3100-MCM
Example Ladder Logic
Revision 2.1

February 23, 2000

PLC Examples
Application Manual

ProSoft Technology, Inc.
9801 Camino Media, Suite 105
Bakersfield, CA 93311
(661) 664-7208
(661) 664-7233 (fax)
E-mail address: prosoft@prosoft-technology.com
Web Site : http://www.prosoft-technology.com

Quick Start Implementation Guide

Integration of the MCM module into a PLC 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 FTP 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.

Starting with one of the ladder logic programs provided on disk with the MCM complete the following steps:

a) Edit the ladder logic provided on disk as needed for the application (See Section 3.0)
   Verify rack and slot location in program
   Modify ladder instruction addresses as needed

c) Setup the Communication Configuration parameters (See Section 4.2)
   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

d) Setup the Command List if configuring a Master (See Section 4.4)
   Be sure to review register map of slave device to build most effective memory map

e) Identify the module jumper requirements (See Appendix D)

f) Make up the communication cables (See Section 8). 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.

g) Place processor into the run mode

h) Monitor the data table for the Master and Slave Error Status values (See Section 5.1)

'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. To access this information, please visit our web site as follows:

http://www.prosoft-technology.com
   Select 'Web Site Index'
   Select 'MCM Connectivity Listing'
   Select 'Test Document' for desired product

Revision Notes

2/23/00 Fix typo error in Expanded Slave register map

PLC Ladder Logic Examples

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

Slave Mode Examples

Example #1 : Slave Mode w/ Pass-Thru - Minimum Configuration
MCM5EX1S

Example #2 : Slave Mode w/ Pass-Thru - Expanded Application
MCM5EX2S

Master Mode Examples

Example #1 : Master Mode - Basic Application
MCM5EX1M

Example #2 : Master Mode w/ Command Control
MCM5EX2M

Testing Tools and Suggestions

There are several tools available for assisting in testing the MCM and the associated ladder logic.

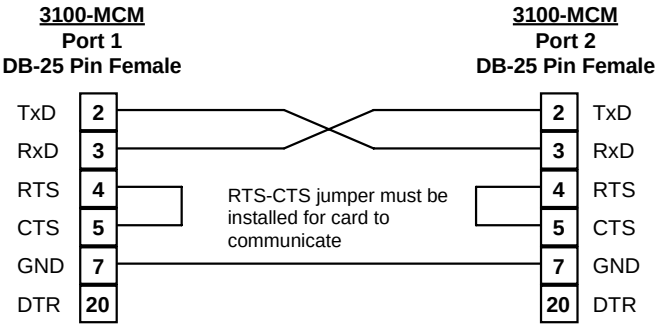
Slave Mode Testing

The simplest test tool we have found for testing out a slave implementation of the MCM product is a Windows based application available off the Internet. We have provided the shareware version of the program on the sample logic diskette under the 'utils\modscan' subdirectory. Simply copy this file to your hard drive and 'Run' the program from Windows. Instructions are available through the Help File and purchasing instructions are also available.

Master Mode Testing

Testing a Master implementation of the MCM is easily accomplished if the default configuration provided in the example ladder logic is followed. The default configuration places Port 1 as a Master port and Port 2 as a Slave port. In this configuration, the Command List which has been entered in the data table will execute and transfer data between the ports. This method of testing can often be useful when the slave device is not available for testing.

The only external tool necessary to allow Port 1 talk to Port 2 is a short cable with the following configuration:



Slave Mode Example #1 : Slave Mode w/ Pass-Thru - Minimum Configuration

Assumptions

- 10 words of Output Binary data
- 10 words of Input Memory data
- 30 words of Holding Register Data

Port Configuration

PLC Addr	Value	
N[]:7	0	Input Data Start Address
N[]:17		- Function Codes 2 and 4
		This configuration value determines the beginning address in the module from which the host will begin reading when using Function Codes 2 and 4.
N[]:8	10	Output Data Start Address
N[]:18		- Function Codes 1, 5, 15
		This configuration value determines the beginnng address in the module from which the host will begin reading and writing data when using Function Codes 1, 5 and 15. Note that in the pass-thru mode the address which the host is writing to will be offset by the value entered here
N[]:9	20	Holding Register Data Start Addr
N[]:19		- Function Codes 3, 6, 16
		Determines the beginning address in the module in which the host will begin reading and writing data when using Function Codes 3, 6 and 16. Note that when a write command is received in the Pass-Thru mode from a host, the value entered here will be added to the address being received from the host.

System Configuration

N[]:20	1	Read Block Count
		As a minimum in a slave application we would like to bring back one block which will contain the Slave Error Table (a set of counters and status registers indicating the port status). This is a 20 word block which we will locate at register 50 in our example.
N[]:21	1	Write Block Count
		This value reflects the number of 50 words blocks that need to be moved to the module to provide data for the host to read. In our example application below we have assumed that the host is reading less than 50 words.
N[]:22	0	Command Block Count
		When configuring the module in the slave mode only, this value may be set to 0.
N[]:23	50	Slave Error Table Pointer
		Location Slave Error Table in Module's memory space.
N[]:24	500	Master Error Table Pointer
		Not used in Slave only configuration, therefore set out of the way (< 3880)
N[]:27	1	Read Block ID Start Value
		This value determines the starting BTR Block ID number which will be returned from the module. In this example, we want to return only block #1, therefore by setting the value to 1, the module will begin returning from Block #1. The number of blocks returned is determined by the configuration value selected above in the *Read Block Count.*
N[]:28	0	Write Block ID Start Value
		This value determines the starting BTW Block ID number which be generated by the module. In this example, we wish to write data into Block #0, therefore we will set this value to 0. If we desired to write the data into the module starting at Module Address 100, we would set this configuration value to 2.

Slave Mode example #1 : Slave Mode w/ Pass-Thru - Minimum Configuration

Modbus Memory map

PLC Data Address N10	Module Address	FC 2 Input Bit Addresses	FC 4 Input Register Addresses	FC 1,5,15 Output Bit Address	FC 3,6,16 Holding Register Address
0	0	10001 -10016	30001		
1	1	10017 -10032	30002		
2	2	10033 -10048	30003		
3	3	10049 -10064	30004		
4	4	10065 -10080	30005		
5	5	10081 -10096	30006		
6	6	10097 -10112	30007		
7	7	10113 -10128	30008		
8	8	10129 -10144	30009		
9	9	10145 -10160	30010		
10	10			1 - 16	
11	11			17 - 32	
12	12			33 - 48	
13	13			49 - 64	
14	14			65 - 80	
15	15			81 - 96	
16	16			97 - 112	
17	17			113 - 128	
18	18			129 - 144	
19	19			145 - 160	
20	20				40001
21	21				40002
22	22				40003
23	23				40004
24	24				40005
25	25				40006
26	26				40007
27	27				40008
28	28				40009
29	29				40010
30	30				40011
31	31				40012
32	32				40013
33	33				40014
34	34				40015
35	35				40016
36	36				40017
37	37				40018
38	38				40019
39	39				40020
40	40				40021
41	41				40022
42	42				40023
43	43				40024
44	44				40025
45	45				40026
46	46				40027
47	47				40028
48	48				40029
49	49				40030
50	50 to 69	Slave Error Table			

Slave Mode example #1 : Slave Mode w/ Pass-Thru - Minimum Configuration

Data Table File N7

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
N7:0	9	1	5	0	0	0	0	0	10	20	**Port 1 Config**
N7:10	9	1	5	0	0	0	0	0	10	20	Port 2 Config
N7:20	1	1	0	50	500	0	0	1	0	0	System Config
N7:30	0	0	0	0	0	0	0	0	0	0	Route Table

Data Table File N10

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
N10:0	1	2	5	4	5	6	7	8	9	10	Write Data To Module
N10:10	11	12	13	14	15	16	17	18	19	20	
N10:20	0	0	0	0	0	0	0	0	0	0	
N10:30	0	0	0	0	0	0	0	0	0	0	
N10:40	0	0	0	0	0	0	0	0	0	0	
N10:50	0	0	0	0	0	0	0	0	0	0	Read Data From Module
N10:60	MC	M	2.	00	11	32	0	0	0	0	- Slave Err Table
N10:70	0	0	0	0	0	0	0	0	0	0	(N10:50-N10:69)
N10:80	0	0	0	0	0	0	0	0	0	0	
N10:90	0	0	0	0	0	0	0	0	0	0	

Data Table File B11

Address	Data (Radix=BINARY)	Address	Data (Radix=BINARY)
B11:0	0000 0000 0000 0000	B11:11	0000 0000 0000 0000
B11:1	0000 0000 0000 0000	B11:12	0000 0000 0000 0000
B11:2	0000 0000 0000 0000	B11:13	0000 0000 0000 0000
B11:3	0000 0000 0000 0000	B11:14	0000 0000 0000 0000
B11:4	0000 0000 0000 0000	B11:15	0000 0000 0000 0000
B11:5	0000 0000 0000 0000	B11:16	0000 0000 0000 0000
B11:6	0000 0000 0000 0000	B11:17	0000 0000 0000 0000
B11:7	0000 0000 0000 0000	B11:18	0000 0000 0000 0000
B11:8	0000 0000 0000 0000	B11:19	0000 0000 0000 0000
B11:9	0000 0000 0000 0000	B11:20	0000 0000 0000 0000
B11:10	0000 0000 0000 0000		

B11:10-19 are used to accept FC 5 bit set/reset commands from the host. The ladder logic takes care in Rung 3:1 of moving the 10 word block back into the module. NOTE that this block location and length are user defined for the application and can easily be modified.

