresses, the command is routed out the master port and the response is routed back to the slave port.

7.3 Functional Overview

7.3.1 General

The MCM products are single slot rack resident modules which have been designed to provide a tightly integrated Modbus communication interface for the Rockwell Automation 1771 and 1746 I/O platforms. The product will support the following processors:

3100-MCM for 1771 Platform

- PLC 5 family
- PLC 2 family
- PLC 3 family

3150-MCM for 1746 Platform

SLC 5/02 (CPUs with M0/M1 direct memory file access only), 5/03, 5/04, 5/05

The 3100-MCM module will work in the local rack with the processor or can be installed in a remote rack using Remote I/O

communications to link the racks. The 3150-MCM module will work in the local or extended rack with the processor. The 3150-MCM may not be used in remote racks using SLC Remote I/O communications scanners or links.

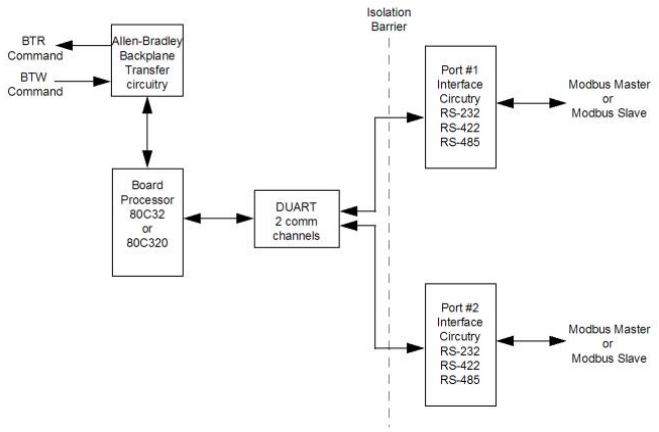
The following illustration shows the two forms in which the product is available.

3100 Module
1771 Platform

3150 Module
1746 Platform

7.3.2 Hardware Overview

The design of the MCM module for the two hardware platforms are very similar. The following discussion, unless identified otherwise, will apply to both the 3100 and the 3150 platforms. The following illustration shows the functional components on the modules.



Hardware layout diagram of 3100/3150 modules

The primary functional components on the boards are:

- A microcontroller responsible for the overall operation of the board, including:
  - Backplane communications with Rockwell Automation processor
  - Transferring data from module to PLC
  - Accepting data from PLC into the module
  - Servicing DUART communications
  - LED Status Indications
- Rockwell Automation backplane chipset services the communications between the module and the Rockwell Automation processor. The chipset contains proprietary technology licensed from Rockwell Automation designed to:
  - In the case of the PLC the chipset has been designed to communicate with backplane using the Block Transfer commands, transferring 64 words at a time
  - In the case of the SLC, the chipset has been designed to communicate with the backplane using the M0/M1 files. As there is no real Block Transfer functionality in the SLC, we have implemented a form of block transfer using the I/O table to control the handshaking between the module and the processor. Up to 64 words may be transferred at a time. Shown below, presuming the module is in slot 1, are these bits:

    I:1/0 Transfer Enable: This bit is set by the module and used by the ladder logic to enable the movement of data over the backplane

    O:1/0 Transfer Done: This bit is set by the ladder logic to communicate to the module that the ladder has completed the data transfer

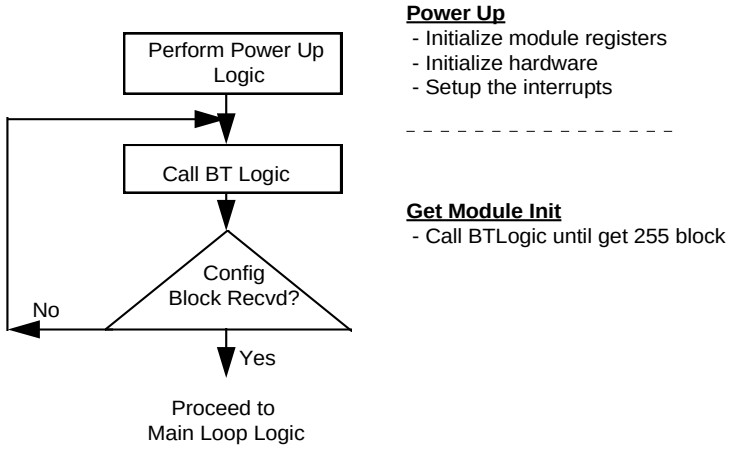
- The port interface circuitry providing the physical interface to the real world. The ports and the interface circuitry are optically isolated from the rest of the card, and therefore the backplane, providing a high level of protection to the Rockwell Automation processor. Both ports are capable of supporting:
  - RS-232
  - RS-422, also called a 4 wire connection
  - RS-485, also called a 2 wire connection

7.3.3 General Concepts

The following discussion explains several concepts that are important for understanding module operation.

Module Power Up and Reset

On power up, or after pressing the **RESET** pushbutton (3100 only), the module begins performing its logical functions. These functions shown in the flow chart below, include:



1 Initialize hardware
  - Initialize the backplane
  - Initialize the DUART

2 Initialize Module registers
  - Clear the Module Data Block
  - Clear Command List
  - Clear Error Status Tables
  - Preset constants

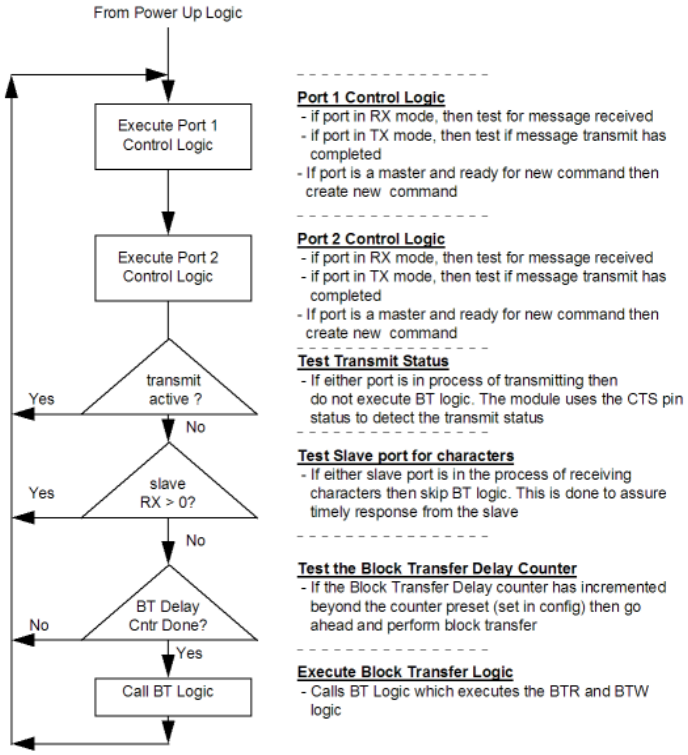
After the register space has been initialized, the module will begin to block transfer with the ladder logic. The first block transfer sent from the module will initiate the configuration process, initiate the configuration process by sending a Block ID of 255, causing the ladder logic to send configuration and command data from processor data files to the module. After the module is configured, it will begin the Main Logic Loop.

Main Loop Logic

Upon completing the power up configuration process, the module jumps into an infinite loop which includes the following functions:

1 Port 1 and Port 2 handlers
- Detect end of message condition
- Call message handlers
- Initiate commands if a Master

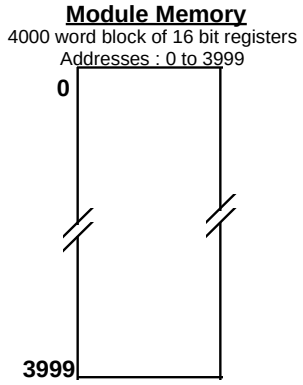
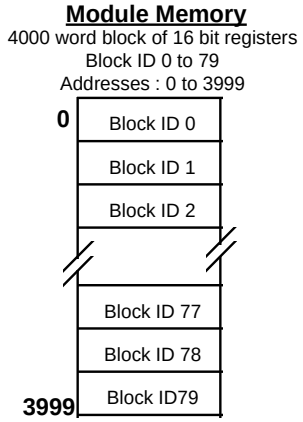
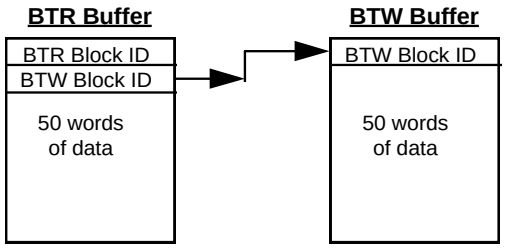
2 Block Transfer
- Test CTS pin to assure module is not in transmit mode
- Test slave port buffer to be sure not receiving
- Test Block Transfer Delay counter
- If all OK then block transfer

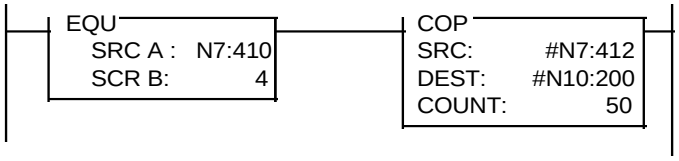


The Data Space in the module

One of the concepts which is important to develop an understanding of is the relationship between the data space in the module and how this data can be moved between the module and the PLC/SLC processor.

The following discussion explains the data structure in the module and how this data can be moved between the module and the ladder program. Some key points to understand:

Key Point	Description
Size of data register space in the module	The module maintains a 4000 word data space which can be used as needed by the application for data storage 
How 4000 word module data space is broken down in blocks	This 4000 words block of data is logically broken down into 80 fifty (50) word blocks: 80 blks x 50 wrds/blk=4000 words 
How data is 'paged' between the module and processor	Via the data transfer sequence outlined in the next section, 50 word blocks of data (or 'pages') are transferred bi-directionally between the module and the PLC/SLC processor. 

Key Point	Description
How data 'page' is placed in the processor's data table	The placement of data in the PLC/SLC processor is controlled by the user and the application ladder logic. Any available data file in the processor can be used as a source of data for the module and as a destination for data from the module. 

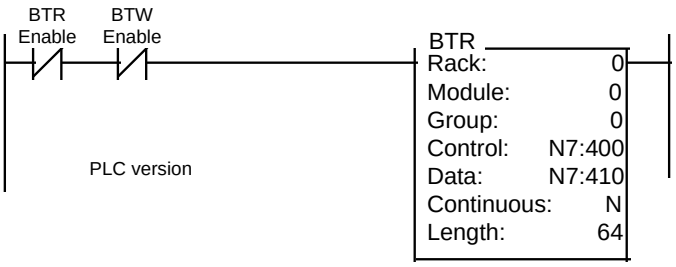
Backplane Data Transfer

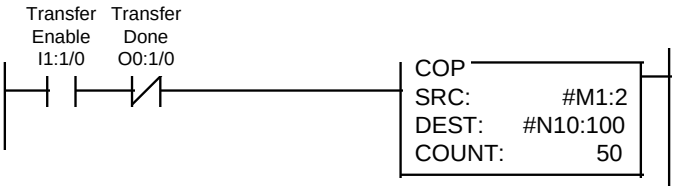
The following table describes the data transfer process between the Rockwell Automation processor and the module. This process is effectively controlled by the ladder logic in the processor. The following provides some insight into the steps which occur in the module and in the ladder to effect a successful data transfer. Example Ladder Logic (page 106) contains an actual implementation.

Step Number	Description

Step 1	Module generates BTR and BTW Block ID numbers based on the following logic:
	`BTW Block ID`
	`  if ( BTW Block ID >= Write Block Cnt ) then`
	`BTW Block ID = 80`
	`  elseif( BTW Block ID >= 80 + Command Block Cnt) then`
	`BTW Block ID = Write Block Start`
	`  else BTW block ID = BTW block ID + 1`
	`BTR Block ID`
	`  if ( BTR Block ID >= Read Block Cnt ) then`
	`BTR Block ID = Read Block Start`
	`  else BTR block ID = BTR block ID + 1`

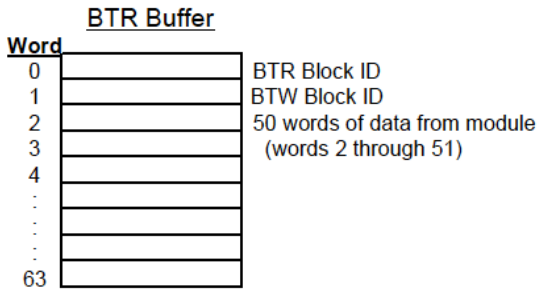
Step Number	Description
Step 2	Module executes a BTR command with the Rockwell Automation Processor.



