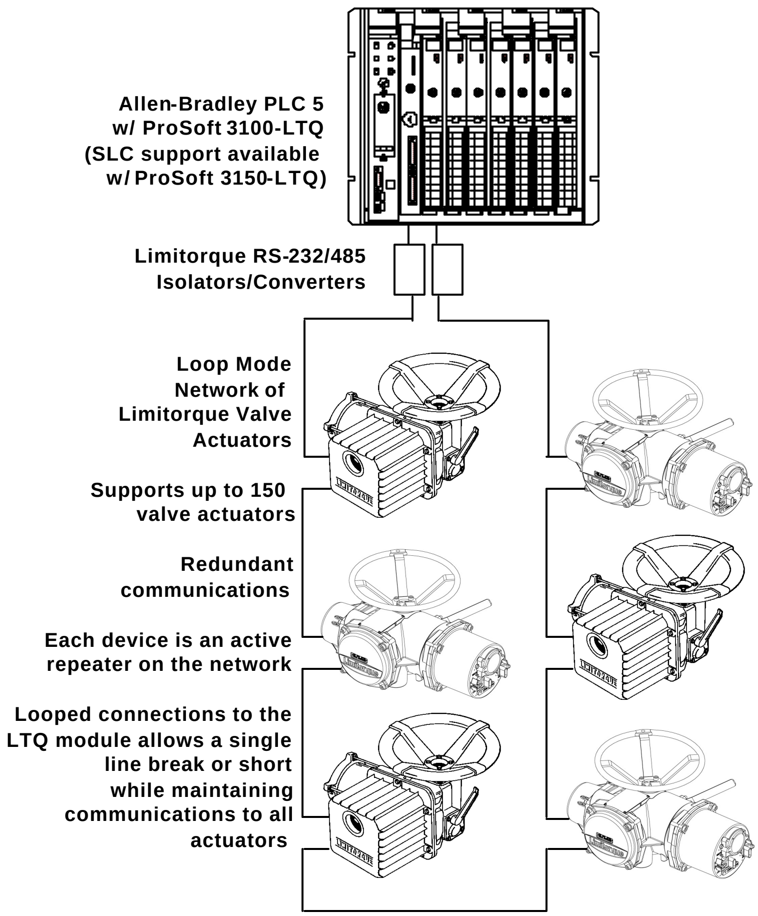
3100/3150 – LTQ
Limitorque Valve Actuator
Master Module

Revision 1.7



USER MANUAL

February 2000

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Please Read This Notice

Successful application of the LTQ card requires a reasonable working knowledge of the Allen-Bradley PLC or SLC hardware and the application in which the combination is to be used. For this reason, it is important that those responsible for implementing the LTQ satisfy themselves that the combination will meet the needs of the application without exposing personnel or equipment to unsafe or inappropriate working conditions.

This manual is provided to assist the user. Every attempt has been made to assure that the information provided is accurate and a true reflection of the product's installation requirements. In order to assure a complete understanding of the operation of the product, the user should read all applicable Allen-Bradley documentation on the operation of the A-B hardware.

Under no conditions will ProSoft Technology, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of the LTQ product.

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Product Revision History

09/23/96	Revision 1.0 Initial release of product
04/30/97	Corrected manual errors
01/31/00	Add Accutronix MX documentation
02/23/00	Added Special Polling documentation

Implementation Guide

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

a) Obtain project application and operation requirements. Read and understand all relevant specifications drawings, diagrams, checkout procedures, performance audits, etc.

b) Read the 3100/3150-LTQ User Manual.

c) Obtain and read appropriate Limitorque supporting documents for product being networked. These documents may be obtained from your local Limitorque representative or downloaded from the Limitorque website: http://www.limitorque.com

435-23009	DDC-100 Direct-to-Host Programming Guide
130-43510	Accutronix MX DDC-100 Field Unit Installation and Operation Manual
440-20014	DDC-100 UEC Field Unit (Modbus) Installation and Operation Manual
435-20013	DDC-100 I/O Module Installation and Operation Manual
437-13001	DDC-100 UEC Field Unit (UEC-3-DDC) Wiring & Startup Guidelines
130-11000	Accutronix MX Installation & Operation Manual

d) Starting with one of the ladder logic programs provided on disk with the LTQ, complete the following steps:

PLC 5	LTQ5
SLC 5/03	LTQ503

e) Edit the ladder logic provided on disk as needed for the application
Verify rack and slot location in program
Modify ladder instruction addresses as needed
Reference Appendix for tips in the SLC platform

f) Setup the Communication Configuration parameters (See Section 2)
Determine the configuration requirements
Baud Rate, Slave Count, and the Active Slave Map

g) Identify the jumper requirements (See Appendix)

h) Make up the communication cables (See Section 5)

i) Place processor into the run mode

j) Monitor the data table Error Status values (See Section 2)

Table of Contents

1 Product Specifications

The 3100/3150-LTQ ("Limitorque Valve Master Module") product family allows Allen-Bradley 1771 and 1746 I/O compatible processors to easily interface as a host with up to 150 Limitorque Valve actuators.

The LTQ product includes the following standard features:

General Specifications

- Support for up to 150 Limitorque valve actuators
  - Supports all models, including:
    - MX/DDC-100
    - UEC-3-DDC Modbus
    - DDC-100M I/O Module
    - DDC-100M Field Unit
    - Valvcon IVO (unit is multidrop only)
- Implements Limitorque's Port A/B polling scheme using both ports on the LTQ module
- RS-232 or RS-485 communications (jumper selectable)
- Software configuration (From processor ladder logic)
  - Baud Rate: 1,200 to 38,400
  - Message Response Timeout
  - Number of active slaves: 1 to 150
  - Last State on Comm Fail
  - Network Polling Scheme
    - Looped
    - Port 1 Only
    - Port 2 Only
  - Active Slave Table: Bit mapped
- Supported commands:
  - Continuously Polled
    - Read registers 40008 – 40013, Optional: 40055 or 40006/40007
  - Commands
    - Open
    - Stop
    - Close
    - Initiate Network ESD
    - Terminate Network ESD
    - Engage Contactors 1 - 6
    - Disengage Contactors 1 - 6
    - Position Valve (0 - 100%)
- Data returned to the ladder data table includes the following per valve:
  - Valve Position (0 – 100%)
  - Status Register
  - Fault Register
  - Digital Outputs
  - Digital Input Registers 1 and 2
  - Comm Error Code
  - Comm Counter
  - Special Polled Registers
- Response time

  The 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

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 (32 to 140 F)
- Storage Temperature : -40 to 85 C (-40 to 185 F)
- Connections:
  - 3100 : 2 - DB25 Female Connectors
  - 3150 : 2 - DB9 Male Connectors

2 LTQ Theoretical Operation

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.

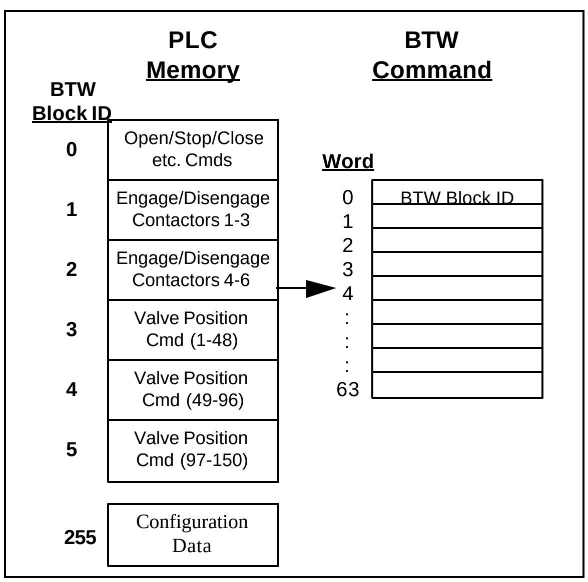
The following discussion details the data structures used to transfer the different types of data between the ProSoft Technology module and the processor. The term 'Block Transfer' is used generically in the following discussion to depict the transfer of data blocks between the processor and the ProSoft 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 Appendix A.

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

2.1 Block Transferring Data 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 Open/Stop/Close/ESD Commands 1 Engage/Disengage 1 - 3 Commands 2 Engage/Disengage 4 - 6 Commands 3-5 Valve Position Commands 255 Module Communication Configuration
1 to 63	Data	The data to be written to the module. The structure of the data is dependent on the Block ID code. The following sections provide details on the different structures.



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.

2.1.1 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.

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 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.