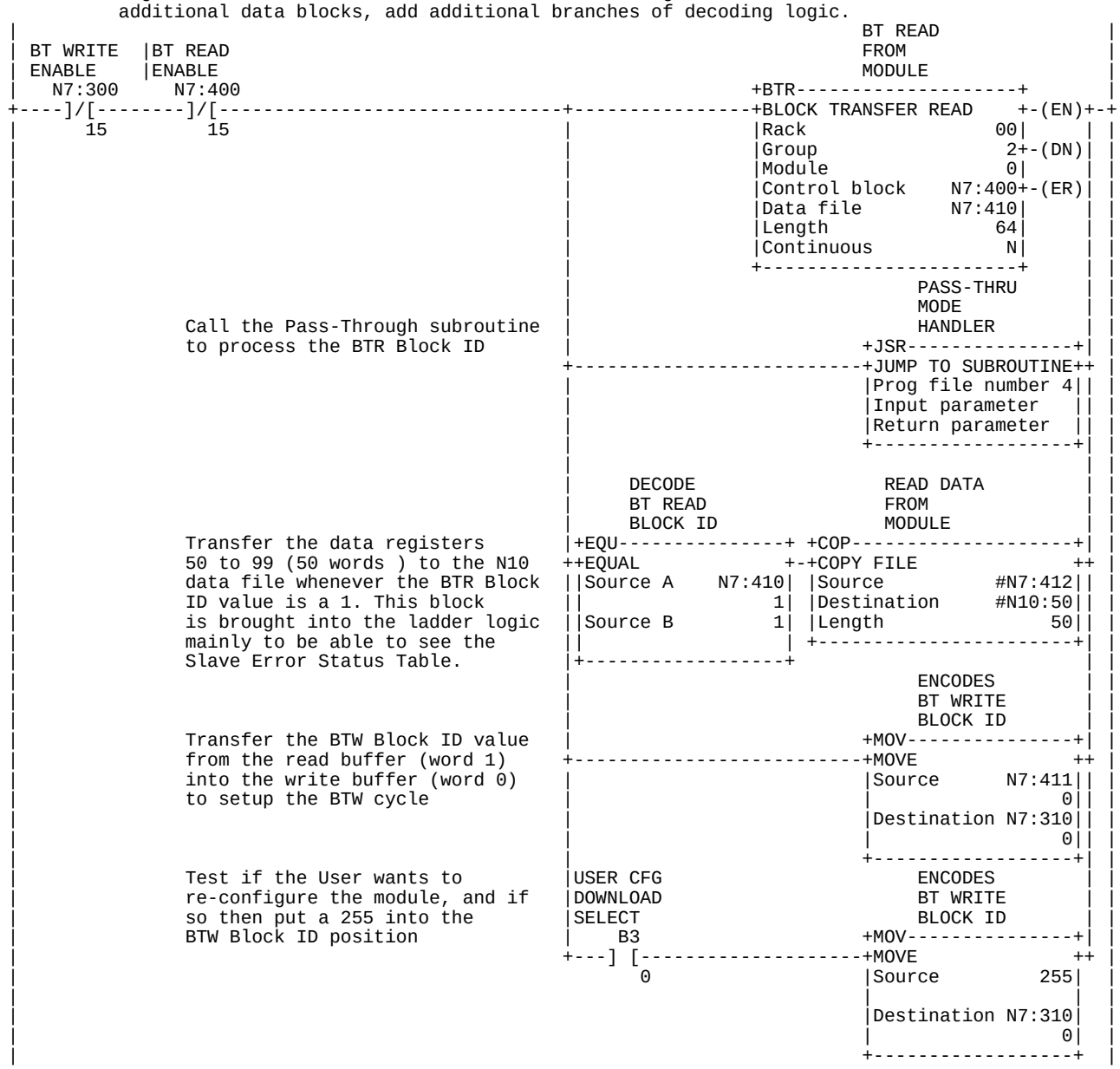
PLC Example Logic

Slave Mode example #1 : Slave Mode w/ Pass-Thru - Minimum Configuration

3100-MCM Rev 2 Example #1 Ladder Logic
Program Listing Report PLC-5/15 File MCM5EX1S

Rung 3:0

BT READ AND REGISTER TRANSFER FROM MODULE DECODING
BT READ from module. If BT READ Block ID is 1, then transfer the module's registers 50 - 99 into the PLC data table starting at N10:50. To add additional data blocks, add additional branches of decoding logic.



PLC Example Logic

Slave Mode example #1 : Slave Mode w/ Pass-Thru - Minimum Configuration

```
3100-MCM Rev 2 Example #1 Ladder Logic
Program Listing Report                        PLC-5/15    File MCM5EX1S                           Rung 3:1

Rung 3:1
|                                                                              COPY                 |
|                                                       DECODE                 OUTPUT                |
| BT READ    |BT WRITE                                 BT WRITE               IMAGE TO              |
| ENABLE     |ENABLE                                   BLOCK                  MODULE                |
|   N7:400     N7:300                               +EQU---------------+ +COP--------------------+   |
+----]/[--------]/[-----------------------------+-+EQUAL             +++COPY FILE              +++-+
|      15         15                             ||Source A    N7:310|||Source         #B11:10||| |
|                                                ||                 0|||Destination     #N10:10||| |
|              Move the data for module          ||Source B         0|||Length              10||| |
|              addresses 0 to 49.  In this       ||                  ||+-----------------------+|| |
|              application this is data that     |+------------------+|       WRITE TO          || |
|              the host will be reading from     |                    |       BT WRITE          || |
|              the slave (the module)            |                    |       BUFFER            || |
|                                                |                    |+COP--------------------+|| |
|                                                |                    ++COPY FILE              ++| |
|                                                |                     |Source          #N10:0|  | |
|                                                |                     |Destination     #N7:311|  | |
|                                                |                     |Length              50|  | |
|                                                |                     +-----------------------+  | |
|                                                |     DECODE                 WRITE TO            | |
|                                                |     BT WRITE               BT WRITE            | |
|                                                |     BLOCK                  BUFFER              | |
|              Configuration of the module       |+EQU---------------+ +COP--------------------+ | |
|                                                ++EQUAL             +++COPY FILE              +++ |
|                                                ||Source A    N7:310|||Source          #N7:0||| |
|                                                ||                 0|||Destination     #N7:311||| |
|                                                ||Source B       255|||Length              40||| |
|                                                ||                  ||+-----------------------+|| |
|                                                |+------------------+|               USER CFG  || |
|                                                |                    |               DOWNLOAD  || |
|                                                |                    |               SELECT    || |
|                                                |                    |                   B3    || |
|                                                |                    +-------------------(U)----+| |
|                                                |                                          0     | |
|                                                |                        BT WRITE                | |
|                                                |                        TO MODULE               | |
|                                                |                 +BTW--------------------+     | |
|                                                +-----------------+BLOCK TRANSFER WRITE   +-(EN)+ |
|                                                                  |Rack                 00|        |
|                                                                  |Group                 2+-(DN)  |
|                                                                  |Module                0|        |
|                                                                  |Control block    N7:300+-(ER)  |
|                                                                  |Data file        N7:310|        |
|                                                                  |Length               64|        |
|                                                                  |Continuous            N|        |
|                                                                  +-----------------------+        |
Rung 3:2
|                                                                                                   |
+----------------------------------------------------[END OF FILE]---------------------------------+
|                                                                                                   |
```

PLC Example Logic

Slave Mode example #1 : Slave Mode w/ Pass-Thru - Minimum Configuration

```
3100-MCM Rev 2 Example #1 Ladder Logic
Program Listing Report                        PLC-5/15    File MCM5EX1S                        Rung 4:0
Rung 4:0
          FC 6/16 REGISTER WRITE HANDLER (DELETE IF NOT BEING USED)
          If the BTR Block ID number is 256, then decode the length and destination
          addresses and move the data using the FAL command.  If floating point data is
          being written, use similar logic but append a COP instruction to move the data
          to a floating point file
|      DECODE                                                                    FC 6 & 16           |
|      BT READ                                                                   COPY WRITE          |
|      BLOCK ID                                                                  LENGTH              |
| +EQU---------------+                                                       +MOV--------------------+  |
+-+EQUAL             +-----------------------------------------+-----------+MOVE                    ++-+
| |Source A    N7:410|                                         |           |Source           N7:412|| |
| |                1|                                         |           |                      0|| |
| |Source B       256|                                         |           |Destination    R6:0.LEN|| |
| |                  |                                         |           |                      2|| |
| +------------------+                                         |           +-----------------------+| |
|                                                              |             FC 6 & 16               | |
|               FC 6 and FC 16 handler                         |             COPY WRITE              | |
|               This rung takes care of either Function.       |             DATA                    | |
|               The first branch sets up the length of the     |+FAL-------------------------+      | |
|               FAL instruction.                               ++FILE ARITH/LOGICAL           +-(EN)+ |
|                                                               |Control                 R6:0|        |
|                                                               |Length                    2+-(DN)   |
|                                                               |Position                  0|        |
|                                                               |Mode                    ALL+-(ER)   |
|                                                               |Destination     #N10[N7:413]|        |
|                                                               |                          0|        |
|                                                               |Expression                 |        |
|                                                               |#N7:414                    |        |
|                                                               +---------------------------+        |
Rung 4:1
          FC 5 - BIT SET/RESET COMMAND (DELETE IF NOT BEING USED)
          When the BTR Block ID number is 258, set or reset the addressed bit.
|      DECODE                                                                  DECODE    |             |
|      BT READ                                                                 FC 5 BIT  |EXECUTE      |
|      BLOCK ID                                                                SET/RESET |SET/RESET    |
| +EQU---------------+                                                          N7:413      B11       |
+-+EQUAL             +-------------------------------------------------------+---] [--------(L)----+-+
| |Source A    N7:410|                                                       |      0     [N7:412] | |
| |                1|                                                       |DECODE    |           | |
| |Source B       258|                                                      |FC 5 BIT  |EXECUTE    | |
| |                  |                                                      |SET/RESET |SET/RESET  | |
| +------------------+                                                      |  N7:413      B11     | |
|                                                                           +---]/[--------(U)----+ |
|               FC 5 handler.  This rung tests if the bit is                       0     [N7:412]   |
              being commanded on or off and then latches/unlatches
              the bit accordingly.
```