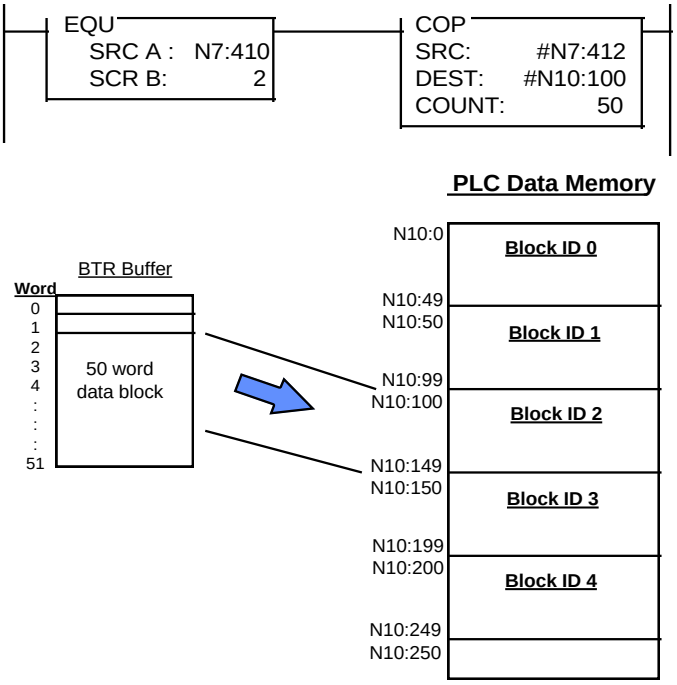


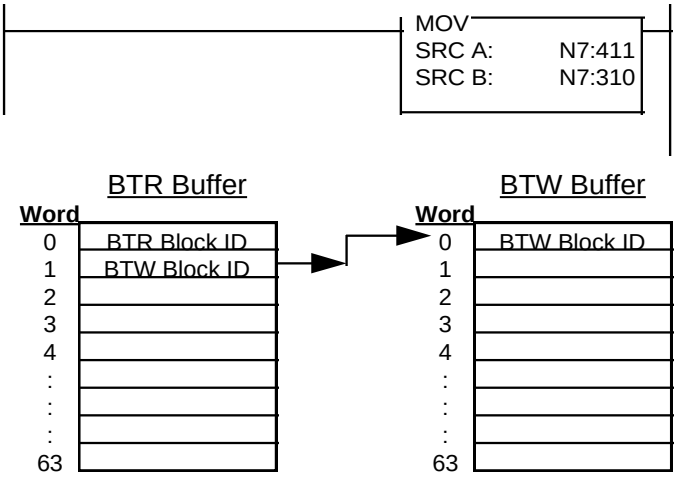
SLC version : When the Input bit goes true (the module turns this bit on), the data is ready to be copied out of the M1 file

The structure of the BTR buffer being transferred from the module is:

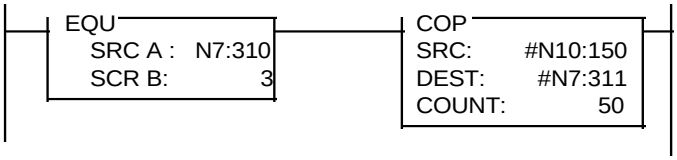


Step Number	Description
Step 3	The ladder logic decodes the BTR Block ID and copies the data from the BTR buffer into the ladder data table based on the value of the BTR Block ID.
Step 4	Transfer the BTW Block ID from the BTR Buffer to the BTW buffer.

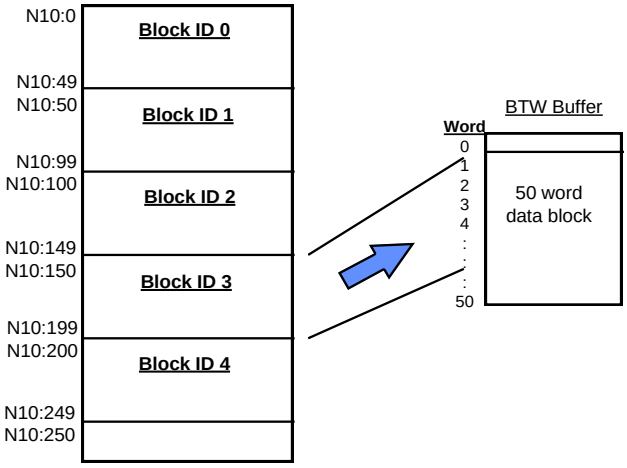




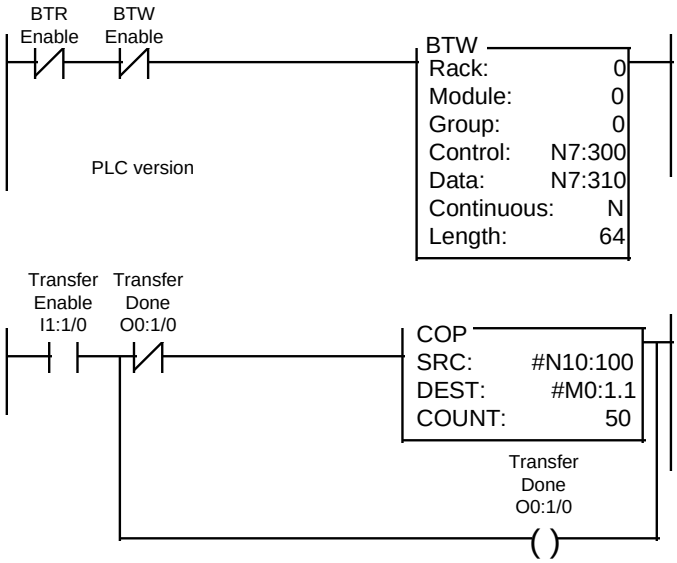
Step Number	Description
Step 5	Copy ladder data memory, whether Data, Command List or Configuration, to the BTW buffer. The actual data copied depends on the decoding of the BTW Block ID number.



PLC Data Memory



Step 6	Execute the BTW Command



SLC version : When the ladder logic has transferred the ladder data into the M0 file, the Transfer Done bit is set by the ladder. This bit is used by the module to determine when the transfer process is complete.

Step 7	The module receives the BTW data. After decoding the BTW Block ID number, the module will transfer the BTW buffer data into the correct location in the modules memory.

Interlocking the Block Transfers

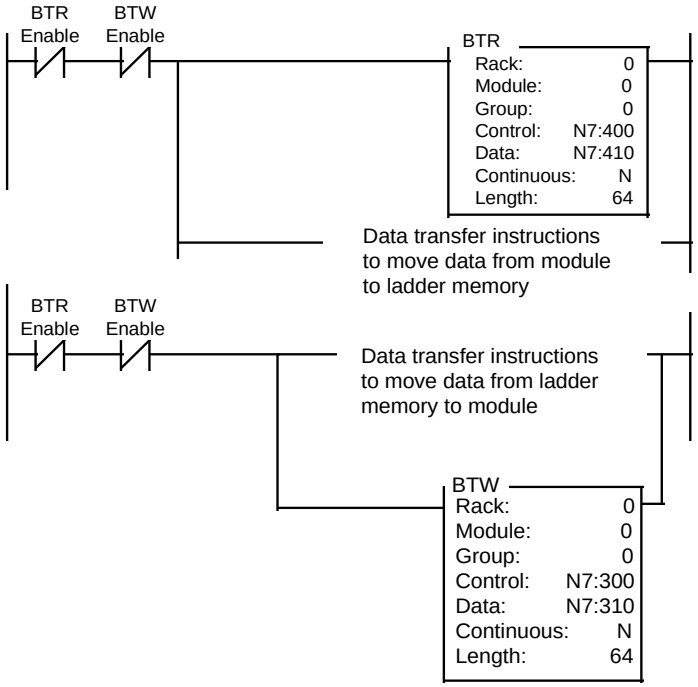
One of the fundamental assumptions that the module makes is that there will be one BTR per one BTW command. In the module, upon completing the BTR instruction, the module jumps immediately to the BTW instruction. To the programmer who follows our example logic this has rather minor implications.

Problems arise however when a ladder logic implementation is attempted which does not meet the module's block transfer expectations. Specifically, the following must be adhered to when programming the ladder logic for the module:

PLC Program using BTR/BTW Instructions

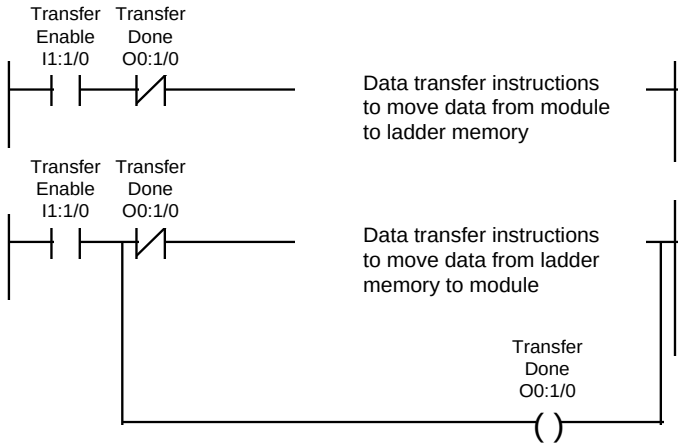
In the 1771 types of processors (PLC 2, PLC 3 and PLC 5), the BTR and BTW Enable bits must be used to enable the Block Transfer Instructions. With this type of programming, the PLC is guaranteed not to execute two block transfers at the same time, and the BTR and BTW instructions are guaranteed to alternate.

Ample examples of this type of block transfer programming are available in Rockwell Automation documentation as well as in the example ladder logic program in the Reference (page 69) section.



SLC Program using M0/M1Instructions

In the SLC processors, there is no true mechanism for guaranteeing the integrity of data block transfers, as there is in the PLC platform. For this reason we have developed a handshaking mechanism which is designed to assure that all the words in the M0 and M1 files are transferred in unison. Following this mechanism is the only way that we can assure that the data in a block corresponds to the Block ID being transferred. The basic ladder programming which must be implemented in an SLC application is as follows:



SLC Processor Configuration

When initially setting up the SLC program file, or when moving the module from one slot to another, you must configure the slot to accept the MCM module.

It is important that the slot containing the ProSoft module be configured as follows:

- 1746-BAS module with 5/02 or greater configuration
- or enter 13106 for the module ID code
- Configure the M0/M1 files for 64 words
- Configure I/O for 8 words

The following is a step by step on how to configure these files using Rockwell Automation APS software. Other software applications users should follow similar steps.

From the Main Menu:

1 Select the correct processor program and F3 for Off-line programming

2 F1 for Processor Functions

3 F1 for Change Processor

Modify the processor here if necessary (Note the MCM will only work with 5/02 or greater processors

4 F5 for Configure I/O

Select *1746-BAS module for SLC 5/02* or greater, or enter 13106 for module code

5 F9 for SPIO Config when the correct slot is highlighted

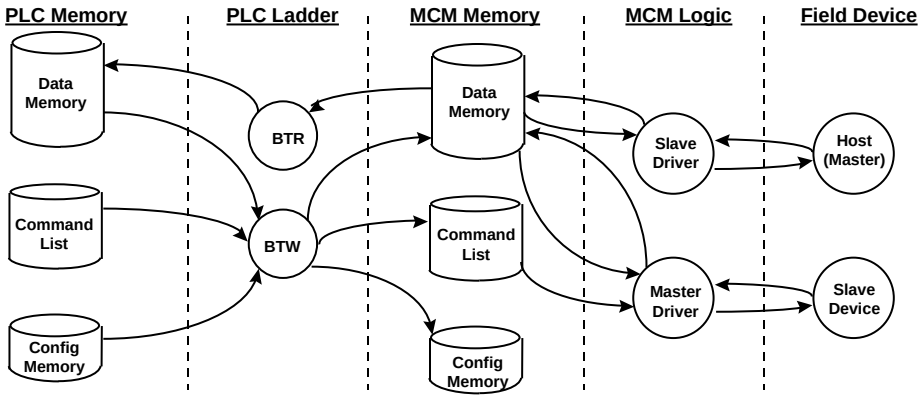
6 F5 Advanced Setup
7 F5 for M0 file length: type in 64 and Enter
8 F6 for M1 file length: type in 64 and Enter

Esc out and save configuration

7.3.4 Data Flow

General concepts

In developing a solid understanding of the module's operation, it is important to understand the movement of data in between the ladder logic, the module and the Master/Slave drivers.



The following topics describe the flow of data in the different stages. Further discussion is available in later sections on the flow of data under the different operating modes of the ports.

Reading data from the module

The module maintains a 4000 block of data memory. This memory contains:

1 The results of Master port transactions
2 Data moved to the module through the Slave port
3 Slave port Status data
4 Module Revision information
5 Master port Status data

During the transfer of data from the module to the PLC, the ladder logic is able to gain access to this information.

Writing data to the module

The module, depending on the configuration of the ports, requires three basic types of data in order to operate correctly. The three types of memory which can be transferred to the module are as follows:

1 Configuration Data. This data contains all of the parameters necessary for the module to configure the serial ports and to set up the data transfers between the module and the ladder logic

2 Command List . This set of data contains all of the parameters the module required to encode valid commands which will be transmitted out the Master port to other Modbus slave devices. Up to 20 Command List blocks can be sent to the module for a total of 100 commands
3 Data Memory. This type of memory is moved to the module to provide the data values necessary for the Slave port to service read requests (that is, the data that a host would receive as the result of a read command), or for the Master port to service write requests (that is, the data written to the slaves).

Master Port Driver

Under normal applications, the Master port is used primarily to issue read commands to slave devices, thereby acting as a data gatherer and then transferring the data which has been read to the ladder logic.

The module uses the Command List entries to encode valid Modbus commands. As each command is executed, the module scans for the next entry in the Command List. If the Master port is issuing a read command, the results of the read are deposited in the Data Memory. If the Master port is issuing a write command, data from the Data Memory is written to the slave device.

For every command which the module executes, the status of the command can be found in the Master Error Table. This table can be located anywhere in the Data Memory block and is read back into the ladder logic as part of the regular data transfer process.

