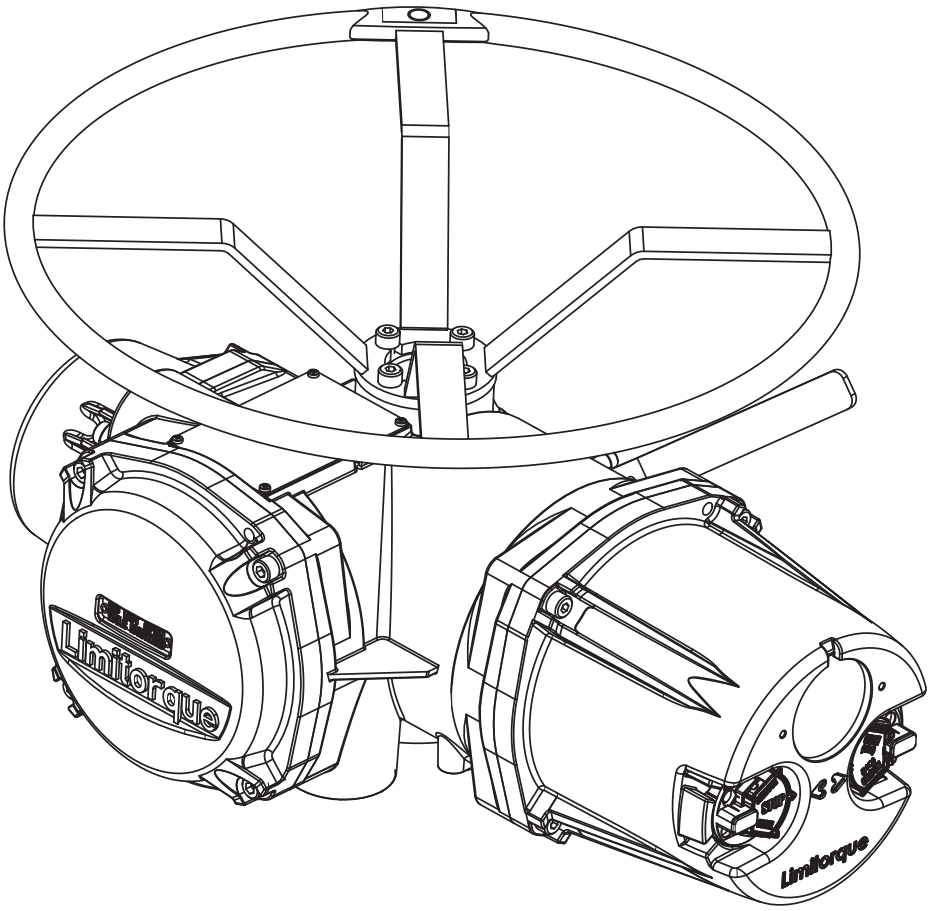
FLOWSERVE

USER INSTRUCTIONS

MX/QX FOUNDATION Fieldbus Field Unit

Installation
Operation
Maintenance

FCD LMENIM2330-02 AQ – 02/17



Experience In Motion

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1 Introduction

1.1 Purpose

This manual explains how to install and operate the MX/QX FOUNDATION™ fieldbus field unit (MX/QX FF). Actuators containing the FF field unit may be connected by a single twisted-pair cable to form a FOUNDATION fieldbus communication system network. The FOUNDATION fieldbus communication system is a digital, serial, two-way bus system running at 31.25 kbits/s. This system allows a host system such as a distributed control system (DCS) to control and monitor the actuators, including the acquisition of status and alarm data from each MX/QX.

1.2 How to Use this Manual

Each section provides the MX/QX FF user with information on installing and operating the MX/QX FF field unit.

Section 1. Introduction
Details user safety and knowledge requirements, system capabilities, and features.

Section 2. System Components
Focuses on the description of the FOUNDATION fieldbus system hardware and software components.

Section 3. Installation and Configuration
Provides details for installing and configuring a field unit.

Section 4. Associated Documents
Provides a list of documents on related subjects for additional MX/QX and FOUNDATION fieldbus system information.

Section 5. How to Order Parts

Appendix A – Wiring Diagram
Detail wiring connections to the MX/QX field unit.

Appendix B – Feature Definitions
Limitorque actuator Transducer Block I/O channels and parameters.

Appendix C – Fieldbus Parameter Descriptions
FOUNDATION Fieldbus Function Block parameters and descriptions.

Glossary

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1.3 User Safety

Safety notices in this manual detail precautions the user must take to reduce the risk of personal injury and damage to the equipment. The user must read and be familiar with these instructions before attempting installation, operation, or maintenance. Failure to observe these precautions could result in serious bodily injury, damage to the equipment, warranty void, or operational difficulty. User must follow local and state safety regulations.

Safety notices are presented in this manual in three forms:

☠ **WARNING:** Refers to personal safety. Alerts the user to potential danger. Failure to follow warning notices could result in personal injury or death.

⚠ **CAUTION:** Directs the user's attention to general precautions that, if not followed, could result in personal injury and/or equipment damage.

NOTE: Highlights information critical to the user's understanding of the actuator's installation and operation.

1.4 User Knowledge

It is recommended that the user read this manual in its entirety before the MX/QX FF equipped actuator is installed and operated.

The user needs to have a fundamental knowledge of electronics and microprocessor concepts. An understanding of valve actuators and digital control systems is beneficial to the field unit user. Refer to the Glossary for terms used throughout this manual.

The following web sites have documents on Foundation Fieldbus and electric actuators: www.fieldbus.org and www.flowserve.com

For fieldbus technology and cabling information, refer to the following documents:

- FOUNDATION Fieldbus Wiring and Installation 31.25 kbits/s, Voltage Mode, Wire Medium AG-140
- FOUNDATION Fieldbus Technical Overview, FD-043
- Relcom Inc. Fieldbus Wiring Design and Installation Guide
- ANSI/ISA-S50.02, Part 2-1992, Fieldbus Standard for Use in Industrial Control Systems Part 2: Physical Layer Specification and Service Definition
- FOUNDATION Fieldbus FF-890 and FF-891, FOUNDATION Specification, Function Block Application Process, Part 1 and 2.

Reference can also be made to the following book:

- Fieldbuses for Process Control: Engineering, Operation, and Maintenance. ISBN 1-55617-760-7.

1.5 MX/QX FF System Capabilities and Features

Limitorque's FOUNDATION fieldbus field unit conforms to the open fieldbus standard IEC 61158. It is suitable for use on the Fieldbus H1 highway and uses a twisted-pair cable for connection to the highway. The communication system theoretically supports up to 240 actuators with the use of repeaters.

The MX/QX FF field unit fits in the actuator in the sealed electrical housing. Adjustments to the MX/QX FF settings may be made over the FOUNDATION fieldbus data highway using a network configuration tool.

The MX/QX FF unit may command its actuator and others to:

- Open
- Stop
- Close
- Move to a set position
- Accept & prioritize control signals from multiple sources
- Perform an emergency shutdown operation
- Read and control relays
- Perform partial stroke test
- Monitor position, torque, and analog inputs
- Monitor modes and alarms
- Configure warning & fault notifications
- Configure actuator settings and features

Commands to the unit come over the network from the host system, which may be:

- Personal Computer (PC)
- Distributed Control System (DCS)
- Programmable Logic Controller (PLC)
- Field Device Tool (FDT) w/ Device Type Manager (DTM)
- Some other microprocessor-based device

Commands may also be generated in another network actuator or device and transmitted over fieldbus using peer-to-peer, consumer/producer communication.

The MX/QX FF also has the capacity of being a Link Active Scheduler (LAS) on a FOUNDATION Fieldbus network. It can be configured either for Basic or LAS mode. In BASIC mode, the MX/QX will display COMM LOSS if power is removed from the FF field unit. In LAS mode, the MX/QX will display HARDWARE FAILURE if power is removed from the FF field unit.

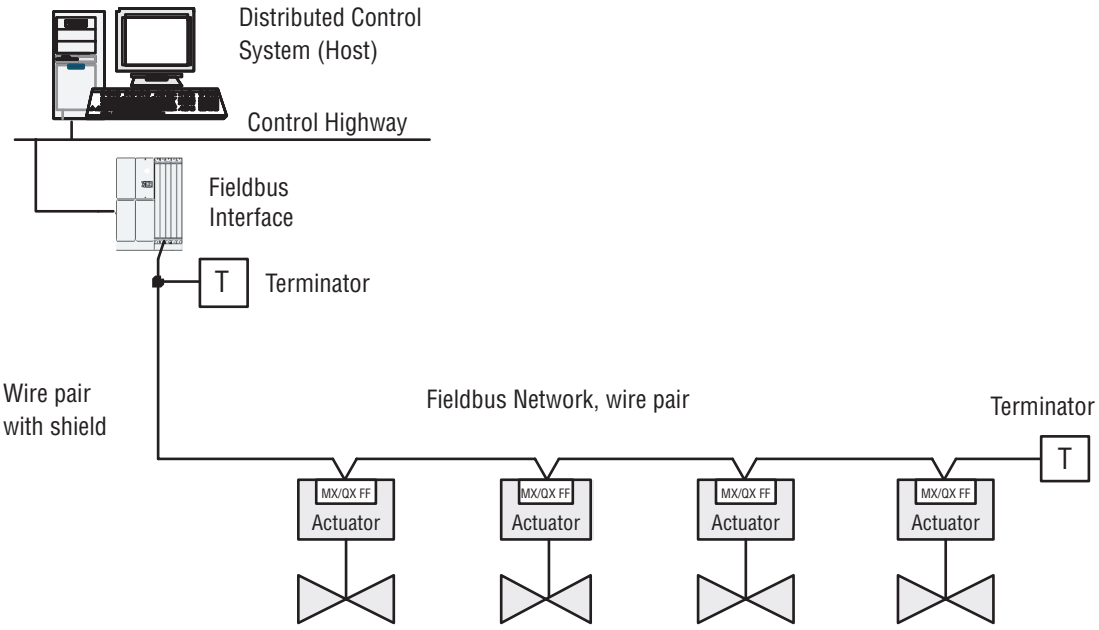
A fieldbus device is an intelligent device within the actuator that can send multiple variables to the control system over a high-resolution and distortion-free digital communication network. The device provides control and self-test capabilties, which allows abnormal conditions to be easily and immediately identified before an unplanned shutdown.

Additional features and capabilities are:

- The system reduces the cost of wiring and installation – existing wiring and multi-drop connections can be used
- The devices are interoperable – devices from different suppliers can communicate with one another on the same network.

A typical MX/QX FF system is shown in Figure 1.1.

Figure 1.1 – Typical FOUNDATION Fieldbus System with a DCS Host



Power for the fieldbus devices and cable shield grounding are discussed in Sections 2.4 and 2.5.

1.5.1 General Network Specification

System Specifications:

- Communicates using the FOUNDATION fieldbus protocol
- Employs high-speed communication
- Complies with the IEC61158 fieldbus standard.

Network Specification

Several topologies are available, point-to-point, bus with spurs, daisy chain, tree, or a combination of these. Network features include:

- Link Active Scheduler controls the system
- High-speed communications up to 31.25 kbits/s
- Peer-to Peer communication.

MX/QX FF Field Unit Specification

The field unit mounts in the actuator and is software controlled in order to allow functionality of:

- Input and Output Function Blocks (Analog and Digital)
- Control Selector (CS) Function Block
- Proportional Integral Derivative (PID) Function Block
- Device descriptions
- Network communication
- Parameter configuration by user.

Link Active Scheduler Specification

Fieldbus segments have one, and only one, active Link Active Scheduler (LAS) at a given time. The LAS acts as the bus arbiter, and does the following:

- Recognizes and adds new devices to the link
- Removes non-responsive devices from the link
- Schedules control activity in, and communication activity between, devices
- Regularly polls devices for process data
- Distributes a priority-driven token to devices for unscheduled transmissions.

System Host Specification

The system host is usually a distributed control system (DCS), or some other intelligent device. The host does the following:

- Acts as the system LAS
- Issues requests for process data from the field devices
- Issues commands to the field devices
- Interfaces with any process control going on between network devices.

2 System Components and Installation

2.1 Introduction

This section is an overview of the components used in the FOUNDATION fieldbus system and their installation. The MX/QX FF unit is installed in the MX or QX actuator as shown in Figures 2.1 and 2.2. The network cable connects to the fieldbus unit at the actuator terminal block. The network cable connects all the fieldbus actuators to the distributed control system, which usually acts as the host and LAS.

2.2 Hardware

Figure 2.1 – MX-05 Actuator

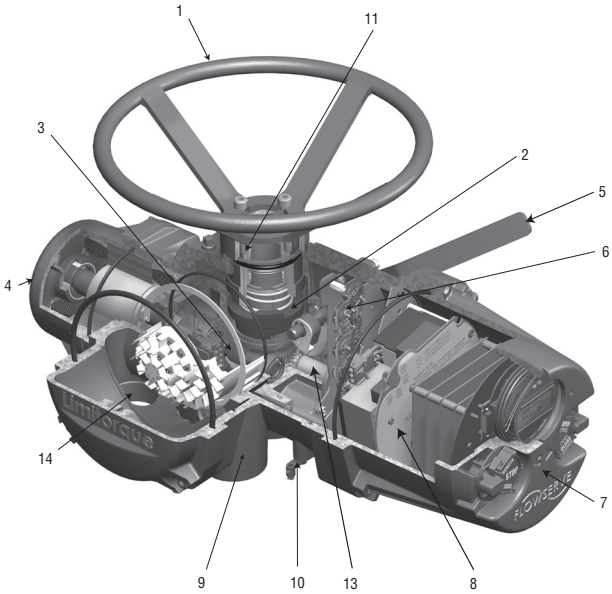


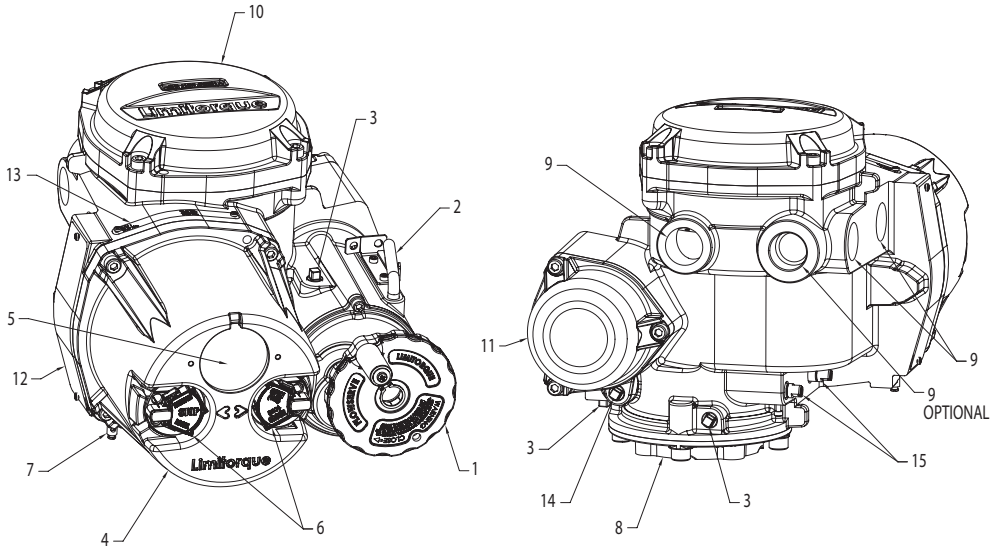
Table 2.1 – MX Actuator Components

No.	Description
1	Top-mounted handwheel
2	Drive sleeve
3	Worm shaft
4	Motor
5	Declutch lever
6	Encoder
7	Control panel (CP)
8	Control module
9	Optional bases
	Thrust base type
	• A1 = Standard thrust base
	• A1E = Extended-reach thrust base
10	Baseplate-type B4 with stem nut options type:
	• B4 = stem nut with variable bore and key
	• B4E = extended-reach stem nut with variable bore and key
	• BL = splined stem nut (SAE or Involute)
11	Handwheel adapter/handwheel worm gear
12	Side-mounted handwheel (not shown, but available for the MX-10, -20,-85, -140, and -150)
13	Encoder drive cartridge
14	Terminal block

Table 2.2 – QX Actuator Components

Piece	Description
1	Handwheel
2	Declutch Lever (QX-05)
3	Oil Fill
4	Controls Cover
5	LCD
6	Control Knob
7	Ground Lug
8	Baseplate
9	Conduit Entry
10	Terminal Compartment
11	Motor
12	Certification Nameplate
13	Tag Nameplate
14	Oil Plug
15	Stem Nut Stops

Figure 2.2 - QX-05 Actuator



2.2.1 MX/QX Electric Actuators

The MX/QX actuators control the opening and closing of valves. The MX is a multi-turn valve while the QX is a quarter-turn valve actuator. Both actuators are designed for operation of ON-OFF and modulating valve applications.

The MX/QX features include the following:

- Non-intrusive setup
- Separately sealed terminal compartment
- Unique absolute encoder for valve position sensing (no battery required)
- 32-character LCD for indication and calibration
- Sophisticated electronic control, monitoring, and diagnostic capabilities with LimiGard™ technology.

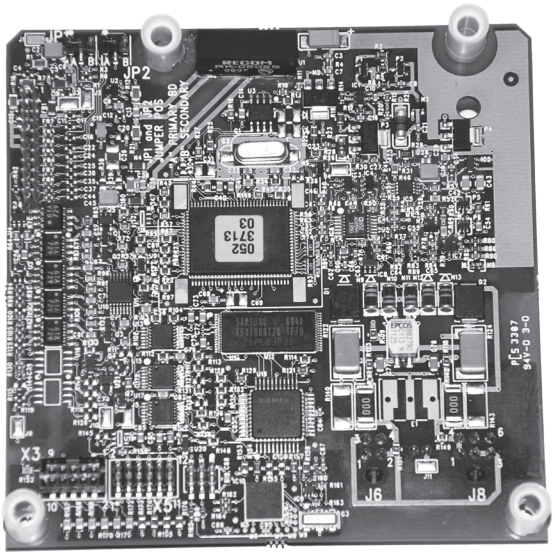
NOTE: Recommended storage procedures for the MX are detailed in Bulletin LMENIM2306, MX Maintenance and Spare Parts Manual. QX procedures are detailed in Bulletin LMENIM3306, QX Maintenance and Spare Parts Manual. Failure to comply with recommended procedures will void the warranty. For longer-term storage, contact Limitorque for procedure and recommendations.

2.2.2 MX/QX FF Interface Board

The MX/QX FF interface board is installed in the actuator controls compartment (Figure 2.3). This unit permits the actuator to be controlled by a DCS or master station over the fieldbus network. The following commands and feedback information are transmitted through this unit:

- OPEN, CLOSE, and STOP commands
- MOVE-TO (0-100% position) commands
- Unit output torque (0-100% rating)
- ESD (Emergency Shutdown) commands
- Partial Stroke Test commands
- Actuator status, alarm, and diagnostic messages
- User analog input feedback

Figure 2.3 – MX/QX Interface Board



2.2.3 Network Host

The FOUNDATION fieldbus network is connected to the host device, which can be a distributed control system (DCS), a PC, a PLC, or other microprocessor-based device. The host device can be the Link Active Scheduler (LAS), which performs the duty of network traffic controller. Networks can have multiple Link Masters, which have LAS capability, but only one of these can be the LAS at any time. If the LAS device fails another LAS is automatically created; this redundancy ensures continuing communication in the event of a failure. The MX/QX FF unit can be configured for Basic or LAS mode. In BASIC, the MXa/QX will display COMM LOSS, while in LAS it will display HARDWARE FAILURE, if power is removed from unit.

2.2.3.1 LAS Tasks

The main task of the LAS is to schedule Compel Data (CD) messages to all devices in turn. The CD message is directed to one device so it can broadcast (publish) data to all other devices. The LAS also updates the Live List, which contains all devices on the network with the capability to communicate, and schedules a Pass Token that allows devices to send unscheduled messages such as setpoint changes and downloads. The LAS does the following:

- Recognizes and adds new devices to the link
- Removes non-responsive devices from the link
- Polls devices for process data at scheduled times
- Distributes a priority-driven token to devices between scheduled transmissions
- Controls the Publisher/Subscriber process using the CD message
- Controls Server/Client communication between pairs of devices
- Broadcasts a time signal to synchronize all devices on the link

CD Schedule
The CD scheduler contains a list of activities that are scheduled to occur on a cyclic basis. At the scheduled time, the LAS sends a Compel Data (CD) message to a specific buffer in a fieldbus device. The device immediately broadcasts or “publishes” a message to all devices on the fieldbus.

Unscheduled Communication
All devices on the fieldbus are given a chance to send “unscheduled” messages between transmissions of scheduled messages. The LAS grants permission to a device to use fieldbus by sending a pass token (PT) message to the device. Upon receipt of the PT, the device is allowed to send messages until the token hold time has expired.

Live List Maintenance
The list of all devices that are properly responding to the pass token is called the “Live List.” New devices may be added to the fieldbus at any time. The LAS periodically sends Probe Node (PN) messages to the addresses not in the Live List. If a device is present at the address and receives the PN, it immediately returns a Probe Response (PR) message, and the LAS adds the device to the Live List.

2.2.4 Network Cable

Network cabling should be in accordance with FOUNDATION fieldbus guidelines. Table 2.3 details various types of cable that can be used for a network cable. For additional guidelines see the following publications:

- FOUNDATION Fieldbus Wiring and Installation. 31.25 kbits/s, Voltage Mode, Wire Medium AG-140
- Relcom Inc. Fieldbus Wiring Design and Installation Guide
- ANSI/ISA-S50.02, Part 2-1992, Fieldbus Standard for Use in Industrial Control Systems Part 2: Physical Layer Specification and Service Definition.

Table 2.3 – Recommended Cable Types

Cable Type	Gauge No.	Resistance, Ohms/km	Atten, dB/km	Maximum Length
A Shield twisted-pair	#18 AWG	22	3	1900 m
B Shielded multi-twisted pair	#22 AWG	56	5	1200 m
C Twisted-pair	#22 AWG	132	8	400 m
D Shielded multi-core	#16 AWG	20	8	200 m

NOTE: The maximum lengths are estimates and depend on the condition of the actual cable.