Transferring the Communications Configuration Parameters to the module will force a reset of the communication ports

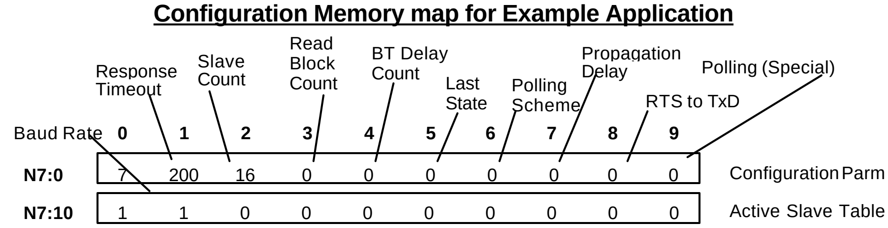
The configuration data block structure which must be transferred from the processor to the module is as follows:

BTW Block ID 255

Word	Description
0	BTW Block ID = 255
1-10	Config parameters
11-20	Active Slave Table

BTW Buffer	Data Word	Description
0		Block ID Header = 255
Configuration Parameters		
1	N[ ]:0	Baud Rate
2	N[ ]:1	Response Timeout
3	N[ ]:2	Max Number of Slaves
4	N[ ]:3	Read Block Count
5	N[ ]:4	Block Transfer Delay Count
6	N[ ]:5	Last State on Comm Fail
7	N[ ]:6	Network Poll Scheme
8	N[ ]:7	Propagation Delay
9	N[ ]:8	RTS to TxD Delay
10	N[ ]:9	Polling (special)
Active Slave Table		
11-20	N[ ]:10-19	Slaves 1 - 150

Configuration Memory map for Example Application



Name	Description
Baud Rate	The baud rate at which the port is to operate. The available configurations are as follows: Value / Baud Rate 2 — 1200 Baud 3 — 2400 Baud 4 — 4800 Baud 5 — 9600 Baud * 6 — 19200 Baud 7 — 38400 Baud * Limitorque Field Unit Factory Default Setting
Message Response Timeout	This register represents the message response timeout period in 1 msec 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. A value of 200 msec should be the minimal setting. Values from 200 to 65535 (0xffff) are permitted.
Max Number of Slaves	This value is used by the module to optimize the number of data blocks returned to the PLC data table as well as several of the internal logic routines. The value entered here can range from 1 to 150, and should always meet or exceed the last slave in the Active Slave Table.
Read Data Block Count	This value represents the number of 50 word data blocks which are to be transferred from the LTQ Module to the processor. The blocks returned from the module start at block 0 and increment from there. The maximum block count is 80. As an 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 of 0 is entered the LTQ module uses the Number of Slaves configuration value to determine the Read Block Count value.
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. 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 75-150. The value must be determined empirically.
Last State on Comm Fail	This value determines the state of the Limitorque read register values which are returned to the PLC upon the detection of a communication failure state (ie., comm has failed on both Port A and B). Value / Description 0 — Clear last data values (default) 1 — Maintain last data values

Network Polling Scheme	<u>Value</u> <u>Description</u> 0 Loop Mode (Port 1 and 2 alternating) 1 Port 1 polling only 2 Port 2 polling only The Network Loop Mode emulates Limitorque's polling scheme which takes advantage of the actuator ability to repeat data transmissions and to operate in a looped mode. In this mode, the module will alternate communications between Port 1 and 2. Command failures on one port will be retried on the other port.
Active Slave Table	These 10 words allow the user to configure the specific slaves which are active on a network. The intent of this table is to allow the user to selectively enable slave addresses and therefore not have to be concerned about activating slave addresses continuously. **Active Slave Table** Word 0 **15** Bits **0** 1000 0000 0000 0001 Slave Address #1 Enable Slave Address #16 Enable All values are entered into the table in a right to left order with bit 0 representing the lower address. The slave addresses are mapped into the table as follows: <u>Word</u> <u>Description</u> 0 Slaves 1 to 16 1 Slaves 17 to 32 2 Slaves 33 to 48 3 Slaves 49 to 64 4 Slaves 65 to 80 5 Slaves 81 to 96 6 Slaves 97 to 112 7 Slaves 113 to 128 8 Slaves 129 to 144 9 Slaves 145 to 150
Propagation Delay	Provides a delay time between primary port polls to prevent network collisions on port changeover. Values should be no lower than the listed minimal settings. The value represents delay time in milliseconds. <u>Value</u> <u>Number of Slaves</u> 0 1 to 20 10 21 to 40 15 41 to 60 20 61 to 80 25 81 to 100 30 101 to 120 35 121 to 140 40 141 to 150 Note: These values are reference only. Empirical data gathered on site will enable proper adjustment of these values. Slave #1 Channel A Fail bit (port 1) being true AND all other slave communications not in fault will be an indication of improper adjustment of this value.

RTS to TxD	This value represents the time in <u>1 msec increments</u> for delay between asserting RTS and the actual transmission of data. Delay between the receipt of messages and transmit of new message must be greater than 10 msec. When used, a value of 20 is typically inserted into this field. Note: This value is reference only. Empirical data gathered on site will enable proper adjustment of these values.
Polling (Special)	Enables polling of specific registers in addition to the standard polling. A value other than zero will cause an additional poll request to be sent to the slaves that are enabled. The results are placed in registers 8 and 9 in the slave response data block. Using this feature has a performance cost as the time available for the standard polling is shared with the special polling. <u>Value</u> <u>Description</u> 0 Disabled 1 Register 55, TP_BEFORE_MID_T_HIGH 2 Registers 6/7, Analog Input 1 and 2

2.1.2 Command Blocks [BTW Block ID Code 0 to 5]

An LTQ Master port establishes communications and performs various communications functions based on data the user has placed in the Command Blocks. The Command Blocks are 60 word data blocks containing bit mapped 'Enable Bits'. The actual command executed by the module is determined by the user setting the correct 'Enable Bit' to a 1.

All commands are one-shoted by the module (ie., the module must see a 1 to 0 transition before the command can be re-enabled with a 0 to 1 transition). The user may use the 'Cmd Done Bit' (See Section 2.2.4) to clear the command or any other means appropriate. This command data, entered into the processor Data Table, is transferred to the module's memory using Block IDs 0 through 5, depending on the command to be executed.

Word	Description
0	BTW Block ID Code (= 0)
1 to 10	Open Commands - Slaves 1-150
11 to 20	Stop Commands - Slaves 1-150
21 to 30	Close Commands - Slaves 1-150
31 to 40	Initiate ESD - Slaves 1-150
41 to 50	Terminate ESD - Slaves 1-150
51 to 60	Spare (Future)

Word	Description
0	BTW Block ID Code (= 1)
1 to 10	Engage Contactor #1 - Slaves 1-150
11 to 20	Disengage Contactor #1 - Slaves 1-150
21 to 30	Engage Contactor #2 - Slaves 1-150
31 to 40	Disengage Contactor #2- Slaves 1-150
41 to 50	Engage Contactor #3 - Slaves 1-150
51 to 60	Disengage Contactor #3 - Slaves 1-150

Word	Description
0	BTW Block ID Code (= 2)
1 to 10	Engage Contactor #4 - Slaves 1-150
11 to 20	Disengage Contactor #4 - Slaves 1-150
21 to 30	Engage Contactor #5 - Slaves 1-150
31 to 40	Disengage Contactor #5- Slaves 1-150
41 to 50	Engage Contactor #6 - Slaves 1-150
51 to 60	Disengage Contactor #6 - Slaves 1-150

Word	Description
0	BTW Block ID Code (= 3)
1 to 3	Analog Write Enable - Slaves 1 to 48
6 to 53	Analog Values - Slaves 1 to 48

Word	Description
0	BTW Block ID Code (= 4)
1 to 3	Analog Write Enable - Slaves 49 to 96
6 to 53	Analog Values - Slaves 49 to 96

Word	Description
0	BTW Block ID Code (= 5)
1 to 4	Analog Write Enable - Slaves 97 to 150
6 to 59	Analog Values - Slaves 97 to 150

Command Blocks

Block ID 0

16 Slave Address 1
0000 0000 0000 0001

Bit mapped Commands
(Ex. Send Open Command to slave #1)

Slave	16-1	32-17	48-33	64-49	80-65	96-81	112-97	127-113	143-128	150-144	
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
N10:0	1	0	0	0	0	0	0	0	0	0	Open Commands
N10:10	0	0	0	0	0	0	0	0	0	0	Stop Commands
N10:20	0	0	0	0	0	0	0	0	0	0	Close Commands
N10:30	0	0	0	0	0	0	0	0	0	0	Init Net ESD Commands
N10:40	0	0	0	0	0	0	0	0	0	0	Stop Net ESD Commands
N10:50	0	0	0	0	0	0	0	0	0	0	Spare

Block ID 1

N10:60	1	0	0	0	0	0	0	0	0	0	Engage Contactor #1
N10:70	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #1
N10:80	0	0	0	0	0	0	0	0	0	0	Engage Contactor #2
N10:90	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #2
N10:100	0	0	0	0	0	0	0	0	0	0	Enagage Contactor #3
N10:110	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #3

Block ID 2

N10:120	1	0	0	0	0	0	0	0	0	0	Engage Contactor #4
N10:130	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #4
N10:140	0	0	0	0	0	0	0	0	0	0	Engage Contactor #5
N10:150	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #5
N10:160	0	0	0	0	0	0	0	0	0	0	Engage Contactor #6
N10:170	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #6

Block ID 3

16 Slave Address 1
0000 0000 0000 0001

Bit mapped Commands
(Ex. Send Open Command to slave #1)

Valve Position Cmd Enables

Valve Position Values
(0 to 100 %)