Slave Port Driver

Operation of the Slave port can actually be a function of how the Slave port is configured. The port can operate in 3 modes:

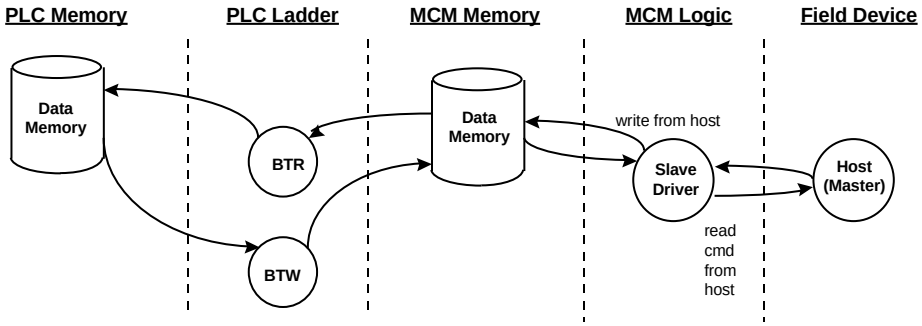
1 Normal Mode. In this mode, host read commands are serviced directly out of the Data Memory block and host write command data is sent directly into the Data Memory
2 Pass Through Mode. In this mode, hosts read request are services as in the Normal Mode, directly out of the Data Memory block. The principle difference is that host write commands are transferred to the BTR buffer for processing in the ladder logic
3 Route Mode. This mode is available when one port is configured as a Master and the other port is a Slave . In this mode, the Slave driver checks every command's slave address against up to six entries in the Routing Table (user setup). If there is a match, the command which has been received on the slave port is routed out the master port. The response from the slave is received by the module and transferred to the slave port for transmission to the host.

The following topics provide some data flow diagrams to assist in understanding the different modes.

Slave Port: Normal Mode

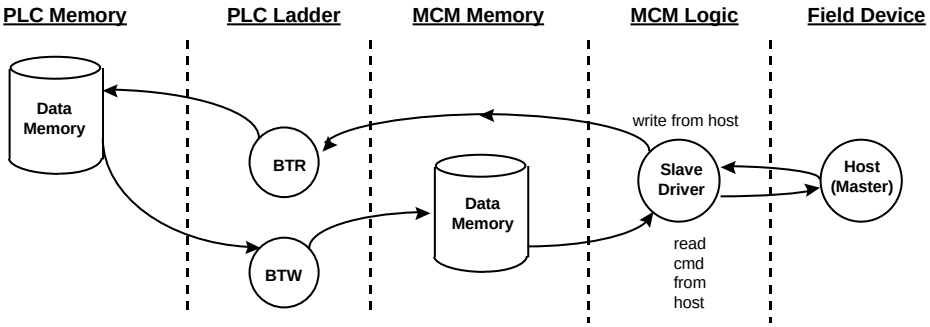
Under normal operation (that is, no special features enabled) the Slave port services all of received read and write requests using the Data Memory. This offers the advantage that it is very simple to set up and requires very little ladder logic to implement.

The primary requirement is that the data space which the host is writing into must not overlap with the data space which the ladder logic is writing into. Under many conditions, this limitation does not pose a problem, in which case this is the best mode in which to configure the module.



Slave Port: Pass Through Mode

The Pass Through Mode offers the advantage that it overcome the one limitation imposed by the Normal mode. As mentioned above, if host write commands received by the slave port must overlap with the address space which the ladder logic is also writing into, then the Normal Mode cannot be used.



In the Pass Through mode, all write commands received by the module (addressed to the local slave address or broadcast) are transferred into the BTR buffer for handling by the ladder logic. This mode offers several advantages:

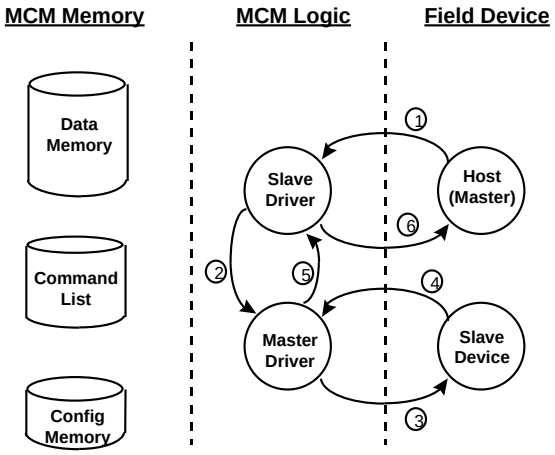
- The ladder data table can be accessed directly by the host commands
- All write commands can be conditionally accepted by implementing ladder logic which limits such things as address range, data value limits, and so on.
- The ladder program will know definitively when the slave port has received a write command from the host. In the Normal Mode, the ladder logic cannot differentiate between the types of commands which have been handled.

The only consideration to implementing the Pass Through Mode is that the ladder logic requirements are a bit more substantial than those of the Normal Mode.

Slave Port: Route Mode

The Route Mode can be a powerful tool if a host must have periodic access to data from a slave connected to the module' master port. This can be a common requirement in SCADA types of applications where there may be some other Modbus devices connected to the Master port (such as Flow Computers) which have large volumes of data useful to a host but not required by the local PLC/SLC.

When the Slave driver detects that a command has been received for a device in the module's Route List (configured during module setup), the following steps occur:



1 The host issues a read or write command to a slave address matching one of the entries in the MCM module's Route List
2 The MCM Slave driver detects the match with the entry in the Route List and sends the command to the Master driver
3 The Master driver executes the command at the soonest possible time (that is, as soon as any currently executing command transaction is completed)
4 The addressed slave responds to the command
5 The slave's response is passed from the Master driver to the Slave driver
6 The Slave driver returns the response to the Host

7.3.5 Modbus Addressing

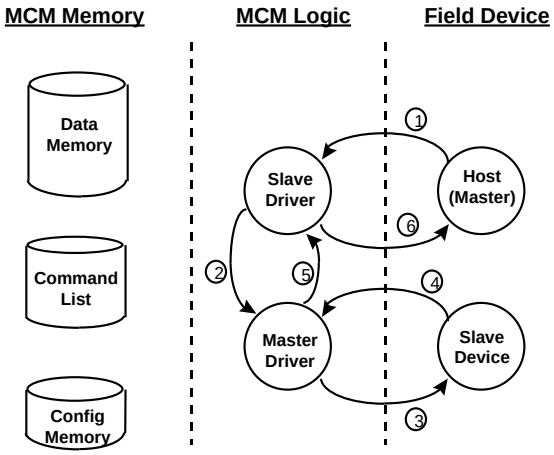
When applying the MCM module, whether as a Master or as a Slave, it is important to understand, to at least a minimum level, the issues associated with Modbus addressing. This section provides a primer on Modbus addressing to familiarize new Modbus users with terminology and concepts. If more is desired on the subject of Modbus, excerpts from the Modbus Protocol Specifications are available in the Reference (page 69) section.

Modbus Addressing Concepts

The Modbus addressing scheme was developed early on around the data table and I/O structure in Modicon PLCs. As a result, the Modbus protocol supports access to the various data spaces in the Modicon PLC.

By far the most common data space used is the 4xxxx space using the Function Codes 3, 6 and 16. This space transfers 16 bit register values, floating point values, and even bit mapped data. Using formal Modbus addressing terminology, this data space actually starts at address 40001 (Modbus is one based, while the MCM data table addressing is zero (0) based).

Access to the different data spaces is determined by the Function Code which is used. The following chart shows the four different types of data spaces, the numerical range of these spaces, and the function codes which execute read and write instructions within these data spaces.



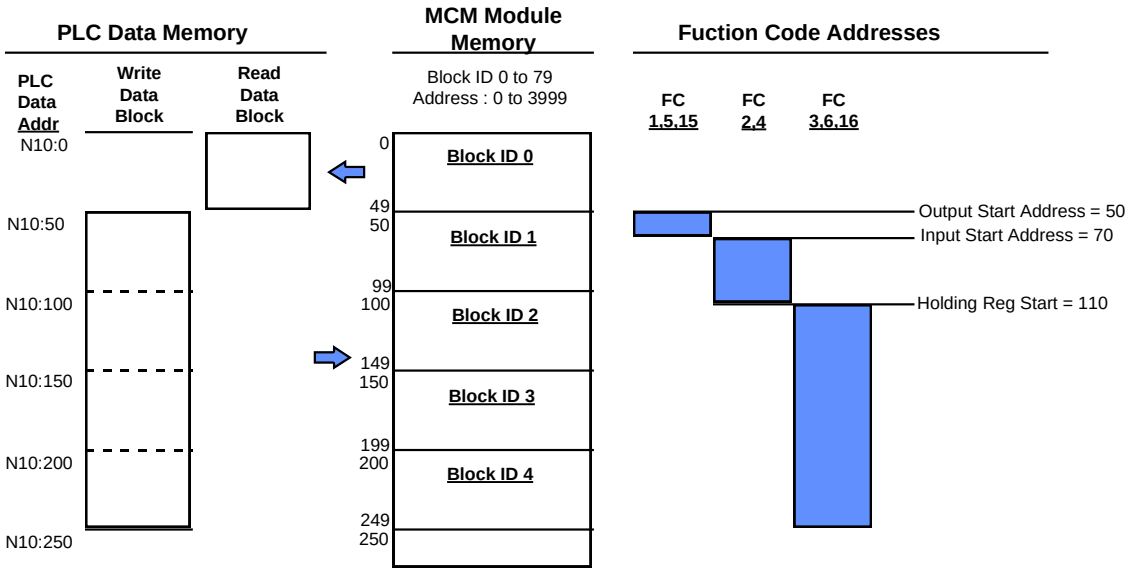
MCM Support of Modbus Functionality

The MCM module supports all of the common Modbus Function Codes used for data transfer. The following table documents the Function Codes and the addressing ranges which are supported.

Function Code	Description	Address Range
1	Read Output Status	0001 to 9999
2	Read Input Status	10001 to 29999
3	Read Holding Regs	40001 to 49999
4	Read Input Regs	30001 to 39999
5	Force Single Coil	00001 to 9999
6	Preset Single Reg	40001 to 49999
8	Loopback Test	
15	Force Multiple Coils	0001 to 9999
16	Preset Multiple Regs	40001 to 49999

Mapping Modbus Addresses to Ladder Data Addresses

The relationship between the ladder logic and the Modbus addressing scheme is controlled by the Application Programmer. The following diagram is an example of the memory map which could be setup in an application involving the module.



In this example, the MCM is setup as a Modbus Slave responding to queries from a Host. The Host will read data from the module starting at module register 50. The following memory table will be true for this layout:

Function Code	Module Address	Modbus Address
1,5,15	50 to 69	801 to 1120
2, 4	70 to 109	11121 to 11760 30071 to 30110
3, 6, 16	110 to 249	40111 to 40250

7.4 Modbus Protocol Specification

The following pages give additional reference information regarding the Modbus protocol commands supported by the 3100-3150 MCM.

7.4.1 Read Coil Status (Function Code 01)

Query

This function allows the user to obtain the ON/OFF status of logic coils used to control discrete outputs from the addressed Slave only. Broadcast mode is not supported with this function code. In addition to the Slave address and function fields, the message requires that the information field contain the initial coil address to be read (Starting Address) and the number of locations that will be interrogated to obtain status data.

The addressing allows up to 2000 coils to be obtained at each request; however, the specific Slave device may have restrictions that lower the maximum quantity. The coils are numbered from zero; (coil number 1 = zero, coil number 2 = one, coil number 3 = two, and so on).

The following table is a sample read output status request to read coils 0020 to 0056 from Slave device number 11.

Adr	Func	Data Start Pt Hi	Data Start Pt Lo	Data # Of Pts Ho	Data # Of Pts Lo	Error Check Field
11	01	00	13	00	25	CRC

Response

An example response to Read Coil Status is as shown in Figure C2. The data is packed one bit for each coil. The response includes the Slave address, function code, quantity of data characters, the data characters, and error checking. Data will be packed with one bit for each coil (1 = ON, 0 = OFF). The low order bit of the first character contains the addressed coil, and the remainder follow. For coil quantities that are not even multiples of eight, the last characters will be filled in with zeros at high order end. The quantity of data characters is always specified as quantity of RTU characters, that is, the number is the same whether RTU or ASCII is used.

Because the Slave interface device is serviced at the end of a controller's scan, data will reflect coil status at the end of the scan. Some Slaves will limit the quantity of coils provided each scan; thus, for large coil quantities, multiple PC transactions must be made using coil status from sequential scans.

Adr	Func	Byte Count	Data Coil Status 20 to 27	Data Coil Status 28 to 35	Data Coil Status 36 to 43	Data Coil Status 44 to 51	Data Coil Status 52 to 56	Error Check Field
11	01	05	CD	6B	B2	OE	1B	CRC

The status of coils 20 to 27 is shown as CD(HEX) = 1100 1101 (Binary). Reading left to right, this shows that coils 27, 26, 23, 22, and 20 are all on. The other coil data bytes are decoded similarly. Due to the quantity of coil statuses requested, the last data field, which is shown 1B (HEX) = 0001 1011 (Binary), contains the status of only 5 coils (52 to 56) instead of 8 coils. The 3 left most bits are provided as zeros to fill the 8-bit format.

7.4.2 Read Input Status (Function Code 02)

Query

This function allows the user to obtain the ON/OFF status of discrete inputs in the addressed Slave PC Broadcast mode is not supported with this function code. In addition to the Slave address and function fields, the message requires that the information field contain the initial input address to be read (Starting Address) and the number of locations that will be interrogated to obtain status data.