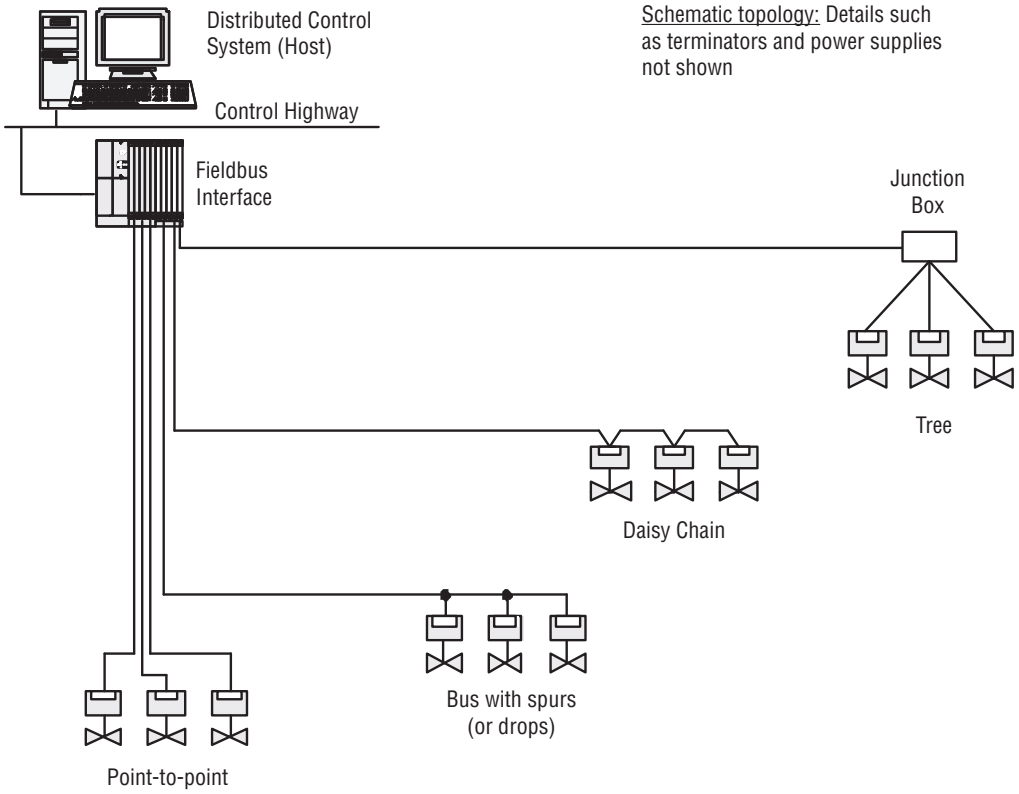
For example, Belden 3076F Fieldbus Cable, or equivalent, could be used.

There are several possible topologies for fieldbus networks:

- Point-to-point
- Bus with Spurs
- Daisy Chain
- Tree topology
- Combination of the above

The following Figure 2.4 illustrates these four types of network. Details such as power supplies and terminators are omitted for clarity.

Figure 2.4 – Cable Topologies



2.3 Other Network Components

In addition to the network cable, the following components may be used in the network. Each network is designed based on its application and therefore may not require all of these components.

- **Terminal Blocks**. These provide multiple connections to the bus (network)
- **Connectors**. These make connections to junction boxes, terminators, or other connectors. They are useful in installations where devices will be periodically disconnected or when a device is only going to be temporarily disconnected.
- **Couplers**. These provide one or several connection points to a network segment.
- **Terminators**. These are used at each end of a fieldbus segment to prevent signal reflections. Terminators should be placed as far apart as possible.
- **Power Supplies/Conditioners**. There are four types of power supplies that can be used in a FOUNDATION fieldbus network, as follows:
    1. Non I.S. (intrinsically safe) power supply
    2. Standard linear or switching power supply used with a power conditioner
    3. Fieldbus power supply
    4. Fieldbus power supply, intrinsically safe

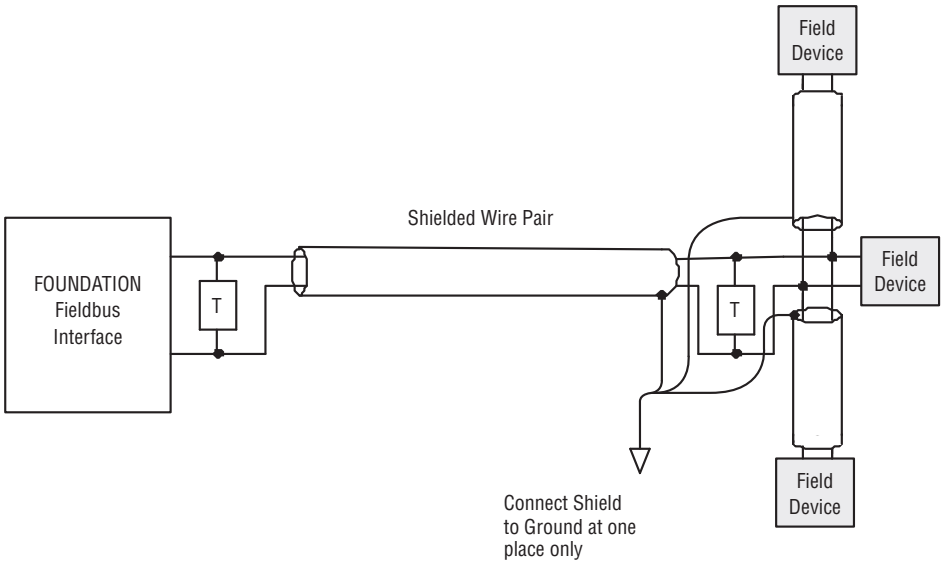
Power Conditioners are power supply impedance matching networks and are required. For additional details see FOUNDATION Fieldbus Wiring and Installation 31.25 kbits/s, Voltage Mode, Wire Medium AG-140, available on the web at www.fieldbus.org.

2.4 Cable Shielding and Grounding

For best performance, Fieldbus cables should be shielded. When using shielded cable, connect each spur's shield to the trunk shield, and connect the overall shield to ground at one point.

For most networks the ground point can be anywhere. In Figure 2.5 the grounding point has been chosen as the junction of the field instruments.

Figure 2.5 – Use of Shielded Cable



2.5 Fieldbus Power Supply

The MX/QX FF board requires 9-32 VDC and 20 mA per MX/QX FF board on the bus. The 9-32 VDC power can come from a separate power supply, usually located at the host end of the cable, or from the Fieldbus interface.

NOTE: Even if main power is lost to the actuator the FF board will remain active and communicative as long as the fieldbus power supply is present.

Figure 2.6 shows a typical Fieldbus power supply arrangement.

Figure 2.6 – Fieldbus Power Supply with External Termination

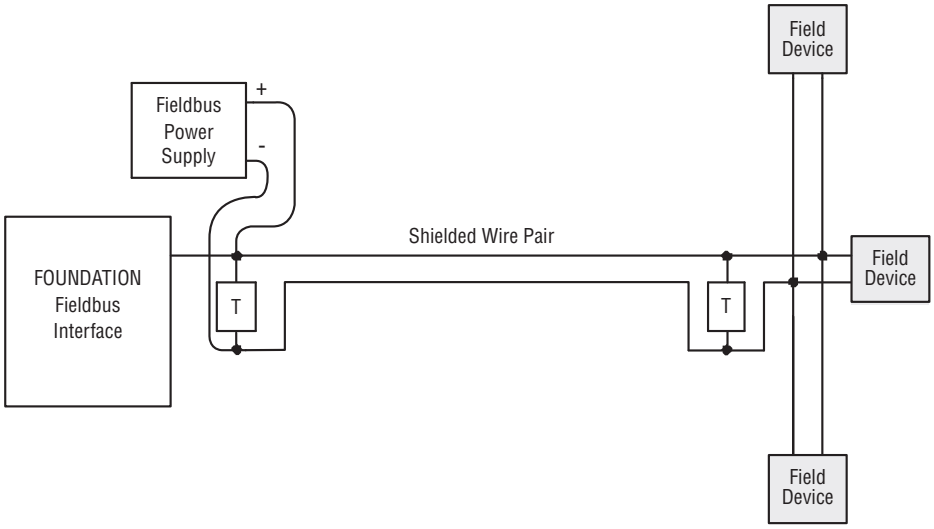
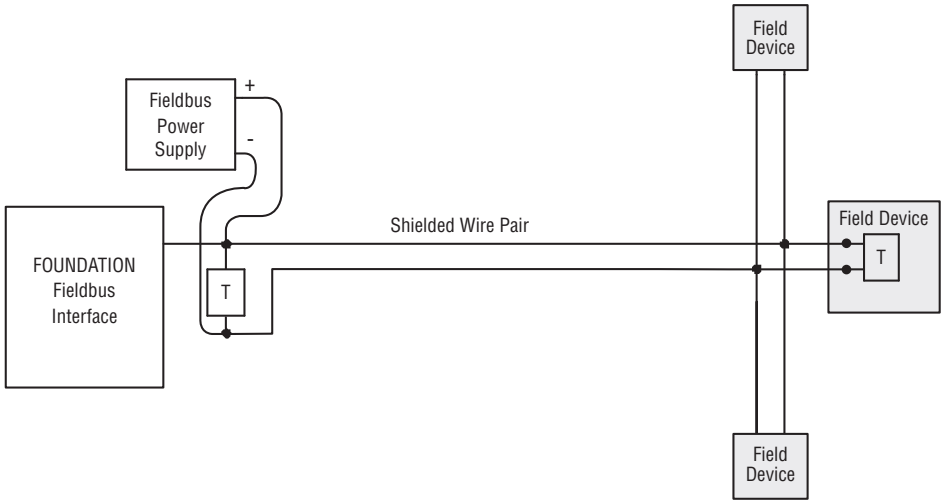


Figure 2.7 – Fieldbus Power Supply with MX/QX FF Termination



2.6 Site and Network Cable Preparation

2.6.1 Site Preparation

Prepare the site and associated equipment for operation of the MX/QX FF controlled MX/QX actuators as follows:

1. Prepare a detailed site plan consisting of the following:
   - Actuator locations and tag numbers
   - Junction boxes and terminal strip locations and tag numbers
   - Terminators and power supplies/conditioners, and repeaters
   - Provide free access to the MX/QX control panel and terminal block for setup, configuration, and troubleshooting.

2. Prepare the cable and label all wires. See Section 2.6.2.
3. Install power and control wires in separate conduits.
4. Install and verify earth grounds. The cable shields should be tied together. Ground the fieldbus shield only at one point. The MX/QX FF unit should not connect either conductor of the cable to ground at any point in the network. Refer to Section 2.4 - Cable Grounding.

NOTE: Limitorque defines an effective local earth ground as a low impedance (less than 5 ohms) path to either:

- A ground electrode placed in the close vicinity of the actuator, which is free of ground loop currents. OR
- A safety ground that is free of ground loop currents running from the actuator back to the system ground electrode. If the signal wiring is run on aerial cable where it may be exposed to high energy electrostatic discharge (such as lightning), a low impedance path to ground which is capable of high current must be provided a short distance from the actuator as described above. OR
- A power distribution grid identifying the impact of power isolation to a particular actuator or group of actuators should be provided.

2.6.2 Network Cable Preparation

Care must be taken during cable preparation:

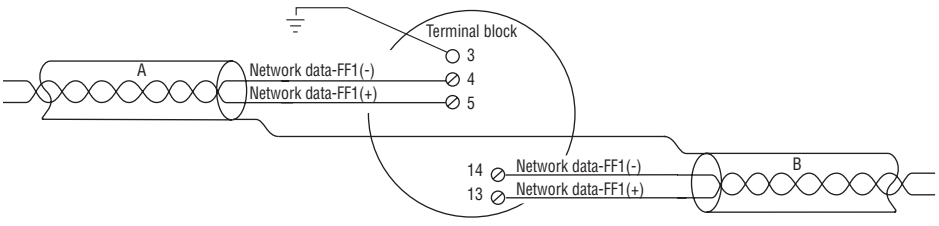
- When stripping the insulation, use wire strippers that do not nick the wire.
- Use crimp ferrules to prevent stranded wires from getting loose and shorting to other wires.
- Use vibration resistant wiring terminals that hold the ferrule securely.

2.6.2.1 Network Cable Connection to the MX/QX FF Unit

The field device is connected to the network through the MX/QX terminal block. The network cable is connected to terminal block as shown in Figure 2.8.

NOTE: The MX/QX FF device is sensitive to polarity. The cables should indicate polarity and polarity should be maintained through all connection points.

Figure 2.8 – Network Cable Connections to Terminal Blocks



NOTE:

- Shielded twisted-pair cables are used.
- Shields are connected to earth ground at only one point in the segment to avoid ground loops.
- Clean earth-ground connection (less than 5 ohms) provides noise protection and a clear, safe path for surge currents.

Prepare the network cable for connection to the MX/QX terminals a follows:

⚠ **CAUTION:** Strip stranded conductors carefully; do not damage the strands. This will weaken the conductor. Do not nick conductors when stripping away the insulation. Nicking stresses the conductor and can cause the conductor to break. This type of damage may not be apparent and failure can occur later without warning.

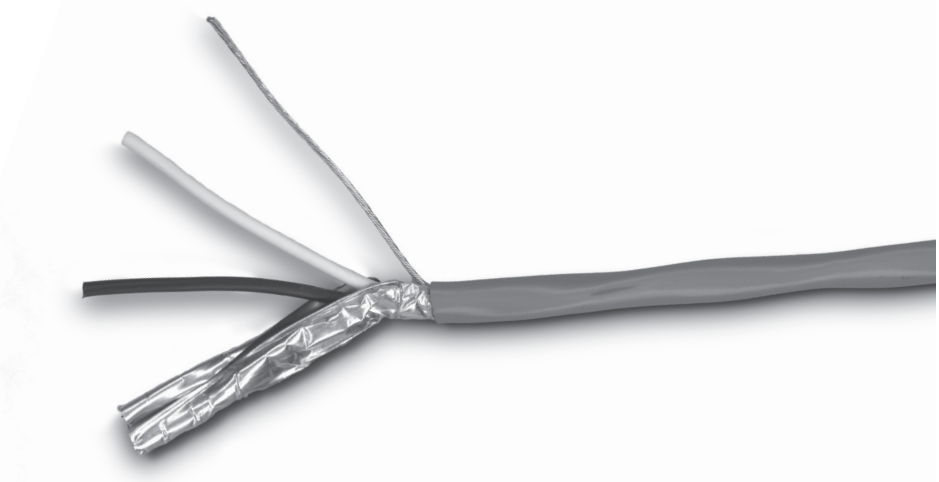
1. Remove two to three inches (5 to 8 cm) of the outer plastic jacket as shown in Figure 2.9. Do not cut or nick the drain wire or the insulated conductors.

Figure 2.9 – Removing Outer Plastic Jacket

NOTE: Excess cable should be cut, not coiled or looped, to prevent noise induction into the network.

2. Separate the cable parts. Unbraid the shield and peel back the foil shield to the same point where the outer jacket was removed as shown in Figure 2.10.

Figure 2.10 – Seperating Cable Parts



3. Cut away the foil shield. Strip the insulation from the conductors approximately 0.4 inch (1 cm) as shown in Figure 2.11.

Figure 2.11 – Stripping Conductors

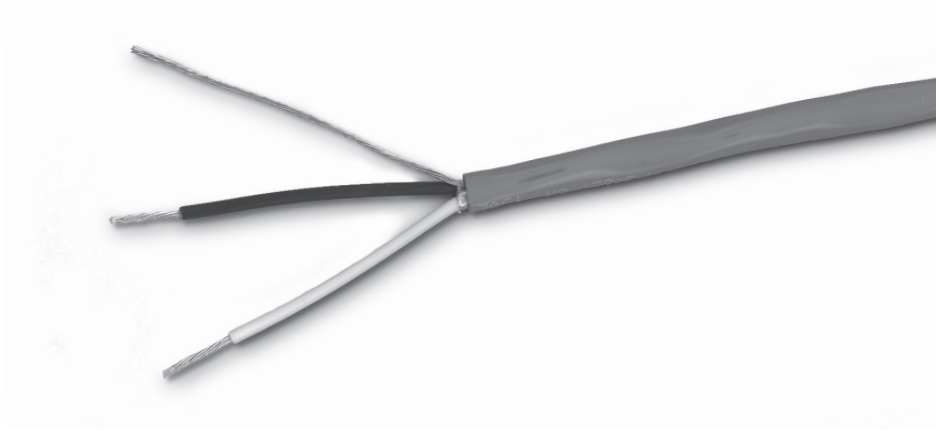


Figure 2.12 – Applying Heat Shrink Tubing

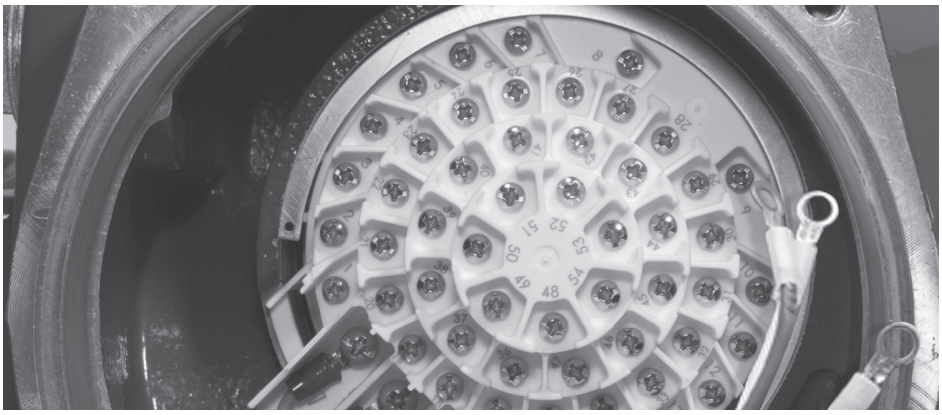
4. Apply heat shrink tubing to insulate the braided shield and to provide stress relief to the cable as shown in Figure 2.12.

⚠ **CAUTION:** Do not melt the insulation.

5. Install ring tongue connectors as shown in Figure 2.13.

NOTE: Flowserve recommends the use of Thomas and Betts #RZ22-6 for optimum results.

Figure 2.13 – Ring tongue connectors



6. Connect the network cables to the MX/QX terminal block as shown in Figure 2.14.

Table 2.4 details a connection for the daisy chain topology. If the actuator is to be connected on a spur (as a drop) use only terminals 4 and 5.

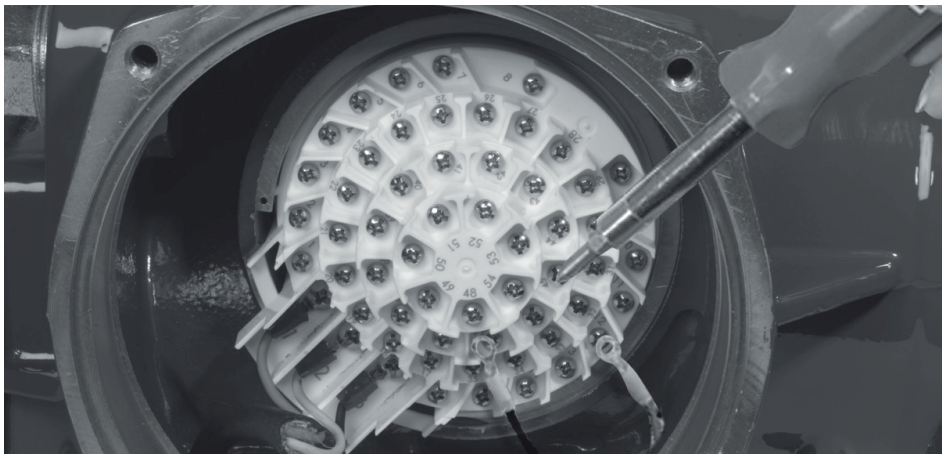
Table 2.4 – Loop Topology Connection

Terminal Block Number	Function
4	FF1 (-)
5	FF1 (+)
14	FF1 (-)
13	FF1 (+)
3	Surge Protection

NOTE: Ground each segment of the cabling at only one point to prevent ground loops that can affect system performance, see Section 2.4. Verify the actuator is properly grounded.

7. Connect the cable shields toeach other inside the unit. Do not connect then to the unit in any way. The network shield should be grounded at only one place in the network. If it is desired to ground the entire network shield at the actuator, then install a jumper cable from terminal 3 to earth ground or ground lug.

Figure 2.14 – Connecting Network Cable to MX/QX Terminal Block



2.6.2.2 Network Cable Connections to Other Network Components

Each FOUNDATION fieldbus network may require some or all of the following components depending on the application:

- Junction Box/Terminal Blocks
- Connectors
- Power Supplies
- Power Conditioners
- Terminators
- Intrinsic Safety Barriers
- Bridge and Repeaters

For cable connecting information on these components, see the following:

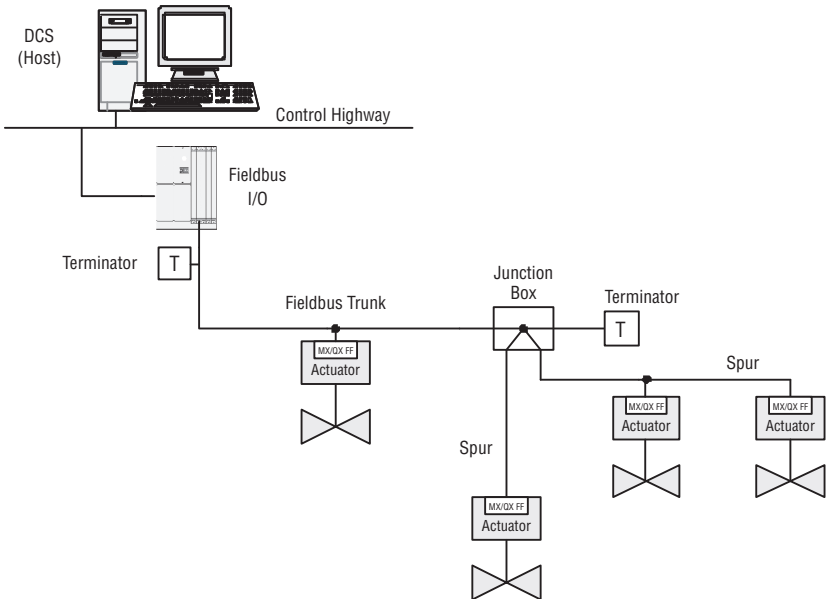
- FOUNDATION Fieldbus Wiring and Installation 31.25 kbits/s, Voltage Mode, Wire Medium AG-140
- Relcom Inc. Fieldbus Wiring Design and Installation Guide
- ANSI/ISA-S50.02, Part 2-1992, Fieldbus Standard for Use in Industrial Control Systems Part 2: Physical Layer Specification and Service Definition

2.6.2.3 Cable Length and Number of Devices Requirements

The network cable consists of a trunk, segments, and spurs. The trunk is the main connection between all the devices. A segment is a section of the cable that contains the terminators. A spur connects to the trunk through a junction box. The following topologies are possible:

- Point-to-point
- Bus with Spurs
- Daisy Chain
- Tree topology
- Combination of the above

Figure 2.15 – Network with Spurs



The maximum length of the fieldbus cable is determined by the following:

- Communication rate
- Cable type
- Wire size
- Bus power option
- Intrinsic safety option

The maximum number of devices on the MX/QX FF fieldbus segment is based on the following:

- The communication rates of the devices
- The maximum number of addresses on a segment.
- The available power

Table 2.5 – Recommended Maximum Spur Length, m (ft)

Total Devices per Network	1 Device per Spur	2 Devices per Spur	3 Devices per Spur	4 Devices per Spur
25-32	1 (3)	1 (3)	1 (3)	1 (3)
19-24	30 (98)	1 (3)	1 (3)	1 (3)
15-18	60 (197)	30 (98)	1 (3)	1 (3)
13-14	90 (295)	60 (197)	30 (98)	1 (3)
1-12	120 (394)	90 (295)	60 (197)	30 (98)

For further details on maximum cable length and number of devices, see the fieldbus references listed in Section 2.6.2.2.

2.6.2.4 Network Cable Connection to the Host System (DCS)

For instructions on connecting to the DCS, see the applicable DCS instruction manual. There are several possible topologies for the network as detailed in FOUNDATION Fieldbus Application Guide AG-140, 31.25 kbits/s, Wiring and Installation.