	0	1	2	3	4	5	6	7	8	9
Slave	16-1	32-17	48-33							
N11:0	1	0	0	0	0	75	0	0	0	0
N11:10	0	0	0	0	0	0	0	0	0	0
N11:20	0	0	0	0	0	0	0	0	0	0
N11:30	0	0	0	0	0	0	0	0	0	0
N11:40	0	0	0	0	0	0	0	0	0	0
N11:50	0	0	0	0	0	0	0	0	0	0

Block ID 4

Valve Position Cmd Enables

Valve Position Values
(0 to 100 %)

	0	1	2	3	4	5	6	7	8	9
Slave	64-49	80-65	96-81							
N11:60	1	0	0	0	0	30	0	0	0	0
N11:70	0	0	0	0	0	0	0	0	0	0
N11:80	0	0	0	0	0	0	0	0	0	0
N11:90	0	0	0	0	0	0	0	0	0	0
N11:100	0	0	0	0	0	0	0	0	0	0
N11:110	0	0	0	0	0	0	0	0	0	0

Block ID 5

Valve Position Cmd Enables

Valve Position Values
(0 to 100 %)

	0	1	2	3	4	5	6	7	8	9
Slave	112-97	128-113	144-129	150-145						
N11:120	1	0	0	0	0	75	0	0	0	0
N11:130	0	0	0	0	0	0	0	0	0	0
N11:140	0	0	0	0	0	0	0	0	0	0
N11:150	0	0	0	0	0	0	0	0	0	0
N11:160	0	0	0	0	0	0	0	0	0	0
N11:170	0	0	0	0	0	0	0	0	0	0

Command Usage for Limitorque Products

LTQ Commands	MX-DDC	UEC-3-DDC	I/O Module
Open	Yes	Yes	Do Not Use
Stop	Yes	Yes	Do Not Use
Close	Yes	Yes	Do Not Use
Start Network ESD	Yes	Yes	Do Not Use
Stop Network ESD	Yes	Yes	Do Not Use
Engage Relay #1	Yes (AS-1)	Do Not Use	Yes (K2)
Engage Relay #2	Yes (AS-2)	Do Not Use	Yes (K1)
Engage Relay #3	Yes (AS-3)	Yes (K3)	Yes (K3)
Engage Relay #4	Yes (AS-4)	Do Not Use	Yes (K4)
Engage Relay #5	Yes (AR-1)	Do Not Use	Yes (K5)
Engage Relay #6	Yes (AR-2)	Yes (K6)	Yes (K6)
Disengage Relay #1	Yes (AS-1)	Do Not Use	Yes (K2)
Disengage Relay #2	Yes (AS-2)	Do Not Use	Yes (K1)
Disengage Relay #3	Yes (AS-3)	Yes (K3)	Yes (K3)
Disengage Relay #4	Yes (AS-4)	Do Not Use	Yes (K4)
Disengage Relay #5	Yes (AR-1)	Do Not Use	Yes (K5)
Disengage Relay #6	Yes (AR-2)	Yes (K6)	Yes (K6)

2.2 Transferring data from the module [BTR Block ID 0 to 30]

When the LTQ Master port driver reads data from a slave the resulting data is placed into the ProSoft module's data space (Addresses 0 to 1499). The structure of each set of slave data is predetermined and programmed into the module (see below). The position of each slave's data structure is a function of the slave address, with the data table beginning at slave 1 and working upwards.

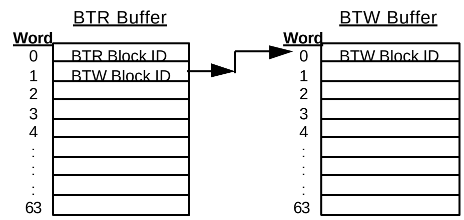
The transfer of data from the ProSoft Technology module to the processor is executed through the Block Transfer Read function. The following sections detail the handling of the read data.

> 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

The ladder logic must be programmed to look at the BTR buffer, decode several words, and then take action.

2.2.1 The Read Data Block Structure

The BTR buffer definition is:

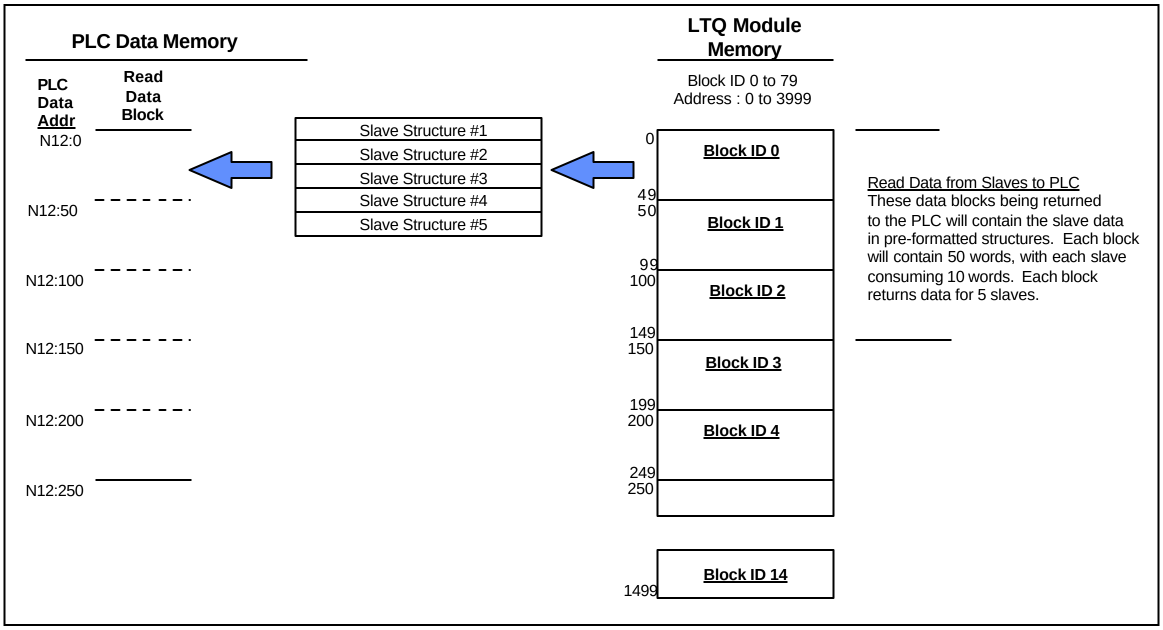
Word	Name	Description
0	BTR Block ID	The ladder logic uses this value to determine the contents of the data portion of the BTR buffer. With some conditional testing in ladder logic, the data from the module can be placed into the PLC/SLC data table. The relationship between the BTR Block ID number and the register table can be put into an equation: Starting Register Address = Block ID Number * 50 Valid codes are between 0 and 79.
1	BTW Block ID	The module returns this value to the processor to be used to enable the movement of and command data blocks to the module. 
2 to 51 (50 words)	Data	The contents of the module's Register Data space (0 - 3999). The data will contain the slave data structure for up to 5 slaves. The structure is outlined below.
52 to 61 (10 words)	Command Done Bits	These 10 words contain bit mapped Command Done Bits which correspond to the slave address (i.e., bit 0 of the block corresponds to slave #1, etc.). These bits are intended to be used to unlatch the Cmd Enable bits through ladder logic.

2.2.2 Moving the data from the module to the processor

Data which has been read from the slave devices is deposited into a 4000 word register table in the module based on the slaves Modbus address.

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 module's configuration 'Max Number of Slaves' register, or if non-zero, the value in 'Read Block Count'. In this example we have assumed a 'Max Slave Count' value of 15, allowing three (3) data blocks to be returned from the module.



Read Data Blocks being returned from the LTQ module to the PLC data table. The actual number of data blocks returned from the module is determined by the value 'Max Number of Slaves' entered during module configuration (1 block is returned per 5 slaves).

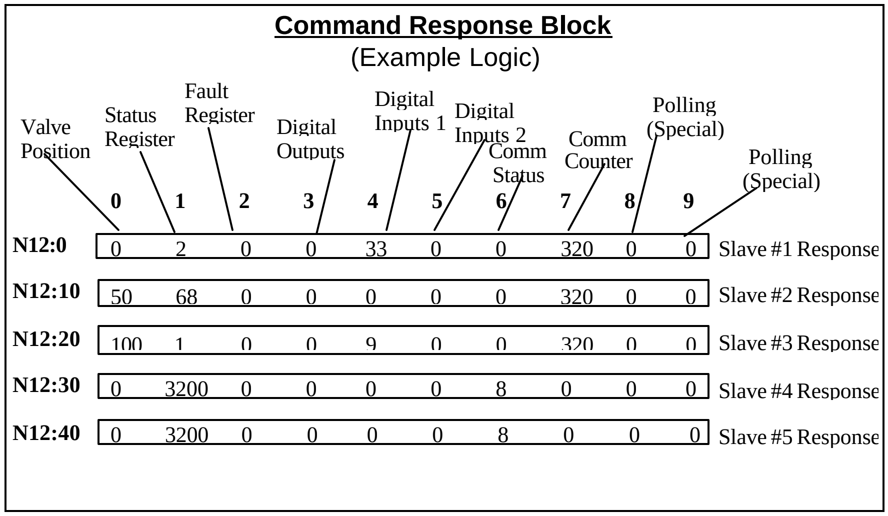
2.2.3 Slave Data Results

The data values returned from each of the active slaves are placed in the module's data table and then transferred over to the PLC data table for handling by the ladder logic. Several important points to understand include:

1. The position of each slave's data in the module is determined solely by the Slave Address
2. The positioning of data in the module begins with Slave Address 1 and goes to Slave Address 150 (Max number supported by the LTQ module)
3. Each slave address, whether activated in the Active Slave Table or not, has space reserved in the module
4. Non-contiguous slaves in the Active Slave Table will result in holes in the data table being returned from the module. Although not normally a problem, caution should be exercised when selecting slave addresses to minimize these holes (ie., reduce the number of Block Transfers needed to read back the data).