The addressing allows up to 2000 inputs to be obtained at each request; however, the specific Slave device may have restrictions that lower the maximum quantity. The inputs are numbered form zero; (input 10001 = zero, input 10002 = one, input 10003 = two, and so on, for a 584).

The following table is a sample read input status request to read inputs 10197 to 10218 from Slave number 11.

Adr	Func	Data Start Pt Hi	Data Start Pt Lo	Data #of Pts Hi	Data #of Pts Lo	Error Check Field
11	02	00	C4	00	16	CRC

Response

An example response to Read Input Status is as shown in Figure C4. The data is packed one bit for each input. The response includes the Slave address, function code, quantity of data characters, the data characters, and error checking. Data will be packed with one bit for each input (1=ON, 0=OFF). The lower order bit of the first character contains the addressed input, and the remainder follow. For input quantities that are not even multiples of eight, the last characters will be filled in with zeros at high order end. The quantity of data characters is always specified as a quantity of RTU characters, that is, the number is the same whether RTU or ASCII is used.

Because the Slave interface device is serviced at the end of a controller's scan, data will reflect input status at the end of the scan. Some Slaves will limit the quantity of inputs provided each scan; thus, for large coil quantities, multiple PC transactions must be made using coil status for sequential scans.

Adr	Func	Byte Count	Data Discrete Input 10197 to 10204	Data Discrete Input 10205 to 10212	Data Discrete Input 10213 to 10218	Error Check Field
11	02	03	AC	DB	35	CRC

The status of inputs 10197 to 10204 is shown as AC (HEX) = 10101 1100 (binary). Reading left to right, this show that inputs 10204, 10202, and 10199 are all on. The other input data bytes are decoded similar.

Due to the quantity of input statuses requested, the last data field which is shown as 35 HEX = 0011 0101 (binary) contains the status of only 6 inputs (10213 to 102180) instead of 8 inputs. The two left-most bits are provided as zeros to fill the 8-bit format.

7.4.3 Read Holding Registers (Function Code 03)

Query

Read Holding Registers (03) allows the user to obtain the binary contents of holding registers 4xxxx in the addressed Slave. The registers can store the numerical values of associated timers and counters which can be driven to external devices. The addressing allows up to 125 registers to obtained at each request; however, the specific Slave device may have restriction that lower this maximum quantity. The registers are numbered form zero (40001 = zero, 40002 = one, and so on). The broadcast mode is not allowed.

The example below reads registers 40108 through 40110 from Slave 584 number 11.

Adr	Func	Data Start Reg Hi	Data Start Reg Lo	Data #of Regs Hi	Data #of Regs Lo	Error Check Field
11	03	00	6B	00	03	CRC

Response

The addressed Slave responds with its address and the function code, followed by the information field. The information field contains 1 byte describing the quantity of data bytes to be returned. The contents of the registers requested (DATA) are two bytes each, with the binary content right justified within each pair of characters. The first byte includes the high order bits and the second, the low order bits.

Because the Slave interface device is normally serviced at the end of the controller's scan, the data will reflect the register content at the end of the scan. Some Slaves will limit the quantity of register content provided each scan; thus for large register quantities, multiple transmissions will be made using register content from sequential scans.

In the example below, the registers 40108 to 40110 have the decimal contents 555, 0, and 100 respectively.

Adr	Func	ByteCnt	Hi Data	Lo Data	Hi Data	Lo Data	Hi Data	Lo Data	Error Check Field
11	03	06	02	2B	00	00	00	64	CRC

7.4.4 Read Input Registers (Function Code 04)

Query

Function code 04 obtains the contents of the controller's input registers at addresses 3xxxx. These locations receive their values from devices connected to the I/O structure and can only be referenced, not altered from within the controller, The addressing allows up to 125 registers to be obtained at each request; however, the specific Slave device may have restrictions that lower this maximum quantity. The registers are numbered for zero (30001 = zero, 30002 = one, and so on). Broadcast mode is not allowed.

The example below requests the contents of register 3009 in Slave number 11.

Adr	Func	Data Start Reg Hi	Data Start Reg Lo	Data #of Regs Hi	Data #of Regs Lo	Error Check Field
11	04	00	08	00	01	CRC

Response

The addressed Slave responds with its address and the function code followed by the information field. The information field contains 1 byte describing the quantity of data bytes to be returned. The contents of the registers requested (DATA) are 2 bytes each, with the binary content right justified within each pair of characters. The first byte includes the high order bits and the second, the low order bits.

Because the Slave interface is normally serviced at the end of the controller's scan, the data will reflect the register content at the end of the scan. Each PC will limit the quantity of register contents provided each scan; thus for large register quantities, multiple PC scans will be required, and the data provided will be form sequential scans.

In the example below the register 3009 contains the decimal value 0.

Adr	Func	Byte Count	Data Input Reg Hi	Data Input Reg Lo	Error Check Field
11	04	02	00	00	E9

7.4.5 Force Single Coil (Function Code 05)

Query

This message forces a single coil either ON or OFF. Any coil that exists within the controller can be forced to either state (ON or OFF). However, because the controller is actively scanning, unless the coil is disabled, the controller can also alter the state of the coil. Coils are numbered from zero (coil 0001 = zero, coil 0002 = one, and so on). The data value 65,280 (FF00 HEX) will set the coil ON and the value zero will turn it OFF; all other values are illegal and will not affect that coil.

The use of Slave address 00 (Broadcast Mode) will force all attached Slaves to modify the desired coil.

Note: Functions 5, 6, 15, and 16 are the only messages that will be recognized as valid for broadcast.

The example below is a request to Slave number 11 to turn ON coil 0173.

Adr	Func	Data Coil # Hi	Data Coil # Lo	Data On/off Ind	Data	Error Check Field
11	05	00	AC	FF	00	CRC

Response

The normal response to the Command Request is to re-transmit the message as received after the coil state has been altered.

Adr	Func	Data Coil # Hi	Data Coil # Lo	Data On/ Off	Data	Error Check Field
11	05	00	AC	FF	00	CRC

The forcing of a coil via MODBUS function 5 will be accomplished regardless of whether the addressed coil is disabled or not (*In ProSoft products,* the coil *is only affected if the necessary ladder logic is implemented).*

Note: The Modbus protocol does not include standard functions for testing or changing the DISABLE state of discrete inputs or outputs. Where applicable, this may be accomplished via device specific Program commands (*In ProSoft products, this is only accomplished through ladder logic programming).*

Coils that are reprogrammed in the controller logic program are not automatically cleared upon power up. Thus, if such a coil is set ON by function Code 5 and (even months later), an output is connected to that coil, the output will be "hot".

7.4.6 Preset Single Register (Function Code 06)

Query

Function (06) allows the user to modify the contents of a holding register. Any holding register that exists within the controller can have its contents changed by this message. However, because the controller is actively scanning, it also can alter the content of any holding register at any time. The values are provided in binary up to the maximum capacity of the controller unused high order bits must be set to zero. When used with Slave address zero (Broadcast mode) all Slave controllers will load the specified register with the contents specified.

Note Functions 5, 6, 15, and 16 are the only messages that will be recognized as valid for broadcast.

Adr	Func	Data Start Reg Hi	Data Start Reg Lo	Data #of Regs Hi	Data #of Regs Lo	Error Check Field
11	06	00	01	00	03	CRC

Response

The response to a preset single register request is to re-transmit the query message after the register has been altered.

Adr	Func	Data Reg Hi	Data Reg Lo	Data Input Reg Hi	Data Input Reg Lo	Error Check Field
11	06	00	01	00	03	CRC

7.4.7 Force Multiple Coils (Function Code 15)

Query

This message forces each coil in a consecutive block of coils to a desired ON or OFF state. Any coil that exists within the controller can be forced to either state (ON or OFF). However, because the controller is actively scanning, unless the coils are disabled, the controller can also alter the state of the coil. Coils are numbered from zero (coil 00001 = zero, coil 00002 = one, and so on). The desired status of each coil is packed in the data field, one bit for each coil (1= ON, 0= OFF). The use of Slave address 0 (Broadcast Mode) will force all attached Slaves to modify the desired coils.

Note: Functions 5, 6, 15, and 16 are the only messages (other than Loopback Diagnostic Test) that will be recognized as valid for broadcast.

The following example forces 10 coils starting at address 20 (13 HEX). The two data fields, CD =1100 and 00 = 0000 000, indicate that coils 27, 26, 23, 22, and 20 are to be forced on.

Adr	Func	Hi Add	Lo Add	Quantity	Byte Cnt	Data Coil Status 20 to 27	Data Coil Status 28 to 29	Error Check Field	
11	0F	00	13	00	0A	02	CD	00	CRC

Response

The normal response will be an echo of the Slave address, function code, starting address, and quantity of coils forced.

Adr	Func	Hi Addr	Lo Addr	Quantity	Error Check Field	
11	0F	00	13	00	0A	CRC

The writing of coils via Modbus function 15 will be accomplished regardless of whether the addressed coils are disabled or not.

Coils that are unprogrammed in the controller logic program are not automatically cleared upon power up. Thus, if such a coil is set ON by function code 15 and (even months later) an output is connected to that coil, the output will be hot.

7.4.8 Preset Multiple Registers (Function Code 16)

Query

Holding registers existing within the controller can have their contents changed by this message (a maximum of 60 registers). However, because the controller is actively scanning, it also can alter the content of any holding register at any time. The values are provided in binary up to the maximum capacity of the controller (16-bit for the 184/384 and 584); unused high order bits must be set to zero.

Note: Function codes 5, 6, 15, and 16 are the only messages that will be recognized as valid for broadcast.

Adr	Func	Hi Add	Lo Add	Quantity		Byte Cnt	Hi Data	Lo Data	Hi Data	Lo Data	Error Check Field
11	10	00	87	00	02	04	00	0A	01	02	CRC

Response

The normal response to a function 16 query is to echo the address, function code, starting address and number of registers to be loaded.

Adr	Func	Hi Addr	Lo Addr	Quantity		Error Check Field
11	10	00	87	00	02	56

7.5 Jumper Configurations

The following section describes the available jumper configurations for the 1771 (PLC) and 1746 (SLC) platform solutions. As needed, differences between the module based solutions and the firmware based solutions are highlighted.

3100 for the 1771 Platform

Following are the jumper positions for the ProSoft Technology 3100-MCM module:

Jumper	3100
JW1	N/A
JW2	N/A
JW3	N/A
JW4	Flash Pgm/Run Mode
JW5	8 Pt
JW6	Not Used
JW7	Enabled
JW8	Port 2 RS-232/422/485 config
JW9	Port 1 RS-232/422/485 config

JW4 Flash Pgm/Run Mode Select Run Position

The position of this jumper should only be changed if needing to reprogram the MCM FLASH memory. This will only need to be done if the module is to be upgraded in the field to a later version of firmware.

JW5 Backplane 8/16 point 8 Point

The module should be operated in the 8 point configuration unless specifically directed otherwise by ProSoft technical support.

JW7 Battery Enable / Disable Enabled

This jumper should be placed in the Enabled position when the module is powered up. Although not critical to the operation of the module, this will back up some data registers in the module during a power failure or reset.

JW8/9 RS Configuration for Port 1 and 2 RS-232,422,485

The default is RS-232, but all options are supported by the MCM firmware

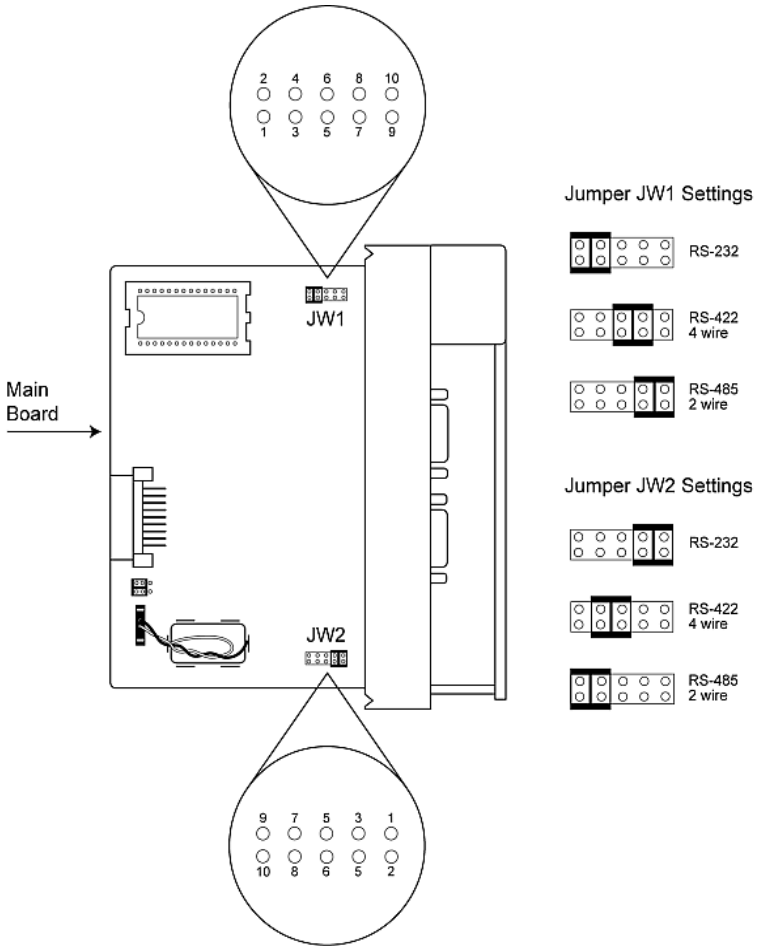
3150 for the 1746 Platform

Following are the jumper positions for the ProSoft Technology 3150-MCM module:

Jumper	3150-MCM
JW1	As Needed
JW2	As Needed

JW1/2 RS configuration for port 1 and 2 RS-232 Position

The default is RS-232, but RS-422 and RS-485 are supported by the firmware and hardware. Refer to the following diagram:



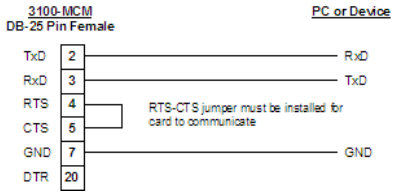
7.6 Cable Connections

The following diagrams show the connection requirements for the ports on the 3100 and 3150 modules.