2.6.3 MX/QX FF Device Installation

The MX/QX FF board is located in the controls cover. The board has four standoffs and mounts on top of the main processor board. If the I/O board option is present, the I/O board will be on top of the MX/QX FF board. For installation instructions, refer to the MX Maintenance and Spare Parts Manual, LMENIM2314 or the QX Maintenance and Spare Parts Manual LMENIM3314.

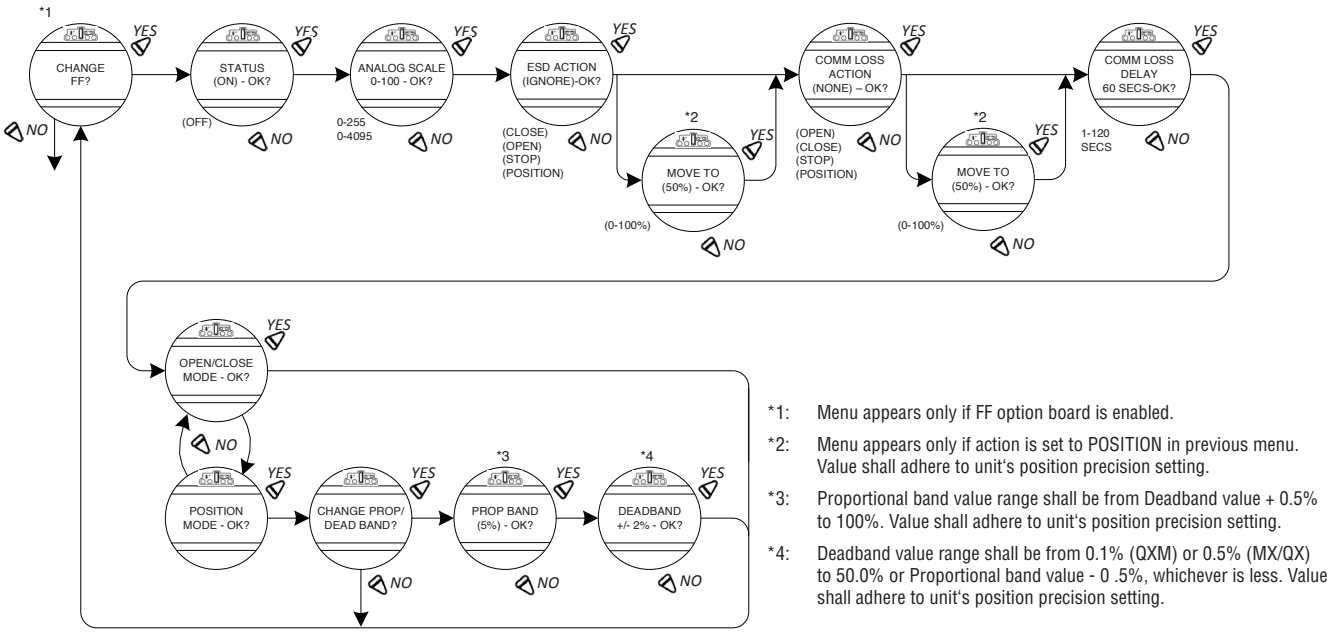
2.6.4 MX/QX FF Device Setup

The MX/QX FF option enables the actuator to be controlled by a Foundation fieldbus communications signal. If the option has been purchased, it is automatically enabled.

NOTE: If the FF option has not been purchased, the screens for changing FF will not be available. To add the FF option, please consult Limitorque service at (434) 528-4400.

Figure 2.16 illustrates the setup sequence. For proper operation either Position Mode or Open/Close Mode must be selected.

Figure 2.16 – MX/QX FF Setup Sequence



*1: Menu appears only if FF option board is enabled.

*2: Menu appears only if action is set to POSITION in previous menu. Value shall adhere to unit's position precision setting.

*3: Proportional band value range shall be from Deadband value + 0.5% to 100%. Value shall adhere to unit's position precision setting.

*4: Deadband value range shall be from 0.1% (QXM) or 0.5% (MX/QX) to 50.0% or Proportional band value - 0 .5%, whichever is less. Value shall adhere to unit's position precision setting.

NOTE: This menu is displayed after the actuator and FF board have been powered up together at least one time.

To setup the MX or QX FF device, enter the Setup mode as detailed in Installation and Operation Manual Bulletins LMENIM2306 for the MX and LMENIM3306 for the QX:

1. Proceed through Setup to the CHANGE FF? display. Select YES to get to the STATUS display.
2. STATUS enables the user to change from the default condition to turn on and off the digital control capability of the actuator. Select NO to change the setting or YES to get to the next display. (Default = ON)
3. ANALOG SCALE allows the user to change the scaling range used by the actuator when working with analog values (position, torque, analog inputs). The scaling options include 0-100, 0-255, or 0-4095. To change from the default setting, select NO until the desired option is displayed. Select YES if the setting is correct to go to the next display (Default = 0-100).
4. ESD ACTION allows a network ESD function to be enabled after the ESD configuration has been established for the unit. This network ESD can be selected to do one of the following: IGNORE, CLOSE, OPEN, STOP, or POSITION the actuator. To change from the default setting, select NO until the desired option is displayed. Select YES if the setting is correct to go to the next display. (Default = IGNORE)

NOTE: if POSITION is chosen as the action, a MOVE TO display will be shown where the user can select the desired position between 0 and 100% open, in one percent increments, by selecting NO until the desired position is selected. Select YES once the setting is correct to go to the next display.

5. COMM LOSS ACTION allows the user to select the action to be taken after a communication loss to the actuator. The action can be one of the following: no action (NONE), CLOSE, OPEN, STOP, or POSITION the actuator. To change from the default setting, select NO until the desired option is displayed. Select YES if the setting is correct to go to the next display. (Default = NONE)

NOTE: if POSITION is chosen as the action, a MOVE TO display will be shown where the user can select the desired position between 0 and 100% open, in one percent increments, by selecting NO until the desired position is selected. Select YES once the setting is correct to go to the next display.

6. COMM LOSS DELAY sets the time before which the COMM LOSS ACTION is taken after a communication loss. The setting can be between 1-120 seconds in one-second increments. To change from the default setting, select NO until the desired value is displayed. Select YES if the setting is correct to go to the next display. (Default = 60)

7. MODE display allows the user to select the mode of operation of the actuator. In OPEN/CLOSE mode the host can only fully open or fully close the valve. In POSITION mode the host can set the valve position to any desired value within the analog scale range. To change from the default setting, select NO until the desired mode is displayed. Select YES once the setting is correct to go to the next display (Default = OPEN/CLOSE).

2.6.4.1 Proportional Band

Proportional band is the range of errors between the position and demand signal that will produce reduced speed (pulsing). The default value is 5%.

To change from default, select NO until the desired value is displayed, then select YES. The value is adjustable between 1% and 100%, in 1% increments.

2.6.4.2 Deadband

The default deadband value is 2%. For error signals less than this, no motion occurs.

The deadband should be wide enough to prevent “hunting” of the actuator but as low as possible to give adequate response to changes in the error signal. To change from the default, select NO until the desired value is displayed, then select YES. The value is adjustable between 1% and 50%, in 1% increments.

2.6.5 Valve Data

Valve data may be stored in the MX/QX FF transducer block for use by the host system. Refer to Bulletin LMENIM2306 for the MX and LMENIM3306 for the QX for instructions to edit data for the valve serial number, model and type.

2.7 MX/QX FF Device Description, Capabilities, and Device Type Manager Files Installation

2.7.1 Device Description and Capabilities Files

A Capabilities File (CF) describes the communication objects in a fieldbus device. In the Host system, the configuration device can use DD files or CF files to configure a fieldbus system without having the fieldbus devices online. Some host systems need both DD and CF files. Refer to your host system documentation for the files that are needed. The DD files are downloaded from the Fieldbus web site (www.fieldbus.org) into the DCS workstation or host device.

2.7.2. DD Methods

The DD file contains a series of configuration prompts known as DD Methods to assist with actuator commissioning. These DD Methods provide the end user with a clear, convenient mechanism for setting the actuator torque limits, configuring the digital or analog control functionality, and enabling other optional features (if present) over the FF network.

2.7.3 Device Type Manager File

The DTM file provides an interface between the actuator's specific application software and a Network Host Station's Field Device Tool (FDT) frame. The DTM can be integrated into FDT frame applications to allow users to perform offline and online parameterization, configuration, and status and diagnostic retrieval. The DTM files can be downloaded from the Flowserve Limitorque web site (www.flowserve.com).

2.8 Installation Verification

2.8.1 Network Cabling Installation Verification

After installation is complete and prior to operation, inspect the network cable and its connection to each field device.

NOTE: Units should be disconnected from power. The network should be disconnected from the host device.

Check for the following:

1. There should not be:
   - Nicks in the insulation - this can cause a short to the grounded shield.
   - Cut strands in a stranded conductor - this can cause a poor connection and eventually an open circuit.
   - Cable armor shorted to the cable shield/drain wire - this may not be at ground potential and could be subject to lightning strikes.
2. The Shield/drain wire should only be grounded at one point in the segment to avoid ground loop problems.
3. The ground/earth connection should be at true ground potential and effective at all times. See No. 5 in Section 2.6.1, Site Preparation.

2.8.2 MX/QX FF Device Installation Verification

Verify the field device is installed as follows:

1. Enter the Setup mode as detailed in Installation and Operation Manual Bulletins LMENIM2306 for the MX or LMENIM3306 for the QX.

2. In the Setup mode, use the black control knob to select YES to the main menu selection VIEW DIAGNOSTICS?
3. Select YES to the display VIEW HARDWARE STATUS?
4. Select YES to scroll through the menu selections. The LCD will read FF (OK) - NEXT? if installed.

   NOTE: If the FF (OK) - NEXT? does not appear, contact Limitorque for assistance.
5. To return to the normal display, use the red knob to select either LOCAL or REMOTE.

2.9 Configuration Confirmation

Field device operation cannot be verified until the complete Fieldbus system is operational. However, routine checks can be performed to verify many functions.

2.9.1 Checking Connections

Verify that all connections, including data wires, shield ground, digital inputs (optional), digital outputs (optional), and analog inputs (optional) are in accordance with MX/QX wiring diagrams and MX/QX FF device diagrams in Section 2.6.

2.9.2 View Settings

Refer to Installation and Operation Manual Bulletins (LMENIM2306 for the MX, LMENIM3306 for the QX) to access the view settings menu. Verify the settings as follows:

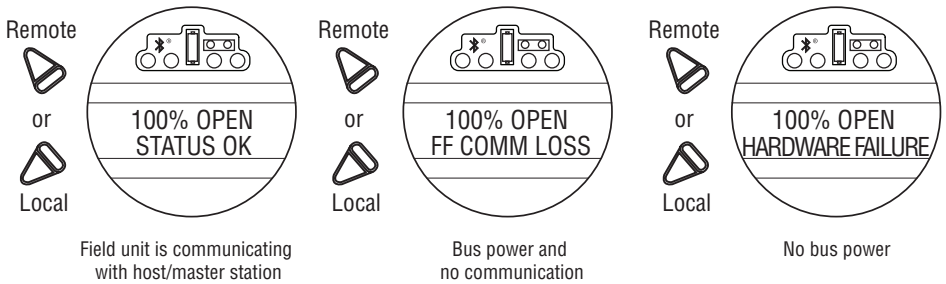
1. From the VIEW SETTINGS display, scan to the VIEW FF? display.
2. From VIEW FF? display, select YES and check that the FF status is ON. This confirms that FF is enabled.
3. If the MX/QX contacts are to be controlled via the network to control external equipment, from the VIEW FF? display, select NO and obtain the VIEW STATUS AND ALARM CONTROL? display. Verify that the digital outputs, (S1a, S1b, S2a, S2b) are set for “Network” control.

2.9.3 Checking the Normal Display

Place the selector switch in LOCAL or REMOTE position. The valve position will be indicated at the top of the LCD. STATUS OK or FF COMM LOSS should be indicated at the bottom of the LCD display.

- If STATUS OK is displayed, then the field device is communicating with the LAS.
- If FF COMM LOSS is displayed, no communication is occurring. This could be due to a number of factors, including problems with the Host/Master station and/or the network. Check all local connections and configurations. If these are correct and the FF COMM LOSS is still displayed, then the solution to this problem must await full system commissioning.

Figure 2.17 – Normal Display



3 Software

3.1 Fieldbus Protocol

The fieldbus system uses the FOUNDATION fieldbus protocol to communicate over the H1 Fieldbus network with other Fieldbus devices. The signals are encoded using the Manchester Biphase-L technique. The signal is called synchronous serial because the clock information is embedded in the serial stream. The protocol uses built-in error checking rules when processing data.

3.2 Fieldbus Function Blocks

The user application layer is programmed using software function blocks located in the device. The function blocks provide the interface with the actuator and process, and the interface with the network and control system.

The user layer in each device contains the following:

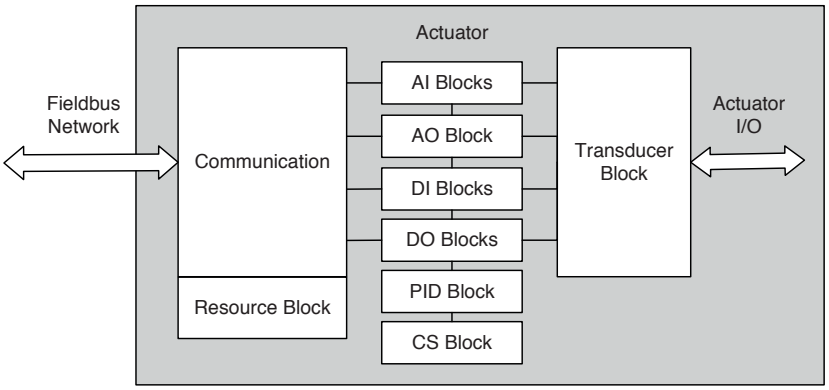
- One Resource Block
- One Transducer Block
- Function Blocks for Analog Input/Output (AI/AO) and Digital Input/Output (DI/DO)
- Function Block for Proportional Integral Derivative (PID) Control
- Function Block for Control Selector (CS) Control

The Resource Block describes the hardware specific characteristics associated with the actuator and its associated blocks; it has no inputs or outputs. Data in the Resource Block includes the following:

- Manufacturer's name
- Device name
- Serial number

The Transducer Block represents local connection for the physical I/O. It connects function blocks to the local inputs and outputs. It reads sensor hardware and writes to actuator hardware. The Transducer Block executes as frequently as necessary to obtain good data from sensors and ensures proper writes to the actuator without burdening the function blocks that use the data.

Figure 3.1 – Fieldbus Function Blocks



A Virtual Field Device (VFD) is used to remotely view local device data described in the object dictionary. The VFD in each device is used for network management and system management, and contains configuration information such as function block schedules.

The Function Blocks provide the control and I/O behavior of the device. They perform analog to digital conversion, linearization, and transmit information to and from other function blocks. Function Blocks are connected together during the configuration to perform the specific control functions of the process, and communicate with the host device, which supervises the entire control system.

Table 3.1 – Description of the Function Blocks

Function Block	Name	No. of Blocks	Description
Analog Input	AI	2	Processes field device measurements and makes them available to other function blocks; supports alarming, filtering, signal status, mode control, and simulation.
Analog Output	AO	1	Assigns an analog setpoint value to a field device through a transducer block I/O channel; supports mode control, signal status calculation, and simulation.
Discrete Input	DI	4	Processes a single discrete input from a field device and makes it available to other function blocks; supports alarming, signal status propagation, mode control, and simulation.
Discrete Output	DO	2	Processes a discrete setpoint and outputs it to a specified I/O channel to produce an output signal; supports mode control, output tracking, and simulation.
Transducer Block		1	A custom block to monitor and control the actuator; connects function blocks to local input/output functions.
PID Block	PID	1	Combines all necessary logic algorithms to perform process control; supports mode control, signal scaling and limiting, feed forward control, override tracking, alarm limit detection and signal status propagation.
Control Selector Block	CS	1	Manages multiple (up to 3) control sources for a field device; supports mode control and output tracking.
Resource Block		1	A standard block to provide general management of the device.

Standard Fieldbus parameters used in these blocks are listed in Appendix C.

3.3 Analog Input Function Block

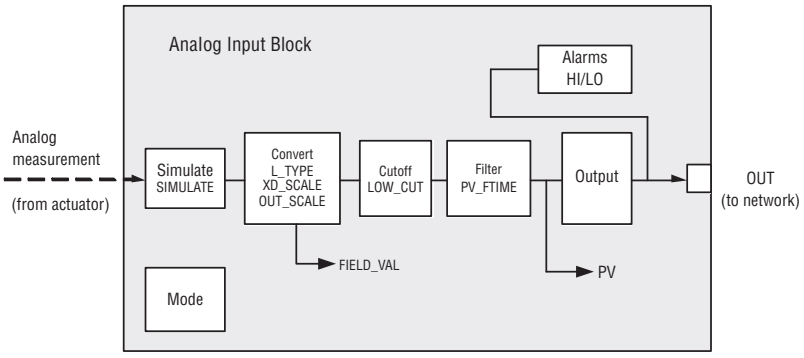
The Analog Input (AI) function block (Figure 3.2) is a standard block over all fieldbus systems. The AI block processes field measurements and makes them available to other function blocks. The output value from the AI blocks is in engineering units and contains a status indicating the quality of the

measurement. The measuring device may have several measurements or derived values available in different channels. Use the Channel number to define the desired variable from the transducer block.

There are two AI blocks in the Limitorque actuator control system and four channels:

Channel No.12	—	AI_POSITION_CHAN	—	Current valve position
Channel No.13	—	AI_ANALOG_INPUT_1_CHAN	—	Value of analog input 1
Channel No.14	—	AI_ANALOG_INPUT_2_CHAN	—	Value of analog input 2
Channel No.16	—	AI_TORQUE_CHAN	—	Current torque

Figure 3.2 – Analog Input Block



The AI block supports alarming, signal scaling, signal filtering, signal status calculation, mode control, and simulation. In Automatic mode, the block's output reflects the Process Variable (PV) Value and Status. In Manual Mode, Output may be set manually by the operator. Manual Mode is reflected on the Output Status. Alarms can be generated based on the value of the block output.

Output
OUT is the block output value and status.

Scaling
Transducer scaling (XD_SCALE) is applied to the value from the channel to produce the FIELD_VAL in percent. The XD_SCALE units code must match the channel units code (if one exists), or the block will remain in O/S mode after being configured. A block alarm for units mismatch will be generated.

The OUT_SCALE is normally the same as the transducer, but if L_TYPE is set to Indirect or Indirect Square Root, OUT_SCALE determines the conversion from FIELD_VAL to the output. PV and OUT always have identical scaling.

OUT_SCALE provides scaling for PV. The PV is always the value that the block will place in OUT if the mode is Auto.

Manual Mode
If Manual is allowed, someone may write a value to the output. The status will prevent any attempt at closed loop control using the Manual value, by setting the Limit value to Constant.

Low Cutoff
The LOW_CUT parameter has a corresponding "Low cutoff" option in the IO_OPTS bit string. If the option bit is true, any calculated output below the low cutoff value will be changed to zero. This is only useful for zero based measurement devices, such as flow.

Filter
The PV filter, whose time constant is PV_FTIME, is applied to the PV and not the FIELD_VAL.

Simulation
Simulation is used to support testing. Simulation can be enabled through the configuration tool and allows the manual entry of a value for a measurement and its status.

This feature requires the installation of a hardware jumper on the MX/QX FF interface, located on header X5 Pins 7 and 8.

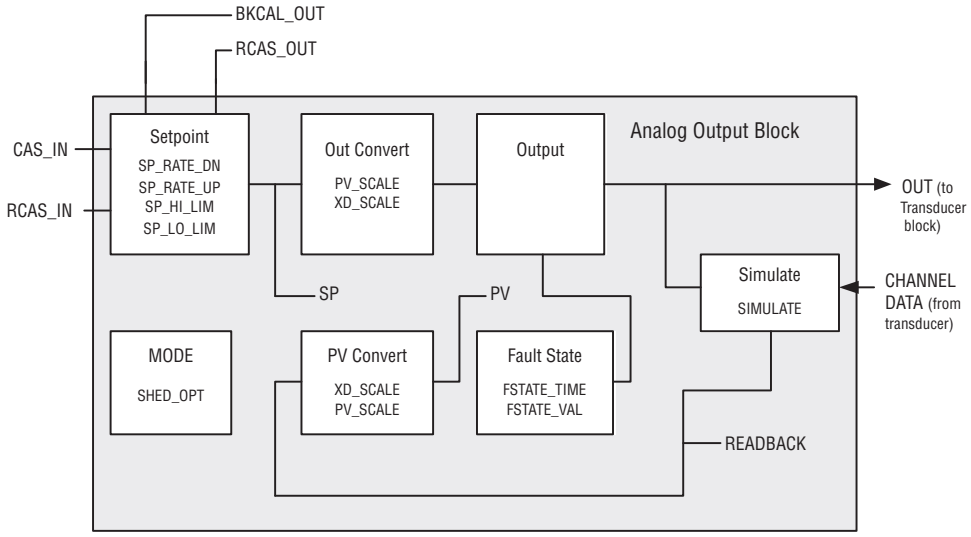
3.4 Analog Output Function Block

The Analog Output (AO) block assigns an output value to a field device through a specified transducer block I/O channel. The block supports mode control, signal limiting, rate limiting, signal status calculation, and simulation. There are provisions to ensure bumpless mode transfer when this block is part of a control loop.

There is one AO block in the Limitorque actuator control system and one channel:

Channel No.1 — AO_CTRL_VALVE_FLOW_CHAN — Desired valve position (in %)

Figure 3.3 – Analog Output Block



The output can be set in four ways. In Manual Mode, the output can be set by the user, and this value is independent of the Setpoint. In Automatic Mode, the output is set by the Setpoint value in engineering units and the I/O options parameter. In Cascade Mode, the Cascade Input value from another block is used to update the Setpoint. In Remote Cascade Mode, the setpoint comes from a remote computer or DCS. The Setpoint value can be limited, and also the rate at which the setpoint output changes can be limited.

To provide bumpless transfer on mode changes and windup protection if there is an upstream PID block, the Back Calculation Out parameter is used, and various block I/O options.

Inputs
CAS_IN is the remote setpoint from another function block.

RCAS_IN is a target setpoint and status provided by a supervisory host to an analog control or output block.

Outputs
OUT is the block output and status.

RCAS_OUT is a block setpoint and status after ramping, provided to a supervisory host for back calculation and to allow action to be taken under limiting conditions or mode change.

BKCAL_OUT is the value and status required by the BKCAL_IN of another block to prevent windup and to provide bumpless transfer to closed loop control.

Scaling
The PV_SCALE range is used to convert the SP to percent of span. The XD_SCALE range is used to convert percent of span to the number used by the hardware. This allows portions of the SP span to cause full span movement of the output. The Increase to close option in IO_OPTS can be used to invert the span.