The structure of the BTR buffer when reading data from the module is as follows:

Word	Description
0	BTR Block ID Code
1	BTW Block ID
2 to 11	Slave #1 Response
12 to 21	Slave #2 Response
22 to 31	Slave #3 Response
32 to 41	Slave #4 Response
42 to 51	Slave #5 Response



Slave data after placement into the PLC data table.

Slave #x Response: The structure of each slaves read data and communication status data is as follows:

Position	Name	MX-DDC	UEC-3-DDC
0	Analog Register	Valve Position (0 – 100%)	Valve Position (0 – 100%)
1	Status Register		
	Bit 00	Opened	Opened
	01	Closed	Closed
	02	Stopped	Stopped
	03	Opening	Opening
	04	Closing	Closing
	05	Valve Jammed	Valve Jammed
	06	Local Mode Selected	Local Mode Selected
	07	Combined Fault *	Combined Fault *
	08	Thermal Overload Fault	Thermal Overload Fault
	09	Future Use	Fail De-Energize
	10	Channel A Fault	Channel A Fault
	11	Channel B Fault	Channel B Fault
	12	Open Torque Switch Fault	Open Torque Switch Fault
	13	Close Torque Switch Fault	Close Torque Switch Fault
	14	Manual Operation	Manual Operation
	15	Phase Error	Phase Error
2	Fault Register		
	Bit 00	Not Used	Open Verify Fault
	01	Not Used	Close Verify Fault
	02	Not Used	Open De-Energize Fault
	03	Not Used	Close De-Energize Fault
	04	Phases Missing	Phases Missing
	05	Phase Reversed	Phase Reversed
	06	Not Used	Manual Mid to Open
	07	Not Used	Manual Open to Mid
	08	Not Used	Manual Mid to Close
	09	Not Used	Manual Close to Mid
	10	Network ESD is ON **	Network ESD is ON**
	11	Local ESD is ON	Local ESD is ON
	12	Unit Reset since last poll	Unit Reset since last poll
	13	Local Stop Selected	Wrong Rotation
	14	Opening in Local	Opening in Local
	15	Closing in Local	Closing in Local

*** Combined Fault:**

Bit 07 of Field Unit Status Register (Word 1) indicates a fault when both bits 10 AND 11, or bit 05, or 08, or 09, or 15 indicate a fault.

**** Field unit Network ESD**

Parameter must be configured to Open, Stop, or Close.

Position	Name	MX-DDC	UEC-3-DDC
3	Digital Output		
	Bit 00	Close Contactor	Close Contactor
	01	Open Contactor	Open Contactor
	02	AS-1	User (K3)
	03	AS-2	SW-93 LED
	04	AS-3	SW-93 LED
	05	AS-4	User (K6)
	06	AR-1, Opt	N/A
	07	AR-2, Opt	N/A
	08	AR-3, Opt	Bits 08 - 15
	09	Network Relay	Field Unit Software
	10 - 15	Not Used	Version ID
4	Digital Inputs 1		
	Bit 00	Remote Mode Selected	Remote Mode Selected
	01	Thermal Overload Fault	Thermal Overload Fault
	02	Open Torque Switch	Open Torque Switch
	03	Open Limit Switch	Open Limit Switch
	04	Close Torque Switch	Close Torque Switch
	05	Close Limit Switch	Close Limit Switch
	06	Not Used	Aux. Open Input
	07	Not Used	Aux. Close Input
	08	User 0, Terminal-21	User 0, TB2-1
	09	User 1, Terminal-10	User 1, TB2-2
	10	User 2, Terminal-9	User 2, TB2-3
	11	User 3, Terminal-6	User 3, TB2-4
	12	User 4, Terminal-7	User 4, TB2-5
	13	User 5, Terminal-5	User 5, TB2-6
	14	User 6, Opt, Terminal-23	User 6, I/O Module Only
	15	User 7, Opt, Terminal-24	User 7, I/O Module Only
5	Digital Inputs 2		
	Bit 00	Not Used	Analog In 1 Lost
	01	Not Used	Analog In 2 Lost
	02	Analog In 1 Lost	Analog In 3 Lost
	03	Analog In 2 Lost	Analog In 4 Lost
	04	Network A/B Lost	Network A/B Lost
	05	Not Used	Reserved
	06	DDC Bd. Present	Reserved
	07	I/O Opt Board Present	Reserved
	08	Not Used	Reserved
	09	Not Used	Reserved
	10	Not Used	Reserved
	11	Not Used	Reserved
	12	Phase Lost	Phase Lost
	13	Phase Reverse	Phase Reverse
	14	User 8, Opt, Terminal-25	User 8, I/O Module Only
	15	Not Used	User 9, I/O Module Only
6	Communication Status Code	See Trouble Shooting Section. Do not use this word to determine Slave communication status. Word N[ ]:1 (Status) bits 10 and 11 are preferred. This is a module diagnostic word only.	
7	Communication Counter	This is a rollover counter (0 to 32767) which increments upon completion of every successful communication transaction with a slave. This counter will increment on poll (read) commands as well as write commands.	
8	Polling (Special)		
	0	Unused	
	1	TP_BEFORE_MID_T_HIGH Register 55	
	2	Analog 1 Register 6	
9	Polling (Special)		
	0	Unused	
	1	Unused	
	2	Analog 2 Register 7	

For a more complete discussion on register values for Limitorque actuators or I/O Modules, please reference Limitorque Document #435-23009, available from Limitorque.

2.2.4 Command Done Bits

The LTQ Module returns 'Command Done' bits to the ladder logic. A single bit is returned per slave address, allowing ladder logic to be used to clear the Command Enable bits. The following important points should be noted about the Command Done bits:

1. There is only one bit returned per slave address, not one bit per command per slave. The implication of this is that one Done bit must be used to clear all possible Enable bits for one slave address. Example logic is provided in the Appendix demonstrating this
2. The Command Done bit is a positive indication that the module executed the command. It is not an indication of the command's success. A Done bit is returned to the ladder logic whether the command was completed without error or not. This allows all commands to be unlatched the same way. To determine if there is a communication problem with a slave, verify the Channel A/B Comm Status bits in the slave Status field.
3. The Done bit data registers in the module are cleared and then updated prior to each backplane transfer sequence. This is done to assure that the ladder logic receives the quickest possible acknowledgment of a commands execution.

The structure of the Command Done bits in the BTR buffer when reading data from the module is as follows:

Word	Description
52	Cmd Done - Slaves 1 - 16
53	Cmd Done - Slaves 17 - 32
54	Cmd Done - Slaves 33 - 48
55	Cmd Done - Slaves 49 - 64
56	Cmd Done - Slaves 65 - 80
57	Cmd Done - Slaves 81 - 96
58	Cmd Done - Slaves 97 - 112
59	Cmd Done - Slaves 113 - 128
60	Cmd Done - Slaves 129 - 144
61	Cmd Done - Slaves 145 - 150

2.2.5 Module Information Table

The LTQ Module provides product data to the ladder logic during power up through the BTR data buffer whenever the BTW Block ID is set to 255. This data is useful for determining revision information and can be useful should support be necessary from the factory. This 10 word block of data is returned in the BTR data fields.

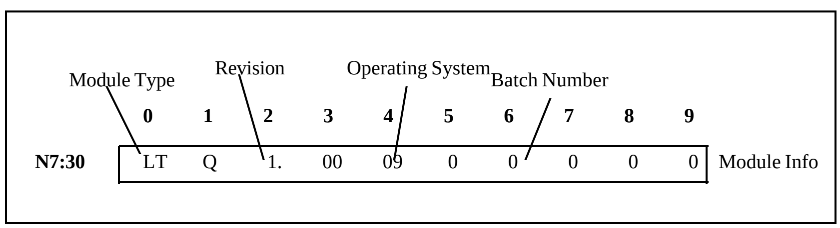
Word	Description
0	BTR Block ID Code
1	BTW Block ID(=255)
2-3	Product Name (ASCII)
4-5	Revision (ASCII)
6-7	Operating System Rev(ASCII)
8-9	Production Run Number (ASCII)
10-11	Spare

Product Name: These two words represent the product name of the module in an ASCII representation. In the case of the LTQ product, the letters ' LTQ ' should be displayed when placing the programming software in the ASCII data representation mode.

