FLOWSERVE

# *Limitorque MX*

The Next Generation in Smart Actuation


*Experience In Motion*

# Flowserve Limitorque Actuation Systems

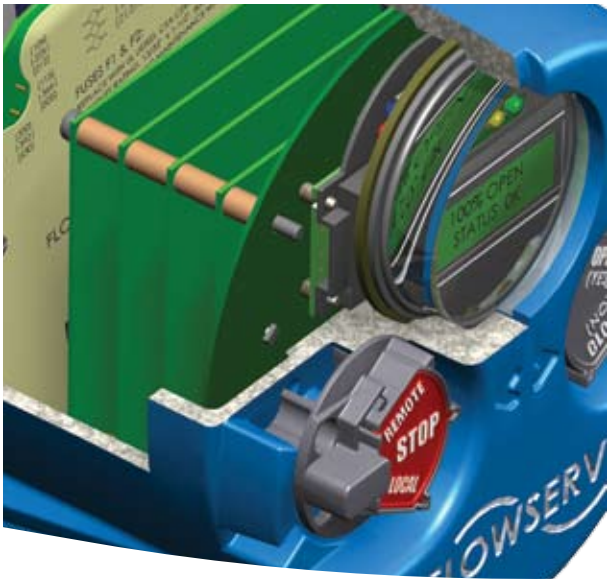
Limitorque is an operating unit of Flowserve, a $2+ billion-a-year company strongly focused on automation and support of the valve industry. Flowserve is the world's premier provider of flow management services.

Limitorque has evolved over 75 years since its strategic introduction of a "torque-limiting" design that changed an industry. Flowserve Limitorque offers solutions and automation choices for customers which provide:

- cost savings from field devices such as electric valve actuators.
- greater operating efficiencies from control room performance sequencing, interlocking, and continuous process optimization.
- competitive advantages derived from increased management visibility of databases and networks.

*Limitorque is one of the primary reasons Flowserve is "Experience In Motion."*

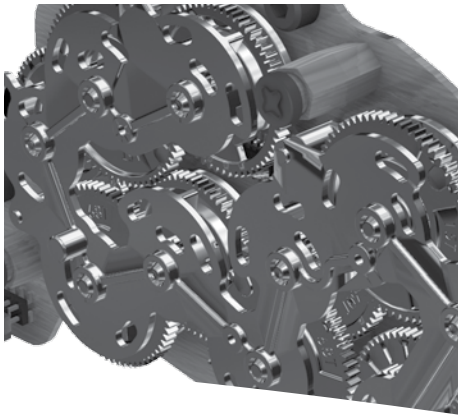
***The MX speaks your language, whether it's management, technical, financial, operations, or service.***




## MX – Still "No Batteries Required"

*Limitorque MX: smart multi-turn actuator that delivers what you want most — control, ease of use and "no batteries required."*

Flowserve Limitorque introduced the MX electronic actuator in 1997 as the first smart actuator that provided uncompromised reliability and performance in a design that was easy to use. The MX innovations which were market firsts – patented absolute encoder that doesn't require battery back-up – patented Limigard™ technology – easy to use menus in six languages – the use of Hall effect devices to eliminate potentially troublesome reed switches – have been improved. The features Users have come to expect from Flowserve Limitorque are still standard, but the list of improvements and optional equipment permits improved reliability, functional performance and durability. The MX is the smart actuator design that is rigorous and easy to use. It is the only non-intrusive, double-sealed electronic actuator to display the Limitorque brand.

# MX: The Next Generation in Smart Actuation

## Speed, Precision and Simplicity

The MX control panel features an improved 32-character LCD screen that provides actuator status and diagnostics in an easy to use, easy to read, graphical format. The industry's first multilingual actuator is now capable of configuration in English, Spanish, German, French, Italian, Portuguese, Mandarin, Russian, Bahasa Indonesia and Katakana as standard configuration languages. In addition, the LCD can be rotated 180˚ for better field visibility.