Cascade Operation
The SP supports the full cascade sub-function. In fact, Cascade mode must be used to transfer the output of another block to the SP of the AO. The SP has standard ramp rate and absolute limits. There are additional I/O options which will cause the SP value to track the PV value when the block is in an actual mode of Local Override or Manual. If the Output Readback feature is turned on, such as valve position, that value should be run backwards through the XD scaling to act as the PV for this block. If not supported, READBACK is generated from OUT. The OUT and READBACK parameters both use XD_SCALE. The PV and SP use PV_SCALE.

Since the Analog Output block interfaces to the transducer block, there is no BKCAL_IN parameter. ROut mode is not supported.

For the BKCAL_OUT value, there is an option to use either the SP value after limiting or the PV value.

Supported Modes
OOS, LO, IMan, Man, Auto, Cas, and Rcas modes are supported. The Man mode can be used in maintenance or troubleshooting where the OUT value may need to be adjusted directly. This requires that the manufacturer put operational limits in the transducer block, where they are not accessible to an operator.

Simulation
Simulation is used to support testing. Simulation can be enabled through the configuration tool and allows the manual setting of the channel feedback.

This feature requires the installation of a hardware jumper on the MX/QX FF interface, located on header X5 Pins 7 and 8.

3.5 Discrete Input Function Block

The Discrete Input (DI) function block processes a single discrete input from a field device and makes it available to other function blocks. The user can configure alarm detection and inversion on the input signal. The DI block supports mode control, signal status propagation, and simulation.

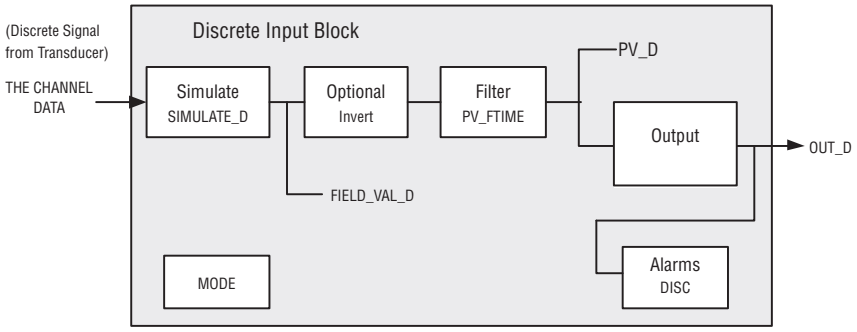
There are four DI blocks in the Limitorque actuator control system and eight channels:

Chan. No.2 — DI_POSITION_AND_BUS_MODE_CHAN — Valve status and control mode

Chan. No.3 — DI_POSITION_CHAN — Valve status, moving/stopped

Chan. No.4	—	DI_ACTUATOR_FAULTS_1_CHAN	—	Mechanical and electrical faults 1
Chan. No.5	—	DI_ACTUATOR_FAULTS_2_CHAN	—	Mechanical and electrical faults 2
Chan. No.6	—	DI_ACTUATOR_ALARMS_CHAN	—	Emergency shutdown and inhibits
Chan. No.7	—	DI_DISC_USER_INPUT_CHAN	—	Discrete input from user
Chan. No.8	—	DI_READ_DISC_OUTPUT_CHAN	—	Read discrete output
Chan. No.15	—	DI_READ_HARDWARE_FAULTS_CHAN	—	Hardware faults

Figure 3.4 – Discrete Input Function Block



Normally the block is used in Automatic Mode so that the Process Variable is copied to the Output. If necessary, the operator can change the mode to Manual, which disconnects the field signal and substitutes a manually entered value for the Output.

Inputs
The discrete input comes from a transducer, as selected by the CHANNEL.

Outputs
OUT_D is the block discrete output.

The FIELD_VAL_D shows the true on/off state of the hardware, using XD_STATE. The Invert I/O option can be used to do a Boolean NOT function between the field value and the output. A discrete value of zero(0) will be considered to be a logical zero(0) and an non-zero discrete value will be considered to be a logical (1) e.g. if invert is selected, the logical NOT of a non-zero field value would result in a zero(0) discrete output, the logical NOT of a zero field value would result in a discrete output value of one(1).

Filtering and Scaling
PV_FTIME may be used to set the time that the hardware must be in one state before it gets passed to the PV_D. The PV_D is always the value that the block will place in OUT_D if the mode is Auto. The PV_D and the OUT_D always have identical scaling. OUT_STATE provides scaling for PV_D.

Supported Modes
OOS, Manual, and Auto modes are supported. If Manual is allowed, someone may write a value to OUT_D.

Alarm Types
Standard block alarm plus standard discrete alarm applied to OUT_D.

Simulation
Simulation is used to support testing. Simulation can be enabled through the configuration tool and allows the manual setting of the measurement value through the Simulate parameter (SIMULATE_D). Alternatively the operator can change the block Mode to Manual and adjust the Output Value.

This feature requires the installation of a hardware jumper on the MX/QX FF interface, located on header X5 Pins 7 and 8.

3.6 Discrete Output (DO) Function Block

The Discrete Output (DO) function block processes a single discrete setpoint and outputs it to a specified I/O channel to produce an output signal. The DO block supports mode control, output tracking, and simulation. There is no process alarm detection in the block. In operation, the DO function block determines its setpoint, sets the output, and (optionally) checks a readback signal from the field device to confirm the physical output operation.

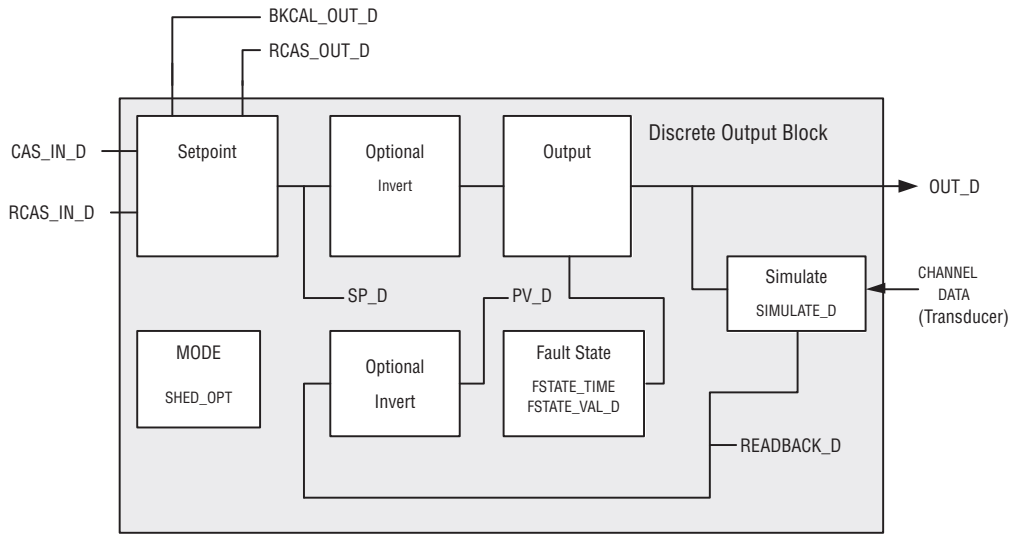
There are two DO blocks in the Limitorque actuator control system and three channels:

Chan. No.9 — DO_POSITION_CHAN — Command Stop/Open/Close

Chan. No.10 — DO_ESD_CHAN — Command Emergency Shutdown

Chan. No.11 — DO_RELAY_CHAN — Command Energize Relays

Figure 3.5 – Discrete Output Function Block



To set the DO block output, the operator first sets the mode to define how the block obtains its output. In Cascade Mode, the setpoint equals the input value from another block. In Auto Mode, the setpoint is written to the block. In Manual Mode, the setpoint is written to the Output. In Remote Cascade Mode, the setpoint is determined by a host computer or DCS that writes to the RCAS input.

Inputs

CAS_IN_D is the remote (cascade) setpoint value from another function block.

RCAS_IN_D is a target setpoint and status provided by a supervisory host to a discrete control or output block.

Outputs

OUT_D is the discrete output value and status.

BKCAL_OUT_D is the back calculation output value and status required by the BKCAL_IN_D input of another block for output tracking.

RCAS_OUT_D is a block setpoint and status provided to a supervisory host for back calculation and to allow action to be taken under limiting conditions or mode change.

SP_D is the discrete target block output value (setpoint).

The Invert I/O option can be used to do a Boolean NOT function between the SP_D and the hardware.

The SP_D supports the full cascade sub-function. Cascade mode must be used to transfer the output of another block to the SP_D of the DO. There are additional I/O options which will cause the SP_D value to track the PV_D value when the block is in an actual mode of Local Override or Manual.

Readback
If the hardware supports a readback value, it is used for READBACK_D, which (after accounting for the Invert I/O option) acts as the PV_D for this block. If not supported, READBACK_D is generated from OUT_D. The OUT_D and READBACK_D parameters both use XD_STATE. The PV_D and SP_D use PV_STATE.

Supported Modes
OOS, LO, IMan, Man, Auto, Cas, and RCas. The Man mode can be used to force the output, in a PLC sense.

Alarm Types
Standard block alarm.

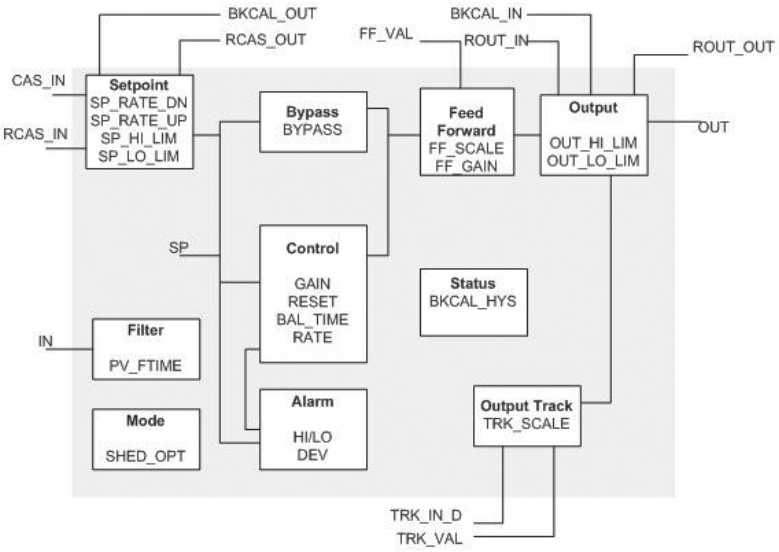
Simulation
Simulation is used to support testing. Simulation can be enabled through the configuration tool and allows the manual entry of the Readback Value and its Status. Alternatively the operator can change the block mode to Manual and adjust the Output value.

This feature requires the installation of a hardware jumper on the MX/QX FF interface, located on header X5 Pins 7 and 8.

3.7 Proportional Integral Derivative (PID) Function Block

The Proportional Integral Derivative (PID) function block combines all necessary logic algorithms to perform process control. The block supports mode control, signal scaling and limiting, feed forward control, override tracking, alarm limit detection and signal status propagation.

Figure 3.6 – Proportional Integral Derivative Function Block



Setpoint selection and limiting

The setpoint of the PID block is determined by the mode. One can configure the SP_HI_LIM and SP_LO_LIM parameters to limit the setpoint. In Cascade or Remote Cascade mode the setpoint is adjusted by another function block or by a host computer, and the output is computed based on the setpoint.

In Automatic mode the setpoint is entered manually by the operator, and the output is computed based on the setpoint. One can also adjust the setpoint limit and the setpoint rate of change using the SP_RATE_UP and SP_RATE_DN parameters.

In Manual mode the output is entered manually by the operator and is independent of the setpoint. In Remote Output mode the output is entered by a host computer and is independent of the setpoint.

Filtering

The filtering feature changes the response time of the device to smooth variations in output readings caused by rapid changes in input. One can configure the filtering feature with the FILTER_TYPE parameter, and one can adjust the filter time constant (in seconds) using the PV_FTIME or SP_FTIME parameters. Set the filter time constant to zero to disable the filter feature.

Feedforward calculation

The feedforward value (FF_VAL) is scaled (FF_SCALE) to a common range for compatibility with the output scale (OUT_SCALE). A gain value (FF_GAIN) is applied to achieve the total feedforward contribution.

Tracking

One can enable the use of output tracking through the control options. One can set control options in Manual or Out of Service mode only.

The track enable control option must be set to true for the track function to operate. When the track in Manual control option is set to true, tracking can be activated and maintained only when the block is in Manual mode. When track in Manual is false, the operator can override the tracking function when the block is in Manual mode. Activating the track function causes the block's actual mode to revert to Local Override.

The TRK_VAL parameter specifies the value to be converted and tracked into the output when the track function is operating. The TRK_SCALE parameter specifies the range of TRK_VAL.

When the TRK_IN_D parameter is true and the track enable control option is true, the TRK_VAL input is converted to the appropriate value and output in units of OUT_SCALE.

Output selection and limiting
Output selection is determined by the mode and the setpoint. In Automatic, Cascade, or Remote Cascade mode, the output is computed by the PID control equation. In Manual and Remote Output mode, the output may be entered manually. One can limit the output by configuring the OUT_HI_LIM and OUT_LO_LIM parameters.

Bumpless transfer and setpoint tracking
One can configure the method for tracking the setpoint by configuring the following control options (CONTROL_OPTS):

SP-PV Track in Man — Permits the SP to track the PV when the target mode of the block is Man.

SP-PV Track in LO or IMan — Permits the SP to track the PV when the actual mode of the block is Local Override (LO) or Initialization Manual (IMan).

When one of these options is set, the SP value is set to the PV value while in the specified mode. One can select the value that a master controller uses for tracking by configuring the use PV for BKCAL_OUT control option. The BKCAL_OUT value tracks the PV value. BKCAL_IN on a master controller connected to BKCAL_OUT on the PID block in an open cascade strategy forces its OUT to match BKCAL_IN, thus tracking the PV from the slave PID block into its cascade input connection (CAS_IN). One can set control options in Manual or Out of Service mode only. When the mode is set to Auto, the SP will remain at the last value (it will no longer follow the PV).

Reset Limiting
The PID function block provides a modified version of feedback reset limiting that prevents windup when output or input limits are encountered, and provides the proper behavior in selector applications.

Modes
The PID function block supports the following modes:

MANUAL (MAN)—The block output (OUT) may be set manually.

AUTOMATIC (AUTO)—The SP may be set manually and the block algorithm calculates OUT.

CASCADE (CAS)—The SP is calculated in another block and is provided to the PID block through the CAS_IN connection.

REMOTE CASCADE (RCAS)—The SP is provided by a host computer that writes to the RCAS_IN parameter.

REMOTE OUTPUT (ROUT)—The OUT is provided by a host computer that writes to the ROUT_IN parameter.

LOCAL OVERRIDE (LO)—The track function is active. OUT is set by TRK_VAL. The BLOCK_ERR parameter shows Local Override.

INITIALIZATION MANUAL (IMAN)—The output path is not complete (for example, the cascade-to-slave path might not be open). In IMan mode, OUT tracks BKCAL_IN.

OUT OF SERVICE (OOS)—The block is not processed. The OUT status is set to Bad: Out of Service. The BLOCK_ERR parameter shows Out of Service.

Alarm Detection

A block alarm will be generated whenever the BLOCK_ERR has an error bit set. The types of block error for the PID block are defined above. Process alarm detection is based on the PV value. One can configure the alarm limits of the following standard alarms:

- High (HI_LIM)
- High high (HI_HI_LIM)
- Low (LO_LIM)
- Low low (LO_LO_LIM)

Additional process alarm detection is based on the difference between SP and PV values and can be configured via the following parameters:

- Deviation high (DV_HI_LIM)
- Deviation low (DV_LO_LIM)

In order to avoid alarm chattering when the variable is oscillating around the alarm limit, an alarm hysteresis in percent of the PV span can be set using the ALARM_HYS parameter. The priority of each alarm is set in the following parameters:

- HI_PRI
- HI_HI_PRI
- LO_PRI
- LO_LO_PRI
- DV_HI_PRI
- DV_LO_PR

Priority Number	Priority Description
0	The priority of an alarm condition changes to 0 after the condition that caused the alarm is corrected.
1	An alarm condition with a priority of 1 is recognized by the system, but is not reported to the operator.
2	An alarm condition with a priority of 2 is reported to the operator, but does not require operator attention (such as diagnostics and system alerts).
3 - 7	Alarm conditions of priority 3 to 7 are advisory alarms of increasing priority.
8 - 15	Alarm conditions of priority 8 to 15 are critical alarms of increasing priority.

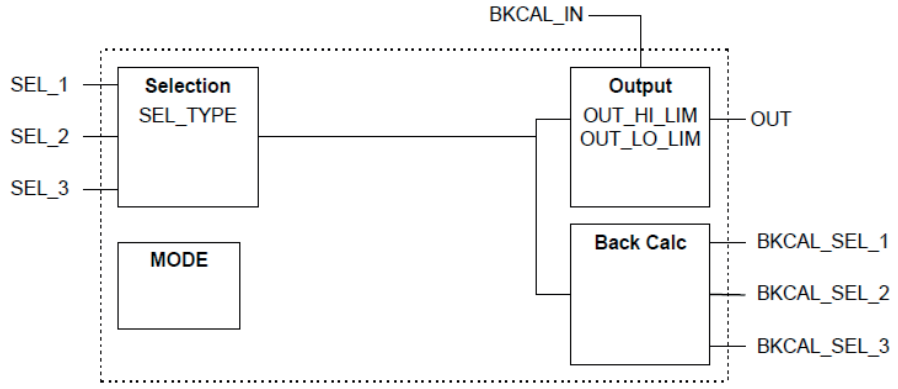
Status handling

If the input status on the PID block is bad the mode of the block reverts to Manual. In addition, one can change the target mode in the event of a error condition by modifying the status option parameter (STATUS_OPTS). Status option can be set in Manual or Out of Service mode only.

3.8 Control Selector (CS) Function Block

The Control Selector (CS) function block is used to manage and prioritize multiple control sources into a single output signal. The block supports mode control and output tracking.

Figure 3.7 – Control Selector Function Block



Inputs

Three separate SEL_N inputs are available for control signals. All inputs to the block are assumed to have the same scaling as OUT, since any one of them may be selected to be OUT. BKCAL_IN is the back calculation input used for output tracking of other blocks.

Outputs

OUT serves as the output control signal of the block. One can configure the OUT_HI_LIM and OUT_LOW_LIM parameters to limit the output.

Three separate BKCAL_SEL_N outputs are available (one for each SEL_N input) as back calculation outputs to other blocks for output tracking. The value of each BKCAL_SEL_N output is the same as OUT.

Supported Modes

OOS, IMan, Man, and Auto.

Alarm Types

Standard block alarm.

Modes of Operation

When in Auto mode, one of two (or three) control signals is selected in a manner determined by SEL_TYPE.

When in Manual mode, no input is selected. All three BKCAL_SEL_N outputs will have a Not Invited status and Constant limits, which a value equal to OUT.

Status Handling

The status will indicate those inputs that are not selected. Control blocks that are not selected are limited in one direction only, which is determined by the type of selector. The limits of back calculation outputs corresponding to deselected inputs will be high for a LOW selector and low for a HIGH selector, or both for a MID selector.

If an input is Uncertain, it is treated as Bad (unless Use Uncertain as Good option is set). When any input is Bad, the actual mode goes to manual. This condition will set IFS in the output status (if the option IFS if BAD IN is set in STATUS_OPTS).

If the status of BKCAL_IN is NI or IR it is passed back on all three BKCAL_SEL_N outputs. This causes all inputs to initialize to the BKCAL_IN value. Otherwise, if the status of BKCAL_IN is not normal it is passed back on BKCAL_SEL_Y (where Y is the number of the selected input). The other BKCAL_SEL outputs (that correspond to the deselected inputs) have the Not Selected status with the appropriate high or low limit set.

3.9 Resource Block (RB2)

The Resource (RB2) block provides useful device identification information for the MX/QX FF field unit. It also contains the Field Diagnostic Profile (FDP), a highly customizable diagnostic interface which provides actuator warning & fault data in accordance with the NAMUR NE107 standard.

For complete details on how to configure and use the Field Diagnostics Profile, please consult the appropriate sections within the FOUNDATION Fieldbus FF-891 (Function Block Part 2) specification.

The tables in Appendix D provide a full list of the warning & fault events available within the Field Diagnostic Profile (organized by category).

3.10 Limitorque Transducer Block (LTB)

The custom Limitorque Transducer (LTB) block is the interface between the function blocks and the rest of the MX/QX FF field unit. It provides all the connections to the actuator itself and contains within its parameters all the information about the Foundation device, commands, and data feedback. This block is customized, and the links between the hardware and block are already made to allow the user to access defined settings for the device.

Many of the links between the Transducer block and the Input/Output blocks are also defined and may not be altered. Data may be read from the parameters but not all parameters permit write commands. Writes are limited to the parameters used to set up the actuator control functions.

Some of the Transducer block parameters represent multiple conditions for the state of the actuator. The tables in Appendix B give a full list of the available parameters.

3.11 Device Description and Capabilities Files

Device Descriptions (DDs) provide an extended description of the data in a device. DDs and Capabilities Files are obtained from the Fieldbus Foundation website (www.fieldbus.org).

The DDs are written in a standard Device Description Language (DDL) to provide an extended descripton of the field device capabilities and names. A DD can be thought of as a driver for the device. The Link Active Scheduler (LAS) interprets these DDs to see and use the field devices.

For each device, the device description defines the format of its data:

- Tag name
- Parameter labels
- Parameter relationships
- Coding and how many decimal points to display
- Engineering units
- Calibration and diagnostic menus
- Help text

The host interprets these descriptions and provides views to allow efficient communication of common group parameters. There is easy access to parameters for:

- Face plate HMI
- Loop tuning
- Configuration changes

A Capabilities File describes the communication objects in a fieldbus device. A configuration device can use Device Description (DD) files and Capabilities files to configure a fieldbus system without having the fieldbus devices online. The files provide the following:

- Profile information
- Actual number of Function Blocks inside the device
- Function Block timing
- Example communication and function block data
- Host system needs for offline configuration
- Methods that provide guided prompts for performing configuration operations

Table 3.2 – Summary of Device Descriptions and Capabilities Files

Device Description	Capabilities File
Describes objects in the VFD	Profile information
Parameter relationships	Actual number of Function Blocks inside the device
Parameter labels	Function Block timing
	Provides example communication and function block data
	Details the host system needs for offline configuration

3.12 Device Type Manager (DTM)

The (DTM) provides an interface between its specific application software and a Network Host Station's Field Device Tool (FDT) frame. The DTM can be integrated into FDT frame applications to allow users to perform offline and online parameterization, configuration, and status and diagnostic retrieval. An enhanced graphical user interface allows the user access to the following:

Dashboard - The Dashboard is the default view of the DTM. It shows the online health status of the actuator, valve, and overall control response. It shows real-time measured values of setpoint, position, position deviation, motor temperature, compartment temperature, supply voltage and frequency. The setpoint mode can be selected and modified from the Dashboard. The Dashboard uses intuitive, user-friendly graphics to display vital data.

Alarms - The DTM annunciates the real-time alarm information received from the device.

Diagnostics - multiple views are included to provide diagnostic features such as Limigard, Travel Histogram, Partial Stroke Test, Built In Self Test, Data Logger, and Operation Log.

Configuration - All the configurable parameters of the device are read and written in the configuration views. These variables are presented in groups such as Actuator, Tuning, ESD Settings, Relay Configuration, Units, Analog Transmitters, FF Information, FF Block Information, and Valve.