Revision: These two words represent the product revision level of the firmware in an ASCII representation. An example of the data displayed would be '1.01' when placing the programming software in the ASCII data representation mode.

Operating System Revision: These two words represent the module's internal operating system revision level in an ASCII representation.

Production Run Number: This number represents the 'batch' number that your particular chip belongs to in an ASCII representation.



3 Protocol Commands

The ProSoft Technology LTQ module Master module is pre-programmed to support a subset of the Modbus protocol. The commands are hard coded into the module and have been selected to implement specific functionality. The programmed commands are documented in the following table. **For a more complete discussion on these commands for Limitorque actuators or I/O Modules, please reference Limitorque Document #435-23009, available from Limitorque.**

Command Function	Modbus Function Code	Register Address	Count or Write Value	Description
Poll Slave	3	40008	6	Command is executed automatically to any slave in the Active Slave Table
Open Command	6	40001	256	Open Command (Interlocked with Close Command in the slave)
Stop Command	6	40001	512	Disengages Open or Close
Close Command	6	40001	768	Close Command (Interlocked with Open Command in the slave)
Start Network ESD	6	40001	1280	Initiates Network ESD function in the addressed slave
Stop Network ESD	6	40001	1536	Terminates Network ESD function in the addressed slave
Engage Relay #1	6	40001	2304	Engages Relay #2 (I/O Module) Engages AS-1 (MX-DDC)
Engage Relay #2	6	40001	2560	Engages Relay #1 (I/O Module) Engages AS-2 (MX-DDC)
Engage Relay #3	6	40001	2816	Engages Relay #3 Engages AS-3 (MX-DDC)
Engage Relay #4	6	40001	3072	Engages Relay #4 (I/O Module) Engages AS-4 (MX-DDC)
Engage Relay #5	6	40001	3328	Engages Relay #5 (I/O Module) Engages AR-1 (MX-DDC)
Engage Relay #6	6	40001	3584	Engages Relay #6 Engages AR-2 (MX-DDC)
Disengage Relay #1	6	40001	4352	Disengages Relay #2 (I/O Module) Disengages AS-1 (MX-DDC)
Disengage Relay #2	6	40001	4608	Disengages Relay #1 (I/O Module) Disengages AS-2 (MX-DDC)
Disengage Relay #3	6	40001	4864	Disengages Relay #3 Disengages AS-3 (MX-DDC)
Disengage Relay #4	6	40001	5120	Disengages Relay #4 (I/O Module) Disengages AS-4 (MX-DDC)
Disengage Relay #5	6	40001	5376	Disengages Relay #5 (I/O Module) Disengages AR-1 (MX-DDC)
Disengage Relay #6	6	40001	5632	Disengages Relay #6 Disengages AR-2 (MX-DDC)
Send Valve Position Value	6	40002	Value from PLC	Position to move actuator 0 - 100% of Open
Enable Valve Position Value	6	40001	6656	Move-To (enable)
Poll Slave Special 1	3	40055	1	Command is executed automatically if Special Polling is set to 1
Poll Slave Special 2	3	40006	2	Command is executed automatically if Special Polling is set to 2

Commands sent upon issuance from PLC ladder program

4 Diagnostics and Troubleshooting

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

4.1 3100 PLC Platform LED Indicators

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

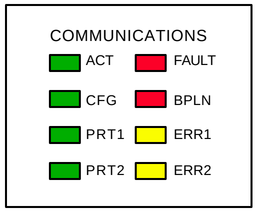
ProSoft CIM
Card

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

ProSoft CIM	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. Please contact factory 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. See Section 4 for details
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. See Section 4 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 LTQ slave • Recurring error condition on LTQ master
Tx1 Tx2	Green	Blink	The port is transmitting data.
Rx1 Rx2	Green	Blink	The port is receiving data

4.2 3150 SLC Platform LED Indicators

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



LED Name	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 factory 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. See Section 4 for details
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. See Section 4 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 LTQ slave • Recurring error condition on LTQ master
PRT1 PRT2	Green	Blink	The port is communicating, either transmitting or receiving data

4.3 Troubleshooting - General

In order to assist in the troubleshooting of the module, the following tables have been put together to assist you. Please use the following to help in using the module, but if you have additional questions or problems please do not hesitate to contact us.

The entries in this section have been placed in the order in which the problems would most likely occur after powering up the module.

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 (ie., 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. See Section 2.2.4 for details or the example ladder logic in the Appendix. • 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	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.
Module is not transmitting	Presuming that the processor is in run, verify the following: • Check Error Status codes for 255 code. If so see next problem If all the ladder logic is block transferring with the module (Active LED is toggles)
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.
ERR light flashing periodically	Intermittent communication error. Check slave error status values and the Channel A/B Status bits for each slave to determine where there may be a communication problem
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, simply add a run to set the 'User Config Bit' based on the First Scan Status Bit (S1:1/15)

4.4 Communication Error Codes

The Error Codes returned from the module represent 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:

Note:
These Error Codes are used for communication module diagnostics.

For programming purposes, use the Slave Data Table (Slave #x Response Data Word N[ ]:1) for determining slave communication status.

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.
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 one time before alternating to the other communications port.
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 misconfigured. To determine the exact source of the problem, verify the following: - Baud Rate Configuration
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
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

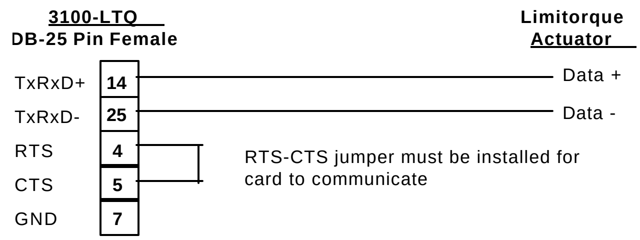
5 Cable Connection

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

3100-LTQ Module

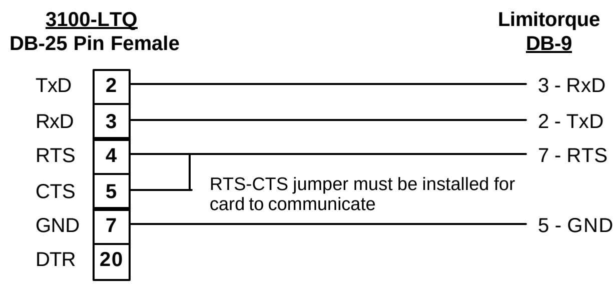
RS-485/2-Wire Connection
The jumper on the module must be set in the RS-485 position

DO NOT USE 3100-LTQ pin 7 for connection of network cable shield. Network cable shield must be connected to proper earth ground lug/ rod.



RS-232 to Limitorque Steered RS-232/485 Converter Limitorque PN 61-825-0966-4

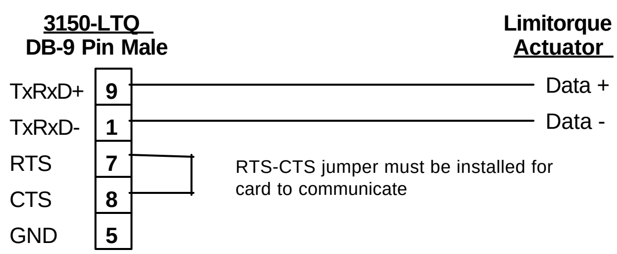
Jumper must be added between pins 4 and 5 on DB-25 to DB-9 cable purchased from Limitorque.



3150-LTQ Module

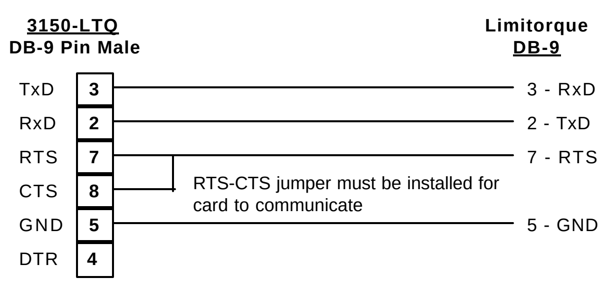
RS-485/2-Wire Connection
The jumper on the module must be set in the RS-485 position

DO NOT USE 3150-LTQ pin 5 for connection of network cable shield. Network cable shield must be connected to proper earth ground lug/ rod.