PLC Example Logic

Slave Mode example #1 : Slave Mode w/ Pass-Thru - Minimum Configuration

```
3100-MCM Rev 2 Example #1 Ladder Logic
Program Listing Report                        PLC-5/15    File MCM5EX1S                        Rung 4:2
Rung 4:2
          FUNCTION CODE 15 - MULTIPLE BIT WRITE (DELETE IF NOT BEING USED)
          This rung accepts a pass-thru write command from the MCM module for FC 15.  The
          logic takes care of combining the data received with the data that is already
          in the PLC.
|      DECODE                                                                                  |
|      BT READ                                                                                 |
|      BLOCK ID                                                                                |
| +EQU--------------+                                    +FAL--------------------+         |
+-+EQUAL             +--------------------------------------+-----+FILE ARITH/LOGICAL     +-(EN)+-+
| |Source A    N7:410|                                    |     |Control            R6:5|     | |
| |                1|                                    |     |Length                4+-(DN)| |
| |Source B       259|                                   |     |Position              0|      | |
| |                  |                                    |     |Mode                ALL+-(ER)| |
| +------------------+                                    |     |Destination   #R6:1.LEN|      | |
|               This rung will handle a FC 15 from the    |     |                      1|      | |
|               minimum length up to the maximum length   |     |Expression             |      | |
|               with any bit starting address (ie. does   |     |N7:412                 |      | |
|               not have to be on a word boundary). If    |     +-----------------------+      | |
|               the FC 15 command is to be implemented in |          +FAL---------------+      | |
|               your application, this rung should be     +----------+FILE ARITH/LOGICAL+-(EN)+ |
|               followed exactly, with the only changes   |          |Control       R6:1|     | |
|               being file addresses.                     |          |Length           1+-(DN)| |
|                                                         |          |Position         0|      | |
|                                                         |          |Mode           ALL+-(ER)| |
|                                                         |          |Destination #N13:0|      | |
|                                                         |          |                -13|      | |
|                                                         |          |Expression         |      | |
|                                                         |          |NOT #N7:444        |      | |
|                                                         |          +-------------------+      | |
|                                                         |     +FAL--------------------+      | |
|                                                         +-----+FILE ARITH/LOGICAL     +-(EN)+ |
|                                                         |     |Control            R6:2|     | |
|                                                         |     |Length                1+-(DN)| |
|                                                         |     |Position              0|      | |
|                                                         |     |Mode                ALL+-(ER)| |
|                                                         |     |Destination     #N13:30|      | |
|                                                         |     |                      3|      | |
|                                                         |     |Expression             |      | |
|                                                         |     |#B11[N7:413] AND #N13:0|      | |
|                                                         |     +-----------------------+      | |
|                                                         |+FAL-------------------------+      | |
|                                                         ++FILE ARITH/LOGICAL          +-(EN)+ |
|                                                         ||Control                R6:3|     | |
|                                                         ||Length                    1+-(DN)| |
|                                                         ||Position                  0|      | |
|                                                         ||Mode                    ALL+-(ER)| |
|                                                         ||Destination     #B11[N7:413]|      | |
|                                                         ||           0000000000000000|      | |
|                                                         ||Expression                 |      | |
|                                                         ||#N7:414 AND #N7:444        |      | |
|                                                         |+-----------------------------+      | |
|                                                         |+FAL-------------------------+      | |
|                                                         ++FILE ARITH/LOGICAL          +-(EN)+ |
|                                                          |Control                R6:4|     |
|                                                          |Length                    1+-(DN)  |
|                                                          |Position                  0|       |
|                                                          |Mode                    ALL+-(ER)  |
|                                                          |Destination     #B11[N7:413]|       |
|                                                          |           0000000000000000|       |
|                                                          |Expression                 |       |
|                                                          |#B11[N7:413] OR #N13:30     |       |
|                                                          +----------------------------+       |
Rung 4:3
|                                                                                              |
+-----------------------------------------------[END OF FILE]-------------------------------+
```

Slave Mode Example #2 : Slave Mode w/ Pass-Thru Expanded Application

Assumptions

- 30 words of Output Binary data (N10:40 t0 N10:69)
- 40 words of Input Memory data (N10:0 to N10:39)
- 130 words of Holding Register Data (N10:70 to N10:199)

Port Configuration

PLC Addr	Value	
N[]:7	0	Input Data Start Address
N[]:17		- Function Codes 2 and 4
		This configuration value determines the beginning address in the module from which the host will begin reading when using Function Codes 2 and 4.
N[]:8	40	Output Data Start Address
N[]:18		- Function Codes 1, 5, 15
		This configuration value determines the beginnng address in the module from which the host will begin reading and writing data when using Function Codes 1, 5 and 15. Note that in the pass-thru mode the address which the host is writing to will be offset by the value entered here
N[]:9	70	Holding Register Data Start Addr
N[]:19		- Function Codes 3, 6, 16
		Determines the beginning address in the module in which the host will begin reading and writing data when using Function Codes 3, 6 and 16. Note that when a write command is received in the Pass-Thru mode from a host, the value entered here will be added to the address being received from the host.

System Configuration

N[]:20	1	Read Block Count
		As a minimum in a slave application we would like to bring back one block which will contain the Slave Error Table (a set of counters and status registers indicating the port status). This is a 20 word block which we will locate at register 200 in our example.
N[]:21	4	Write Block Count
		This value reflects the number of 50 words blocks that need to be moved to the module to provide data for the host to read. In our example application below we have assumed that the host is reading 200 words (4 blocks)
N[]:22	0	Command Block Count
		When configuring the module in the slave mode only, this value may be set to 0.
N[]:23	200	Slave Error Table Pointer
		Location Slave Error Table in Module's memory space.
N[]:24	500	Master Error Table Pointer
		Not used in Slave only configuration, therefore set out of the way (< 3880)
N[]:27	4	Read Block ID Start Value
		This value determines the starting BTR Block ID number which will be returned from the module. In this example, we want to return only block #4, therefore by setting the value to 4, the module will begin returning from Block #4. The number of blocks returned is determined by the configuration value selected above in the *Read Block Count.*
N[]:28	0	Write Block ID Start Value
		This value determines the starting BTW Block ID number which be generated by the module. In this example, we wish to write data into Block #0, therefore we will set this value to 0. If we desired to write the data into the module starting at Module Address 100, we would set this configuration value to 2.

Slave Mode Example #2 : Slave Mode w/ Pass-Thru - Expanded Configuration

Modbus Memory map

PLC Data Address N10	Module Address	FC 2 Input Bit Addresses	FC 4 Input Register Addresses	FC 1,5,15 Output Bit Address	FC 3,6,16 Holding Register Address
0	0	10001 -10016	30001		
1	1	10017 -10032	30002		
2	2	10033 -10048	30003		
3	3	10049 -10064	30004		
4	4	10065 -10080	30005		
up to	up to				
38	38	10609 -10624	30039		
39	39	10625 -10640	30040		
40	40			1 - 16	
41	41			17 - 32	
42	42			33 - 48	
43	43			49 - 64	
44	44			65 - 80	
up to	up to				
68	68			449 - 464	
69	69			465 - 480	
70	70				40001
71	71				40002
72	72				40003
73	73				40004
74	74				40005
75	75				40006
76	76				40007
77	77				40008
78	78				40009
79	79				40010
80	80				40011
81	81				40012
189	189				40120
190	190				40121
191	191				40122
192	192				40123
193	193				40124
194	194				40125
195	195				40126
196	196				40127
197	197				40128
198	198				40129
199	199				40130
200	200 to 219	Slave Error Table			

Slave Mode Example #2 : Slave Mode w/ Pass-Thru - Expanded Configuration

Data Table File N7

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
N7:0	9	1	5	0	0	0	0	0	40	70	**Port 1 Config**
N7:10	9	1	5	0	0	0	0	0	40	70	Port 2 Config
N7:20	1	4	0	200	500	0	0	4	0	0	System Config
N7:30	0	0	0	0	0	0	0	0	0	0	Route Table

Data Table File N10

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
N10:0	1	2	5	4	5	6	7	8	9	10	Write Data To Module
N10:10	11	12	13	14	15	16	17	18	19	20	
N10:20	0	0	0	0	0	0	0	0	0	0	
N10:30	0	0	0	0	0	0	0	0	0	0	
N10:40	0	0	0	0	0	0	0	0	0	0	
N10:50	0	0	0	0	0	0	0	0	0	0	
N10:60	0	0	0	0	0	0	0	0	0	0	
N10:70	0	0	0	0	0	0	0	0	0	0	
N10:80	0	0	0	0	0	0	0	0	0	0	
N10:90	0	0	0	0	0	0	0	0	0	0	
N10:100	0	0	0	0	0	0	0	0	0	0	
N10:110	0	0	0	0	0	0	0	0	0	0	
N10:120	0	0	0	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	Read Data From Module
N10:210	MC	M	2.	00	11	32	0	0	0	0	-Slave Err Table
N10:220	0	0	0	0	0	0	0	0	0	0	(N10:200-N10:219)
N10:230	0	0	0	0	0	0	0	0	0	0	
N10:240	0	0	0	0	0	0	0	0	0	0	

Data Table File B11

Address	Data (Radix=BINARY)	Address	Data (Radix=BINARY)
B11:40	0000 0000 0000 0000	B11:51	0000 0000 0000 0000
B11:41	0000 0000 0000 0000	B11:52	0000 0000 0000 0000
B11:42	0000 0000 0000 0000	B11:53	0000 0000 0000 0000
B11:43	0000 0000 0000 0000	B11:54	0000 0000 0000 0000
B11:44	0000 0000 0000 0000	B11:55	0000 0000 0000 0000
B11:45	0000 0000 0000 0000	B11:56	0000 0000 0000 0000
B11:46	0000 0000 0000 0000	B11:57	0000 0000 0000 0000
B11:47	0000 0000 0000 0000	B11:58	0000 0000 0000 0000
B11:48	0000 0000 0000 0000	B11:59	0000 0000 0000 0000
B11:49	0000 0000 0000 0000	up to	
B11:50	0000 0000 0000 0000	B11:69	0000 0000 0000 0000

B11:40-69 are used to accept FC 5 bit set/reset commands from the host. The ladder logic takes care in Rung 3:1 of moving the 30 word block back into the module. NOTE that this block location and length are user defined for the application and can easily be modified.