The DTM file can be downloaded from the Flowserve website (www.flowserve.com).

4 Associated Documents

Additional information can be found in the following documents:

MX Actuator	
Quick Start-Up Instructions (MX Actuators)	Limitorque Bulletin LMENIM2310
MX Installation and Operation Manual	Limitorque Bulletin LMENIM2306
Protection, Control and Monitoring Features of MX Electric Actuators	Limitorque Bulletin LMENTB2300
MX Maintenance and Spare Parts Manual	Limitorque Bulletin LMENIM2314

QX Actuator	
Quick Start-Up Instructions (QX Actuators)	Limitorque Bulletin LMENIM3313
QX Installation and Operation Manual	Limitorque Bulletin LMENIM3306
Protection, Control and Monitoring Features of QX Electric Actuator	Limitorque Bulletin LMENIM2300
QX Maintenance and Spare Parts Manual	Limitorque Bulletin LMENIM3314

Fieldbus	
Foundation Fieldbus Technical Overview	Foundation Fieldbus FD-043
Foundation Fieldbus Wiring and Installation 31.25 kbits/s, Voltage Mode, Wire Medium, Application Guide	Foundation Fieldbus AG-140
Foundation Specification. Function Block Application Process (Part 1)	Foundation Fieldbus FF-890
Foundation Specification. Function Block Application Process (Part 2)	Foundation Fieldbus FF-891
Foundation Specification. Transducer Block Application Process (Part 2) Revision PS 3.0, Date: 12 April, 1998	Foundation Fieldbus FF-903

FOUNDATION Fieldbus documentation is available at http://www.fieldbus.org

5 How to Order Parts

To order parts or obtain further information about your Limitorque MX/QX FF field unit, contact your local Limitorque distributor sales office, or:

FLOWSERVE CORPORATION
FLOW CONTROL DIVISION,

Limitorque Actuation Systems
5114 Woodall Road
P.O.Box 11318
Lynchburg, VA 24506-1318

Phone (434) 528-4400
Fax (434) 845-9736

To find the Limitorque distributor or sales office near you, go to http://www.limitorque.com

All inquiries or orders must be accompanied by the following information supplied on the actuator nameplate:

1. Unit size
2. Order number
3. Serial number

A Appendix – Wiring Diagrams

Figure A.1 (1 of 3) – Typical MX/QX FF_H1 Wiring Diagram

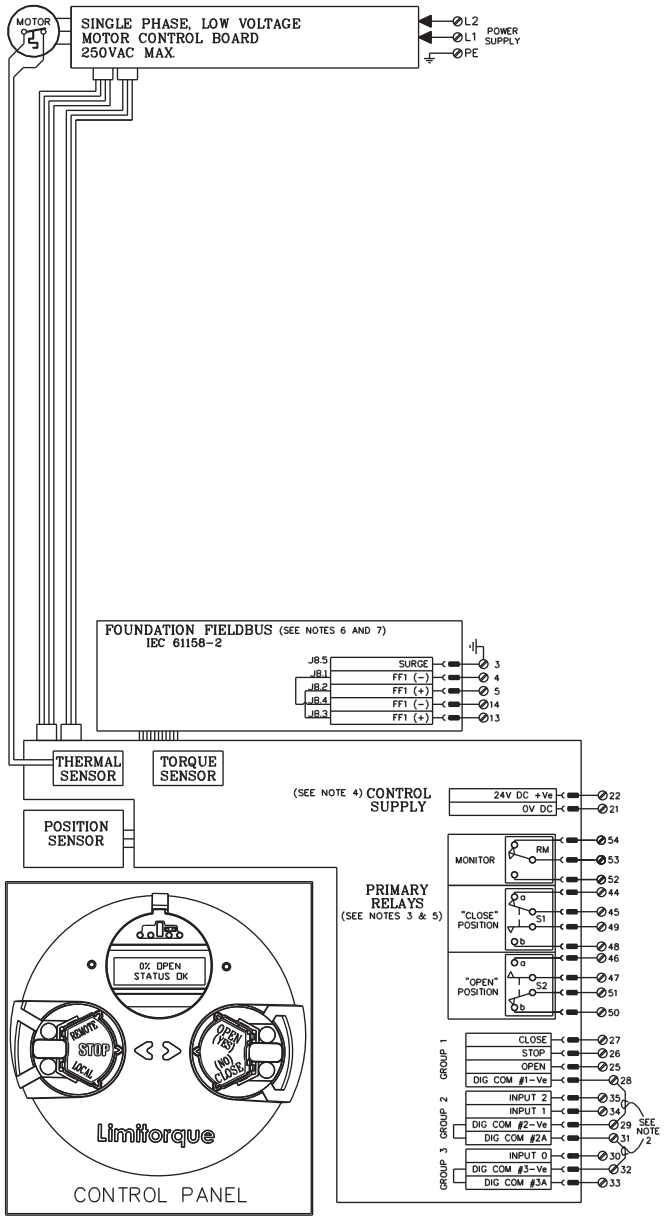


Figure A.2 (2 of 3) – Typical MX/QX FF_H1 Wiring Diagrams (continued)

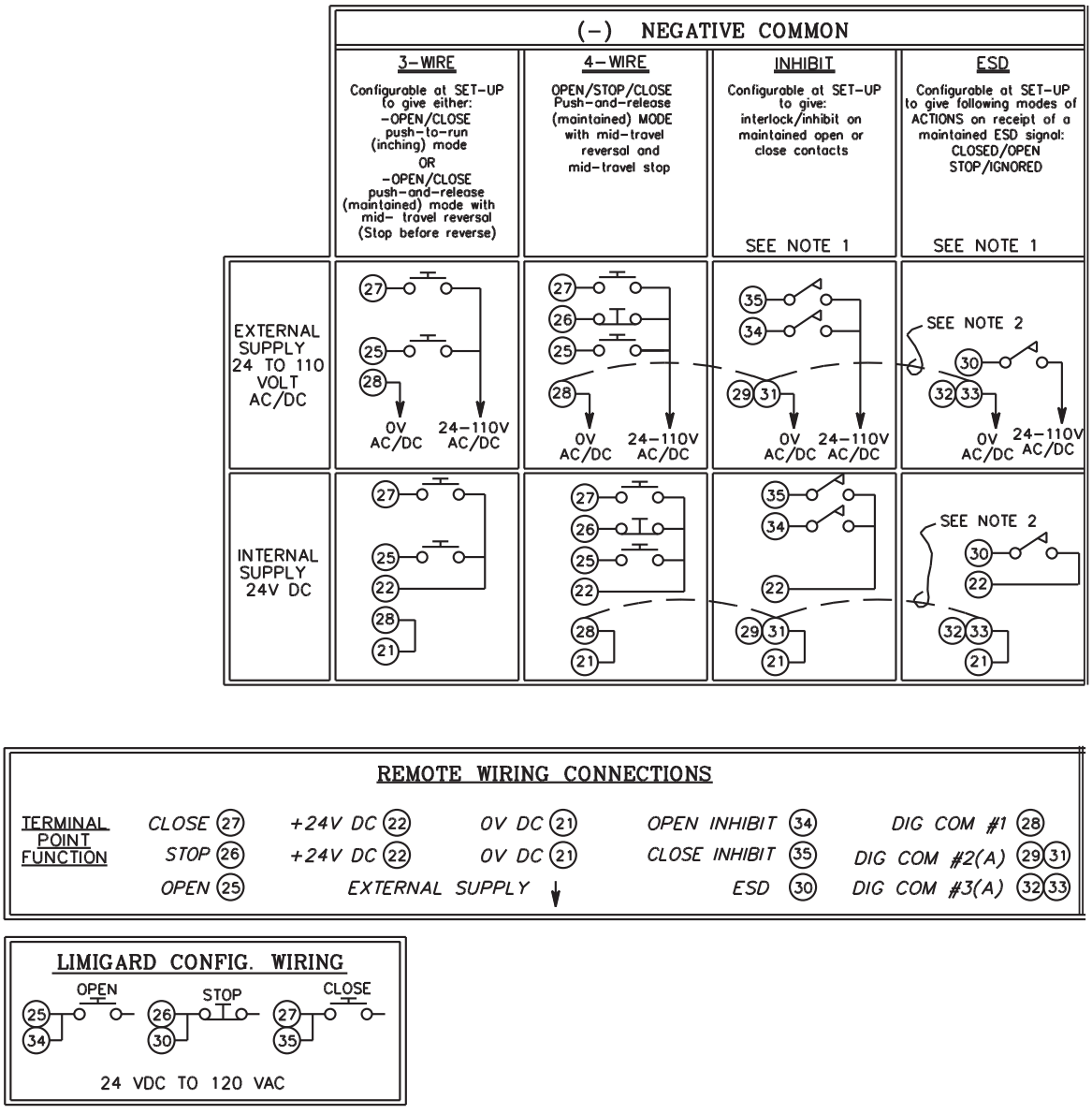


Figure A.3 (3 of 3) – Typical MX/QX FF_H1 Wiring Diagram Notes

NOTES: (SEE INSTALLATION & OPERATION MANUAL LMENIM 3306 FOR DETAILS)

CIRCUIT SHOWN WITH VALVE IN FULLY CLOSED POSITION AND WITH POWER OFF.

1. REMOTE INPUTS

SIGNAL THRESHOLD – MINIMUM "ON" 19.2V AC/DC
MAXIMUM "OFF" 5.0V AC/DC
MAX LOAD – 10 mA / 110V AC
2 mA / 24V DC
REQUIRED CONTROL SIGNAL DURATION = 350ms MIN.
INPUTS 0,1,2 ARE FIELD CONFIGURABLE FOR
CLOSE/OPEN INHIBIT, USER INPUT, OR ESD.
IN ADDITION, INPUT 2 MAY BE CONFIGURED
FOR CSE REMOTE SELECTION INDICATION.
DEFAULT INPUT CONFIGURATION:
INPUT 0 – ESD.
INPUT 1 – OPEN INHIBIT.
INPUT 2 – CLOSE INHIBIT.

2. REMOTE INPUT JUMPERS

JUMPERS CAN BE USER WIRED TO CONNECT DIG COMMONS #1, 2 & 3 (AS NEEDED). THE 3 REMOTE WIRING GROUPS ARE ELECTRICALLY ISOLATED, INTERNALLY. ONLY A SINGLE POWER SOURCE MAY BE USED TO POWER ANY ONE GROUP BUT DIFFERENT SOURCES MAY POWER DIFFERENT GROUPS. IF DIFFERENT SOURCES ARE USED, ENSURE THAT THE POLARITIES ARE CORRECT.

3. DEFAULT [S] SETTINGS

THE DEFAULT OPERATING CONFIGURATION FOR THE "S" OUTPUTS ARE SHOWN IN THE TABLE BELOW. THE CONTACT STATES SHOWN IN THE SCHEMATIC REPRESENT A FULLY CLOSED VALVE. SEE OPERATION MANUAL FOR ALTERNATE CONFIGURATIONS.

OUTPUT SWITCH CONTACT DEVELOPMENT

OUTPUT SWITCH	VALVE POSITION: FULL CLOSE / FULL OPEN	FUNCTION
S1a	– – – – – –	CLOSE LIMIT
S1b	———	
S2a	– – – – ———	OPEN LIMIT
S2b	——— –	

– – OPEN CONTACT
——— CLOSED CONTACT

4. MAXIMUM EXTERNAL LOAD

TERMINALS 21 AND 22 (24 VDC)
– 5W MAX. EXT. LOAD

5. CONTACT RATINGS

S1, S2– 0.5 AMP @ 125 VAC, 2 AMPS @ 30 VDC (RESISTIVE)
MONITOR– 0.5 AMP @ 125 VAC, 2 AMPS @ 30 VDC (RESISTIVE)

6. COMMAND PRIORITY

PLEASE SEE INSTALLATION AND OPERATION MANUAL LMENIM 3306 FOR NETWORK COMMAND PRIORITIES.

7. FF–H1

JP1 AND JP2 MUST BE IN POSITION "A". CUSTOMER IS REQUIRED TO CONNECT WIRE BETWEEN TERMINAL 3 AND CHASSIS GROUND FOR SURGE PROTECTION. PREFERRED NETWORK WIRING IS TO CONNECT SEGMENT SHIELD TO EARTH/GROUND AT ONE POINT ONLY. ATTACH SHIELD TO TERMINAL 3 ONLY IF SEGMENT IS NOT GROUNDED ELSEWHERE. CUSTOMER MUST CONNECT INDIVIDUAL NETWORK CABLE SHIELDS TOGETHER TO INSURE PROPER SHIELDING OF THE ENTIRE NETWORK. THE 6–PIN CONNECTOR WITH BLUE WIRES SHOULD BE CONNECTED TO J8 OF THE FF–H1 BOARD.

B Appendix – Feature Definitions

Transducer Block I/O Channels

The following section defines the Transducer Block I/O channels available for use by the function blocks.

Channel	Channel Name	Description
0	NOT_INITIALIZED_CHAN	
1	AO_CTRL_VALVE_FLOW_CHAN	Desired valve position (in %)
2	DI_POSITION_AND_BUS_MODE_CHAN	Valve status and control mode
3	DI_POSITION_CHAN	Valve status, moving/stopped
4	DI_ACTUATOR_FAULTS_1_CHAN	Mechanical and electrical faults 1
5	DI_ACTUATOR_FAULTS_2_CHAN	Mechanical and electrical faults 2
6	DI_ACTUATOR_ALARMS_CHAN	Emergency shutdown and inhibits
7	DI_DISC_USER_INPUT_CHAN	Discrete input from user
8	DI_READ_DISC_OUTPUT_CHAN	Read discrete output
9	DO_POSITION_CHAN	Command Stop/Open/Close
10	DO_ESD_CHAN	Command Emergency Shutdown
11	DO_RELAY_CHAN	Command Energize Relays
12	AI_POSITION_CHAN	Current valve position (0-100%)
13	AI_ANALOG_INPUT_1_CHAN	Value of analog input 1 (0-100%)
14	AI_ANALOG_INPUT_2_CHAN	Value of analog input 2 (0-100%)
15	DI_HARDWARE_FAULTS_CHAN	Hardware faults
16	AI_TORQUE_CHAN	Current torque (0-100%)

The actuator fieldbus control contains four discrete input (DI) blocks. However, as described below, there are seven DI channels to choose from so three channels are inactive.

Details of the channels are shown in the following tables.

Channel 1 – Set Actuator Position

The AO_CTRL_VALVE_FLOW_CHAN channel is used to set the position of the actuator when it is locally configured to run in the Position mode.

Control valve is in units of 0-100%.

AO_CTRL_VALVE_FLOW_CHAN will only function when the actuator is in POSITION mode. POSITION mode is selected using the setup menus, refer to Installation and Operation Manuals LMENIM2306 for the MX and LMENIM3306 for the QX.

Channel 2 – Position and Bus Mode

The DI_POSITION_AND_BUS_MODE_CHAN channel makes actuator status information available to other function blocks. The status information describes the position of the actuator, the direction of motion of the actuator, and the operating mode.

Channel 2	DI_POSITION_AND_BUS_MODE_CHAN	Value
	Opened + Remote	0x21
	Closed + Remote	0x22
	Opening + Remote	0x24
	Closing + Remote	0x28
	Stop + Remote	0x30
	Opened + Local	0x41
	Closed + Local	0x42
	Opening + Local	0x44
	Closing + Local	0x48
	Stop + Local	0x50
	Opened + Stop	0x81
	Closed + Stop	0x82
	Opening + Stop	0x84
	Closing + Stop	0x88
	Stop + Stop	0x90

Channel 3 – Position Channel

The DI_POSITION_CHAN channel makes actuator status information available to other function blocks. The status information describes the position or direction of motion of the actuator.

Channel 3	DI_POSITION_CHAN	Value
	Opened	0x01
	Closed	0x02
	Opening	0x04
	Closing	0x08
	Stop	0x10

Channel 4 – Actuator Faults 1

The DI_ACTUATOR_FAULTS_1_CHAN channel makes actuator faults available to other function blocks. The reported faults include:

- Valve jammed in motion due to a tripped torque switch
- Valve was manually moved with the actuator handwheel
- An over torque condition while traveling
- Loss of electrical phase
- Thermal overload indicating the motor has overheated and the thermistor has opened; time is required for the motor to cool and reset the thermistor

Channel 4	DI_ACTUATOR_FAULTS_1_CHAN	Value
	Monitor Relay	0x01
	Valve Jammed	0x02
	Manual Moved	0x04
	Over Torque	0x08
	Phase Error	0x10
	Over Temp	0x20
	Monitor Relay + Valve Jammed	0x03
	Monitor Relay + Manual Move	0x05
	Monitor Relay + Over Torque	0x09
	Monitor Relay + Phase Error	0x11
	Monitor Relay + Over Temp	0x21
	Monitor Relay + Valve Jammed + Manual Move	0x07
	Monitor Relay + Valve Jammed + Phase Error	0x13
	Monitor Relay + Valve Jammed + Over Temp	0x23

Channel 5 – Actuator Faults 2

The DI_ACTUATOR_FAULTS_2_CHAN channel makes actuator faults available to other function blocks. The reported faults include:

- Valve jammed in motion due to a tripped torque switch
- Valve was manually moved with the actuator handwheel
- An over torque condition occurred while traveling in the open direction
- An over torque condition occurred while traveling in the close direction
- Loss of electrical phase at the motor
- Thermal overload indicating the motor has overheated and the thermistor has opened; time is required for the motor to cool and reset the thermistor.

Channel 5	DI_ACTUATOR_FAULTS_2_CHAN	Value
	Thermal Overload	0x01
	Phase Error	0x02
	Valve Jammed	0x04
	Manual Moved	0x08
	Open Torque Switch Fault	0x10
	Close Torque Switch Fault	0x20
	Thermal Overload + Manual Moved	0x09
	Thermal Overload + Phase Error	0x03
	Thermal Overload + Valve Jammed	0x05
	Open Torque Switch Fault + Manual Moved	0x18
	Close Torque Switch Fault + Manual Moved	0x28

Channel 6 – Actuator Alarms

The DI_ACTUATOR_ALARMS_CHAN channel makes actuator alarms available to other function blocks. The alarms include:

- Local emergency shut down has occurred; the field unit will command the actuator to go to a preconfigured position, or stop, or ignore the ESD.
- Remote emergency shut down has been received from the network host; the field unit will command the actuator to go to a preconfigured position, or stop, or ignore the ESD.
- Open inhibit is active.
- Close inhibit is active.

Channel 6	DI_ACTUATOR_ALARMS_CHAN	Value
	Local ESD Active	0x01
	Remote ESD Active	0x02
	Open Inhibit Active	0x04
	Close Inhibit Active	0x08
	Local ESD Active + Open Inhibit	0x05
	Local ESD Active + Close Inhibit	0x09
	Remote ESD Active + Open Inhibit	0x06
	Remote ESD Active + Close Inhibit	0x0A
	Open Inhibit Active + Close Inhibit Active	0x0C

Channel 7 - Discrete User Input

The DI_DISC_USER_INPUT_CHAN channel makes general-purpose contact inputs available to other function blocks. The functions in the table, such as ESD, must be configured to the OFF state locally in the MX/QX FF setup menus in order to use the inputs as general-purpose inputs. Refer to the following sections in Installation and Operation Manual Bulletins LMENIM2306 for the MX and LMENIM3306 for the QX:

- Section 4.17 – ESD - Emergency Shutdown
- Section 4.17.2 – Inhibits - Open/Close Inhibit
- Section 4.13 – Remote Control - Open/Close/Stop Pushbutton Inputs.

This channel reports each discrete input as ‘0’ if not enabled and ‘1’ if enabled.

Channel 7	DI_DISC_USER_INPUT_ CHAN	Terminal #	Function	Value
	User input number 0	30	ESD Input (default)	Bit 0
	User input number 1	34	Open Inhibit (default)	Bit 1
	User input number 2	35	Close Inhibit (default)	Bit 2
	Remote Stop Input	26	Stop Pushbutton Input	Bit 3
	Remote Open Input	25	Open Pushbutton Input	Bit 4
	Remote Close Input	27	Close Pushbutton Input	Bit 5

Channel 8 – Read Discrete Output

The DI_READ_DISC_OUTPUT_CHAN channel allows the fieldbus user to monitor the state of up to eight latching relays; S1a, S1b, S2a, S2b (standard) or R1-R8 (optional). These relays control external equipment, and the feedback inputs are available to other function blocks. The four latching relays are configurable to be set when certain events happen, as discussed in Section 4.12, Status and Alarm Contacts in Installation and Operation Manual Bulletins LMENIM2306 for the MX and LMENIM3306 for the QX. The relays can be configured to trip, for example, when the valve reaches the OPEN and CLOSED positions. This channel is formatted in bit string format such that each bit represents the readback of a single discrete output.

The configuration may be changed to NETWORK CONTROLLED, in which case the fieldbus user can change the state of the contacts over the network using Channel 11.

Channel 8	DI_READ_DISC_OUTPUT_CHAN	Terminal #	Digital Ouput	Value
	Discrete output number 1	44,45	State of S1 or R1 (opt)	Bit 0
	Discrete output number 2	46,47	State of S2 or R2 (opt)	Bit 1
	Discrete output number 3	48,49	R3 (opt)	Bit 2
	Discrete output number 4	50,51	R4 (opt)	Bit 3
	Discrete output number 5	36,37	R5 (opt)	Bit 4
	Discrete output number 6	38,39	R6 (opt)	Bit 5
	Discrete output number 7	40,41	R7 (opt)	Bit 6
	Discrete output number 8	42,43	R8 (opt)	Bit 7

Channel 9 - Position

The DO_POSITION_CHAN channel provides three commands that can be sent to the actuator: STOP, OPEN, or CLOSE. It also provides three status values, read back from the actuator, indicating:

- The actuator has stopped
- The actuator is opening or opened
- The actuator is closing or closed

DO_POSITION_CHAN will only function when the actuator has been locally configured to be in Open/Close mode, as can be selected in the setup menus documented in Installation and Operation Manual Bulletins LMENIM2306 for the MX and LMENIM3306 for the QX.

Channel 9	DO_POSITION_CHAN	Value
	Valid values to write to this block	
	Stop	0x00
	Open	0x01
	Close	0x02
	Readback on the DO_POSITION_CHAN	
	Stop	0x00
	Opening / Opened	0x01
	Closing / Closed	0x02

Channel 10 – Emergency Shutdown

The DO_ESD_CHAN channel accepts values requesting that the network ESD be disabled or enabled. It also provides two status values, read back from the network ESD, indicating:

- The network ESD is not active
- The network ESD is active

Channel 10	DO_ESD_CHAN	Value
	Valid values to write to this block	
	Disable Network ESD	0x00
	Enable Network ESD	0x01
	Readback on the DO_ESD_CHAN	
	Network ESD NOT active	0x00
	Network ESD active	0x01

Channel 11 – Relay Outputs

The DO_RELAY_CHAN channel provides seven outputs to control seven actuator relays, four of them latching and three non-latching. It also accepts seven status values and read back of host-initiated values.