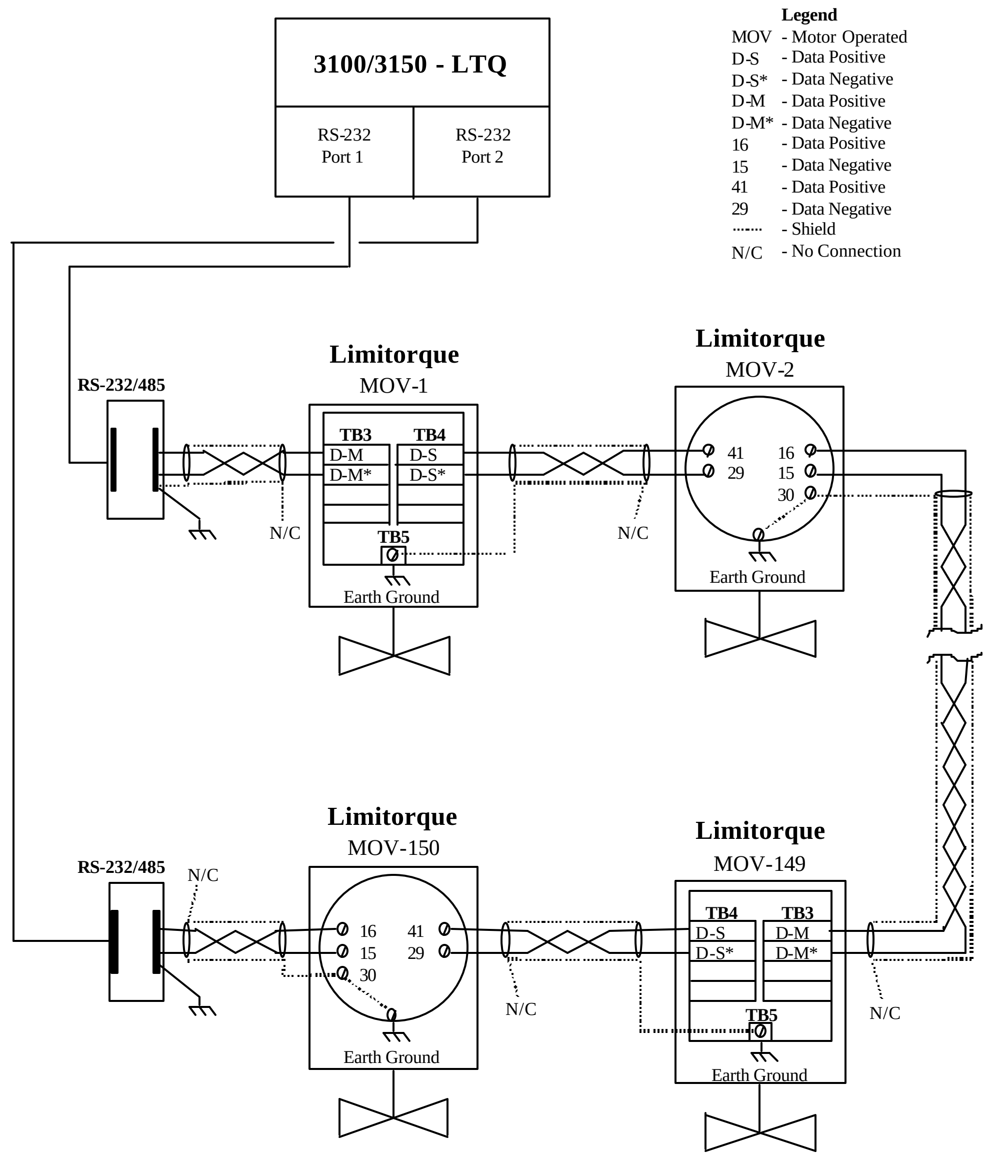


RS-232 to Limitorque Steered RS-232/485 Converter Limitorque PN 61-825-0966-4

Cables purchased from Limitorque as part of converter assembly are DB-25 to DB-9. The DB-25 will require 25-9 pin adapter or replacement.



Typical Network Loop
with
Limitorque MX-DDC and UEC-3-DDC Actuators



Notes:

1) Belden 3074F, 3105A, or 9841 shielded cable is recommended.
2) Correct polarity for field unit and 3100/3150-LTQ is required for proper network operation.
3) Connections shown are typical. The number of MOVs shown may not indicate true network size.
4) ⏚ Earth ground: ground rod.
5) ⏚ Earth ground: ground rod or lug in actuator if actuator is grounded.

Support, Service and Warranty

Technical Support

ProSoft Technology survives on its ability to provide meaningful support to its customers. Should any questions or problems arise, please feel free to contact us at:

Factory/Technical Support
ProSoft Technology, Inc.
9801 Camino Media, Suite 105
Bakersfield, CA 93311
(661) 664-7208
(800) 326-7066
(661) 664-7233 (fax)
E-mail address: prosoft@prosoft-technology.com

Before calling for support, please prepare yourself for the call. In order to provide the best and quickest support possible, we will most likely ask for the following information (you may wish to fax it to us prior to calling):

1. Product Version Number
2. Configuration Information
    - Communication Configuration
    - Jumper positions
3. System hierarchy
4. Physical connection information
    - Cable configuration
5. Module Operation
    - Block Transfers operation
    - LED patterns

An after-hours answering system (on the Bakersfield number) allows pager access to one of our qualified technical and/or application support engineers at any time to answer the questions that are important to you.

Module Service and Repair

The LTQ card is an electronic product, designed and manufactured to function under somewhat adverse conditions. As with any product, through age, misapplication, or any one of many possible problems, the card may require repair.

When purchased from ProSoft Technology, the module has a one year parts and labor warranty according to the limits specified in the warranty. Replacement and/or returns should be directed to the distributor from whom the product was purchased. If you need to return the card for repair, it is first necessary to obtain an RMA number from ProSoft Technology. Please call the factory for this number and display the number prominently on the outside of the shipping carton used to return the card.

General Warranty Policy

ProSoft Technology, Inc. (Hereinafter referred to as ProSoft) warrants that the Product shall conform to and perform in accordance with published technical specifications and the accompanying written materials, and shall be free of defects in materials and workmanship, for the period of time herein indicated, such warranty period commencing upon receipt of the Product.

This warranty is limited to the repair and/or replacement, at ProSoft's election, of defective or non-conforming Product, and ProSoft shall not be responsible for the failure of the Product to perform specified functions, or any other non-conformance caused by or attributable to: (a) any misapplication of misuse of the Product; (b) failure of Customer to adhere to any of ProSoft's specifications or instructions; (c) neglect of, abuse of, or accident to, the Product; or (d) any associated or complementary equipment or software not furnished by ProSoft.

Limited warranty service may be obtained by delivering the Product to ProSoft and providing proof of purchase or receipt date. Customer agrees to insure the Product or assume the risk of loss or damage in transit, to prepay shipping charges to ProSoft, and to use the original shipping container or equivalent. Contact ProSoft Customer Service for further information.

Limitation of Liability

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Where directed by State Law, some of the above exclusions or limitations may not be applicable in some states. This warranty provides specific legal rights; other rights that vary from state to state may also exist. This warranty shall not be applicable to the extent that any provisions of this warranty is prohibited by any Federal, State or Municipal Law that cannot be preempted.

Hardware Product Warranty Details

Warranty Period : ProSoft warranties hardware product for a period of one (1) year.

Warranty Procedure : Upon return of the hardware Product ProSoft will, at its option, repair or replace Product at no additional charge, freight prepaid, except as set forth below. Repair parts and replacement Product will be furnished on an exchange basis and will be either reconditioned or new. All replaced Product and parts become the property of ProSoft. If ProSoft determines that the Product is not under warranty, it will, at the Customer's option, repair the Product using current ProSoft standard rates for parts and labor, and return the Product freight collect.

Jumper Configurations

Hardware Overview

When purchasing the LTQ product, there are two available configurations. These choices are as follows:

Description	ProSoft Cat Number PLC	ProSoft Cat Number SLC
Module provided by ProSoft	3100	3150

When purchasing the module from ProSoft Technology, the jumper configurations will have been factory set to default positions for testing prior to shipment.

Module Jumper Configurations

The following section details the available jumper configurations for the 1771 and 1746 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-LTQ 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 RS232/422/485 config
JW9	Port 1 RS232/422/485 config

JW4 Flash Pgm/Run Mode Select — Run Position

The position of this jumper should only be changed if needing to reprogram the LTQ 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 the factory.

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

The default from factory is RS-232, but all options are supported by the LTQ firmware