3100-MCM Module

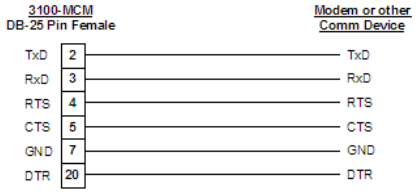
RS-232 w/ No Hardware Handshaking

Port Connection with another communication port



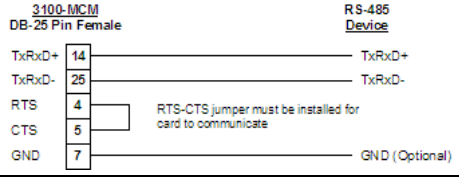
RS-232 w/ Hardware Handshaking

Port Connection with a modem or other similar device



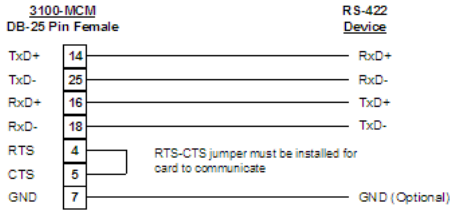
RS-485/2-Wire Connection

The jumper on the module must be set in the RS-485 position for all 2-wire applications



RS-422/4-Wire Connection

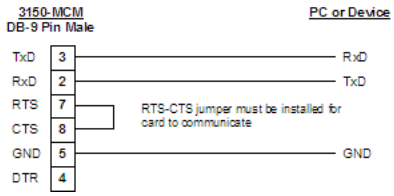
The jumper on the module must be in the RS-422 position for all 4-wire applications



3150-MCM Module

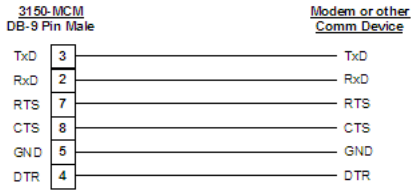
RS-232 w/ No Hardware Handshaking

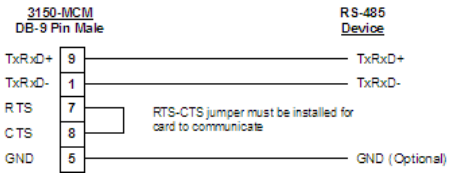
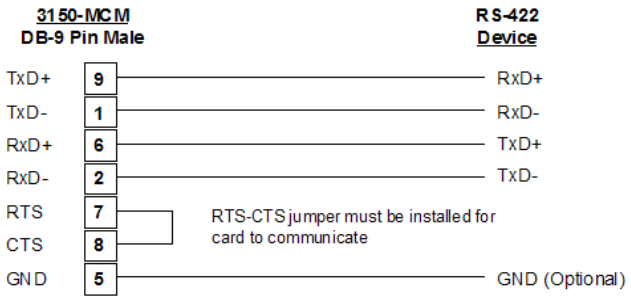
Port Connection with another communication port



RS-232 w/ Hardware Handshaking

Port Connection with a modem or other similar device



3150-MCM Module	
RS-485/2-Wire Connection The jumper on the module must be set in the RS-485 position for all 2-wire applications	
RS-422/4-Wire Connection The jumper on the module must be in the RS-422 position for all 4-wire applications	

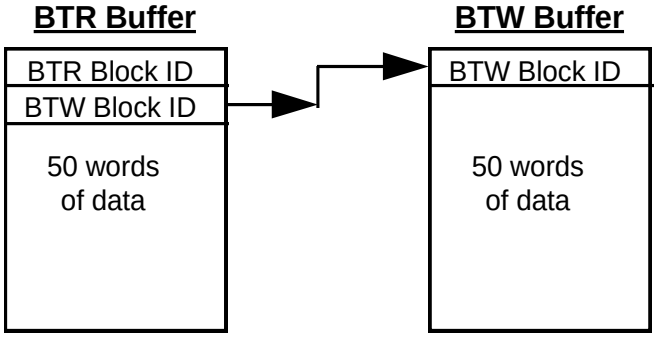
RS-485 and RS-422 Tip: If communication in the RS-422/RS-485 mode does not work at first, despite all attempts, try switching termination polarities. Some manufacturers interpret +/- and A/B polarities differently.

7.7 Read, Write and Command Block Count Values usage

As part of the configuration process, the User is able to configure several parameters in the Communication Configuration Data Block which have a strong impact on how the module transfers data with the PLC/SLC processor.

7.7.1 Overview

The BTR buffer contains the BTR and the BTW Block ID numbers. The BTR Block ID identifies the data contents, while the BTW Block ID is used by the ladder logic to determine which data to move to the module. Diagrammatically, the relationship is as follows:



7.7.2 Configuration Parameters

Three parameters which are important to the transfer of data are:

Read Block Count: This value represents the number of 50 word data blocks which are to be transferred from the MCM Module to the processor. The blocks returned from the module start at the value entered in the Read_Block_Start register and increments from there

Write Block Count: This value represents the number of 50 word data blocks which are to be transferred from the processor to the MCM Module.

Command Block Count: This value represents the number of 50 word Command Blocks which are to be transferred from the processor to the MCM Module.

These values are used by the module in order to determine how the BTW and BTR Block ID Codes are to be manipulated. Part of the functionality that the module provides is to control the incrementing and resetting of the BTR and BTW Block ID codes. This was done in the interest of limiting the amount of ladder logic required to support the module.

7.7.3 Module Operation

As a result of the configuration parameters entered, the module will cycle through the range of BTW and BTR Blocks. The cycle is based on the following equations:

7.7.4 BTW Block ID

```
if ( BTW Block ID >= Write_Block_Start + Write_Block_Cnt ) then BTW Block ID =
80
elseif( BTW Block ID >= 80 + Command_Block_Cnt) then BTW Block ID =
Write_Block_Start
else BTW block ID = BTW block ID + 1
```

7.7.5 BTR Block ID

```
if ( BTR Block ID >= Read_Block_Start + Read_Block_Cnt ) then BTR Block ID =
Read_Block_Start
else BTR block ID = BTR block ID + 1
```

For example, assume that we are configured with the following values:

Read_Block_Cnt	4
Write_Block_Cnt	1
Command_Block_Cnt	2
Read_Block_Start	1
Write_Block_Start	0

These configuration values would lead to the following cycle of Block ID codes:

BTW Block ID	**BTR Block ID**
0	1
80	2
81	3
0	4
80	1
81	2

Note that there is no implicit relationship between the absolute value in the BTW and the BTR Block ID.

7.8 Example Ladder Logic

The following example logic has been provided to assist you in developing applications more effectively.

7.8.1 Slave Mode Examples

Example #1: Slave Mode with Pass-Thru - Minimum Configuration

- MCM5EX1S PLC 5
- MCM3EX1S SLC 5/03

Example #2: Slave Mode with Pass-Thru - Expanded Application

- MCM5EX2S PLC 5
- MCM3EX2S SLC 5/03

7.8.2 Master Mode Examples

Example #1: Master Mode - Basic Application

- MCM5EX1M PLC 5
- MCM3EX1M SLC 5/03

Example #2: Master Mode with Command Control

- MCM5EX2M PLC 5
- MCM3EX2M SLC 5/03

7.9 Basic FAQs

7.9.1 3150-MCM as Master

Q: I want to use Port 1 (master) to read registers 4x0005 and 4x0006 from Slave #10, and store the results in N7:25 and N7:26. How do I do this?

A: Configure Cmd 1 with the following values:

Parameter	Value	Description
N7:50 =	1	Port 1, Continuous command
N7:51 =	10	Slave #10.
N7:52 =	3	Function code=3, "Read multiple holding/data registers"
N7:53 =	5	Source register = 4x0005. "4x" is implied by function code 3. Some devices may offset this by ±1.
N7:54 =	2	Register count = 2. This reads 2 registers.
N7:55 =	25	Destination = internal database 25 (in this example).
N7:56 =	0	No swapping of bytes.
N7:57 =	1	Polling interval = 1 second. Command executes once every 1 second.

Data from registers 4x0005 and 4x0006 of Slave #10 will be stored in MCM database addresses 25 and 26, and transferred to N7:25 and N7:26.

Q: I want to use Port 1 (master) to write values from N12:0, N12:1 and N12:2 to registers 4x0100, 101 and 102 in Slave #1. How do I do this?

A: Step 1: Move N12:0 to N12:2 to the Write data area N10:200 to N10:202 (Write a ladder rung using the SLC COP ladder command).

Step 2: N10:200 to N10:202 is paged to MCM database address 200 to 202 (Done automatically by sample ladder. Nothing to do here).

Step 3: Configure Cmd 2 with the following values:

Parameter	Value	Description
N7:60 =	1	Port 1, Continuous command (see manual section 4.4.2 for other options).
N7:61 =	1	Slave #1.
N7:62 =	16	Function code=16, "Write multiple holding/data registers" (see manual chapter 6 for other function codes).
N7:63 =	200	Source = MCM database address 200.
N7:64 =	3	Register count = 3. This writes 3 registers.
N7:65 =	100	Destination = register 4x0100. "4x" is implied by function code 16. Some devices may offset this by ±1.
N7:66 =	0	Not used.
N7:67 =	2	Polling interval = 2 seconds. Command executes once every 2 seconds.

7.9.2 3150-MCM as Slave

Q: A Modbus master wants to read 10 words, N12:13 to N12:22, from the SLC, through Port 2 (slave port). What should I do?

A: Step 1: Move N12:13 to N12:22 to the Write data area N10:203 to N10:212 (Write a ladder rung using the SLC COP ladder command).

Step 2: N10:203 to N10:212 is paged to MCM database address 203 to 212 (Done automatically by sample ladder. Nothing to do here).

Step 3: Configure the Modbus Master with the following parameters:

Parameter	Value	Description
Function code:	3	Function code=3, "Read multiple holding/data registers"
Modbus Slave node:	1	Port 2 is configured as slave node #1. This can be changed at N7:11.
Starting register:	204	Read starting from 4x0204, that is, MCM database address 203. Some devices may offset this by ±1.
Register count:	10	Read 10 registers

Q: A Modbus master wants to write 1 word to the SLC, through Port 2. What should I do?

A: Step 1: Configure the Modbus Master with the following parameters:

Parameter	Value	Description
Function code:	6	Function code=6, "Write single holding/data register"
Modbus Slave node:	1	Port 2 is configured as slave node #1. This can be changed at N7:11.
Starting register:	1	Write to 4x0001, that is, MCM database address 0. Some devices may offset this by ±1.

Step 2: MCM database address 0 is paged to N7:0 (Done automatically by sample ladder. Nothing to do here).

Data in N7:0 is now available for use in the ladder application.

7.9.3 Port Configuration

Q: How do I configure Port 1 to be Slave? Or Port 2 to be Master?

A: Set N7:0 = 1 to configure Port 1 as Slave. Set N7:10 = 0 to configure Port 2 as Master.

Q: How do I configure other port parameters, like baud rate and so on?

A: For Port 1:

Parameter	Description
N7:0	Configures Port 1 Master/Slave mode, pass-through mode, routing mode, stop bits, parity.
N7:1	Sets Port 1 Slave node address. Only valid if Port 1 is slave.
N7:2	Baud rate. See manual section 4.2

Parameter	Description
N7:3	RTS to TXD delay. See manual section 4.2
N7:4	RTS off delay. See manual section 4.2
N7:5	Message timeout. Only valid if Port 1 is master. See manual section 4.2

For Port 2, use N7:10 … N7:15.

Q: I've made changes to the configuration in runtime. How do I send this new configuration to the 3150-MCM module?

A: Toggle B3:0/0. This will cause the sample ladder to write Block ID 255 to the 3150-MCM module, sending the new configuration.