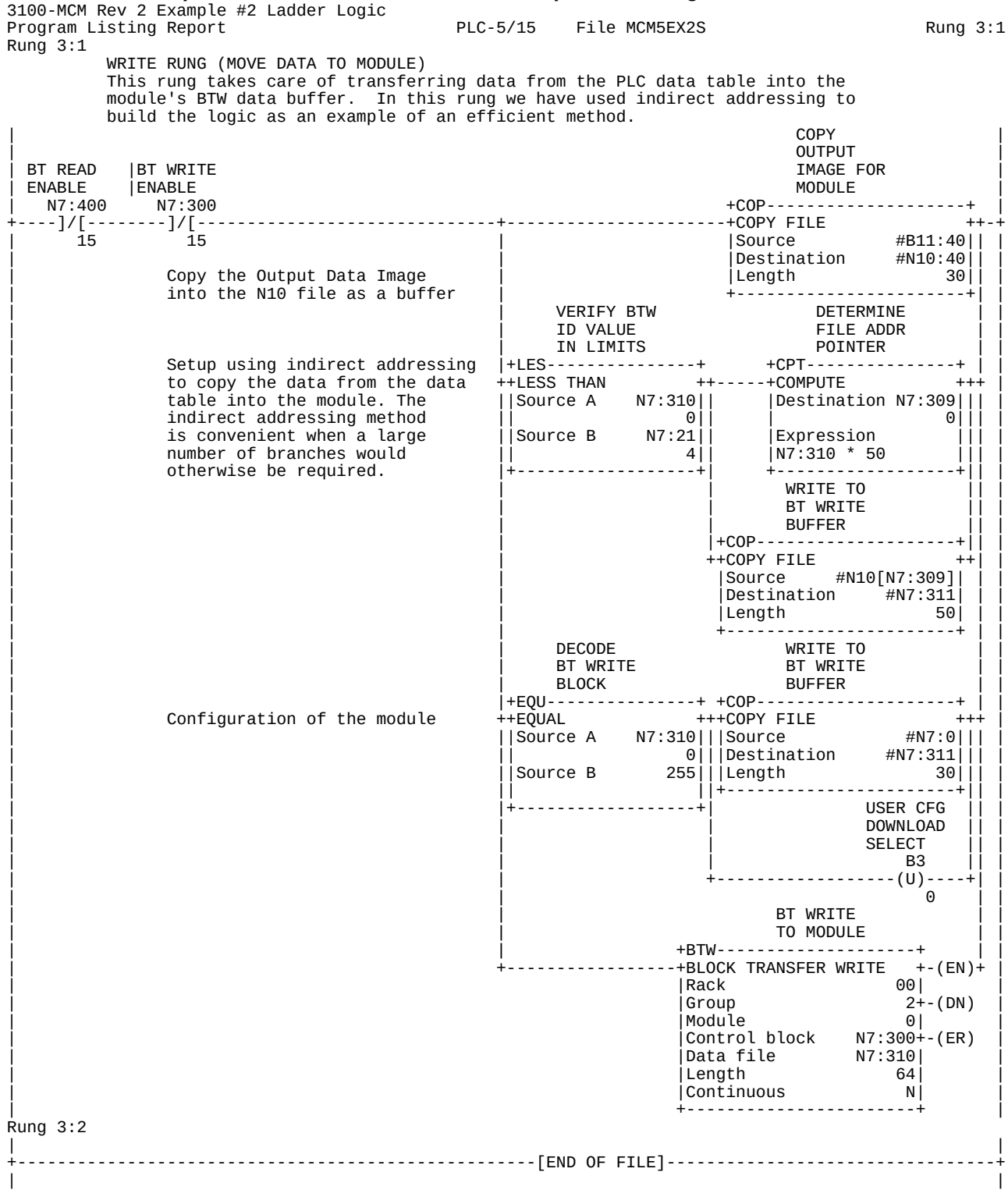
PLC Example Logic

Slave Mode Example #2 : Slave Mode w/ Pass-Thru - Expanded Configuration

```
3100-MCM Rev 2 Example #2 Ladder Logic
Program Listing Report                    PLC-5/15    File MCM5EX2S                    Rung 3:0

Rung 3:0
          BT READ AND REGISTER TRANSFER FROM MODULE DECODING
          BT READ from module.  If BT READ Block ID is 4, then transfer the module's
          registers 200 - 249 into the PLC data table starting at N10:200.  To add
          additional data blocks,add additional branches of decoding logic.
|                                                                                  BT READ              |
| BT WRITE  |BT READ                                                               FROM                 |
| ENABLE    |ENABLE                                                                MODULE               |
|   N7:300     N7:400                                                  +BTR-------------------+        |
+----]/[--------]/[-------------------------------+----------------+BLOCK TRANSFER READ    +-(EN)+-+
|      15         15                               |                |Rack                 00|     | |
|                                                  |                |Group                 2+-(DN)| |
|                                                  |                |Module                0|     | |
|                                                  |                |Control block    N7:400+-(ER)| |
|                                                  |                |Data file        N7:410|     | |
|                                                  |                |Length               64|     | |
|                                                  |                |Continuous            N|     | |
|                                                  |                +----------------------+     | |
|                                                  |                              PASS-THRU      | |
|                                                  |                              MODE           | |
|                                                  |                              HANDLER        | |
|              Call the Pass-Through subroutine    |                          +JSR---------------+| |
|              to process the BTR Block ID        +--------------------------+JUMP TO SUBROUTINE++ |
|                                                  |                          |Prog file number 4|| |
|                                                  |                          |Input parameter   || |
|                                                  |                          |Return parameter  || |
|                                                  |                          +------------------+| |
|                                                  |                                              | |
|                                                  |     DECODE                 COPY              | |
|                                                  |     BT READ                DATA FROM         | |
|              Transfer the data registers 200     |     BLOCK ID               MODULE            | |
|              to 249 (50 words) from the module   |+EQU---------------+ +COP--------------------+| |
|              to the N10 file whenever the BTR    ++EQUAL              +-+COPY FILE              ++ |
|              Block ID is 4.  This block is       ||Source A    N7:410| |Source          #N7:412|| |
|              brought into the data table to      ||                 4| |Destination    #N10:200|| |
|              gain access to the Slave Error      ||Source B         4| |Length               50|| |
|              Table                               ||                  | +----------------------+| |
|                                                  |+------------------+                         | |
|                                                  |                              ENCODES        | |
|                                                  |                              BT WRITE       | |
|                                                  |                              BLOCK ID       | |
|              Transfer the BTW Block ID value     |                          +MOV---------------+| |
|              from the read buffer (word 1) into  +--------------------------+MOVE              ++ |
|              the write buffer (word 0) to setup  |                          |Source      N7:411|| |
|              the BTW cycle                       |                          |                  0|| |
|                                                  |                          |Destination N7:310|| |
|                                                  |                          |                  0|| |
|                                                  |                          +------------------+| |
|                                                  |USER CFG                      ENCODES        | |
|                                                  |DOWNLOAD                      BT WRITE       | |
|              Test if the User wants to           |SELECT                        BLOCK ID       | |
|              re-configure the module and is so   |    B3                    +MOV---------------+| |
|              then put a 255 into the BTW        +---] [--------------------+MOVE              ++ |
|              Block ID position                         0                  |Source         255|  |
|                                                                           |                  |  |
|                                                                           |Destination N7:310|  |
|                                                                           |                  0|  |
|                                                                           +------------------+  |
```