3150 for the 1746 Platform

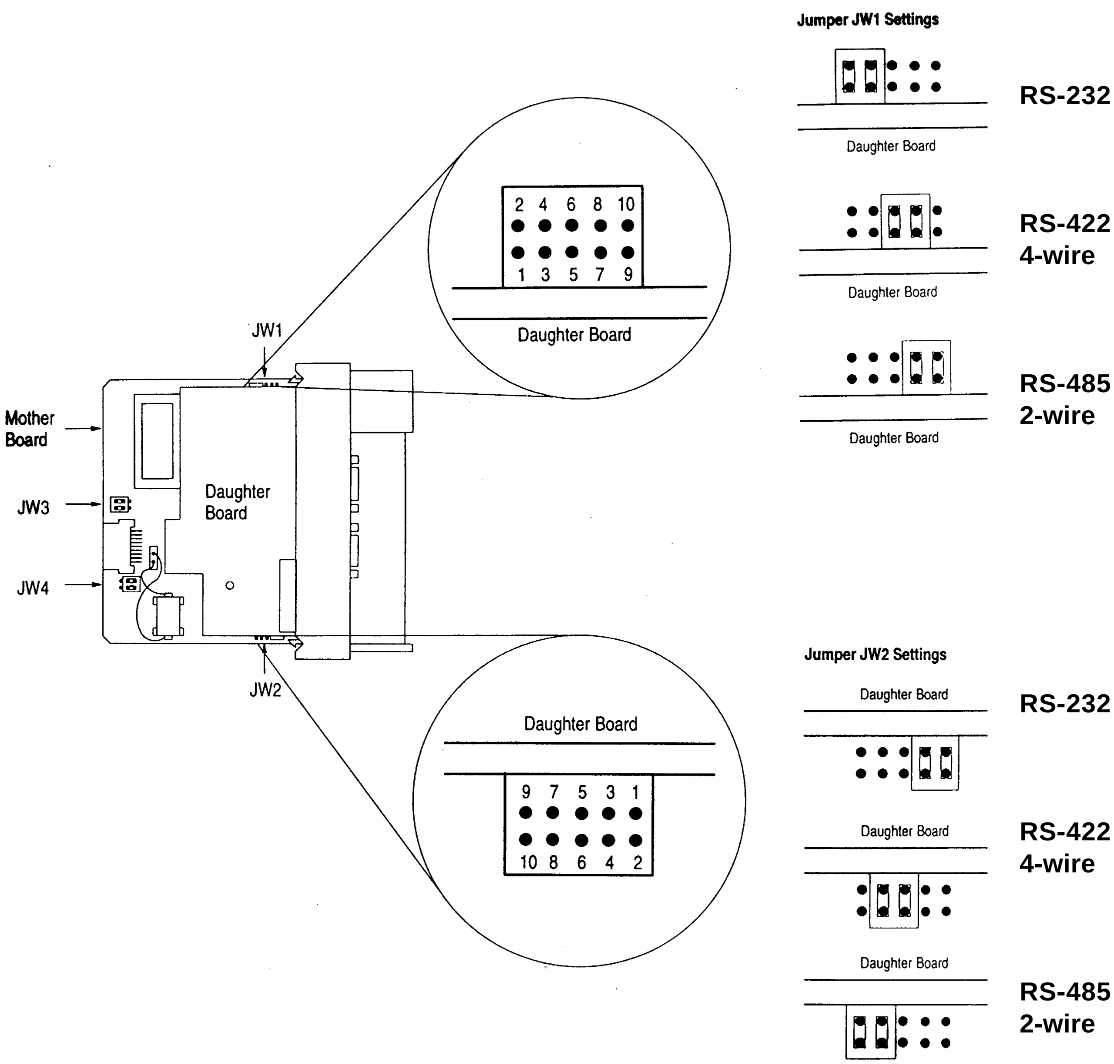
Following are the jumper positions for the 3150-LTQ module:

Jumper	3150-LTQ
JW1	As Needed
JW2	As Needed
JW3	N/A
JW4	N/A

JW1/2 RS configuration for port 1 and 2 — RS-485 Position

The default from factory is RS-232.

Communication Port
Jumper Settings for 3150 Modules - JW1 & JW2



SLC Programming Considerations

The 3150-LTQ is also very easy to get operational.

In order to implement the sample logic, the user must make sure that the correct processor and rack size match up. Also, should it be necessary to re-locate the LTQ module, the user should be certain to configure the correct slot as a 1746-BAS 5/02 Configuration.

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

> It is important that the slot containing the ProSoft module be configured as follows:
> - 1746-BAS module or enter 13106 for the module 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 Allen-Bradley APS software. ICOM software users should follow similar steps.

From the Main Menu:

1) Select the correct processor program and F3 for Offline programming
2) F1 for Processor Functions
3) F1 for Change Processor
   Modify the processor here if necessary (Note the LTQ 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

Network Polling Scheme

In Looped Mode, the LTQ provides communication redundancy to each configured slave on the network. The LTQ monitors the health of each communication path between port 1 and each configured slave and between port 2 and each configured slave. LTQ port 1 communication status between port 1 and the addressed slave is recorded in the slave Channel A status bit. LTQ port 2 communication status between port 2 and the addressed slave is recorded in the slave Channel B status bit. Both Channel A and Channel B status bits are located in the slave Status register, bits 10 and 11(Word N[ ]:1/10 and 11).

On a healthy network where all configured slaves are communicating; the LTQ will first poll all slaves via port 1, then poll all slaves via port 2, back to port 1, and so on. As each slave is successfully polled, the respective Channel bit is set to 0 in the slave Status register. Remember the LTQ port 1 equals Channel A and the LTQ port 2 equals Channel B.

Should a slave not be reached on a poll, the LTQ will set the corresponding Channel Fail bit to 1, switch to the other port and attempt to communicate with the same slave. Should the slave not communicate from the second port, the corresponding Channel Fail bit will be set to 1, and the LTQ will resume polling on the original port. Once the LTQ has completed polling all configured slaves on the first port, the polling routine will switch to the other port and repeat the above process.

Example:
There are 5 slaves on the network and slave number 3 has been turned off. The LTQ is currently polling the slaves through the LTQ port 1 (Channel A). Slave number 1 and 2 respond to the LTQ port 1 poll. Slave number 3 does not respond to the port 1 poll causing the LTQ to set slave 3 Channel A bit to 1. The LTQ now changes to port 2 (Channel B) and polls slave number 3. Slave number 3 does not respond to the port 2 poll causing the LTQ to set the slave 3 Channel B bit to 1. Next the LTQ changes back to port 1 and attempts to poll slave number 4. This communication attempt is successful and the LTQ now polls slave number 5 through the LTQ port 1. Slave number 5 responds completing the port 1 poll.

Next the LTQ repeats the process through port 2 (Channel B). Slave 1 and 2 respond, slave 3 does not respond and the LTQ sets the slave 3 Channel B bit to 1. The LTQ changes to port 1 (Channel A) and attempts to communicate with slave 3. Slave 3 does not respond, the LTQ sets the slave 3 Channel A bit to 1, switches back to port 2 and resumes polling the remainder of the configured slaves. Once slaves 4 and 5 have been successfully polled via port 2, the LTQ then switches to port 1 and repeats the polling process. The port alternation process described above continues until slave 3 is powered on and the communication fault clears.

Commands for slave control interrupt the polling process and are issued through the current poll port. Once the slave has acknowledged the command, the LTQ resumes the polling process. In the event of a communication fault between the current poll port and a commanded slave, the LTQ will issue the command through the other communication port.

Looped Network Truth Table
(Recorded in Slave Status Register Bit 10 and 11)

	Example 1		Example 2		Example 3		Example 4	
Slave #	Ch. A	Ch. B	Ch. A	Ch. B	Ch. A	Ch. B	Ch. A	Ch. B
1	0	0	0	0	0	1	0	1
2	0	0	0	0	0	1	0	1
3	0	0	1	1	0	1	0	1
4	0	0	0	0	1	0	0	1
5	0	0	0	0	1	0	0	1

Example 1:
The LTQ is successfully communicating to each slave and sets the bits equating to Channel A and B to 0. A value of 0 in the Channel A and B status indicate successful communication.

Example 2:

The LTQ is successfully communicating to slaves 1, 2, 4, and 5 via both ports. Slave number 3 is without power causing the slave 3 network board bypass relays to de-energize. This de-energizing of the bypass relays shorts the signal through the network board and isolates the slave from the DDC-100 network.

Example 3:

The LTQ is successfully communicating to slaves 1, 2, 3 via port 1 and 4, 5 via port 2. When a slave doesn't communicate within a predetermined time-out period the LTQ sets the corresponding Channel bit to a value of 1. This example indicates a wiring problem between slave 3 & 4. This problem is typically a cable breakage, short, or improperly terminated wire.

Example 4:

The LTQ is attempting to communicate to the slaves via both ports but is unable to reach any slaves via port 2. This typically indicates a broken cable connection at port 2 or at the first slave from port 2, broken or shorted cable between the LTQ and the first slave from port 2, improperly terminated wires, or loss of power to the RS-232/485 converter if attached to the LTQ port 2.

Non-Looped Network Truth Table via Port 1 Polling Only
(Recorded in Slave Status Register Bit 10, Bit 11 Channel B is always 0)

	Example 5		Example 6		Example 7	
Slave #	Ch. A	Ch. B	Ch. A	Ch. B	Ch. A	Ch. B
1	0	0	0	0	0	0
2	0	0	1	0	0	0
3	0	0	0	0	1	0
4	0	0	0	0	1	0
5	0	0	0	0	1	0

Example 5:

The LTQ is successfully communicating to each slave and sets the bits equating to Channel A to 0. A value of 0 in the Channel A status indicates successful communication.

Example 6:

The LTQ is successfully communicating to slave 1, 3, 4, and 5. Slave 2 does not respond causing the LTQ to set slave 2 Status register bit 10 to 1. In this example, slave 2 is without power causing the slave 2 network board bypass relays to de-energize. This de-energizing of the bypass relays shorts the signal through the network board and isolates the slave from the DDC-100 network.

Example 7:

The LTQ is successfully communicating to slaves 1 and 2 but is not able to communicate to slaves 3, 4, and 5 causing the LTQ to set slave 3, 4, 5 Status register bit 10 to 1. This typically indicates a broken or shorted cable between slave 2 and 3, a broken cable connection at slave 2 or 3, improperly terminated wires at slave 2 or 3, or loss of power to slaves 3, 4, and 5.