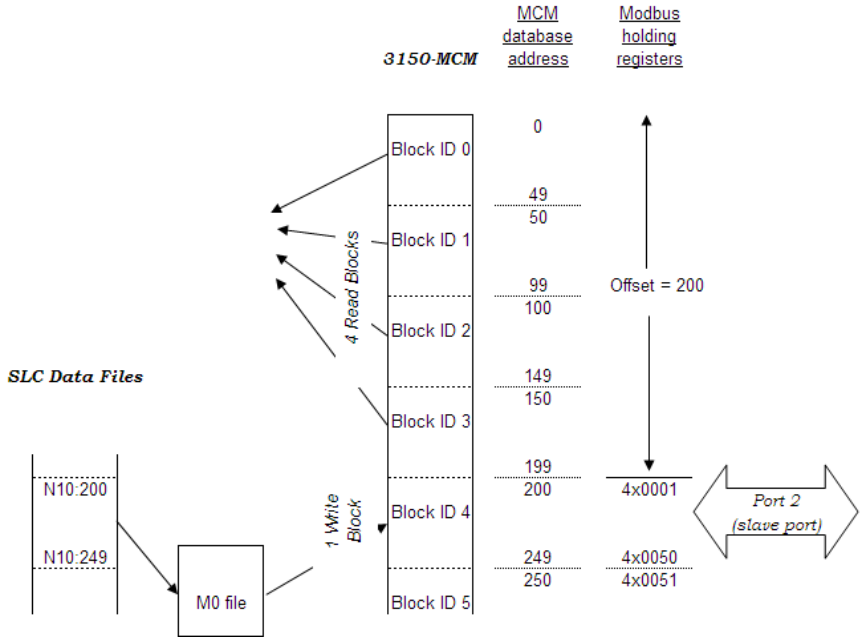
7.10 Intermediate FAQs

7.10.1 Slave Port Offsets

Q: The master that is communicating with Slave Port 2 must read from register 4x0001. But 4x0001 in the MCM is in the Read Block area to the Write Block starts from 4x0201. What can I do?

A: Configure the Port 2 Holding/Data Register Offset: N7:19 = 200. This will offset the 4x registers to start at MCM database address 200:

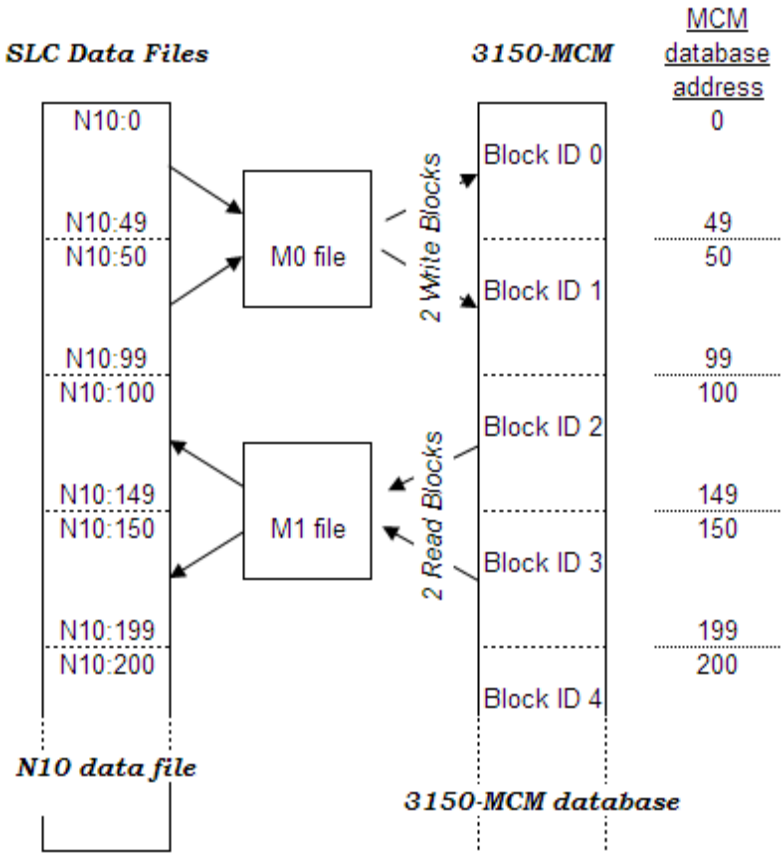
This is only used when the port is configured as Slave.



7.10.2 Read / Write Block Configuration

Q: How can I re-configure the location, and/or number, of Read and Write Blocks?

A: For example, to make the following configuration:

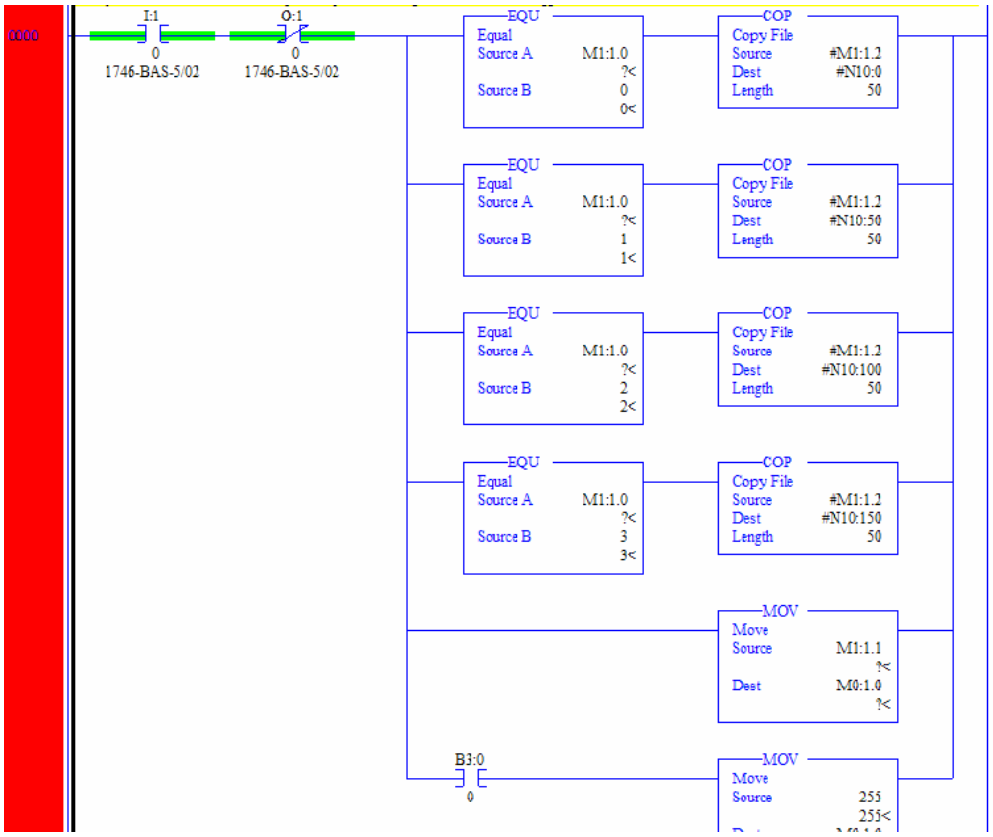


Step 1: Set the following parameters:

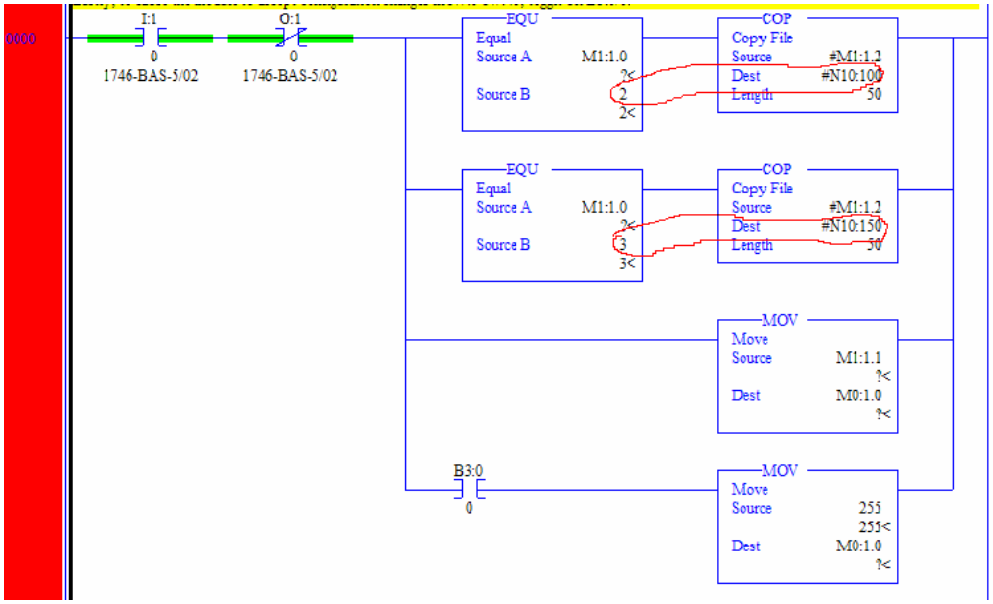
Parameter	Value	Description
N7:20 =	2	Number of Read Blocks
N7:21 =	2	Number of Write Blocks
N7:27 =	2	Read Block starting from Block ID 2
N7:28 =	0	Write Block starting from Block ID 0

Step 2: Modify the sample ladder Rung 0000 to match the Read Block configurations:

Before Modification

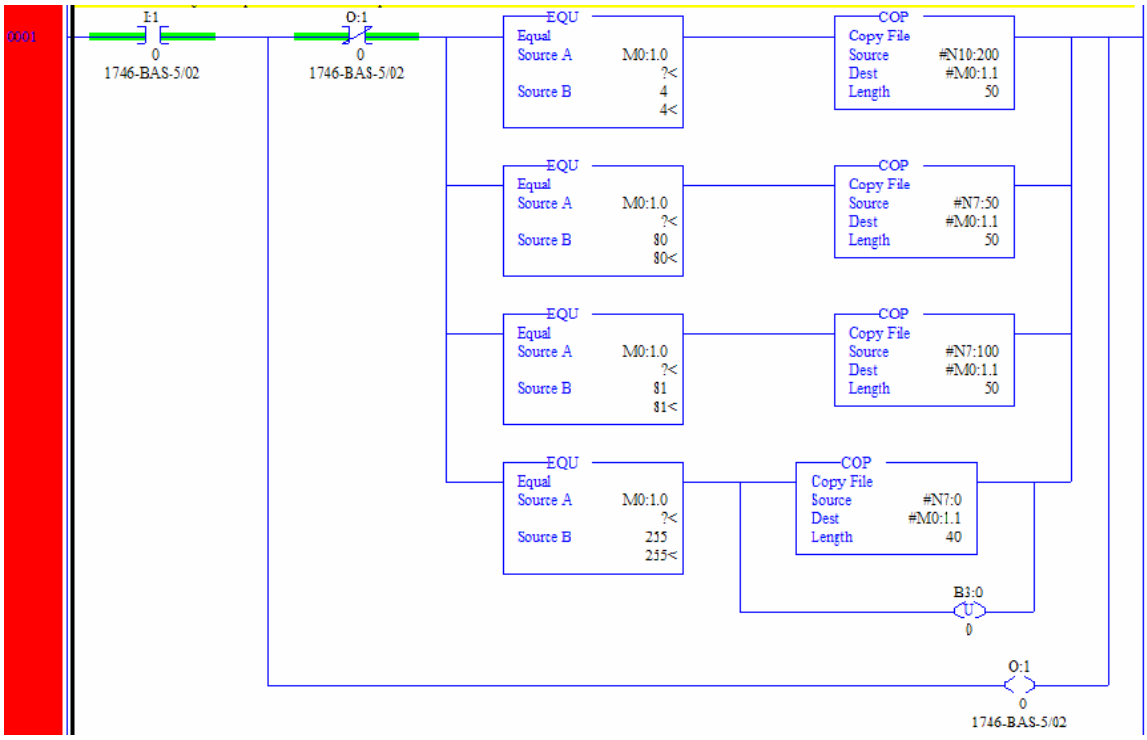


After Modification

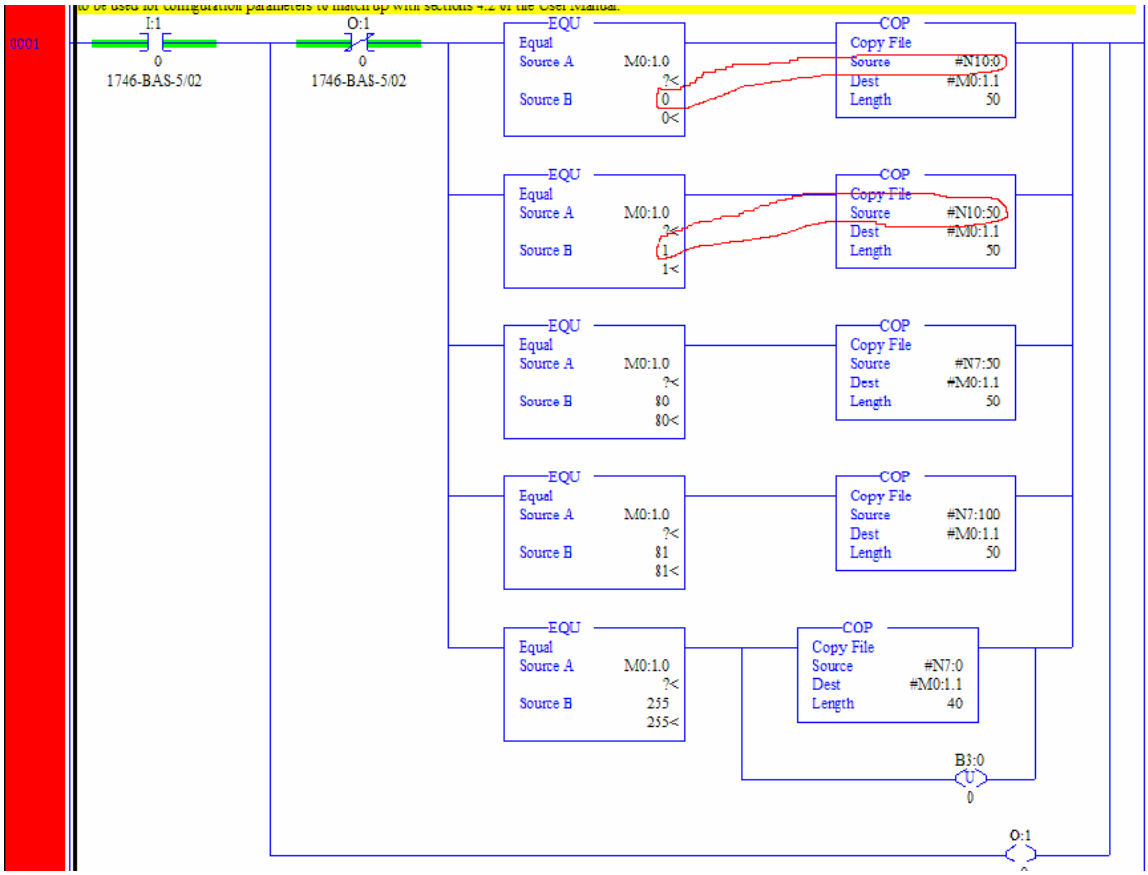


Step 3: Modify the sample ladder Rung 0001 to match the Write Block configurations:

Before Modification



After Modification



7.10.3 Command Configuration

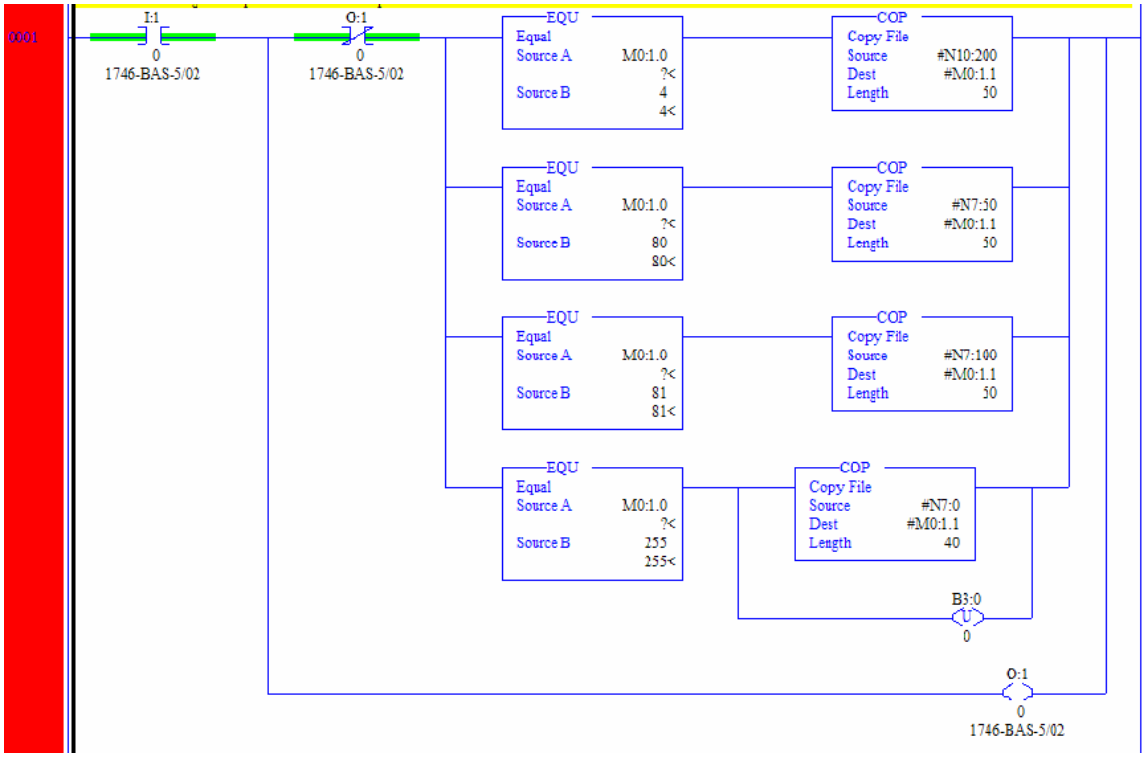
Q: How do I configure more than 10 commands?

A: The sample ladder allows 2 Command Blocks, with 5 commands per block. This gives a total of 10 commands. To increase this to 15 commands (max 100 commands):

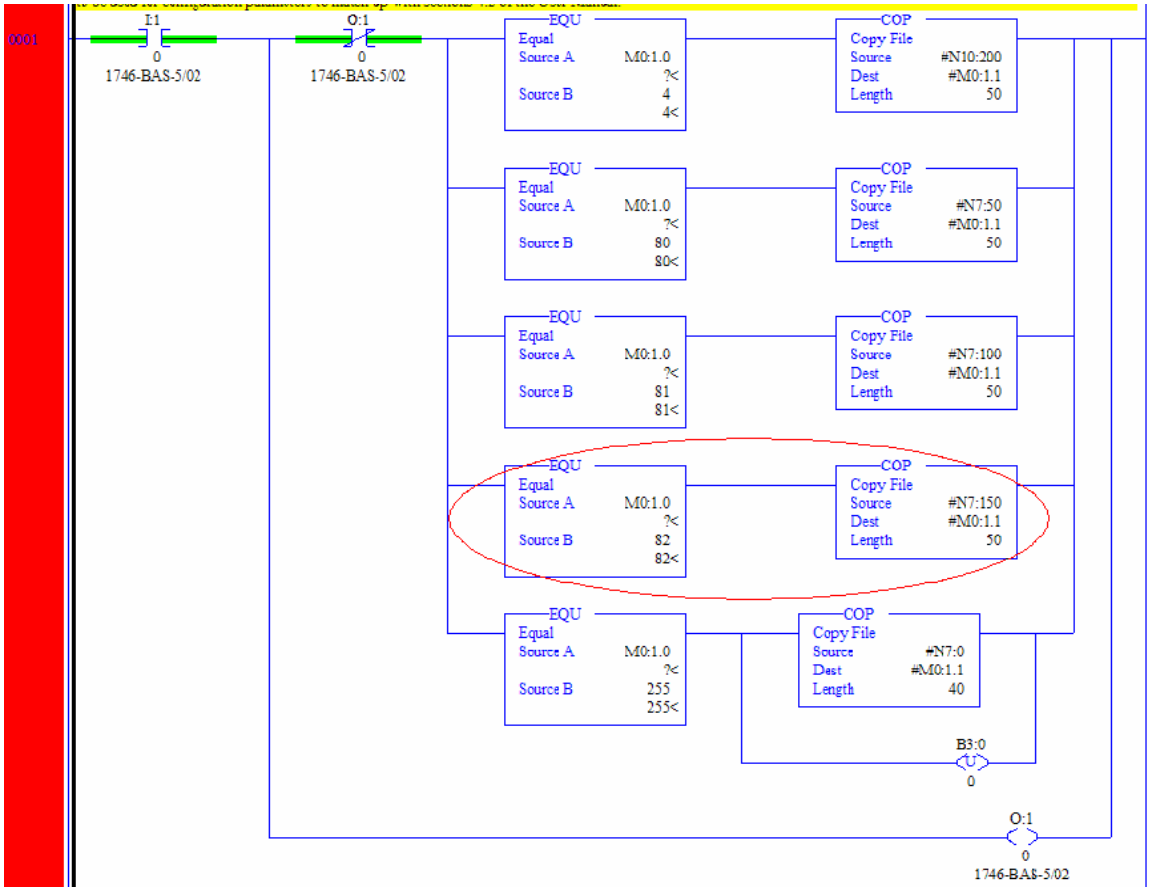
Step 1: Set N7:22 = 3. 3 command blocks = 15 commands.

Step 2: Modify sample ladder Rung 0001 to write the additional command block:

Before Modification



After Modification



7.10.4 Slave Port Status

Q: Port 2 is configured as a Slave. How do I monitor the status of this port?

A: The Slave Error Table is a 20-word block that monitors all 3150-MCM slave ports. The location of this Table is set by a pointer at N7:23, which has a value of 130 in the sample ladder:

This Slave Error Table is paged by the sample ladder to N10:130 - N10:149.

For Port 2:

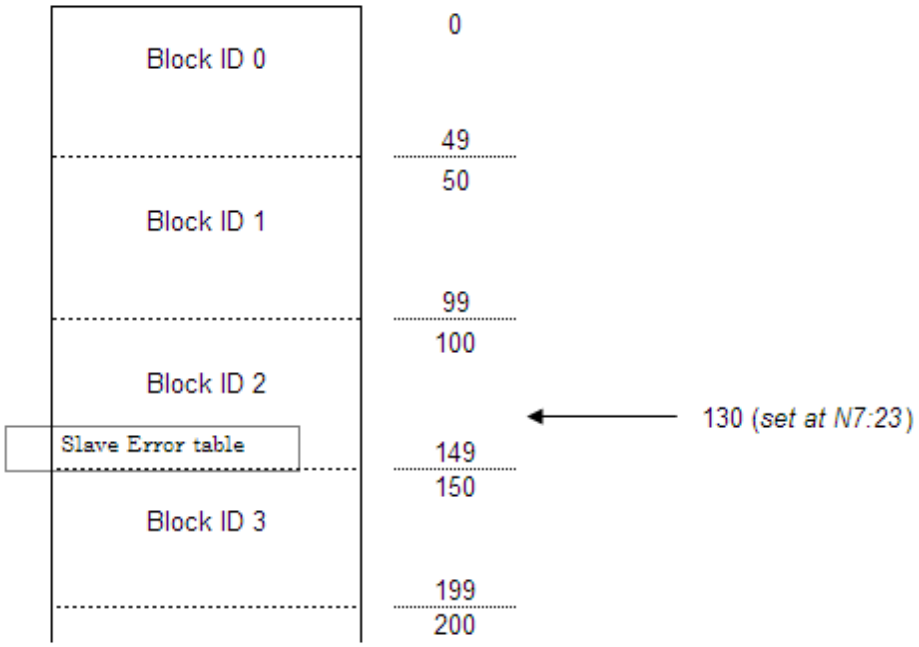
N10:135 = Current Port Status

N10:136 = Last Transmitted Error

N10:137 = Total Messages to this Slave

N10:138 = Total Responses from this Slave

N10:139 = Total Messages seen by this Slave



7.10.5 Master Port Status

Q: Port 1 is configured as a Master. How do I monitor the status of the master commands on this port?

A: The Master Error Table is a 120-word block that monitors all commands. The location of this Table is set by a pointer at N7:24, which has a value of 150 in the sample ladder:

This Master Error Table is paged by the sample ladder to N10:150 - …

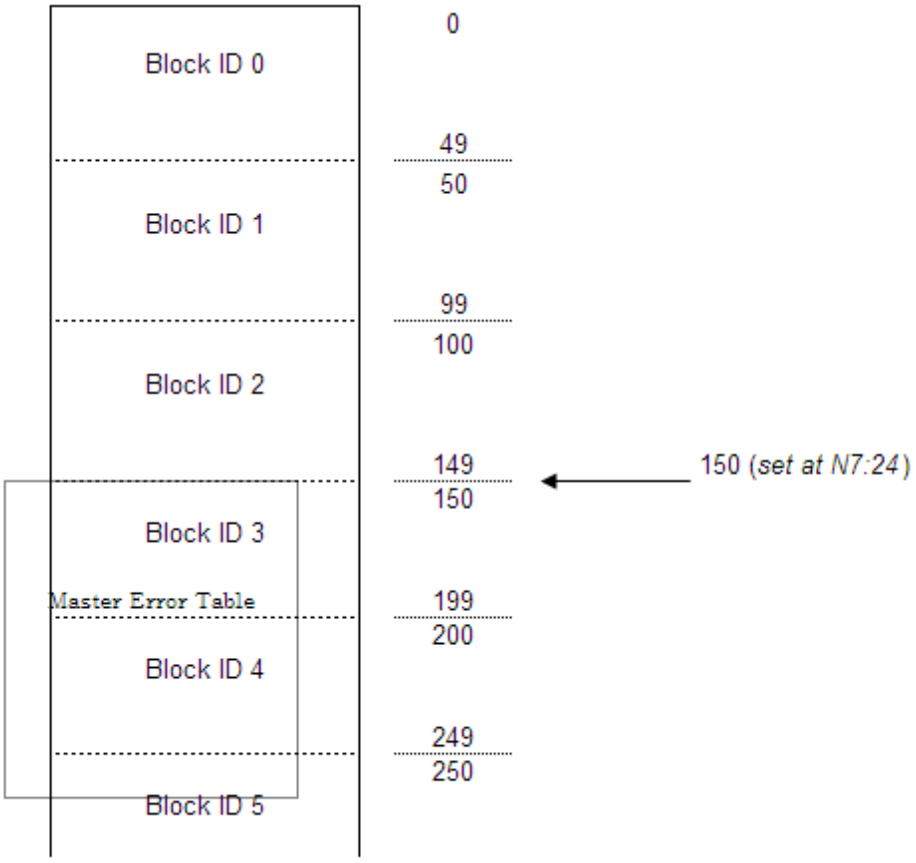
In this configuration:

Parameter	Description
N10:150 =	Command List End of Poll Status
N10:151 =	Command #1 Error Status
N10:152 =	Command #2 Error Status

and so on

Refer to Master Error Code Table (page 49) for more detailed explanations.

Note: In the sample ladder, the Master Error Table overlaps into Block ID 4, a Write Block. This will work because the sample ladder allows only 10 commands and does not use the entire Master Error Table.