Channel 11	DO_RELAY_CHAN	Value
	Valid values to write to this block	
	User Output S2 or R2 & R3 (optional) and R4 (optional)	Bits 0 - 3
	User Output R5, R6, R7, R8 (Located on optional I/O board)	Bits 4 - 6
	Readback on the DO_RELAY_CHAN	
	User Output S2 or R2 & R3 (optional) and R4 (optional) Relay Energized	Bits 0 - 3
	User Output R5, R6, R7, R8 Relay Energized (Located on optional I/O board)	Bits 4 - 6

NOTE: Relays must be configured for network control or data will be invalid.

Channel 12 – Actuator Position Channel

The AI_POSITION_CHAN channel provides the current valve position in units of 0-100%.

Channel 13 – Analog Input 1

The AI_ANALOG_INPUT_1_CHAN channel provides the current value of the Analog Input 1 signal (4-20mA user input) in units of 0-100%.

Channel 14 - Analog Input 2

The AI_ANALOG_INPUT_2_CHAN channel provides the current value of the Analog Input 2 signal (4-20mA user input) in units of 0-100%.

Channel 15 - Hardware Faults

The DI_HARDWARE_FAULTS_CHAN channel makes hardware faults available to other function blocks. The reported faults include:

- Mainboard fault (Flash, EEPROM, or RAM failure)
- Motor controller fault (voltage out of range, IRAM issue, torque over limit, communication loss)
- Motor fault (hall sensors limping or critical)
- Encoder fault
- Knob fault
- Contactor fault
- Torque timer expired (Open Timer or Close Timer)

Channel 15	DI_HARDWARE_FAULTS_CHAN	Value
	Mainboard Fault	0x01
	Motor Controller Fault	0x02
	Motor Fault	0x04
	Encoder Fault	0x08
	Knob Fault	0x10
	Contactor Fault	0x20
	Torque Timer Expired	0x40

Channel 16 - Torque

The AI_TORQUE_CHAN channel provides the current torque in units of 0-100%.

Custom Transducer Block (LTB)

The Custom Transducer Block item name is _lmtrq_tranducer_block (LTB). The table for the Transducer Block is shown below. The Block Tag is defined to be unique throughout the control system at one plant site. The tag may be changed using the FB_Tag service.

Transducer Block Parameters	Description
ST_REV	The revision level of the static data associated with the function block. The revision value is incremented each time a static parameter value in the block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, for example.
MODE_BLK	The actual, target, permitted, and normal modes of the block.
Target	This is the mode requested by the operator. Only one mode from those allowed by the permitted mode parameter may be requested.
Actual	This is the current mode of the block, which may differ from the target based on operating conditions. Its value is calculated as part of block execution.
Permitted	Defines the modes which are allowed for an instance of the block. The permitted mode is configured based on the application requirement.
Normal	This is the mode which the block should be set to during normal operating conditions.
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
UPDATE_EVT	This alert is generated by any change to the static data.
Unacknowledged	A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been noticed.
Update State	A discrete enumeration, which gives an indication of whether the alert has been reported.
Time Stamp	The time when evaluation of the block was started and a change in alarm/event state was detected that is unreported. The time stamp value is maintained constant until alert confirmation has been received — even if another change of state occurs.
Static Rev	The static revision of the block whose static parameter was changed and is being reported. It is possible for the present value of static revision to be greater than this because static can be changed at any time.
Relative Index	The OD index of the static parameter whose change caused this alert, minus the FB starting index. If the update event was caused by a write to multiple parameters at the same time, then this attribute will be zero.
BLOCK_ALM	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
TRANSDUCER_DIRECTORY	A directory that specifies the number and starting indices of the transducers in the transducer block. For further information, please refer to the Transducer Block Application Process – Part 1 (FF-902) specification.
TRANSDUCER_TYPE	Identifies the transducer that follows.

Transducer Block Parameters	Description
XD_ERROR	One of the transducer error codes defined in the FF Transducer Specifications. Refer to Section 4.8 of FF-903.
COLLECTION_DIRECTORY	A directory that specifies the number, starting indices, and DD Item IDs of the data collections in each transducer within a transducer block. For further information, please refer to the Transducer Block Application Process – Part 1 (FF-902) specification.
FINAL_VALUE	The proposed valve position and status written by an analog Function Block.
Status	Digital transducers, unlike their analog versions, can detect faults that make the measurement bad or prevent the actuator from responding. This additional, valuable information is passed along in the form of a status attribute with each transmission of a data value.
Value	A numerical quantity received by the block parameter from another block parameter to which this block is linked. Or a default or user entered value if the parameter has not been linked.
FINAL_VALUE_RANGE	The High and Low range limit values, the engineering unit's code, and the number of digits to the right of the decimal point to be used to display the Final Value.
EU at 100%	The engineering unit value that represents the upper end of range of the associated block parameter.
EU at 0%	The engineering unit value that represents the lower end of range of the associated block parameter.
Units Index	Device Description units code index for the engineering unit descriptor for the associated block value.
Decimal	The number of digits to the right of the decimal point that should be used by an interface device in displaying the specified parameter.
FINAL_VALUE_CUTTOFF_HI	If the FINAL_VALUE is more positive than this value, the value is forced to its maximum high value (fully opened).
FINAL_VALUE_CUTTOFF_LO	If the FINAL_VALUE is more negative than this value, the value is forced to its maximum low value (fully closed).
FINAL_POSITION_VALUE	The actual valve position and status, could be used as the READBACK in an AO block.
Status	Digital transducers, unlike their analog versions, can detect faults that make the measurement bad or prevent the actuator from responding. This additional, valuable information is passed along with each transmission of a data value in the form of a status attribute.
Value	A numerical quantity received by the block parameter from another block parameter to which this block is linked. Or a default or user entered value if the parameter has not been linked.
ACT_FAIL_ACTION	Specifies the action the actuator takes in case of failure.
ACT_MAN_ID	The actuator manufacturer's identification number as defined by the Fieldbus Foundation.
ACT_MODEL_NUM	The actuator model number.
ACT_SN	The actuator serial number.
VALVE_MAN_ID	The valve manufacturer's identification number as defined by the Fieldbus Foundation.
VALVE_MODEL_NUM	The valve model number. Reference Bulletin LMENIM2306 for the MX or LMENIM3306 for the QX.

Transducer Block Parameters	Description
VALVE_SN	The valve serial number. Reference Bulletin LMENIM2306 for the MX or LMENIM3306 for the QX.
VALVE_TYPE	The type of the valve as defined in Fieldbus Transducer Specifications (FF-903) in Section 4.7 Valve Type. Reference Bulletin LMENIM2306 (MX); LMENIM3306 (QX).
SCALED_VALUES	Scaled Information.
Subparameter 0 uint16_var	Indicates if APT and ATT configuration are selected. Refer to Bulletin LMENIM2306 (MX); LMENIM3306 (QX), Installation and Operation Manual for definitions of APT and ATT.
Subparameter 1 uint16_var	APT Output Value. APT is an Analog Position Transmitter representing valve position (4-20 mA or 0-10 VDC). A Read-only, 16-bit unsigned value. APT option MUST be enabled for a value to be displayed in this register. Reports the APT output signal value as configured in 0-100 increments of span. Referenced as terminal points 18 and 17 (common) for mA output.
Subparameter 2 uint16_var	ATT Value. ATT is an Analog Torque Transmitter representing actuator output torque (4-20 mA or 0-10 VDC). A read only 16-bit unsigned value. ATT option MUST be enabled for a value to be displayed in this register. Reports the ATT output signal value as configured in 0-100 increments of span. Referenced as terminal points 16 and 1 (common) for mA output.
DIAGNOSTIC_VALUES	Diagnostic Information.
Subparameter 0 uint16_var	Continuous Torque Feedback. A read only 16-bit unsigned value. Range is 0-100% of unit rating (analog scale setting is applied).
Subparameter 1 uint16_var	Measured Voltage on the 3-Phase Power. Diagnostic use only.
Subparameter 2 uint16_var	Continuous Position Feedback. A read only 16-bit unsigned value. Range is 0-100% of actuator position (analog scale setting is applied).
Subparameter 3 uint16_var	Analog Input 1 Feedback. A read only 16-bit unsigned integer. Range of 0-100% of input signal span (analog scale setting is applied).
Subparameter 4 uint16_var	Analog Input 2 Feedback. A read only 16-bit unsigned integer. Range of 0-100% of input signal span (analog scale setting is applied).
VALVE_STATUS	Valve Status Information.
Subparameter 0 uint16_var	**DO_Readback Data Channel** – Displays last value request by host.
	Bit 00 – S1 or R1 (optional)
	Bit 01 – S2 or R2 (optional)
	Bit 02 – R3 (optional)
	Bit 03 – R4 (optional)
	Bit 04 – R5 (optional)
	Bit 05 – R6 (optional)
	Bit 06 – R7 (optional)
	Bit 07 – R8 (optional)
Subparameter 1 uint16_var	**Valve Status.** Read only. Contains most desired indications of field unit status.
	Bit 00 Open – Valve is fully opened. This bit is ORd with bits 01, 02, 03, 04. Value of 1=True, Value of 0=False.

Transducer Block Parameters	Description
	Bit 01 Close – Valve is fully closed. This bit is ORd with bits 00, 02, 03, 04. Value of 1=True, Value of 0=False.
	Bit 02 Stopped in Mid-Travel – Valve stopped in mid-travel, and neither the Open or Closed limit switch is engaged. This bit is ORd with bits 00, 01, 03, 04. Value of 1=True, Value of 0=False.
	Bit 03 Opening – Valve is traveling in the Open direction. This bit is ORd with bits 00, 01, 02, 04. Value of 1=True, Value of 0=False.
	Bit 04 Closing – Valve is traveling in the Close direction. This bit is ORd with bits 00, 01, 02, 03. Value of 1=True, Value of 0=False.
	Bit 05 Valve Jammed – Valve is jammed. The valve was traveling or attempting to travel in either the Open or Close direction and has tripped the torque switch. This bit is ONLY active if the actuator should be commanded to move by the pushbutton station or remote control, and an over-torque condition occurs. Value of 1=True, Value of 0=False.
	Bit 06 Not in Remote – Monitors the actuator LCS. Indicates the LCS has been switched to the Local or Stop position. The host will not be able to control the actuator. Value of 1=True, Value of 0=False.
	Bit 07 Combined Fault – The combined fault bit indicates there is a severe problem with the field unit. When this bit is TRUE, the actuator must be considered OFFLINE. This bit indicates a fault when both bits (10 and 11) are TRUE or bit 5 or bit 8, or bit 9, or bit 15 is TRUE. Value of 1=True, Value of 0=False.
	Bit 08 Thermal Overload Fault – Indicates the motor has overheated and the thermistor has opened. This unit is unable to operate and time is required for the motor to cool and reset the thermistor. Value of 1=True, Value of 0=False.
	Bit 09 In Stop – Monitors the actuator LCS. Indicates the LCS has been switched to the Stop position. The host will not be able to control the actuator. Value of 1=True, Value of 0=False.
	Bit 10 Channel A Fault – Problem with network channel. Indicates a loss of communication with the host on Channel A (TB 13 & 14). Value of 1=True, Value of 0=False.
	Bit 11 Channel B Fault – Problem with network channel. Indicates a loss of communication with the host on Channel B (TB 4 & 5). Value of 1=True, Value of 0=False.
	Bit 12 Open Torque Switch Fault – Indicates an over-torque condition while traveling in the open direction. The actuator will not move in the open direction unless the actuator is first moved towards the close position. Value of 1=True, Value of 0=False.
	Bit 13 Close Torque Switch Fault – Indicates an over-torque condition while traveling in the close direction. The actuator will not move in the close direction unless the actuator is first moved towards the open position. Value of 1=True, Value of 0=False.
	Bit 14 Valve Manually Moved – Indicates the valve position has been changed by stroking the valve with the actuator handwheel. (Actuator drive sleeve has rotated without motorized operation). Value of 1=True, Value of 0=False.
	Bit 15 Phase Error – Indicates loss of phase. Value of 1=True, Value of 0=False.
Subparameter 2 uint16_var	**Fault Register.** Read only 16-bit unsigned value. Contains additional field unit status. Optional for controlling a field unit.
	Bit 00 Open Inhibit Active – Indicates that movement in the open direction is currently being inhibited. Value of 1=True, Value of 0=False.

Transducer Block Parameters	Description
	Bit 01 Close Inhibit Active – Indicates that movement in the close direction is currently being inhibited. Value of 1=True, Value of 0=False.
	Bit 02 – Not Used
	Bit 03 – Not Used
	Bit 04 Phase Error – Indicates one or more phase(s) is absent for the three-phase power. Value of 1=True, Value of 0=False.
	Bit 05 Phase Reversed Fault – Indicates field unit has noticed incorrect phase rotation of the incoming power. Value of 1=True, Value of 0=False.
	Bit 06 ESD Conflict – Indicates that an ESD conflict is currently active. Value of 1=True, Value of 0=False.
	Bit 07 Inhibit Conflict – Indicates that an Inhibit conflict is currently active. Value of 1=True, Value of 0=False.
	Bit 08 CSE in Local/Stop - Indicates that CSE input is not present. Value of 1=True, Value of 0=False.
	Bit 09 Stop Selected – Monitors the actual Local Control Station (LCS). Indicates the LCS has been switched to the Stop position. The Host and LCS do not have control of the actuator. Value of 1=True, Value of 0= False
	Bit 10 Network ESD is ON – Indicates field unit has been issued a network ESD command. The field unit will command the actuator to operate to the preconfigured position (Open, Close, Stop, Ignore, Position). The network ESD command must be terminated to reset this bit. Value of 1=True, Value of 0=False.
	Bit 11 Local ESD is ON – Indicates field unit has been issued a local ESD command. The field unit will command the actuator to operate to the preconfigured position (Open, Close, Stop, Ignore, Position). The local ESD command must be terminated to reset this bit. Value of 1=True, Value of 0=False.
	Bit 12 Unit Reset Since Last Poll – Indicates field unit has reset since the last network poll. This bit is latched until read by the host controller. Value of 1=True, Value of 0=False.
	Bit 13 Local or Stop Selected – Monitors the actual Local Control Station (LCS). Indicates the LCS has been switched to the Local or Stop position. The Host (and possibly LCS) does not have control of the actuator. Value of 1=True, Value of 0=False.
	Bit 14 Opening in Local Mode – Monitors the actuator LCS Open switch. Indicates the actuator LCS has been switched to the Local position AND the actuator is being opened from the LCS. The Host does not have control of the actuator. Value of 1=True, Value of 0=False.
	Bit 15 Closing in Local Mode – Monitors the actuator LCS Close switch. Indicates the actuator LCS has been switched to the Local position AND the actuator is being closed from the LCS. The Host does not have control of the actuator. Value of 1=True, Value of 0=False.
Subparameter 3 uint16_var	**Additional Status** – Digital Outputs register. A read only 16-bit unsigned value. Contains additional field unit status. Optional for controlling a field unit.
	Bit 00 Close – Indicates the field unit close contactor is engaged and the valve is moving in the close direction. This bit is ORd with Bit 01 in this register. Value of 1=True, Value of 0=False.

Transducer Block Parameters	Description
	Bit 01 Open – Indicates the field unit open contactor is engaged and the valve is moving in the open direction. This bit is ORd with Bit 00 in this register. Value of 1=True, Value of 0=False.
	Bit 02 User Output S1 or R1 (optional) – Indicates the field unit S1 or R1 Relay has been energized. This relay is configurable to operate under many conditions including FF control. Verify current configuration using the LCS. This is a latched digital output, referenced as terminal points 44 and 45.
	Bit 03 User Output S2 or R2 (optional) – Indicates the field unit S2 or R2 Relay has been energized. This relay is configurable to operate under many conditions including FF control. Verify current configuration using the LCS. This is a latched digital output, referenced as terminal points 46 and 47.
	Bit 04 User Output R3 (optional) – Indicates the field unit R3 Relay has been energized. This relay is configurable to operate under many conditions including FF control. Verify current configuration using the LCS. This is a latched digital output, referenced as terminal points 48 and 49.
	Bit 05 User Output R4 (optional) – Indicates the field unit R4 Relay has been energized. This relay is configurable to operate under many conditions including FF control. Verify current configuration using the LCS. This is a latched digital output, referenced as terminal points 50 and 51.
	Bit 06 User Output R5 (optional) – Optional I/O board required. Indicates the optional field unit R5 Relay has been energized. This relay is configurable to operate under many conditions including FF control. Verify current configuration using the LCS. This is a non-latching digital output, referenced as terminal points 36 and 37.
	Bit 07 User Output R6 (optional) – Optional I/O board required. Indicates the optional field unit R6 Relay has been energized. This relay is configurable to operate under many conditions including FF control. Verify current configuration using the LCS. This is a non-latching digital output, referenced as terminal points 38 and 39.
	Bit 08 User Output R7 (optional) – Optional I/O board required. Indicates the optional field unit R7 Relay has been energized. This relay is configurable to operate under many conditions including FF control. Verify current configuration using the LCS. This is a non-latching digital output, referenced as terminal points 40 and 41.
	Bit 09 Network Bypass Relay – Indicates the network bypass relay is energized. Should this relay be de-energized, the actuator will fail to communicate with the host. Value of 1=True, Value of 0=False.
	Bit 10 User Output R8 (optional) – Optional I/O board required. Indicates the optional field unit R8 Relay has been energized. This relay is configurable to operate under many conditions including FF control. Verify current configuration using the LCS. This is a non-latching digital output, referenced as terminal points 42 and 43.
	Bit 11 – Not Used
	Bits 12-15 MOV Series (MX=1, MXa=9, QX=6, QXM=11)
Subparameter 4 uint16_var	**Digital Input_1** – Read only 16-bit unsigned value. Contains field unit status and digital input status.
	Bit 00 Remote Selected – Monitors the actual LCS. Indicates the LCS has been switched to the Remote position. The host is in control of the actuator. Value of 1=True, Value of 0=False.

Transducer Block Parameters	Description
	Bit 01 Thermal Overload fault – Indicates the motor has overheated and the thermistor has opened. This unit is unable to operate and time is required for the motor to cool and reset the thermistor. Value of 1=True, Value of 0=False.
	Bit 02 Open Torque Switch – Indicates an overtorque condition while traveling in the open direction. This condition will also be true if the actuator is 100% open and torque seated. Value of 1=True, Value of 0=False.
	Bit 03 Open Limit Switch – Open limit switch is engaged. Valve is fully opened. Value of 1=True, Value of 0=False.
	Bit 04 Close Torque Switch – Indicates an overtorque condition while traveling in the close direction. This condition will also be true if the actuator is 0% open and torque seated. Value of 1=True, Value of 0=False.
	Bit 05 Close Limit Switch – Close limit switch is engaged. Valve is fully closed. Value of 1=True, Value of 0=False.
	Bit 06 – Not Used
	Bit 07 Partial Stroke Test Active - PST status. Indicates that a partial stroke test is in progress. Value of 1=True, Value of 0=False.
	Bit 08 User Input 0 (default=ESD) – User Input 0. Referenced as Terminal 30. Connect with 120 VAC or 24 VDC. Minimum ON voltage 19.2 VAC/DC; maximum OFF voltage 5 VAC/DC. Value of 1=True/ ON, Value of 0=False/OFF. Emergency shutdown input. ESD must be configured for OFF to use as a basic user input.
	Bit 09 User Input 1 (default=Open Inhibit) – User Input 1. Referenced as Terminal 34. Connect with 120 VAC or 24 VDC. Minimum ON voltage 19.2 VAC/DC; maximum OFF voltage 5 VAC/DC. Value of 1=True/ ON, Value of 0=False/OFF. Open inhibit input. Open inhibit must be configured for OFF to use as a basic user input.
	Bit 10 User Input 2 (default=Close Inhibit) – User Input 2. Referenced as Terminal 35. Connect with 120 VAC or 24 VDC. Minimum ON voltage 19.2 VAC/DC; maximum OFF voltage 5 VAC/DC. Value of 1=True/ ON, Value of 0=False/OFF. Close inhibit input. Close inhibit must be configured for OFF to use as a basic user input.
	Bit 11 User Input 3 (default=Remote Stop) – User Input 3. Referenced as Terminal 26. Connect with 120 VAC or 24 VDC. Minimum ON voltage 19.2 VAC/DC; maximum OFF voltage 5 VAC/DC. Value of 1=True/ON, Value of 0=False/OFF. Remote stop input. Remote Control must be configured for OFF to use as a basic user input.
	Bit 12 User Input 4 (default=Remote Open) – User Input 4. Referenced as Terminal 25. Connect with 120 VAC or 24 VDC. Minimum ON voltage 19.2 VAC/DC; maximum OFF voltage 5 V AC/DC. Value of 1=True/ON, Value of 0=False/OFF. Remote open input. Remote Control must be configured for OFF to use as a basic user input.
	Bit 13 User Input 5 (default=Remote Close) – User Input 5. Referenced as Terminal 27. Connect with 120 VAC or 24 VDC. Minimum ON voltage 19.2 VAC/DC; maximum OFF voltage 5 VAC/DC. Value of 1=True/ON, Value of 0=False/OFF. Remote close input. Remote Control must be configured for OFF to use as a basic user input.
	Bits 14 and 15 – Not Used
Subparameter 5 uint16_var	**Digital Input_2** – Read only 16-bit unsigned value. Contains field unit status and digital input status.
	Bit 00 Analog Board 1 Present – Indicates presence of optional MX/QX Analog Input board (position 1). Value of 1=True, Value of 0=False.

Transducer Block Parameters	Description
	Bit 01 Analog Board 2 Present – Indicates presence of optional MX/QX Analog Input board (position 2). Value of 1=True, Value of 0=False.
	Bit 02 Analog Input 1 Lost – Indicates Analog Input 1 is not receiving a 4-20 mA signal. Referenced as terminals 39 and 28 (common). Value of 1=True, Value of 0=False.
	Bit 03 Analog Input 2 Lost – Indicates Analog Input 2 is not receiving a 4-20 mA signal. Referenced as terminals 40 and 28 (common). Value of 1=True, Value of 0=False.
	Bit 04 – Not Used
	Bit 05 Digital Output Board (R5-R8) Present – Indicates present of optional MX/QX digital output board. This board provides relays R5-R8. Value of 1=True, Value of 0=False.
	Bit 06 – Not Used
	Bit 07 Digital Output Board (R1-R4) Present – Indicates present of optional MX/QX digital output board. This board provides relays R1-R4. Value of 1=True, Value of 0=False.
	Bit 08 FF Board Present – Indicates present of optional MX/QX FF board. This board allows the actuator to be configured for use on the Fieldbus network. Value of 1=True, Value of 0=False.
	Bit 09 – Not Used
	Bit 10 CSE Input – Indicates one of the user inputs has been configured for CSE. Value of 1=True, Value of 0=False.
	Bit 11 – Not Used
	Bit 12 Phase Lost – Indicates field unit has noticed a phase(s) is absent for the three-phase power. Value of 1=True, Value of 0=False.
	Bit 13 Phase Reverse – Indicates field unit has noticed a 3-phase rotation is incorrect. The field unit will operate the actuator in the proper direction to prevent damage to the valve. Value of 1=True, Value of 0=False.
	Bit 14 – Not Used
	Bit 15 – Not Used
TQ_STATUS	**Torque Information**. Details are given for the Reference and the Last torque, expressed as reference percentages of the rated torque (stated on the nameplate) that occurred at Breakout, Ending, and Peak Running for both the opening and closing directions. Torque will be expressed proportionally as a reference only from 40-100% inclusive. Initial indication may read 0% until torque exceeds 40% minimum.
Subparameter 0 uint16_var	Not Used.
Subparameter 1 uint16_var	Average Last Close torque.
Subparameter 2 uint16_var	Average Last Open torque.
Subparameter 3 uint16_var	Last Peak Open torque.
Subparameter 4 uint16_var	Last Breakout Open torque – the last starting to open torque value.