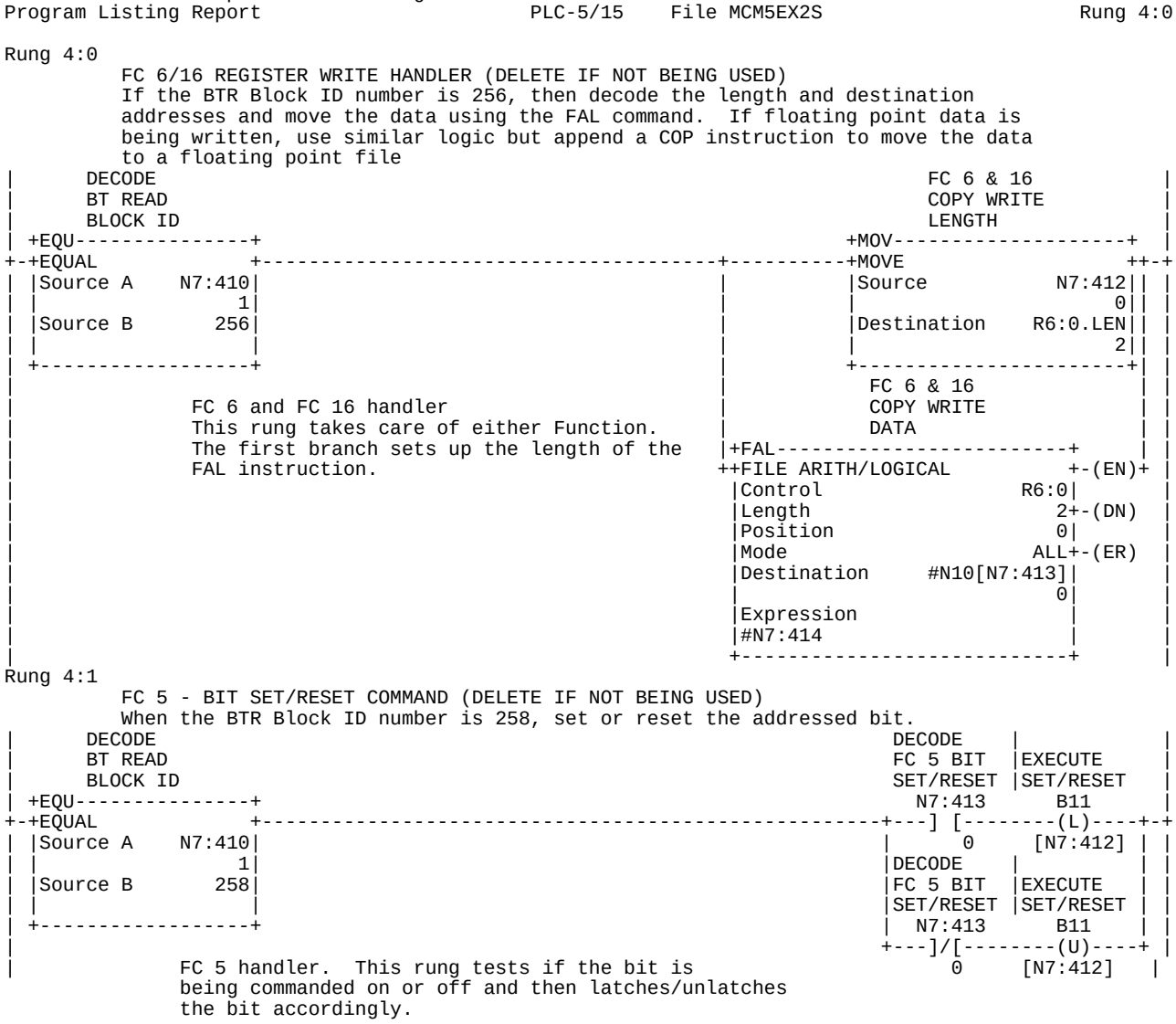
PLC Example Logic

Slave Mode Example #2 : Slave Mode w/ Pass-Thru - Expanded Configuration



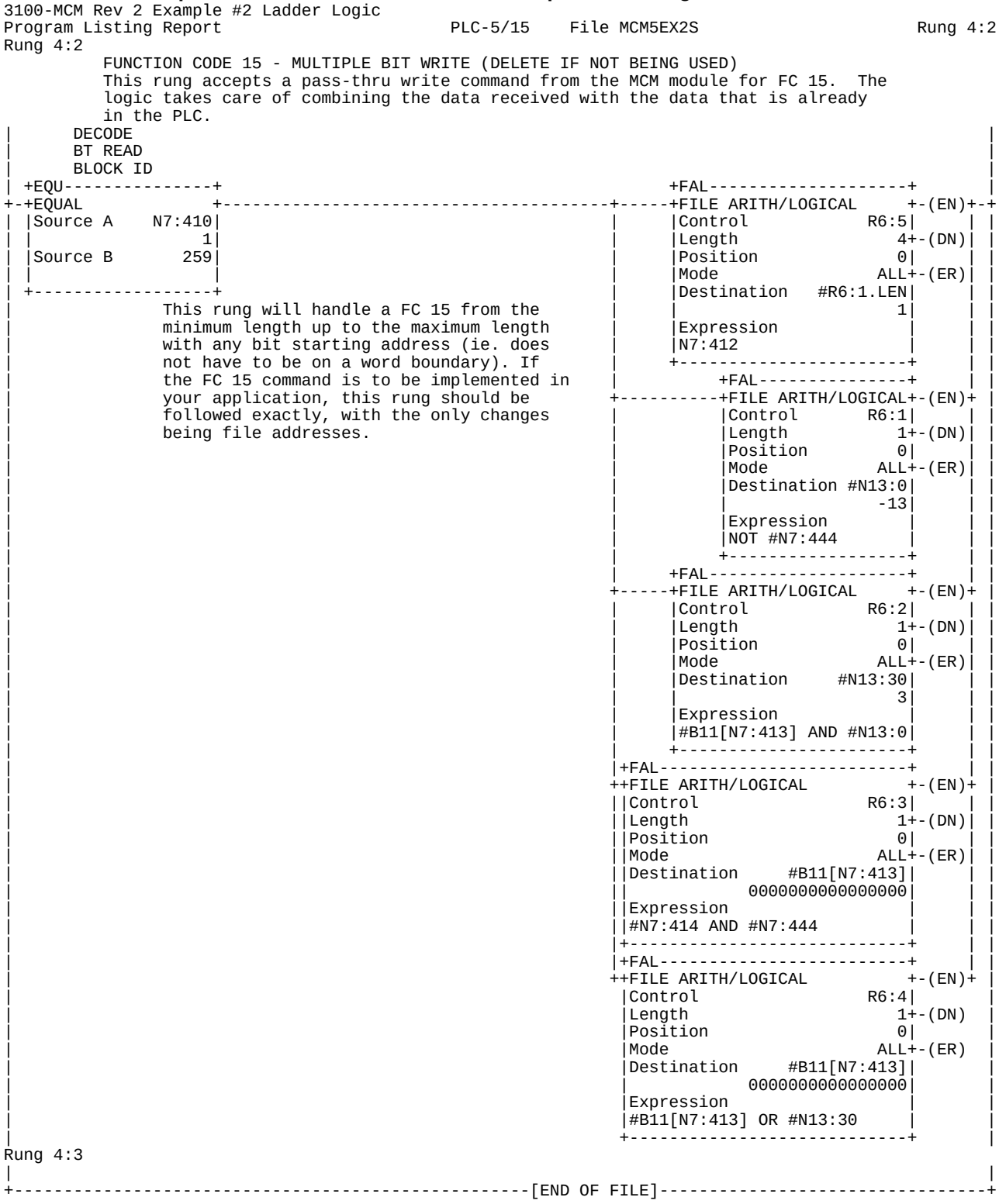
PLC Example Logic

Slave Mode Example #2 : Slave Mode w/ Pass-Thru - Expanded Configuration



PLC Example Logic

Slave Mode Example #2 : Slave Mode w/ Pass-Thru - Expanded Configuration



Master Mode Example #1 : Master Mode - Basic Application

The following example provides an example of the MCM module in a Master application. In this example we have setup Port 1 as a Master. Port 2 has been setup as a Slave for testing purposes only, but you may program it as needed. In order to test the logic which we have provided, install a looped cable from Port 1 to Port 2 as shown in the beginning of this manual.

Assumptions

- Read 200 words from Module (values from slaves and Master Error Table)
- Write 50 words to module (for writing to slaves)

System Configuration

N[]:20	4	Read Block Count	This value represents the total number of 50 word data blocks that we want to read back from the module into the PLC/SLC data table. In this application we have setup to read back registers 0 to 199.
N[]:21	1	Write Block Count	This value reflects the number of 50 words blocks that need to be moved to the module to provide data for the module to write to the slaves.
N[]:22	2	Command Block Count	This value represents the number of Command Blocks (5 commands per block) that we would like to send to the module. In this application we wanted to allow for 10 commands, even if we have only configured 5 of them
N[]:23	130	Slave Table Ptr	Location Slave Error Table in Module's memory space. In a Master application we still would like to bring back this table in order to have the module firmware revision information
N[]:24	150	Master Table Ptr	Location of the Master Error Table in the Module's memory space. In this application we have located this table after the Slave Error Table. Since we do not have more than 50 commands we are not concerned about the remainder of the table. In fact since we have allowed for only 10 commands, we could have set the Master Table Pointer to 189 if we had wanted to conserve memory
N[]:27	0	Read Block ID Start Value	This value determines the starting BTR Block ID number which will be returned from the module.
N[]:28	4	Write Block ID Start Value	This value determines the starting BTW Block ID number which be generated by the module. In this example, we wish to write data into Block #4, therefore we will set this value to 4.

Master Mode example #1 : Master Mode - Basic Application

Data Table File N7:0

Address	0	1	2	3	4	5	6	7	8	9	
N7:0	0	0	5	0	0	0	0	0	0	0	Port 1 Config
N7:10	1	1	5	0	0	0	0	0	0	0	Port 2 Config
N7:20	4	1	2	130	150	0	0	0	4	0	System Config
N7:30	0	0	0	0	0	0	0	0	0	0	Route Table
N7:40	0	0	0	0	0	0	0	0	0	0	
											Command List
N7:50	1	1	3	200	10	0	0	0	0	0	Command #1
N7:60	1	1	3	210	10	10	0	0	0	0	Command #2
N7:70	1	1	4	220	10	20	0	0	0	0	Command #3
N7:80	1	1	3	200	10	30	0	0	0	0	Command #4
N7:90	1	1	16	200	40	40	0	0	0	0	Command #5
N7:100	0	0	0	0	0	0	0	0	0	0	Command #6
N7:110	0	0	0	0	0	0	0	0	0	0	Command #7
N7:120	0	0	0	0	0	0	0	0	0	0	Command #8
N7:130	0	0	0	0	0	0	0	0	0	0	Command #9
N7:140	0	0	0	0	0	0	0	0	0	0	Command #10