Speed, precision, simplicity, and set-up speed are characteristics expected of a smart actuator. Users and valve OEMs demand quick set-up and easy to understand dialog in preferred languages. The ability to either upload new software or download diagnostics is also critical to improving a plant's efficiency. The MX provides customers with the essential tools for rapid installation and root cause diagnostics.

Precision is expected in a smart actuator. The MX was the first such device developed with a patented absolute encoder that doesn't require troublesome and unpredictable battery back-up. Flowserve Limitorque's innovative absolute encoder has been improved to 18-bit resolution over 10,000 drive sleeve rotations and is 100% repeatable. It now has BIST (Built In Self Test) enhancements and redundancy.

When a device is designed for BIST, its methodology is such that much of the test functionality is embedded in the device itself. BIST design facilitates a critical component's ability to communicate its actual state to a CPU for comparison to the expected state. Any deviation from expected values will be reported to the User with correlation to the failed component or sub-system.

Simplicity is expected in a smart actuator. In fact, one of the reasons for using an electronic actuator is the simplicity of set-up, installation on a valve, and acquiring diagnostic information. The MX is the simplest and easiest to use electronic actuator.



## Long Life and Protection

Long life is expected in a smart actuator. There are more than 1,000,000 Limitorque actuators installed around the globe, in every conceivable environment. Many have been functioning for over 50 years. Introduced in 1997, the MX is the Flowserve Limitorque smart actuator that inherits Limitorque's legendary longevity.

In order to last a long time in severe environments smart actuators must have unparalleled protection. The MX's IP68 enclosure rating is 15M for 96 hours, regardless of whether the unit is weatherproof or explosionproof. This is an industry leading feature. Add other certifications to the list – NEMA 4, 4X, 6 – and the MX is unsurpassed in unit protection.

The MX is double-sealed, which isolates the terminal compartment from the controls environment. Any leakage into the terminal compartment is contained in the compartment.

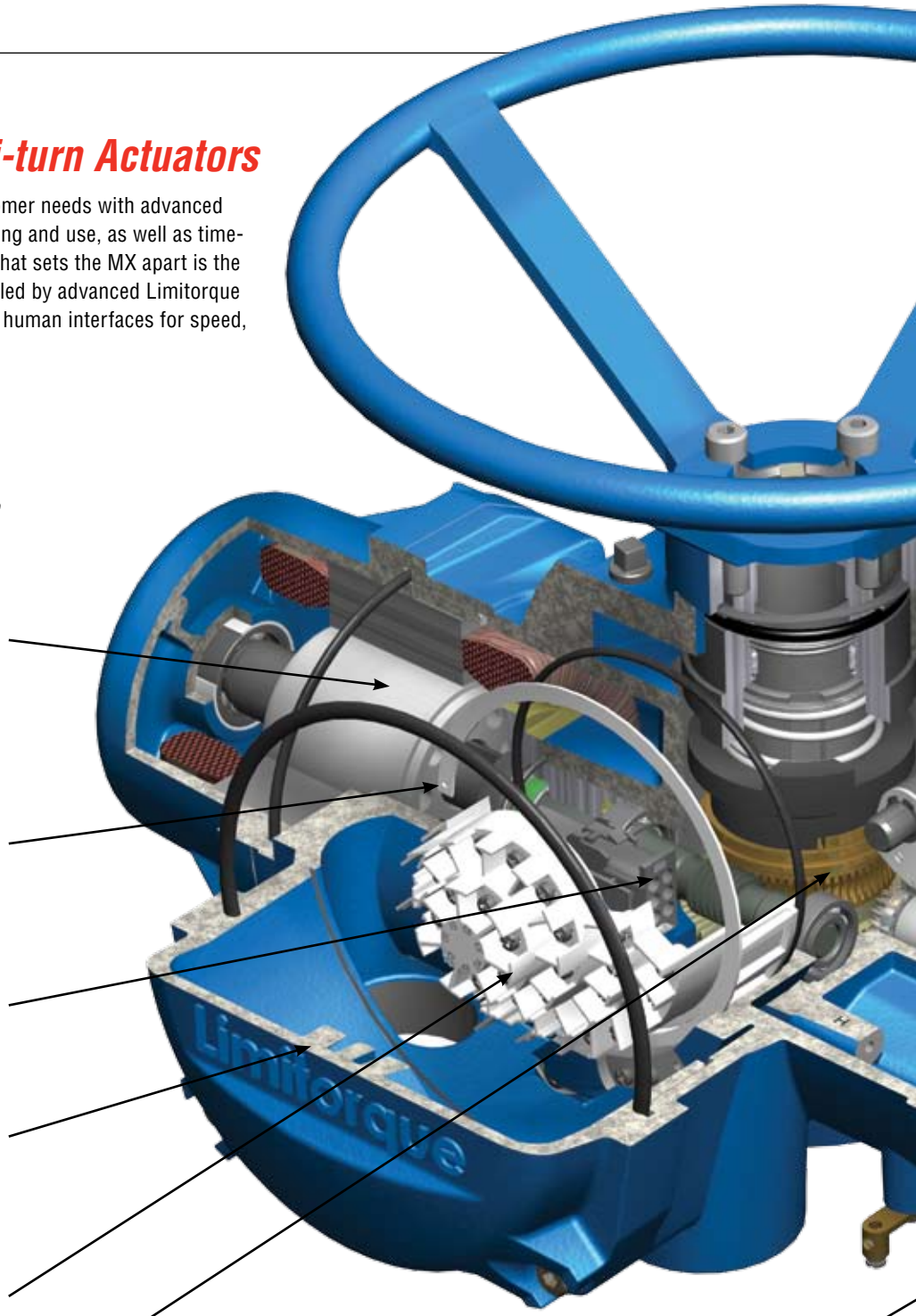
The MX is powder coated using a polyester resin in Dupont Blue Streak color, not only for aesthetics, but also for protection in severe corrosive environments.