Transducer Block Parameters	Description
Subparameter 5 uint16_var	Last Breakout Close torque – the last starting to close torque value.
Subparameter 6 uint16_var	Last Ending Open torque – the last torque value during opening.
Subparameter 7 uint16_var	Last Ending Close torque - the last torque value when going closed.
Subparameter 8 uint16_var	Last Peak Close torque.
Subparameter 9 uint16_var	Peak Ref. Open Torque - the peak reference opening torque value, a saved value.
Subparameter 10 uint16_var	Breakout Ref. Open torque - the reference starting to open torque value, a saved value.
Subparameter 11 uint16_var	Breakout Ref. Close torque - the reference starting to close torque value, a saved value.
Subparameter 12 uint16_var	Ending Ref. Open torque - the reference last torque value during opening, a saved value.
Subparameter 13 uint16_var	Ending Ref. Close torque – the reference ending torque value when going closed, a saved value
Subparameter 14 uint16_var	Peak Ref. Close torque – the peak reference closing torque value, a saved value.
TP_STATUS	Torque Profile Information
Subparameter 0 uint16_var	Not Used
Subparameter 1 uint16_var	**TP_START_POSITION** – The position of the actuator when this sampling period began (0 to 100% OPEN)
Subparameter 2 uint16_var	**TP_STOP_POSITION** – The position of the actuator when this sampling period ended (0 to 100% OPEN)
Subparameter 3 uint16_var	**TP_SAMPLE** – The number of times that the torque value was sampled for this TP sample. This value is also relative indicator of cycle time and may be trended to identify when actuator performance is changing. Cycle time is approximately equal to “TP Samples” times 50 milliseconds.
Subparameter 4 uint16_var	**TP_MID_T_HIGH** – The highest relative torque observed in midtravel during this TP sample.
Subparameter 5 uint16_var	**TP_MID_T_POS** – The position of the actuator (0 to 100% OPEN) when the highest mid-travel torque was observed.
Subparameter 6 uint16_var	**TP_MID_T_AV_VAL** – The average relative torque observed during this TP sample.
Subparameter 7 uint16_var	**TP_STOP_VAL** – The relative torque observed at the moment when the valve motion ended, completing this TP sample.
Subparameter 8 uint16_var	**TP_BEFORE_MID_T_HIGH** – The highest relative torque observed while the actuator is in motion but before the limit switch was cleared indicating that the actuator is in mid-travel. For example, if moving from the CLOSED position, in the OPEN direction, this value represents the highest relative torque value observed before the CLOSED limit switch became inactive.

Transducer Block Parameters	Description
Subparameter 9 uint16_var	**TP_AFTER_MID_T_HIGH** – The highest relative torque observed while the actuator is in motion after the limit switch became active indicating that the actuator is no longer in mid-travel. For example, if torque seated and moving from mid-travel, in the CLOSE direction, this value represents the highest relative torque value observed after the closed limit switch became active but before the torque switch stopped movement.
SOFTWARE_VERSION	Device software version
FACTORY_DIAGNOSTIC	Internal use only
DOWNLOAD_PARAMETER	Internal use only
TARGET_ERROR	Internal use only
DTM_ARGUMENT	DTM specific parameter used in conjunction with DTM_COMMAND_ID parameter for device manufacturer custom operations.
DTM_COMMAND_ID	DTM specific parameter used in conjunction with DTM_ARGUMENT parameter for device manufacturer custom operations.
BULK_DATA	DTM specific parameter used for device manufacturer custom operations of uploading bulk data to DTM.
HARDWARE_FAULTS	The bit enumerated parameter provides hardware fault information such as alarms and warnings. Value of 1=Active, Value of 0=Inactive.
	Bit 00 – SPI bus communication
	Bit 01 to Bit 09 – Not used
	Bit 10 – Valve jammed
	Bit 11 – Over torque
	Bit 12 – Phase sequence warning
	Bit 13 – Phase lost
	Bit 14 – Motor temperature warning
	Bit 15 – Motor temperature alarm
	Bit 16 – Encoder warning
	Bit 17 – Encoder fault
	Bit 18 – RAM fault
	Bit 19 – Flash memory fault
	Bit 20 – EEPROM fault
	Bit 21 – Torque sensor fault
	Bit 22 – Knob fault
	Bit 23 – LimiGard™ alarm
	Bit 24 – Contactors fault
	Bit 25 – Power board fault
	Bit 26 – Digital output board-2 fault
	Bit 27 – Digital output board-1 fault

Transducer Block Parameters	Description
	Bit 28 – Analog output board-2 fault
	Bit 29 – Analog output board-1 fault
	Bit 30 – Fieldbus board-A fault
	Bit 31 – Not used
NO_OF_ACTIVE_ALARMS	Active alarms in the the actuator.
LATEST_ALARM	Latest alarm generated in the actuator.
ENCODER_HEALTH	The bit enumerated parameter provides the encoder health information. Value of 1=Fault Active, Value of 0= Fault Inactive.
Subparameter 0	Provides primary pairs health status of the encoder.
	Bit 00 Pair # 102 – (D102/Q102) of wheel 0 fault
	Bit 01 and Bit 02 – Not used
	Bit 03 Pair # 103 – (D103/Q103) of wheel 1 fault
	Bit 04 Pair # 104 – (D104/Q104) of wheel 1 fault
	Bit 05 Pair # 105 – (D105/Q105) of wheel 1 fault
	Bit 06 Pair # 106 – (D106/Q106) of wheel 2 fault
	Bit 07 Pair # 107 – (D107/Q107) of wheel 2 fault
	Bit 08 Pair # 108 – (D108/Q108) of wheel 2 fault
	Bit **09 Pair # 109** – (D109/Q109) of wheel 3 fault
	Bit 10 Pair # 110 – (D110/Q110) of wheel 3 fault
	Bit 11 Pair # 111 – (D111/Q111) of wheel 3 fault
	Bit 12 Pair # 112 – (D112/Q112) of wheel 4 fault
	Bit 13 Pair # 113 – (D113/Q113) of wheel 4 fault
	Bit 14 Pair # 114 – (D114/Q114) of wheel 4 fault
	Bit 15 Pair # 115 – (D115/Q115) of wheel 5 fault
	Bit 16 Pair # 116 – (D116/Q116) of wheel 5 fault
	Bit 17 Pair # 117 – (D117/Q117) of wheel 5 fault
	Bit 18 Pair # 118 – (D118/Q118) of wheel 6 fault
	Bit 19 Pair # 119 – (D119/Q119) of wheel 6 fault
	Bit 20 Pair # 120 – (D120/Q120) of wheel 6 fault
	Bit 21 Pair # 121 – (D121/Q121) of wheel 7 fault
	Bit **22 Pair # 122** – (D122/Q122) of wheel 7 fault
	Bit 23 Pair # 123 – (D123/Q123) of wheel 7 fault
	Bit 24 Pair # 124 – (D124/Q124) of wheel 8 fault
	Bit 25 Pair # 125 – (D125/Q125) of wheel 8 fault
	Bit 26 Pair # 126 – (D126/Q126) of wheel 8 fault

Transducer Block Parameters	Description
	Bit 27 Pair # 127 – (D127/Q127) of wheel 9 fault
	Bit 28 Pair # 128 – (D128/Q128) of wheel 9 fault
	Bit 29 Pair # 129 – (D129/Q129) of wheel 9 fault
	Bit 30 and Bit 31 – Not used
Subparameter 1	Provides redundant pairs health status of the encoder.
	Bit 00 Pair # 2 – (D2/Q2) of wheel 0 fault
	Bit 01 and Bit 02 – Not used
	Bit 03 Pair # 3 – (D3/Q3) of wheel 1 fault
	Bit 04 Pair # 4 – (D4/Q4) of wheel 1 fault
	Bit 05 Pair # 5 – (D5/Q5) of wheel 1 fault
	Bit 06 Pair # 6 – (D6/Q6) of wheel 2 fault
	Bit 07 Pair # 7 – (D7/Q7) of wheel 2 fault
	Bit 08 Pair # 8 – (D8/Q8) of wheel 2 fault
	Bit 09 Pair # 9 – (D9/Q9) of wheel 3 fault
	Bit 10 Pair # 10 – (D10/Q10) of wheel 3 fault
	Bit 11 Pair # 11 – (D11/Q11) of wheel 3 fault
	Bit 12 Pair # 12 – (D12/Q12) of wheel 4 fault
	Bit 13 Pair # 13 – (D13/Q13) of wheel 4 fault
	Bit 14 Pair # 14 – (D14/Q14) of wheel 4 fault
	Bit 15 Pair # 15 – (D15/Q15) of wheel 5 fault
	Bit 16 Pair # 16 – (D16/Q16) of wheel 5 fault
	Bi**t 17 Pair # 17** – (D17/Q17) of wheel 5 fault
	Bit 18 Pair # 18 – (D18/Q18) of wheel 6 fault
	Bit 19 Pair # 19 – (D19/Q19) of wheel 6 fault
	Bit 20 Pair # 20 – (D20/Q20) of wheel 6 fault
	Bit 21 Pair # 21 – (D21/Q21) of wheel 7 fault
	Bit 22 Pair # 22 – (D22/Q22) of wheel 7 fault
	Bit 23 Pair # 23 – (D23/Q23) of wheel 7 fault
	Bit 24 Pair # 24 – (D24/Q24) of wheel 8 fault
	Bit 25 Pair # 25 – (D25/Q25) of wheel 8 fault
	Bit 26 Pair # 26 – (D26/Q26) of wheel 8 fault
	Bit 27 Pair # 27 – (D27/Q27) of wheel 9 fault
	Bit 28 Pair # 28 – (D28/Q28) of wheel 9 fault
	Bit 29 Pair # 29 – (D29/Q29) of wheel 9 fault
	Bit 30 and Bit 31 – Not used

Transducer Block Parameters	Description
SOURCE_OF_LIMIGARD	The bit enumerated parameter provides LimiGard™ source of failure information. Value of 1=Active, Value of 0=Inactive.
	Bit 00 – Not used
	Bit 01 – CCW & ENABLE asserted but CCW contactor not present
	Bit 02 – CW & ENABLE asserted but CW contactor not present
	Bit 03 – ENABLE not asserted but relay contact closed in error
	Bit 04 – ENABLE not asserted but relay drive transistor asserted in error
	Bit 05 – ENABLE asserted but relay contact not closed
	Bit 06 – ENABLE asserted but relay drive transistor failed
	Bit 07 – CCW not asserted but relay contact closed in error
	Bit 08 – CCW not asserted but relay drive transistor asserted in error
	Bit 09 – CCW asserted but relay contact not closed
	Bit 10 – CCW asserted but relay drive transistor failed
	Bit 11 – CW not asserted but relay contact closed in error
	Bit 12 – CW not asserted but relay drive transistor asserted in error
	Bit 13 – CW asserted but relay contact not closed
	Bit 14 – CW asserted but relay drive transistor failed
	Bit 15 – Stuck relay contacts
COMM_LOSS	The User configurable action of the actuator when network communication is interrupted.
Subparameter ACTION	The user configurable action that actuator should take when network communication is interrupted. Value 1=None, 2=Stop, 4=Close, 8=Open and 16=Position.
Subparameter TARGET_POSITION	User configurable target position to which the actuator should move the valve when network communication is interrupted.
Subparameter DELAY	User configurable amount of time delay (0-60 seconds) before communication loss is flagged.
ESD	Emergency shutdown signal may be applied to the actuator to move the valve to a predetermined user-configured shutdown position, overriding existing control signals.
Subparameter OVERRIDE_SETTINGS	Override settings for ESD.
	Bit 00 to Bit 06 – Not used
	Bit 07 Network ESD – Value 1=ESD overrides network ESD, 0=Network ESD overrides ESD
	Bit 08 Two speed – Value 1=ESD overrides two speed, 0=Two speed overrides ESD
	Bit 09 Thermostat – Value 1=ESD overrides thermostat, 0=Thermostat overrides ESD
	Bit 10 Over torque – Value 1=ESD overrides over torque, 0=Over torque overrides ESD
	Bit 11 Lost phase – Value 1=ESD overrides lost phase, 0=Lost phase overrides ESD

Transducer Block Parameters	Description
	Bit 12 Jam – Value 1=ESD overrides jam, 0=Jam overrides ESD
	Bit 13 Stop – Value 1=ESD overrides stop, 0=Stop overrides ESD
	Bit 14 Local command – value 1=ESD overrides local command, 0=Local command overrides ESD
	Bit 15 Inhibit – Value 1=ESD overrides inhibit, 0=Inhibit overrides ESD
Subparameter ACTION	Predetermined user-configured emergency shutdown action. Value 1=Ignore, 2=Stop, 4=Close, 8=Open and 16=Position.
Subparameter POSITION	Predetermined user-configured emergency shutdown target position. Range 0 to 100%.
Subparameter ACTIVE_SIGNAL	Active emergency shutdown signal. Value 1=Network ESD, 2=Local ESD and 3=Both ESD.
PST	Provides access to partial stroke test for the device.
Subparameter COMMAND	This parameter is used to pass the PST commands to the device. Value 1=Start PST and 2=Stop PST.
Subparameter TARGET_POSITION	PST target position value scaled to 0-100. Range 0 to 1000.
Subparameter STATUS	PST status. Value of 0=Not started, 1=In progress, 2=Completed, 4=Stopped.
Subparameter RESULT	PST result. Value of 0=Not started, 1=Awaited, 2=Passed, 4=Failed.
Subparameter MAXIMUM_TORQUE	Maximum torque recorded during PST execution. Value range 0 to 100%.
TORQUE	Record provides support for actuator torque configuration.
Subparameter CLOSE_SETTING	The torque limits in the close direction are configured from 40 to 100% of the rated torque in increments of 1%.
Subparameter OPEN_SETTING	The torque limits in the open direction are configured from 40 to 100% of the rated torque in increments of 1%.
Subparameter BOOST	Torque boost is to prevent torque trip during initial valve unseating and in cold climates. Value of 1=On, 2=Off and 4=Auto.
Subparameter OUTPUT	Torque sensor derives output from motor speed, temperature and voltage. Value range: 0 to 100%.
ACT_TYPE	Actuator type. Value of 16=MX, 96=QX, 144=MXa, 160=UEX and 176=QXM.
ACT_SERIAL_NUMBER	Actuator serial number.
QA_STAMP	QA stamp.
CONTROL_MODE	The actuator can be configured for continuous Position control or Open/Close operations.
Subparameter TARGET	In Position control mode, the actuator moves the valve to the setpoint value. In Open/Close control mode, the actuator moves the valve to 100% position if setpoint is greater than or equal to 50% and moves to 0% if setpoint is less than 50%. Value of 1=Close/Open and 2=Position.
Subparameter ACTUAL	Actual control mode in which actuator is functioning. Value of 1=Close/Open and 2=Position.
DTM_HEART_BEAT	DTM writes heart beat every 30 seconds. The actuator moves the DTM_OPERATION to DTM_READ_ONLY if it does not receive heart beat for 120 second.

Transducer Block Parameters	Description
DTM_OPERATION	DTM operation can be set from the DCS/Configurators to DTM_READ_ ONLY or DTM_READ_WRITE. In DTM_READ_WRITE mode the actuator does not respond to commands from DCS/Configurators.
REMOTE_INPUT_MODE	The actuator can be placed in various modes. Multi Control mode allows analog, digital and network control modes of operation to the actuator. Digital Control restricts the unit to operate upon the last digital input command received. Network Control restricts the unit to operate only upon the last network command received. Analog Control restricts the unit to operate only upon the last analog input command received.
NETWORK_SETPOINT_MODE	User selectable network setpoint mode from DCS/DTM/Configurators. REMOTE_DTM mode is effective only when DTM_OPERATION is in DTM_READ_WRITE.
PROPORTIONAL_BAND	Proportional band is the range of errors between position and demand signal that will produce reduced speed. Range is 10-1000 in increments of 10 (scaled to 1-100).
DEADBAND	The deadband should be wide enough to prevent hunting of the actuator but as low as possible to give adequate response to changes in the error signal. Range is 10-500 in increments of 10 (scaled to 1-100).
ANALOG_SCALING	Analog scaling allows the user to change the signal range from the default range. Options are 0-100, 0-255, or 0-4095. **NOTE**: In order to use the alternate analog ranges the scaling & limit parameters of the Transducer & Analog blocks must be updated to match the desired option.
ACT_OPT_HARDWARES	Optional electronics connected to the actuator.
	Bit 00 and Bit 01 – Not used
	Bit 02 – Digital output board-2
	Bit 03 – Digital output board-1
	Bit 04 – Analog output board-2
	Bit 05 – Analog output board-1
	Bit 06 – Fieldbus network board-B
	Bit 07 – Fieldbus network board-A
ANALOG_1_OUTPUT	Provides support for configuration of Analog-1 output board.
Subparameter STATUS	On/Off status of the Analog-1 output board. Value 1=On and 2=Off.
Subparameter FUNCTION	Analog-1 output function configuration. Value 1=APT and 2=ATT.
Subparameter OFFSET	Analog-1 output type, value and range configuration. Value 1=4-20mA, 2=0-20mA, 4=1-5V, 8=0-5V, 16=2-10V and 32=0-10V.
Subparameter POLARITY	Analog-1 output polarity configuration. Value 1=High value at Open/Max and 2=High value at Close/Min.
Subparameter ATT_SCALE	ATT scaling when Analog-1 output function configured as ATT.
Subparameter VALUE	Analog-1 output value. Range is 0-100%.
ANALOG_2_OUTPUT	Provides support for configuration of Analog-2 output board.
Subparameter STATUS	On/Off status of the Analog-2 output board. Value 1=On and 2=Off.
Subparameter FUNCTION	Analog-2 output function configuration. Value 1=APT and 2=ATT.
Subparameter OFFSET	Analog-2 output type, value and range configuration. Value 1=4-20mA, 2=0-20mA, 4=1-5V, 8=0-5V, 16=2-10V and 32=0-10V.

Transducer Block Parameters	Description
Subparameter POLARITY	Analog-2 output polarity configuration. Value 1=High value at Open/Max and 2=High value at Close/Min.
Subparameter ATT_SCALE	ATT scaling when Analog-2 output function configured as ATT.
Subparameter VALUE	Analog-2 output value. Range is 0-100%.
STD_DIGITAL_OUTPUT_RELAYS	Configuration for R1, R2, R3 and R4 relays on standard digital output relay board.
Subparameter ENABLED	Digital output relays enabled status. Value 0=Disabled and 1=Enabled.
Subparameter STATUS	Contact operation status.
	Bit 00 to Bit 02 – Not used
	Bit 03 – RM contact status
	Bit 04 – R4 contact status
	Bit 05 – R3 contact status
	Bit 06 – R2 contact status
	Bit 07 – R1 contact status
Subparameter R1_FUNCTION	Function assigned to the relay.
Subparameter R1_CONTACT_TYPE	User configurable relay contact type. Value 1=Close, 2=Open and 4=Blinker.
Subparameter R1_POSITION	The relay gets energized when the actuator moves the valve to this user configurable position.
Subparameter R2_FUNCTION	Function assigned to the relay.
Subparameter R2_CONTACT_TYPE	User configurable relay contact type. Value 1=Close, 2=Open and 4=Blinker.
Subparameter R2_POSITION	The relay gets energized when the actuator moves the valve to this user configurable position.
Subparameter R3_FUNCTION	Function assigned to the relay.
Subparameter R3_CONTACT_TYPE	User configurable relay contact type. Value 1=Close, 2=Open and 4=Blinker.
Subparameter R3_POSITION	The relay gets energized when the actuator moves the valve to this user configurable position.
Subparameter R4_FUNCTION	Function assigned to the relay.
Subparameter R4_CONTACT_TYPE	User configurable relay contact type. Value 1=Close, 2=Open and 4=Blinker.
Subparameter R4_POSITION	The relay gets energized when the actuator moves the valve to this user configurable position.
Subparameter RM_SETTINGS	The monitor relay indicates the actuator is available for remote operation.
	Bit 00 to Bit 02 – Not used
	Bit 03 – ESD signal
	Bit 04 – Inhibit signal
	Bit 05 – Over torque
	Bit 06 – Local stop/off

Transducer Block Parameters	Description
	Bit 07 – Local selected
OPT_DIGITAL_OUTPUT_RELAYS	Configuration for R5, R6, R7 and R8 relays on optional digital output relay board.
Subparameter ENABLED	Digital output relays enabled status. Value 0=Disabled and 1=Enabled.
Subparameter STATUS	Contact operation status.
	Bit 00 to Bit 03 – Not used
	Bit 04 – R8 contact status
	Bit 05 – R7 contact status
	Bit 06 – R6 contact status
	Bit 07 – R5 contact status
Subparameter R5_FUNCTION	Function assigned to the relay.
Subparameter R5_CONTACT_TYPE	User configurable relay contact type. Value 1=Close, 2=Open and 4=Blinker.
Subparameter R5_POSITION	The relay gets energized when the actuator moves the valve to this user configurable position.
Subparameter R6_FUNCTION	Function assigned to the relay.
Subparameter R6_CONTACT_TYPE	User configurable relay contact type. Value 1=Close, 2=Open and 4=Blinker.
Subparameter R6_POSITION	The relay gets energized when the actuator moves the valve to this user configurable position.
Subparameter R7_FUNCTION	Function assigned to the relay.
Subparameter R7_CONTACT_TYPE	User configurable relay contact type. Value 1=Close, 2=Open and 4=Blinker.
Subparameter R7_POSITION	The relay gets energized when the actuator moves the valve to this user configurable position.
Subparameter R8_FUNCTION	Function assigned to the relay.
Subparameter R8_CONTACT_TYPE	User configurable relay contact type. Value 1=Close, 2=Open and 4=Blinker.
Subparameter R8_POSITION	The relay gets energized when the actuator moves the valve to this user configurable position.
ACT_OPT_FEATURES	Software features that are enabled.
	Bit 00 to Bit 05 – Not used
	Bit 06 – Arctic
	Bit 07 – Two speed timer
TST_CLOSE	Provides support for configuration of close two speed timer.
Subparameter STATUS	On/Off status of close two speed timer. Value 1=On and 2=Off.
Subparameter START_POSITION	Close two speed timer start position. Range is 1 to 1000.
Subparameter STOP_POSITION	Close two speed timer stop position. Range is 0 to 999.
Subparameter ON_TIME	Close two speed timer on time. Range is 1-20 seconds in increments of 0.5 seconds.