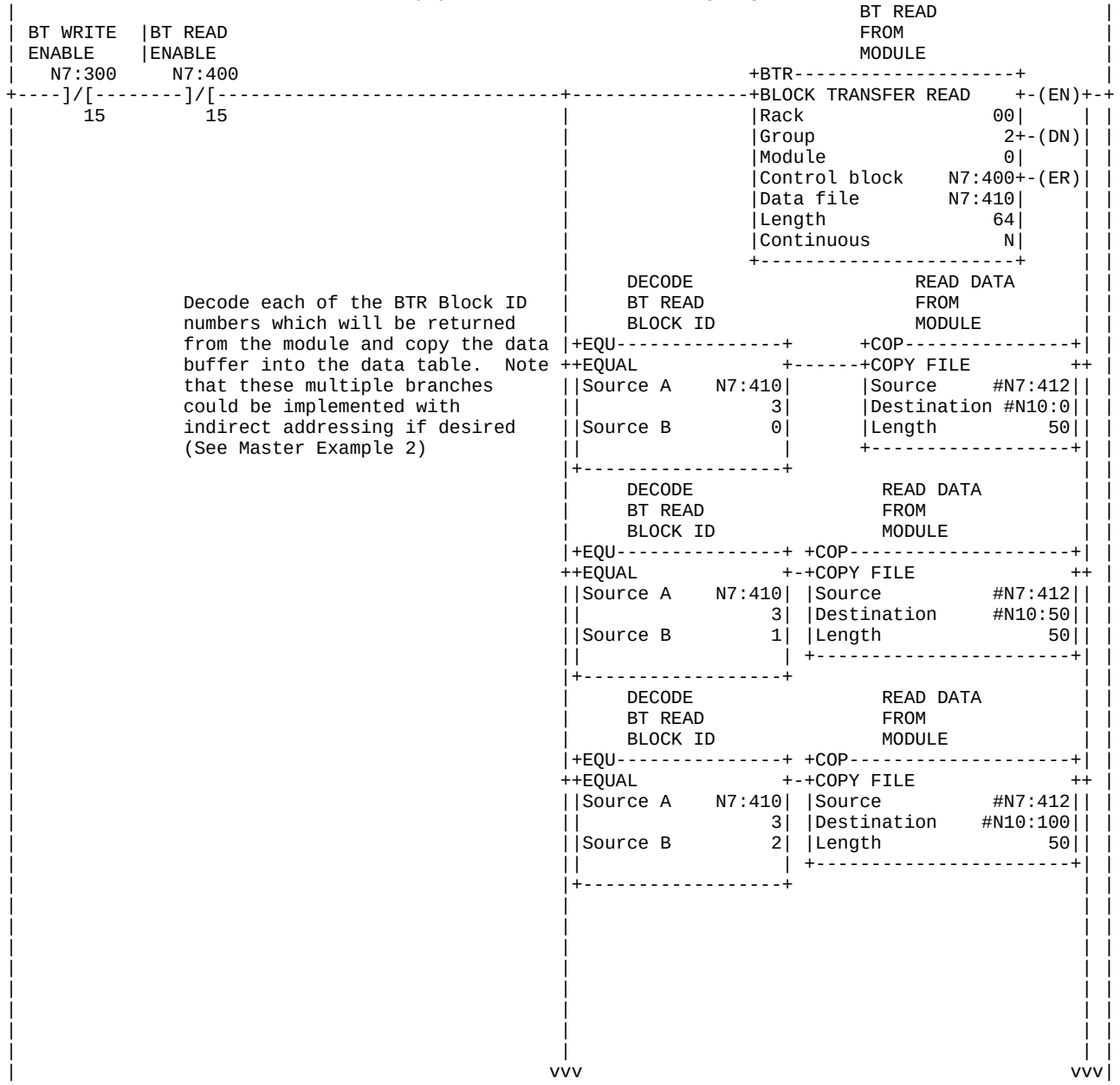
Data Table File N10:0

Address	0	1	2	3	4	5	6	7	8	9	
N10:0	200	201	202	203	0	0	0	0	0	0	Read Data Block
N10:10	210	211	212	213	0	0	0	0	0	0	from Module
N10:20	220	221	222	223	0	0	0	0	0	0	Reg 0 to 199
N10:30	200	201	202	203	0	0	0	0	0	0	
N10:40	200	201	202	203	0	0	0	0	0	0	
N10:50	210	211	212	213	0	0	0	0	0	0	
N10:60	220	221	222	223	0	0	0	0	0	0	
N10:70	200	201	202	203	0	0	0	0	0	0	
N10:80	0	0	0	0	0	0	0	0	0	0	
N10:90	0	0	0	0	0	0	0	0	0	0	
N10:100	0	0	0	0	0	0	0	0	0	0	
N10:110	0	0	0	0	0	0	0	0	0	0	
N10:120	0	0	0	0	0	0	0	0	0	0	
N10:130	0	0	0	0	0	0	0	932	932	932	Slave Error Table
N10:140	MC	M	2.	00	11	32	0	0	0	0	
N10:150	1	0	0	0	0	0	0	0	0	0	Master Error Table
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	200	201	202	203	0	0	0	0	0	0	Write Data Block
N10:210	210	211	212	213	0	0	0	0	0	0	to Module
N10:220	220	221	222	223	0	0	0	0	0	0	Reg 200 to 249
N10:230	0	0	0	0	0	0	0	0	0	0	
N10:240	0	0	0	0	0	0	0	0	0	0	

PLC Ladder Logic

Master Mode example #1 : Master Mode - Basic Application

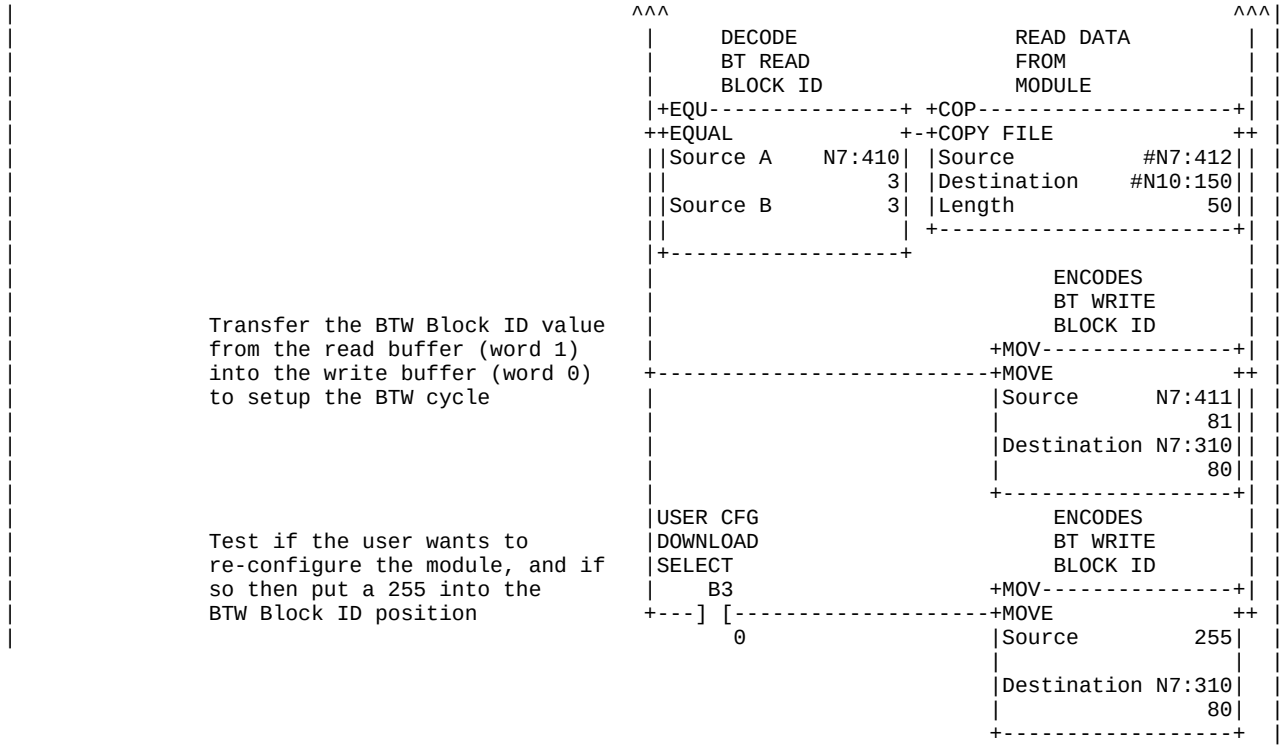
```
3100-MCM Master Example #1 Ladder Logic
Program Listing Report                    PLC-5/15    File MCM5EX1M                    Rung 3:0

Rung 3:0
          BT READ AND REGISTER TRANSFER FROM MODULE DECODING
          BT READ from module.  If BT READ Block ID is between 0 and 3 inclusive, then
          transfers the module's registers into the PLC data table.  To add
          additional data blocks, simply add additional decoding logic.
```



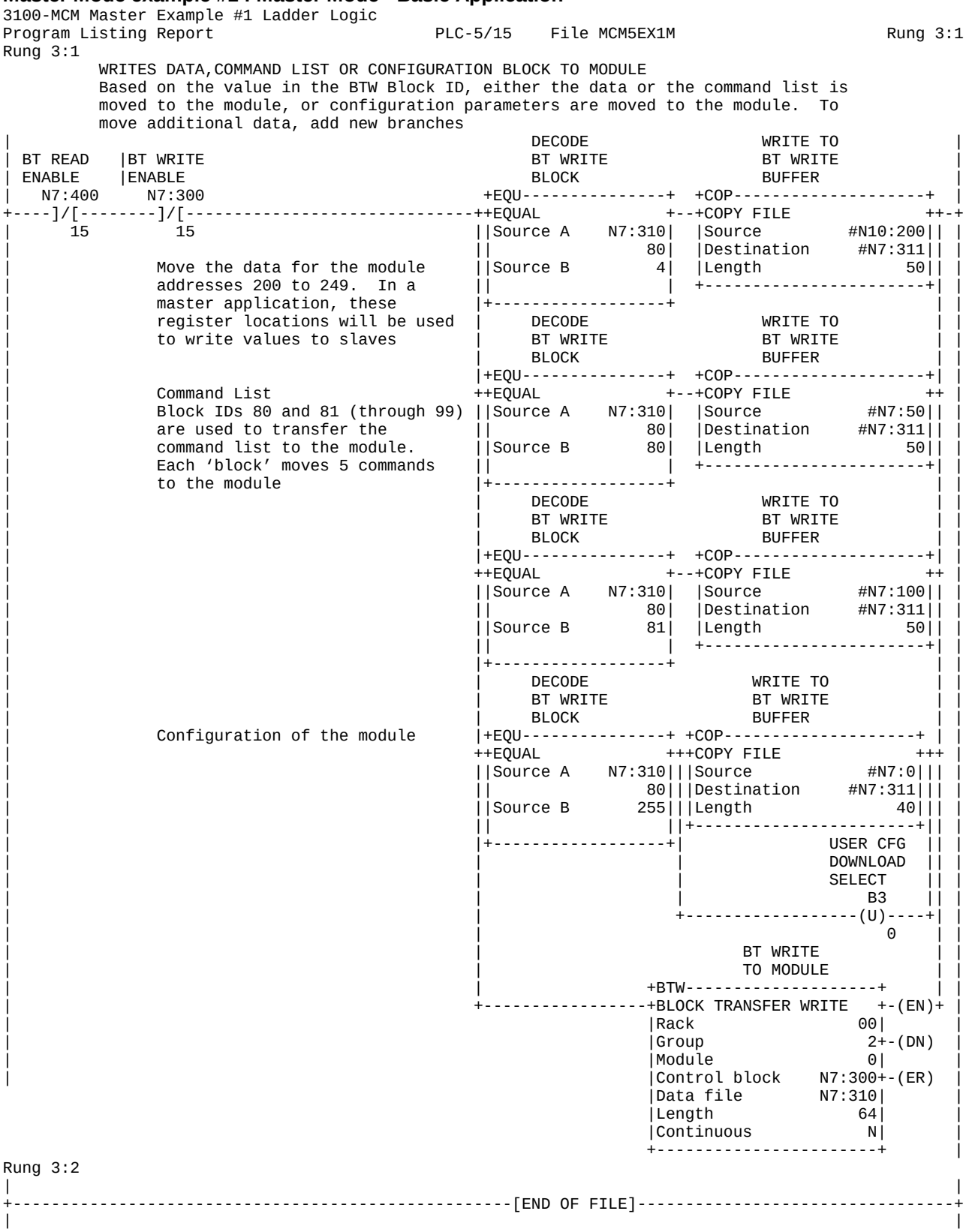
PLC Ladder Logic

Master Mode example #1 : Master Mode - Basic Application

```
3100-MCM Master Example #1 Ladder Logic
Program Listing Report                    PLC-5/15    File MCM5EX1M                    Rung 3:0
```