Programming Recommendations

Programming the PLC to control a DDC-100 Network of Limitorque slaves will require information about the design of the network. Limitorque recommends gathering this information before starting the programming task. After the programming has been completed, the network should be fully tested before commissioning. The following recommendations are provided as the result of a number of successful installations:

1) Obtain supporting Limitorque product documentation.
2) Obtain a wiring diagram of the digital inputs and digital outputs to the controlled devices (slaves) before programming the PLC.
3) Develop a tag table for the installation. This table should include the tag name, network address, desired status indication, command format.
4) If possible test the program prior to site installation. This will provide a program verification time for debugging.
5) Attach a protocol analyzer to the DDC-100 network and monitor the timing, message structure, and message issuance to verify the PLC code. This will assist in the diagnosis of proper command issuing and sequencing of the host control algorithm.
6) Wire the DDC-100 Network per Limitorque's network wiring recommendations. Ground loops, cable termination's, poor grounds, cable shields, and improper cables are frequently the cause of erratic communication errors during the commissioning process.

Monitoring Slave Status

Network control involves two basic functions — monitoring slave status and issuing control commands. The following checklist is provided for monitoring the status of the slaves:

Slave Register	3100/3150-LTQ Word	Definition
8	N[ ]:0	Valve Position
9	N[ ]:1	Status Register
10	N[ ]:2	Fault Register
11	N[ ]:3	Digital Outputs
12	N[ ]:4	Digital Inputs 1
13	N[ ]:5	Digital Inputs 2

1) Determine the LTQ time-out period. Verify that the time-out period is of sufficient duration to allow a slave response under the worst-case conditions. Minimum time-out period is 200 msec.
2) Do not allow more than one LTQ control of the network at any time. A Hot Standby PLC with redundant LTQ Modules requires careful programming considerations. Only one LTQ may be actively in control at any time. Contact ProSoft for further details.
3) Slave register 10 bit 10 (Word N[ ]:2/10) will only report network ESD when the slave network ESD parameter is set to any value but Ignore.
4) Slave register 9 bit 05 (Word N[ ]:1/5), Valve Jammed will only be active when the actuator is moving the valve and the torque switch is tripped.
5) In MOV (Motor Operated Valve) mode, slave registers 9, 10, and 11 (Word N[ ]:1-3) bits are a value of 0 when false. A value of 1 indicates true. Registers 12 and 13 (Word N[ ]:4-5) bits typically are a value of 1 when true except register 12 bit 11 (Word N[ ]:4/11). See item 6 below.
6) In MOV mode, slave register 12 bit 11 (Word N[ ]:4/11), is default inverted to a value of 1 on false and 0 on true. The remaining bits in the high byte are default to a value of 0 on false and 1 on true.

Issuing Control Commands

The following checklist is provided for issuing control commands.

1) Use the proper command for the Limitorque slave to be commanded. Refer to the Command Usage Table.
2) Prior to issuing commands to a slave:
   a) Verify successful communication. This is accomplished via the normal polling process. Item 2.b Combined Fault bit will be true if communications is lost to a slave (Status Register bits 10 and 11 (Word N[ ]:1/10 and 11) will also be true).
   b) Combined Fault bit, Status Register bit 07 (Word N[ ]:1/7), is not a value of 1.
   c) Verify the slave is capable of movement.
   d) Verify slave is in Remote mode.
   e) Slave (actuator) is not at desired position. (Do not send open command if slave is in open position.)
   f) Verify that the desired direction of travel does not have a torque switch fault.
3) Prior to issuing commands to an I/O Module style slave:
   a) Verify successful communication. This is accomplished via the normal polling process. See Item 2.a.
   b) When using 2 relays to control a single device, always disengage the first relay before engaging the second relay.
4) After issuing a command, reset the command enable bit(s) to zero. Allow sufficient time for the block transfer of the set bit(s) AND execution of the command(s) before resetting the bit(s) to zero.
   Hint: Networked slave response times are approximately 50 - 120 ms. per slave.
5) A slave (actuator) configured for intermediate position control (Move-to) should be issued position commands between 2 - 98% of open. Issue open or close commands for 0 and 100% of open.
6) Commands issued to the slave should never be repeated if the slave's status register confirms desired action. Repeated commands sent to the slave will result in increased network traffic and increased network scan times. Also, repeating acknowledged commands may cause erratic slave operation (e.g., stop).
7) The slave will automatically stop (disengage contactor) when the slave reaches the full open or close position. There is no requirement for issuing a stop command when the slave reaches the open or close limit switch.
8) A stop command may be used to stop the slave in mid-travel. When the slave has stopped in mid travel (between the open and close limit switches) the slave Status Register bit 02 (Word N[ ]:1/2), Stopped will be true (1).
9) There is no requirement to first issue a stop command when changing directions from open to close or close to open. When the slave receives the command to change directions the slave will first disengage the contactor (stop the actuator) then engage the opposing contactor.
10) A network stop command will stop the slave if the slave selector switch placed in Remote or Local mode. The slave (actuator) local Stop pushbutton will stop the slave if the slave selector switch is in Remote or Local mode.

Example PLC and SLC Ladder Logic

Overview

The following ladder logic provides an example for the ladder logic necessary to integrate the 3100-LTQ and the 3150-LTQ modules into their respective processor platforms. This logic can be incorporated directly as is, or if desired modified as needed for the application.

Data Files

The examples use the same memory map for both of the platforms, with the exception of the actual block transfer data and control files.

The memory map for the example application has been detailed in the attached data table listing. Please reference the right hand side of the data table listing for details.

Communication Configuration

	Baud Rate	Response Timeout	Slave Count	Read Block Count	BT Delay Count	Last State	Polling Scheme	Propagation Delay	RTS to TxD	Polling (Special)	
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
N7:0	7	200	16	0	0	0	0	0	0	0	Configuration Parm
N7:10	1	1	0	0	0	0	0	0	0	0	Active Slave Table

16 Slave Address 1
0000 0000 0000 0001

Bit mapped Commands
(Ex. Send Open Command to slave #1)

Slave	16-1	32-17	48-33	64-49	80-65	96-81	112-97	127-113	143-128	150-144	
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
N10:0	1	0	0	0	0	0	0	0	0	0	Open Commands
N10:10	0	0	0	0	0	0	0	0	0	0	Stop Commands
N10:20	0	0	0	0	0	0	0	0	0	0	Close Commands
N10:30	0	0	0	0	0	0	0	0	0	0	Init Net ESD Commands
N10:40	0	0	0	0	0	0	0	0	0	0	Stop Net ESD Commands
N10:50	0	0	0	0	0	0	0	0	0	0	Spare

N10:60	1	0	0	0	0	0	0	0	0	0	Engage Contactor #1
N10:70	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #1
N10:80	0	0	0	0	0	0	0	0	0	0	Engage Contactor #2
N10:90	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #2
N10:100	0	0	0	0	0	0	0	0	0	0	Enagage Contactor #3
N10:110	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #3
N10:120	1	0	0	0	0	0	0	0	0	0	Engage Contactor #4
N10:130	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #4
N10:140	0	0	0	0	0	0	0	0	0	0	Engage Contactor #5
N10:150	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #5
N10:160	0	0	0	0	0	0	0	0	0	0	Engage Contactor #6
N10:170	0	0	0	0	0	0	0	0	0	0	Disengage Contactor #6

16 Slave Address 1
0000 0000 0000 0001

Bit mapped Commands
(Ex. Send Open Command to slave #1)

Valve Position Cmd Enables

Slave	16-1 **0**	32-17 **1**	48-33 **2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
N11:0	1	0	0	0	0	75	0	0	0	0
N11:10	0	0	0	0	0	0	0	0	0	0
N11:20	0	0	0	0	0	0	0	0	0	0
N11:30	0	0	0	0	0	0	0	0	0	0
N11:40	0	0	0	0	0	0	0	0	0	0
N11:50	0	0	0	0	0	0	0	0	0	0

Valve Position Values
(0 to 100 %)

Example Ladder Logic

Valve Position Cmd Enables

Valve Position Values (0 to 100 %)

	0	1	2	3	4	5	6	7	8	9
Slave	64-49	80-65	96-81							
N11:60	1	0	0	0	0	30	0	0	0	0
N11:70	0	0	0	0	0	0	0	0	0	0
N11:80	0	0	0	0	0	0	0	0	0	0
N11:90	0	0	0	0	0	0	0	0	0	0
N11:100	0	0	0	0	0	0	0	0	0	0
N11:110	0	0	0	0	0	0	0	0	0	0

Valve Position Cmd Enables

Valve Position Values (0 to 100 %)

	0	1	2	3	4	5	6	7	8	9
Slave	112-97	128-113	144-129	150-145						
N11:120	1	0	0	0	0	75	0	0	0	0
N11:130	0	0	0	0	0	0	0	0	0	0
N11:140	0	0	0	0	0	0	0	0	0	0
N11:150	0	0	0	0	0	0	0	0	0	0
N11:160	0	0	0	0	0	0	0	0	0	0
N11:170	0	0	0	0	0	0	0	0	0	0

Example Ladder Logic