8 Support, Service & Warranty

In This Chapter

Contacting Technical Support

ProSoft Technology, Inc. (ProSoft) is committed to providing the most efficient and effective support possible. Before calling, please gather the following information to assist in expediting this process:

1. Product Version Number
2. System architecture
3. Network details

If the issue is hardware related, we will also need information regarding:

1. Module configuration and associated ladder files, if any
2. Module operation and any unusual behavior
3. Configuration/Debug status information
4. LED patterns
5. Details about the serial, Ethernet or fieldbus devices interfaced to the module, if any.

Note: *For technical support calls within the United States, an after-hours answering system allows 24-hour/7-days-a-week pager access to one of our qualified Technical and/or Application Support Engineers.*

Internet	Web Site: www.prosoft-technology.com/support E-mail address: support@prosoft-technology.com
Asia Pacific (location in Malaysia)	Tel: +603.7724.2080, E-mail: asiapc@prosoft-technology.com Languages spoken include: Chinese, English
Asia Pacific (location in China)	Tel: +86.21.5187.7337 x888, E-mail: asiapc@prosoft-technology.com Languages spoken include: Chinese, English
Europe (location in Toulouse, France)	Tel: +33 (0) 5.34.36.87.20, E-mail: support.EMEA@prosoft-technology.com Languages spoken include: French, English
Europe (location in Dubai, UAE)	Tel: +971-4-214-6911, E-mail: mea@prosoft-technology.com Languages spoken include: English, Hindi
North America (location in California)	Tel: +1.661.716.5100, E-mail: support@prosoft-technology.com Languages spoken include: English, Spanish
Latin America (Oficina Regional)	Tel: +1-281-2989109, E-Mail: latinam@prosoft-technology.com Languages spoken include: Spanish, English
Latin America (location in Puebla, Mexico)	Tel: +52-222-3-99-6565, E-mail: soporte@prosoft-technology.com Languages spoken include: Spanish
Brasil (location in Sao Paulo)	Tel: +55-11-5083-3776, E-mail: brasil@prosoft-technology.com Languages spoken include: Portuguese, English

8.1 Return Material Authorization (RMA) Policies and Conditions

The following Return Material Authorization (RMA) Policies and Conditions (collectively, "RMA Policies") apply to any returned product. These RMA Policies are subject to change by ProSoft Technology, Inc., without notice. For warranty information, see Limited Warranty (page 123). In the event of any inconsistency between the RMA Policies and the Warranty, the Warranty shall govern.

8.1.1 Returning Any Product

a) In order to return a Product for repair, exchange, or otherwise, the Customer must obtain a Return Material Authorization (RMA) number from ProSoft Technology and comply with ProSoft Technology shipping instructions.
b) In the event that the Customer experiences a problem with the Product for any reason, Customer should contact ProSoft Technical Support at one of the telephone numbers listed above (page 119). A Technical Support Engineer will request that you perform several tests in an attempt to isolate the problem. If after completing these tests, the Product is found to be the source of the problem, we will issue an RMA.
c) All returned Products must be shipped freight prepaid, in the original shipping container or equivalent, to the location specified by ProSoft Technology, and be accompanied by proof of purchase and receipt date. The RMA number is to be prominently marked on the outside of the shipping box. Customer agrees to insure the Product or assume the risk of loss or damage in transit. Products shipped to ProSoft Technology using a shipment method other than that specified by ProSoft Technology, or shipped without an RMA number will be returned to the Customer, freight collect. Contact ProSoft Technical Support for further information.
d) A 10% restocking fee applies to all warranty credit returns, whereby a Customer has an application change, ordered too many, does not need, etc. Returns for credit require that all accessory parts included in the original box (i.e.; antennas, cables) be returned. Failure to return these items will result in a deduction from the total credit due for each missing item.

8.1.2 Returning Units Under Warranty

A Technical Support Engineer must approve the return of Product under ProSoft Technology's Warranty:

a) A replacement module will be shipped and invoiced. A purchase order will be required.
b) Credit for a product under warranty will be issued upon receipt of authorized product by ProSoft Technology at designated location referenced on the Return Material Authorization
    i. If a defect is found and is determined to be customer generated, or if the defect is otherwise not covered by ProSoft Technology s warranty, there will be no credit given. Customer will be contacted and can request module be returned at their expense;
    ii. If defect is customer generated and is repairable, customer can authorize ProSoft Technology to repair the unit by providing a purchase order for 30% of the current list price plus freight charges, duties and taxes as applicable.

8.1.3 Returning Units Out of Warranty

a) Customer sends unit in for evaluation to location specified by ProSoft Technology, freight prepaid.
b) If no defect is found, Customer will be charged the equivalent of $100 USD, plus freight charges, duties and taxes as applicable. A new purchase order will be required.
c) If unit is repaired, charge to Customer will be 30% of current list price (USD) plus freight charges, duties and taxes as applicable. A new purchase order will be required or authorization to use the purchase order submitted for evaluation fee.

The following is a list of non-repairable units:

- 3150 - All
- 3750
- 3600 - All
- 3700
- 3170 - All
- 3250
- 1560 - Can be repaired, only if defect is the power supply
- 1550 - Can be repaired, only if defect is the power supply
- 3350
- 3300
- 1500 - All

8.2 LIMITED WARRANTY

This Limited Warranty ("Warranty") governs all sales of hardware, software, and other products (collectively, "Product") manufactured and/or offered for sale by ProSoft Technology, Incorporated (ProSoft), and all related services provided by ProSoft, including maintenance, repair, warranty exchange, and service programs (collectively, "Services"). By purchasing or using the Product or Services, the individual or entity purchasing or using the Product or Services ("Customer") agrees to all of the terms and provisions (collectively, the "Terms") of this Limited Warranty. All sales of software or other intellectual property are, in addition, subject to any license agreement accompanying such software or other intellectual property.

8.2.1 What Is Covered By This Warranty

a) *Warranty On New Products*: ProSoft warrants, to the original purchaser, that the Product that is the subject of the sale will (1) conform to and perform in accordance with published specifications prepared, approved and issued by ProSoft, and (2) will be free from defects in material or workmanship; provided these warranties only cover Product that is sold as new. This Warranty expires three (3) years from the date of shipment for Product purchased **on or after** January 1st, 2008, or one (1) year from the date of shipment for Product purchased **before** January 1st, 2008 (the "Warranty Period"). If the Customer discovers within the Warranty Period a failure of the Product to conform to specifications, or a defect in material or workmanship of the Product, the Customer must promptly notify ProSoft by fax, email or telephone. In no event may that notification be received by ProSoft later than 39 months from date of original shipment. Within a reasonable time after notification, ProSoft will correct any failure of the Product to conform to specifications or any defect in material or workmanship of the Product, with either new or remanufactured replacement parts. ProSoft reserves the right, and at its sole discretion, may replace unrepairable units with new or remanufactured equipment. All replacement units will be covered under warranty for the 3 year period commencing from the date of original equipment purchase, not the date of shipment of the replacement unit. Such repair, including both parts and labor, will be performed at ProSoft's expense. All warranty service will be performed at service centers designated by ProSoft.

b) *Warranty On Services*: Materials and labor performed by ProSoft to repair a verified malfunction or defect are warranteed in the terms specified above for new Product, provided said warranty will be for the period remaining on the original new equipment warranty or, if the original warranty is no longer in effect, for a period of 90 days from the date of repair.

8.2.2 What Is Not Covered By This Warranty

a) ProSoft makes no representation or warranty, expressed or implied, that the operation of software purchased from ProSoft will be uninterrupted or error free or that the functions contained in the software will meet or satisfy the purchaser's intended use or requirements; the Customer assumes complete responsibility for decisions made or actions taken based on information obtained using ProSoft software.
b) This Warranty does not cover the failure of the Product to perform specified functions, or any other non-conformance, defects, losses or damages caused by or attributable to any of the following: (i) shipping; (ii) improper installation or other failure of Customer to adhere to ProSoft's specifications or instructions; (iii) unauthorized repair or maintenance; (iv) attachments, equipment, options, parts, software, or user-created programming (including, but not limited to, programs developed with any IEC 61131-3, "C" or any variant of "C" programming languages) not furnished by ProSoft; (v) use of the Product for purposes other than those for which it was designed; (vi) any other abuse, misapplication, neglect or misuse by the Customer; (vii) accident, improper testing or causes external to the Product such as, but not limited to, exposure to extremes of temperature or humidity, power failure or power surges; or (viii) disasters such as fire, flood, earthquake, wind and lightning.
c) The information in this Agreement is subject to change without notice. ProSoft shall not be liable for technical or editorial errors or omissions made herein; nor for incidental or consequential damages resulting from the furnishing, performance or use of this material. The user guide included with your original product purchase from ProSoft contains information protected by copyright. No part of the guide may be duplicated or reproduced in any form without prior written consent from ProSoft.

8.2.3 Disclaimer Regarding High Risk Activities

Product manufactured or supplied by ProSoft is not fault tolerant and is not designed, manufactured or intended for use in hazardous environments requiring fail-safe performance including and without limitation: the operation of nuclear facilities, aircraft navigation of communication systems, air traffic control, direct life support machines or weapons systems in which the failure of the product could lead directly or indirectly to death, personal injury or severe physical or environmental damage (collectively, "high risk activities"). ProSoft specifically disclaims any express or implied warranty of fitness for high risk activities.

8.2.4 Intellectual Property Indemnity

Buyer shall indemnify and hold harmless ProSoft and its employees from and against all liabilities, losses, claims, costs and expenses (including attorney's fees and expenses) related to any claim, investigation, litigation or proceeding (whether or not ProSoft is a party) which arises or is alleged to arise from Buyer's acts or omissions under these Terms or in any way with respect to the Products. Without limiting the foregoing, Buyer (at its own expense) shall indemnify and hold harmless ProSoft and defend or settle any action brought against such Companies to the extent based on a claim that any Product made to Buyer specifications infringed intellectual property rights of another party. ProSoft makes no warranty that the product is or will be delivered free of any person's claiming of patent, trademark, or similar infringement. The Buyer assumes all risks (including the risk of suit) that the product or any use of the product will infringe existing or subsequently issued patents, trademarks, or copyrights.

a) Any documentation included with Product purchased from ProSoft is protected by copyright and may not be duplicated or reproduced in any form without prior written consent from ProSoft.
b) ProSoft's technical specifications and documentation that are included with the Product are subject to editing and modification without notice.
c) Transfer of title shall not operate to convey to Customer any right to make, or have made, any Product supplied by ProSoft.
d) Customer is granted no right or license to use any software or other intellectual property in any manner or for any purpose not expressly permitted by any license agreement accompanying such software or other intellectual property.
e) Customer agrees that it shall not, and shall not authorize others to, copy software provided by ProSoft (except as expressly permitted in any license agreement accompanying such software); transfer software to a third party separately from the Product; modify, alter, translate, decode, decompile, disassemble, reverse-engineer or otherwise attempt to derive the source code of the software or create derivative works based on the software; export the software or underlying technology in contravention of applicable US and international export laws and regulations; or use the software other than as authorized in connection with use of Product.
f) **Additional Restrictions Relating To Software And Other Intellectual Property**

   In addition to compliance with the Terms of this Warranty, Customers purchasing software or other intellectual property shall comply with any license agreement accompanying such software or other intellectual property. Failure to do so may void this Warranty with respect to such software and/or other intellectual property.

8.2.5 Disclaimer of all Other Warranties

The Warranty set forth in What Is Covered By This Warranty (page 123) are in lieu of all other warranties, express or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose.

8.2.6 Limitation of Remedies **

In no event will ProSoft or its Dealer be liable for any special, incidental or consequential damages based on breach of warranty, breach of contract, negligence, strict tort or any other legal theory. Damages that ProSoft or its Dealer will not be responsible for include, but are not limited to: Loss of profits; loss of savings or revenue; loss of use of the product or any associated equipment; loss of data; cost of capital; cost of any substitute equipment, facilities, or services; downtime; the claims of third parties including, customers of the Purchaser; and, injury to property.

** Some areas do not allow time limitations on an implied warranty, or allow the exclusion or limitation of incidental or consequential damages. In such areas, the above limitations may not apply. This Warranty gives you specific legal rights, and you may also have other rights which vary from place to place.

8.2.7 Time Limit for Bringing Suit

Any action for breach of warranty must be commenced within 39 months following shipment of the Product.

8.2.8 No Other Warranties

Unless modified in writing and signed by both parties, this Warranty is understood to be the complete and exclusive agreement between the parties, suspending all oral or written prior agreements and all other communications between the parties relating to the subject matter of this Warranty, including statements made by salesperson. No employee of ProSoft or any other party is authorized to make any warranty in addition to those made in this Warranty. The Customer is warned, therefore, to check this Warranty carefully to see that it correctly reflects those terms that are important to the Customer.

8.2.9 Allocation of Risks

This Warranty allocates the risk of product failure between ProSoft and the Customer. This allocation is recognized by both parties and is reflected in the price of the goods. The Customer acknowledges that it has read this Warranty, understands it, and is bound by its Terms.

8.2.10 Controlling Law and Severability

This Warranty shall be governed by and construed in accordance with the laws of the United States and the domestic laws of the State of California, without reference to its conflicts of law provisions. If for any reason a court of competent jurisdiction finds any provisions of this Warranty, or a portion thereof, to be unenforceable, that provision shall be enforced to the maximum extent permissible and the remainder of this Warranty shall remain in full force and effect. Any cause of action with respect to the Product or Services must be instituted in a court of competent jurisdiction in the State of California.

Index