PLC Ladder Logic
Master Mode example #1 : Master Mode - Basic Application



Master Mode Example #2: Master Mode w/ Command Control Enabled

The following example provides an example of the MCM module in a Master application. In this example we have setup Port 1 as a Master. Port 2 has been setup as a Slave for testing purposes only, but you may program it as needed. In order to test the logic which we have provided, install a looped cable from Port 1 to Port 2 as shown in the beginning of this manual.

Assumptions

- Read 200 words from Module (values from slaves and Master Error Table)
- Write 50 words to module (for writing to slaves)

System Configuration

N[]:20	4	Read Block Count	This value represents the total number of 50 word data blocks that we want to read back from the module into the PLC/SLC data table. In this application we have setup to read back registers 0 to 199.
N[]:21	1	Write Block Count	This value reflects the number of 50 words blocks that need to be moved to the module to provide data for the module to write to the slaves.
N[]:22	2	Command Block Count	This value represents the number of Command Blocks (5 commands per block) that we would like to send to the module. In this application we wanted to allow for 10 commands, even if we have only configured 5 of them
N[]:23	130	Slave Table Ptr	Location Slave Error Table in Module's memory space. In a Master application we still would like to bring back this table in order to have the module firmware revision information
N[]:24	150	Master Table Ptr	Location of the Master Error Table in the Module's memory space. In this application we have located this table after the Slave Error Table. Since we do not have more than 50 commands we are not concerned about the remainder of the table. In fact since we have allowed for only 10 commands, we could have set the Master Table Pointer to 189 if we had wanted to conserve memory
N[]:27	0	Read Block ID Start Value	This value determines the starting BTR Block ID number which will be returned from the module.
N[]:28	4	Write Block ID Start Value	This value determines the starting BTW Block ID number which be generated by the module. In this example, we wish to write data into Block #4, therefore we will set this value to 4.

Master Mode Example #2 : Master Mode w/ Command Control Enabled

Data Table File N7:0

Address	0	1	2	3	4	5	6	7	8	9	
N7:0	0	0	5	0	0	0	0	0	0	0	Port 1 Config
N7:10	1	1	5	0	0	0	0	0	0	0	Port 2 Config
N7:20	4	1	2	130	150	0	0	0	4	0	System Config
N7:30	0	0	0	0	0	0	0	0	0	0	Route Table
N7:40	0	0	0	0	0	0	0	0	0	0	
											Command List
N7:50	9	1	3	200	10	0	0	0	0	0	Command #1
N7:60	9	1	3	210	10	10	0	0	0	0	Command #2
N7:70	9	1	4	220	10	20	0	0	0	0	Command #3
N7:80	1	1	3	200	10	30	0	0	0	0	Command #4
N7:90	1	1	16	200	40	40	0	0	0	0	Command #5
N7:100	0	0	0	0	0	0	0	0	0	0	Command #6
N7:110	0	0	0	0	0	0	0	0	0	0	Command #7
N7:120	0	0	0	0	0	0	0	0	0	0	Command #8
N7:130	0	0	0	0	0	0	0	0	0	0	Command #9
N7:140	0	0	0	0	0	0	0	0	0	0	Command #10

Data Table File B9

Address	Data (Radix=BINARY)	Address	Data (Radix=BINARY)
B9:0	0000 0000 0000 0000	B9:11	0000 0000 0000 0000
B9:1	0000 0000 0000 0000	B9:12	0000 0000 0000 0000
B9:2	0000 0000 0000 0000	B9:13	0000 0000 0000 0000
B9:3	0000 0000 0000 0000	B9:14	0000 0000 0000 0000
B9:4	0000 0000 0000 0000	B9:15	0000 0000 0000 0000
B9:5	0000 0000 0000 0000	B9:16	0000 0000 0000 0000
B9:6	0000 0000 0000 0000	B9:17	0000 0000 0000 0000
B9:7	0000 0000 0000 0000	B9:18	0000 0000 0000 0000
B9:8	0000 0000 0000 0000		
B9:9	0000 0000 0000 0000		
B9:10	0000 0000 0000 0000		

B9 is used for Command Control.
Words 0 to 5 : Command Enable
Words 6 to 11: Command Done
Words 12 to 17:Command Error

Data Table File N10:0

Address	0	1	2	3	4	5	6	7	8	9	
N10:0	200	201	202	203	0	0	0	0	0	0	Read Data Block
N10:10	210	211	212	213	0	0	0	0	0	0	from Module
N10:20	220	221	222	223	0	0	0	0	0	0	Reg 0 to 199
N10:30	200	201	202	203	0	0	0	0	0	0	
N10:40	200	201	202	203	0	0	0	0	0	0	
N10:50	210	211	212	213	0	0	0	0	0	0	
N10:60	220	221	222	223	0	0	0	0	0	0	
N10:70	200	201	202	203	0	0	0	0	0	0	
N10:80	0	0	0	0	0	0	0	0	0	0	
N10:90	0	0	0	0	0	0	0	0	0	0	
N10:100	0	0	0	0	0	0	0	0	0	0	
N10:110	0	0	0	0	0	0	0	0	0	0	
N10:120	0	0	0	0	0	0	0	0	0	0	
N10:130	0	0	0	0	0	0	0	932	932	932	Slave Error Table
N10:140	MC	M	2.	00	11	32	0	0	0	0	
N10:150	1	0	0	0	0	0	0	0	0	0	Master Error Table
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	200	201	202	203	0	0	0	0	0	0	Write Data Block
N10:210	210	211	212	213	0	0	0	0	0	0	to Module
N10:220	220	221	222	223	0	0	0	0	0	0	Reg 200 to 249
N10:230	0	0	0	0	0	0	0	0	0	0	
N10:240	0	0	0	0	0	0	0	0	0	0	

PLC Ladder Logic

Master Mode Example #2 : Master Mode w/ Command Control Enabled

```
3100-MCM Master Example #2
Program Listing Report                    PLC-5/15    File MCM5EX2M                    Rung 3:0

Rung 3:0
          BT READ AND REGISTER TRANSFER FROM MODULE DECODING
          This example logic uses indirect addressing to decode the BTR Block ID numbers
          coming from the module.  In this case, there is no need to edit the rung if
          more data is to be returned from the module, simply make sure there is enough
          data table space.
|                                                                          BT READ                |
| BT WRITE  |BT READ                                                       FROM                   |
| ENABLE    |ENABLE                                                       MODULE                 |
|   N7:300     N7:400                                          +BTR-------------------+         |
+----]/[--------]/[-------------------------+----------------------+BLOCK TRANSFER READ    +-(EN)+-+
|      15         15                        |                      |Rack                 00|      | |
|                                           |                      |Group                 2+-(DN)| |
|                                           |                      |Module                0|      | |
|                                           |                      |Control block    N7:400+-(ER)| |
|                                           |                      |Data file        N7:410|      | |
|                                           |                      |Length               64|      | |
|                                           |                      |Continuous            N|      | |
|                                           |                      +------------------------+     | |
|                                           |     DECODE                                          | |
|                                           |     BT READ                                         | |
|                                           |     BLOCK ID                                        | |
|        Decode the BTR Block ID numbers    |+LES---------------+           +CPT---------------+  | |
|        which will be returned from the    ++LESS THAN         ++----------+COMPUTE           +++ | |
|        module and copy the data buffer    ||Source A    N7:410||          |Destination N7:409|||  | |
|        into the data table.  This method  ||                 3||          |                100|||  | |
|        of indirect addressing is more     ||Source B     N7:20||          |Expression         |||  | |
|        efficient than the branched        ||                 4||          |N7:410 * 50        |||  | |
|        method used in Master Example #1.  |+-----------------+|          +-------------------+||  | |
|                                           |                    |+COP-------------------------+||  | |
|                                           |                    ++COPY FILE                    ++|  | |
|                                           |                     |Source               #N7:412|  | |
|                                           |                     |Destination     #N10[N7:409]|  | |
|                                           |                     |Length                   50|  | |
|                                           |                     +---------------------------+  | |
|                                           |                                ENCODES             | |
|                                           |                                BT WRITE            | |
|                                           |                                BLOCK ID            | |
|        Transfer the BTW Block ID value    |                               +MOV---------------+| |
|        from the read buffer (word 1) to the-------------------------------+MOVE              ++ |
|        write buffer (word 0) to setup the |                               |Source      N7:411|| |
|        BTW cycle                          |                               |                  80|| |
|                                           |                               |Destination N7:310|| |
|                                           |                               |                  80|| |
|                                           |                               +-------------------+| |
|                                           |USER CFG                            ENCODES         | |
|                                           |DOWNLOAD                            BT WRITE        | |
|        Test if the User wants to          |SELECT                              BLOCK ID        | |
|        re-configure the module, and if    |    B3                             +MOV---------------+| |
|        so then place a 255 into the       +---] [-------------------------+MOVE              ++ |
|        BTW Block ID position.                    0                        |Source         255|  | |
|                                                                           |                  |  | |
|                                                                           |Destination N7:310|  | |
|                                                                           |                  80|  | |
|                                                                           +-------------------+  | |
```