## Quality and Certifications

Flowserve Limitorque is a global leader in quality manufacturing. All Limitorque plants are certified to ISO 9001 standards, the recognized benchmark for quality all over the world. The same unexcelled use of certified materials is found in the MX as in Limitorque's naval and nuclear qualified electric actuators. The MX has used synthetic gear oils especially optimized for use with worm gear sets since the first unit was shipped in 1997. It was the first non-intrusive actuator to use rolled worms and electronic controls designed and produced using surface mount technology. A true globally certified device, MX meets all pertinent European Directives including ATEX, EMC, Machinery and Noise and displays the CE mark associated with such compliance.

# Anatomy of MX Multi-turn Actuators

Limitorque MX actuators respond to customer needs with advanced features designed for ease of commissioning and use, as well as time- and money-saving operational benefits. What sets the MX apart is the combination of control and reliability enabled by advanced Limitorque technology, plus superior ergonomics and human interfaces for speed, comfort, and ease of use.




*The reliable MX motor includes Class F insulation and thermal protection. It is designed specifically for valve actuator service, with a high starting torque and low inertia to reduce valve position overshoot. Class H is available as an option.*

*Motor gear attachment allows the motor to be removed in one assembly for fast, easy inspection, repair, and maintenance.*

*MX actuators feature a LimiGard™ circuit monitor that is designed for Fail/No-Action protection. LimiGard consists of dedicated circuitry that continually monitors the motor contactor, control relays, internal logic circuits, and external command signals to detect and alarm malfunctions. It now includes BIST with Frequency Domain Analysis (FDA) for true predictive maintenance.*

*Plug-in connectors permit quick and easy replacement of components.*

*Double-sealed design provides a termination chamber that is separate and sealed from the control chamber. Control components are never exposed to the elements during site wiring or because of a faulty cable connection.*