Transducer Block Parameters	Description
Subparameter OFF_TIME	Close two speed timer off time. Range is 1-200 seconds in increments of 1 second.
TST_OPEN	Provides support for configuration of open two speed timer.
Subparameter STATUS	On/Off status of open two speed timer. Value 1=On and 2=Off.
Subparameter START_POSITION	Open two speed timer start position. Range is 0 to 999.
Subparameter STOP_POSITION	Open two speed timer stop position. Range is 1 to 1000.
Subparameter ON_TIME	Open two speed timer on time. Range is 1-20 seconds in increments of 0.5 seconds.
Subparameter OFF_TIME	Open two speed timer off time. Range is 1-200 seconds in increments of 1 second.
DIAG_DATA	Cumulative device diagnostic data.
ACT_SERVICE_TIME	The cumulative service time of the actuator.
COUNTERS	Provides support for monitoring all the operation log counters.
Subparameter MOTOR_RUN_TIME	Total motor operation time in seconds.
Subparameter MANUAL_OPERATIONS	Total number of times unit has been manually operated.
Subparameter CLOSE_ CONTACTOR_OPERATIONS	Total number of close contactor operations.
Subparameter OPEN_ CONTACTOR_OPERATIONS	Total number of open contactor operations.
Subparameter CLOSE_CYCLES	Total number of close cycles count.
Subparameter OPEN_CYCLES	Total number of open cycles count.
Subparameter DRIVE_SLEEVE_TURNS	Total number of drive sleeve revolutions.
Subparameter STROKE_TIME	Length of time of last actuator operation.
DEVIATION	Float value to display the deviation between setpoint and present value. Range is 0-100%.
POWER_SUPPLY	Provides support for monitoring the supply voltage and frequency.
Subparameter VOLTAGE	Supply voltage.
Subparameter FREQUENCY	Supply frequency.
COMPARTMENT_TEMPERATURE	Provides support for monitoring the device compartment temperature.
Subparameter VALUE	Device compartment temperature value, unit as specified by the UNIT subparameter.
Subparameter UNIT	Unit for the device compartment temperature. Value of 1=Centigrade, 2=Fahrenheit and 4=Kelvin.
MOTOR_TEMPERATURE	Provides support for monitoring the motor temperature.
Subparameter VALUE	Motor temperature value, unit as specified by the UNIT subparameter.

Transducer Block Parameters	Description
Subparameter UNIT	Unit for the motor temperature. Value of 1=Centigrade, 2=Fahrenheit and 4=Kelvin.
SYS_FAULTS_WARNINGS	Provides support for the reporting of system faults and warnings.
Subparameter MC_FAULTS	Motor controller faults.
	Bit 00 – MC Motor Volt Too Low.
	Bit 01 – MC Motor Volt Too High.
	Bit 02 – MC IRAM Fault.
	Bit 03 – MC IRAM Over Temperature.
	Bit 04 – MC Hall Critical.
	Bit 05 – MC Hall Limping.
	Bit 06 – MC Communication Loss.
	Bit 07 – MC Thermistor Communication Loss.
	Bit 08 – MC Hardware Torque Over Limit.
	Bit 09 – MC COP.
	Bit 10 to Bit 15 – Not Used.
Subparameter GEN_WARNINGS	General warnings.
	Bit 00 – Oil Temperature Too High (Arctic Units).
	Bit 01 – Open Torque Timer Expired.
	Bit 02 – Close Torque Timer Expired.
	Bit 03 – Identical Limits.
	Bit 04 – Line Voltage Too Low.
	Bit 05 – Line Frequency Too Low.
	Bit 06 – Analog Board-1 mA Output Signal Lost.
	Bit 07 – Analog Board-2 mA Output Signal Lost.
	Bit 08 to Bit 15 – Not Used

C Appendix - Fieldbus Parameter Descriptions

FOUNDATION Fieldbus employs the following standard parameter definitions associated with the control Function Blocks.

ACK_OPTION
Selection of whether alarms associated with the block will be automatically acknowledged.

ALARM_HYS
Amount the PV must return within the alarm limits before the alarm condition clears. Alarm Hysteresis is expressed as a percent of the PV span.

ALARM_SUM
The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.

ALERT_KEY
The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.

BAL_TIME
This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds.

In the PID block, it may be used to specify the time constant at which the integral term will move to obtain balance when the output is limited and the mode is Auto, Cas, or RCas.

BIAS
The bias value used in computing the function block output, expressed in engineering units.

BKCAL_HYS
The amount that the output must change away from its output limit before the limit status is turned off, expressed as a percent of the span of the output.

BKCAL_IN
The value and status from a lower block's BKCAL_OUT that is used to prevent reset windup and to initialize the control loop.

BKCAL_OUT
The value and status required by an upper block's BKCAL_IN so that the upper block may prevent reset windup and provide bumpless transfer to closed loop control.

BKCAL_OUT_D
The output value and status provided to an upstream discrete block. This information is used to provide bumpless transfer to closed loop control.

BKCAL_SEL_1
Control selector output value and status associated with SEL_1 input, which is provided to BKCAL_IN of the block connected to SEL_1 in order to prevent reset windup.

BKCAL_SEL_2
Control selector output value and status associated with SEL_2 input, which is provided to BKCAL_IN of the block connected to SEL_2 in order to prevent reset windup.

BKCAL_SEL_3
Control selector output value and status associated with SEL_3 input, which is provided to BKCAL_IN of the block connected to SEL_3 in order to prevent reset windup.

BLOCK_ALM
The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status if the subcode has changed.

BLOCK_ERR
This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.

BYPASS
The normal control algorithm may be bypassed through this parameter. When bypass is set, the setpoint value (in percent) will be directly transferred to the output. To prevent a bump on transfer to/from bypass, the setpoint will automatically be initialized to the output value or process variable, respectively, and the path broken flag will be set for one execution.

CAS_IN
This parameter is the remote setpoint value, which must come from another Fieldbus block or a DCS block through a defined link.

CAS_IN_D
This parameter is the remote setpoint value of a discrete block, which must come from another Fieldbus block or a DCS block through a defined link.

CHANNEL
The number of the logical hardware channel that is connected to this I/O block. This information defines the transducer to be used going to or from the physical world.

CLR_FSTATE
Writing a Clear to this parameter will clear the device fault state for any field conditions that have cleared.

COLLECTION_DIRECTORY
A directory that specifies the number, starting indices, and DD Item IDs of the data collections in each transducer within a transducer block. For further information, please refer to the Transducer Block Application Process – Part 1 (FF-902) specification.

CONFIRM_TIME
The time the resource will wait for confirmation of receipt of a report before trying again. Retry shall not happen when CONFIRM_TIME = 0.

CONTROL_OPTS
Options which the user may select to alter the calculations done in a control block.

CYCLE_SEL
Used to select the block execution method for this resource.

CYCLE_TYPE
Identifies the block execution methods available for this resource.

DD_RESOURCE
String identifying the tag of the resource, which contains the Device Description for this resource.

DD_REV
Revision of the DD associated with the resource — used by an interface device to locate the DD file for the resource.

DEV_REV
Manufacturer revision number associated with the resource — used by an interface device to locate the DD file for the resource.

DEV_TYPE
Manufacturer's model number associated with the resource — used by interface devices to locate the DD file for the resource.

DISC_ALM
The status and time stamp associated with the discrete alarm.

DISC_LIM
State of discrete input, which will generate an alarm.

DISC_PRI
Priority of the discrete alarm.

DV_HI_ALM
The status and time stamp associated with the high deviation alarm.

DV_HI_LIM
The setting of the high deviation alarm limit in engineering units.

DV_HI_PRI
Priority of the high deviation alarm.

DV_LO_ALM
The status and time stamp associated with the low deviation alarm.

DV_LO_LIM
The setting of the low deviation alarm limit in engineering units.

DV_LO_PRI
Priority of the low deviation alarm.

FAULT_STATE
Condition set by loss of communication to an output block, fault promoted to an output block or a physical contact. When Fault State condition is set, then output function blocks will perform their FSTATE actions.

FEATURE_SEL
Used to select resource block options.

FEATURES
Used to show supported resource block options.

FF_GAIN
The gain that the feed forward input is multiplied by before it is added to the calculated control output.

FF_SCALE
The feedforward input high and low scale values, engineering units code, and number of digits to the right of the decimal point.

FF_VAL
The feed forward value and status.

FIELD_VAL
Raw value of the field device in percent of the PV range, with a status reflecting the Transducer condition, before signal characterization (L_TYPE) or filtering (PV_FTIME).

FIELD_VAL_D
Raw value of the field device discrete input, with a status reflecting the Transducer condition.

FREE_SPACE
Percent of memory available for further configuration. Zero in a preconfigured resource.

FREE_TIME
Percent of the block processing time that is free to process additional blocks.

FSTATE_TIME
The time in seconds from detection of fault of the output block remote setpoint to the output action of the block output if the condition still exists.

FSTATE_VAL
The preset analog SP value to use when fault occurs. This value will be used if the I/O option Fault State to value is selected.

FSTATE_VAL_D
The preset discrete SP_D value to use when fault occurs. This value will be used if the I/O option Fault State to value is selected.

GAIN
Dimensionless value used by the block algorithm in calculating the block output.

GRANT_DENY
Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.

HARD_TYPES
The types of hardware available as channel numbers.

HI_ALM
The status for high alarm and its associated time stamp.

HI_HI_ALM
The status for high high alarm and its associated time stamp.

HI_HI_LIM
The setting for high high alarm in engineering units.

HI_HI_PRI
Priority of the high high alarm.

HI_LIM
The setting for high alarm in engineering units.

HI_PRI
Priority of the high alarm.

IO_OPTS
Options which the user may select to alter input and output block processing.

IN
The primary input value of the block, required for blocks that filter the input to get the PV.

IN_1
Auxiliary input value to the block, used for other values than the PV.

ITK_VER
Major revision number of the interoperability test case used in certifying this device as interoperable. The format and range of the version number is defined and controlled by the Fieldbus Foundation.

LIM_NOTIFY
Maximum number of unconfirmed alert notify messages allowed.

L_TYPE
Determines if the values passed by the Transducer block to the AI block may be used directly (Direct), or if the value is in different units and must be converted linearly (Indirect) or with square root (Ind Sqr Root), using the input range defined by the transducer and the associated output range.

LO_ALM
The status of the low alarm and its associated time stamp.

LO_LIM
The setting for the low alarm in engineering units.

LO_LO_ALM
The status of the low low alarm and its associated time stamp.

LO_LO_LIM
The setting of the low low alarm in engineering units.

LO_LO_PRI
Priority of the low low alarm.

LO_PRI
Priority of the low alarm.

LOW_CUT
Limit used in square root processing. A value of zero percent of scale is used in block processing if the transducer value falls below this limit. This feature may be used to eliminate noise near zero for a flow sensor.

MANUFAC_ID
Manufacturer identification number — used by an interface device to locate the DD file for the resource.

MAX_NOTIFY
Maximum number of unconfirmed notify messages possible.

MEMORY_SIZE
Available configuration memory in the empty resource. To be checked before attempting a download.

MIN_CYCLE_T
Time duration of the shortest cycle interval of which the resource is capable.

MODE_BLK
The actual, target, permitted, and normal modes of the block.

NV_CYCLE_T
Minimum time interval specified by the manufacturer for writing copies of NV parameters to NVRAM. Zero means it will never be automatically copied. At the end of NV_CYCLE_TIME, only those parameters which have changed (as defined by the manufacturer) need to be updated in NVRAM.

OUT
The primary analog value calculated as a result of executing the function.

OUT_D
The primary discrete value calculated as a result of executing the function.

OUT_HI_LIM
Limits the maximum output value.

OUT_LO_LIM
Limits the minimum output value.

OUT_SCALE
The high and low scale values, engineering units code, and number of digits to the right of the decimal point to be used in displaying the OUT parameter and parameters which have the same scaling as OUT.

OUT_STATE
Index to the text describing the states of a discrete output.

PV
Either the primary analog value for use in executing the function, or a process value associated with it. May also be calculated from the READBACK value of an AO block.

PV_D
Either the primary discrete value for use in executing the function, or a process value associated with it. May also be calculated from the READBACK_D value of a DO block.

PV_FTIME
Time constant of a single exponential filter for the PV, in seconds.

PV_SCALE
The high and low scale values, engineering units code, and number of digits to the right of the decimal point to be used in displaying the PV parameter and parameters which have the same scaling as PV.

PV_STATE
Index to the text describing the states of a discrete PV.

RA_FTIME
Time constant of a single exponential filter for the value to be ratioed, in seconds.

RATE
Defines the derivative time constant, in seconds.

RCAS_IN
Target setpoint and status provided by a supervisory Host to an analog control or output block.

RCAS_IN_D
Target setpoint and status provided by a supervisory Host to a discrete control or output block.

RCAS_OUT
Block setpoint and status after ramping - provided to a supervisory Host for back calculation and to allow action to be taken under limiting conditions or mode change.

RCAS_OUT_D
Block setpoint and status provided to a supervisory Host for back calculation and to allow action to be taken under limiting conditions or mode change.

READBACK
This indicates the readback of the actual continuous valve or other actuator position, in transducer units.

READBACK_D
This indicates the readback of the actual discrete valve or other actuator position, in the transducer state.

RESET
The integral time constant, in seconds per repeat.

RESTART
Allows a manual restart to be initiated. Several degrees of restart are possible. They are 1: Run, 2: Restart resource, 3: Restart with defaults, and 4: Restart processor.

ROUT_IN
Target output and status provided by a Host to the control block for use as the output (ROut mode).

ROUT_OUT
Block output and status — provided to a Host for back calculation in ROut mode and to allow action to be taken under limited conditions or mode change.

RS_STATE
State of the function block application state machine.

SEL_1
First input value to the selector.

SEL_2
Second input value to the selector.

SEL_3
Third input value to the selector.

SEL_TYPE
This parameter specifies the type of selector action from choices of High, Medium, and Low.

SET_FSTATE
Allows the Fault State condition to be manually initiated by selecting Set.

SHED_OPT
Defines action to be taken on remote control device timeout.

SHED_RCAS
Time duration at which to give up on computer writes to function block RCas locations. Shed from RCas shall never happen when SHED_RCAS = 0.

SHED_ROUT
Time duration at which to give up on computer writes to function block ROut locations. Shed from Rout shall never happen when SHED_ROUT = 0.

SIMULATE
Allows the transducer analog input or output to the block to be manually supplied when simulate is enabled. When simulation is disabled, the simulate value and status track the actual value and status.

SIMULATE_D
Allows the transducer discrete input or output to the block to be manually supplied when simulate is enabled. When simulation is disabled, the simulate value and status track the actual value and status.

SP
The analog setpoint of this block.

SP_D
The discrete setpoint of this block.

SP_HI_LIM
The setpoint high limit is the highest setpoint operator entry that can be used for the block.

SP_LO_LIM
The setpoint low limit is the lowest setpoint operator entry that can be used for the block.

SP_RATE_DN
Ramp rate at which downward setpoint changes are acted on in Auto mode, in PV units per second. If the ramp rate is set to zero, then the setpoint will be used immediately. For control blocks, rate limiting will apply only in Auto. For output blocks, rate limiting will apply in Auto, Cas, and RCas modes.

SP_RATE_UP
Ramp rate at which upward setpoint changes are acted on in Auto mode, in PV units per second. If the ramp rate is set to zero, then the setpoint will be used immediately. For control blocks, rate limiting will apply only in Auto. For output blocks, rate limiting will apply in Auto, Cas, and RCas modes.

ST_REV
The revision level of the static data associated with the function block. To support tracking changes in static parameter attributes, the associated block's static revision parameter will be incremented each time a static parameter attribute value is changed. Also, the associated block's static revision parameter may be incremented if a static parameter attribute is written but the value is not changed.

STATUS_OPTS
Options which the user may select in the block processing of status.

STRATEGY
The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.

TAG_DESC
The user description of the intended application of the block.

TEST_RW
Read/write test parameter - used only for conformance testing.

TRANSDUCER_DIRECTORY
A directory that specifies the number and starting indices of the transducers in the transducer block. For further information, please refer to the Transducer Block Application Process – Part 1 (FF-902) specification.

TRK_IN_D
This discrete input is used to initiate external tracking of the block output to the value specified by TRK_VAL.

TRK_SCALE
The high and low scale values, engineering units code, and number of digits to the right of the decimal point, associated with TRK_VAL.

TRK_VAL
This input is used as the track value when external tracking is enabled by TRK_IN_D.

UPDATE_EVT
This alert is generated by any change to the static data.

WRITE_ALM
This alert is generated if the write lock parameter is cleared.

WRITE_LOCK
If set, no writes from anywhere are allowed except to clear WRITE_LOCK. Block inputs will continue to be updated.

WRITE_PRI
Priority of the alarm generated by clearing the write lock.

XD_SCALE
The high and low scale values, engineering units code, and number of digits to the right of the decimal point used with the value obtained from the transducer for a specified channel.

XD_STATE
Index to the text describing the states of a discrete for the value obtained from the transducer. Writing a Clear to this parameter will clear the device fault state for any field conditions that have cleared.

D Appendix – Field Diagnostic Profile

Flowserve Limitorque actuators provide the following warning & fault information through the Field Diagnostic Profile contained within the Resource block (RB2).

Failure	
Bit	**Meaning**
0	Motor Over Temperature
1	Over Torque
2	Valve Jammed
3	Phase Lost
4	Encoder Fault
5	Contactor Fault
6	Knob Fault
7	Mainboard EEPROM Fault
8	Mainboard Flash Memory Fault
9	Mainboard RAM Fault
10	Oil Temperature Too High (Arctic Units)
11	MC Motor Volt Too Low
12	MC Motor Volt Too High
13	MC IRAM Fault
14	MC IRAM Over Temperature
15	MC Hall Critical
16	MC Hall Limping
17	MC Communication Loss
18	MC Thermistor Communication Loss
19	Monitor Relay Energized
20	SPI To Mainboard Failure
21	FF Board Fault
22	N/A
23	N/A
24	N/A
25	MC Hardware Torque Over Limit
26	MC COP
27	
28	
29	
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Function Check	
Bit	**Meaning**
0	Knob In Local
1	Knob In Stop
2	Open Torque Timer Expired
3	Close Torque Timer Expired
4	Manual Move
5	Open Torque Switch
6	Close Torque Switch
7	Open Position Limit
8	Close Position Limit
9	Local ESD Active
10	Network ESD Active
11	Open Inhibit Active
12	Close Inhibit Active
13	PST Active
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Out of Specification	
Bit	**Meaning**
0	Identical Limits
1	Phase Reverse
2	Line Voltage Too Low
3	Line Frequency Too Low
4	Mainboard mA Input Signal Lost
5	Analog Board-1 mA Input Signal Lost
6	Analog Board-2 mA Input Signal Lost
7	Analog Board-1 mA Output Signal Lost
8	Analog Board-2 mA Output Signal Lost
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Maintenance Request	
Bit	**Meaning**
0	Encoder Warning
1	Motor Temperature Warning
2	Analog Output Board-1 Fault
3	Analog Output Board-2 Fault
4	Digital Output Board-1 Fault
5	Digital Output Board-2 Fault
6	
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Glossary

Communications Protocol A standard for transferring data between intelligent devices, such as a Master Station, distributed control system, programmable controller, or a computer.

DCS Distributed Control System. Geographically distributed intelligent control devices communicating over a digital network (bus).

Device Description Software loaded into the Host controller on that describes the characteristics and parameters of the fieldbus-mounted device.

Device Type Manager (DTM) The DTM is a device driver that provides a unified structure for accessing device parameters, configuring and operating the devices, and diagnosing problems. A Device DTM is provided by the device manufacturer and represents the specific logic and parameters of the device. This standardized interface can be used in any FDT Frame Application.

EIA Electronic Industries Association, an organized body of manufacturers that sets interface standards for the electrical and electronic industry (see RS-232C and RS-485).

Field Device Tool Frame Application A software program that implements DeviceDTMs and CommDTMs. The Frame Application provides:
1) Common environment
2) User Management
3) DTM Management
4) Data Management
5) Network Configuration
6) Navigation

Foundation Fieldbus A standard allowing intelligent field-mounted devices such as valves and transmitters to communicate with each other and with a Host controller such as a DCS.

Function Blocks A standard graphical representation of the control and measurement tasks that take place in the field devices, used for easy system configuration.

Gateway A device in a communication system to translate one set of commands to another set of commands that can be understood by other user-supplied devices in the system.

LED Light Emitting Diode, a semiconductor diode that emits light when current passes through it, used for various displays in industrial systems and consumer products.

Link Active Scheduler The fieldbus device responsible for scheduling communication with, and operation of each of the devices on the fieldbus network.

Modem Modulator/demodulator, hardware that converts serial digital bit streams into audio frequency signals when transmitting or modulating data, then changes the audio frequencies back into digital streams when receiving or demodulating data.

MX/QX FF The intelligent Foundation Fieldbus board residing in the Limitorque actuator that serves as the communication interface to the fieldbus network. It provides diagnostic and control capabilities for the actuator that adhere to FF specifications.

Parallel Data Transmission The transmission of digital data bits in parallel over several wires.

Proportional Integral Derivative Control Methodology Control loop feedback algorithm that calculates an “error” value as the difference between a measured “process variable” and a desired

"setpoint". The weighted sum of the three P-I-D actions is used to adjust the process via a control element such as the position of a valve.

PLC Programmable Logic Controller, an intelligent microprocessor-based replacement for relay logic systems, used for process and machinery control applications.

RS-232C An EIA standard for serial data transmission found in almost all personal computers and other serial communication systems not exceeding 30 feet. Recently the EIA has renamed the standard EIA-232.

RS-485 An EIA standard for half duplex, serial data transmission used in multipoint, or parallel, communication systems. This is an excellent choice for long distance serial data exchange. Contains field unit status and digital input status transfer because it includes data rates up to 10 megabytes/second, excellent noise rejection, and the ability to withstand up to +/- 7 volts of instantaneous common mode voltage without loss of signal.

Serial Data Transmission The transmission of digital data bits sequentially over a transmission medium.

Twisted Pair A serial digital data communications medium incorporating two wires twisted together to minimize interference from near-by noise sources. Limitorque recommends Belden's 3076F (or equivalent cable) for fieldbus applications.

Flowserve Corporation
Flow Control

United States
Flowserve Limitorque
5114 Woodall Road
P.O. Box 11318
Lynchburg, VA 24506-1318
Phone: 434-528-4400
Facsimile: 434-845-9736

England
Flowserve Limitorque
Euro House
Abex Road
Newbury
Berkshire, RG14 5EY
United Kingdom
Phone: 44-1-635-46999
Facsimile: 44-1-635-36034

Japan
Limitorque – Nippon Gear Co., Ltd.
NOF Bldg. 9th Floor
1-11-11, Kita-Saiwai, Nishi-Ku
Yokohama (220-0004)
Japan
Phone: 81-45-326-2065
Facsimile: 81-45-320-5962

Singapore
Flowserve Limitorque
12, Tuas Avenue 20
Singapore 638824
Phone: 65-6868-4628
Facsimile: 65-6862-4940

China
Limitorque Beijing, Pte., Ltd.
RM A1/A2
22/F, East Area, Hanwei Plaza
No. 7 Guanghua Road, Chaoyang District
Beijing 100004, Peoples Republic of China
Phone: 86-10-5921-0606
Facsimile: 86-10-6561-2702

India
Flowserve Limitorque, Ltd.
Plot No 4
Export Promotional Industrial Park
Whitefield, Bangalore 560066
India
Phone: 91-80-40146200
Facsimile: 91-80-28410286

FCD LMENIM2330-02 AQ 02/17 Printed in USA.