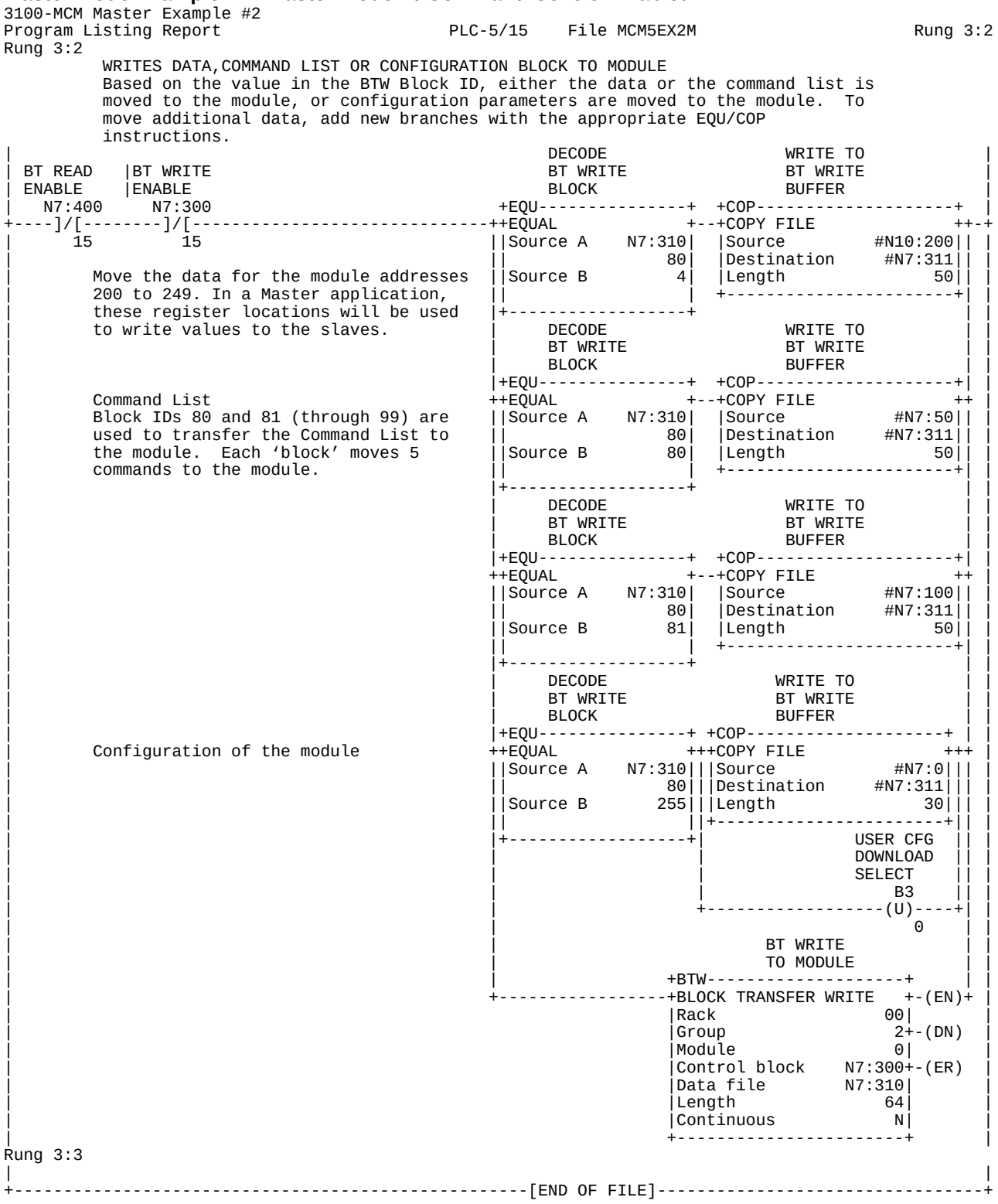
PLC Ladder Logic

Master Mode Example #2 : Master Mode w/ Command Control Enabled

```
3100-MCM Master Example #2
Program Listing Report                    PLC-5/15    File MCM5EX2M                    Rung 3:1

Rung 3:1
          COMMAND CONTROL MODE  (DELETE IF NOT USING COMMAND CONTROL MODE)
          If the BTR Block ID value is not that of a pass-thru command, then the CMD_EN
          and CMD_DONE/ERR bits are copied and the subroutine to manipulate the bits is
          called.
|                                                                                  COPY             |
|                 DECODE                                                           CMD_DN           |
| BT READ         BT READ                                                          CMD_ERR          |
| DONE BIT        BLOCK ID                                                         STATUS           |
|   N7:400   +LES--------------+                                             +COP---------------+  |
+----] [-----+LESS THAN         +-------------------------------------+-----+COPY FILE         ++-+
|      13    |Source A    N7:410|                                     |     |Source     #N7:462|| |
|            |                3|                                     |     |Destination  #B9:6|| |
|            |Source B       256|                                     |     |Length          12|| |
|            |                 |                                     |     +------------------+| |
|            +-----------------+                                     |          COMMAND         | |
|                                                                    |          CONTROL         | |
|                                                                    |          MODE            | |
|                                                                    |          HANDLER         | |
|                                                                    |     +JSR---------------+| |
|        This rung handles the logic for the Command Control         +-----+JUMP TO SUBROUTINE++ |
|        Mode.  The first branch copies the Done and Error status    |     |Prog file number 4|| |
|        bits which are being returned from the module into a        |     |Input parameter   || |
|        working file. The SBR 4 processes the Done and Error bits   |     |Return parameter  || |
|        for the commands which are in the Command Control Mode      |     +------------------+| |
|        (Cmds 1,2,and 3 in this example) and clears the             |       COPY               | |
|        Enable bits if appropriate.  The last branch transfers      |       CMD_EN             | |
|        the Enable bits up to the module.                           |       BITS               | |
|                                                                    |+COP--------------------+| |
|                                                                    |++COPY FILE             ++ |
|                                                                    | |Source           #B9:0|  |
|                                                                    | |Destination    #N7:361|  |
|                                                                    | |Length               6|  |
|                                                                    | +----------------------+  |
```

PLC Ladder Logic

Master Mode Example #2 : Master Mode w/ Command Control Enabled



PLC Ladder Logic
Master Mode Example #2 : Master Mode w/ Command Control Enabled

```
3100-MCM Master Example #2
Program Listing Report                    PLC-5/15    File MCM5EX2M                    Rung 4:0

Rung 4:0
          COMMAND CONTROL EXAMPLE LOGIC (DELETE IF NOT USING COMMAND CONTROL MODE)
          The following rungs of logic control the unlatching of the Command Enable bits
          when the command is done successfully.
|                                                                                  LOGIC                  |
|                                                                                  CMD ENABLE  CMD EN BIT  |
|                                                                                  CMD 1       CMD 1       |
|                                                                                      B3          B9      |
+----------------------------------------------------------------------------------+---] [---------(L)----+-+
|                                                                                  |     16           0   | |
|                                                                                  |CMD DN BIT|CMD EN BIT | |
|        This logic, typical for any Control Mode command,                         |CMD 1     |CMD 1      | |
|        takes the logical enable which would be provided by                       |    B9         B9     | |
|        application ladder (B3/16) and latches the Enable.                        +---] [----+---(U)----++ |
|        When the Done bit is received, the enables are cleared.                         96   |      0   |  |
|        NOTE THAT THE ENABLE IS ONE SHOT IN THE MODULE. THE MODULE                           |LOGIC     |  |
|        MUST SEE A TRANSITION FROM 1 TO 0 BEFORE IT WILL                                    |CMD ENABLE|  |
|        RE-ENABLE A COMMAND                                                                 |CMD 1     |  |
|                                                                                            |    B3    |  |
|                                                                                            +---(U)----+  |
|                                                                                                  16      |
Rung 4:1
|                                                                                  LOGIC                  |
|                                                                                  CMD ENABLE  CMD EN BIT  |
|                                                                                  CMD 2       CMD 2       |
|                                                                                      B3          B9      |
+----------------------------------------------------------------------------------+---] [---------(L)----+-+
|                                                                                  |     17           1   | |
|                                                                                  |CMD DN BIT|CMD EN BIT | |
|                                                                                  |CMD 2     |CMD 2      | |
|                                                                                  |    B9         B9     | |
|                                                                                  +---] [----+---(U)----++ |
|                                                                                        97   |      1   |  |
|                                                                                             |LOGIC     |  |
|                                                                                             |CMD ENABLE|  |
|                                                                                             |CMD 2     |  |
|                                                                                             |    B3    |  |
|                                                                                             +---(U)----+  |
|                                                                                                   17     |
Rung 4:2
|                                                                                  LOGIC                  |
|                                                                                  CMD ENABLE  CMD EN BIT  |
|                                                                                  CMD 3       CMD 3       |
|                                                                                      B3          B9      |
+----------------------------------------------------------------------------------+---] [---------(L)----+-+
|                                                                                  |     18           2   | |
|                                                                                  |CMD DN BIT|CMD EN BIT | |
|                                                                                  |CMD 3     |CMD 3      | |
|                                                                                  |    B9         B9     | |
|                                                                                  +---] [----+---(U)----++ |
|                                                                                        98   |      2   |  |
|                                                                                             |LOGIC     |  |
|                                                                                             |CMD ENABLE|  |
|                                                                                             |CMD 3     |  |
|                                                                                             |    B3    |  |
|                                                                                             +---(U)----+  |
|                                                                                                   18     |
Rung 4:3
|                                                                                                          |
+-------------------------------------------------[END OF FILE]-----------------------------------------+
|                                                                                                          |
```