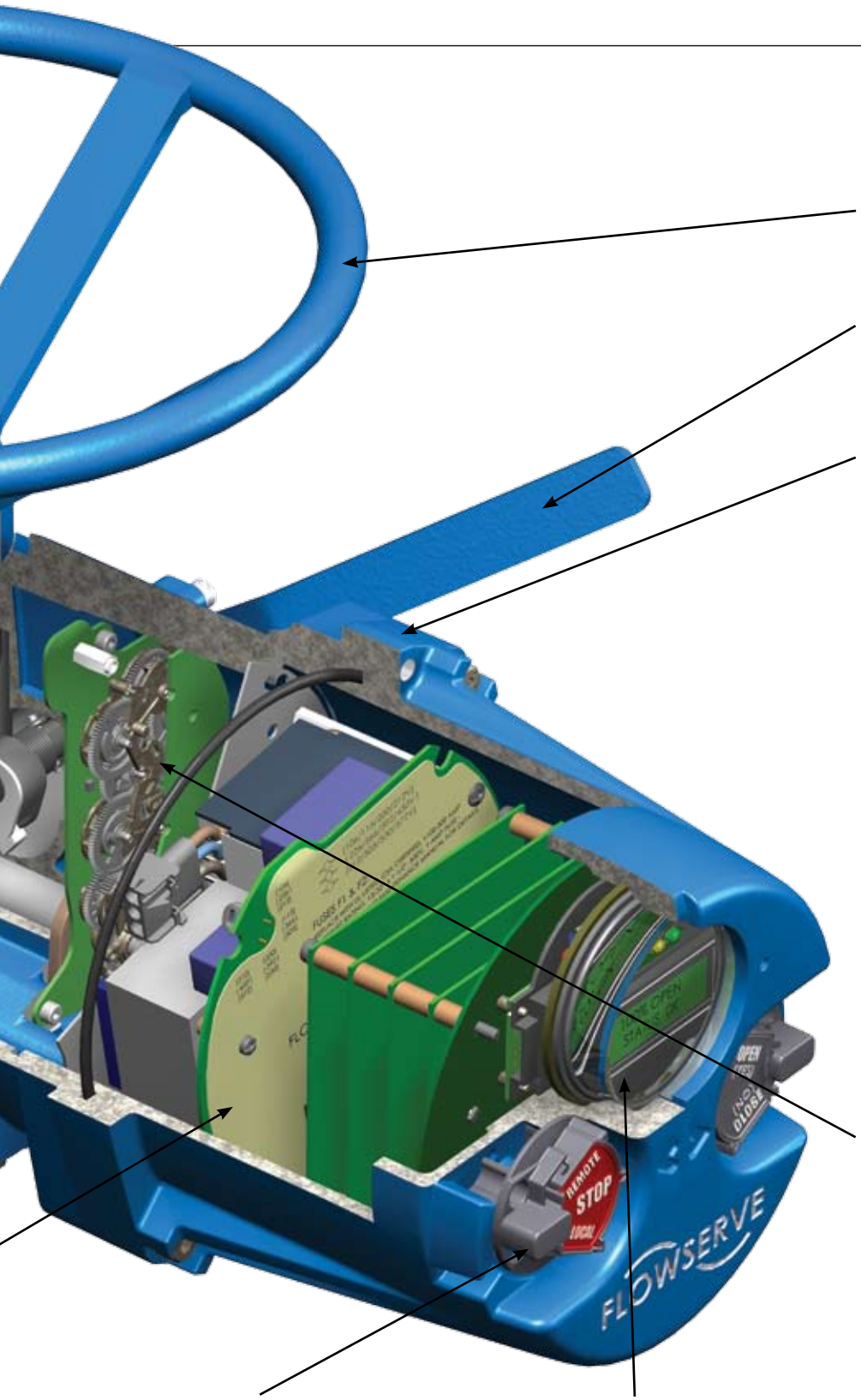
*External connection block has three power terminals, a ground screw, and 54 control screw-type terminals to simplify commissioning and upgrades.*

*Long-life gear set consists of hardened alloy steel rolled worm and bronze worm gear immersed in an extended-life synthetic gear oil specifically developed for worm gear operation. It is completely bearing-supported.*

*Ductile iron thrust base is removable from main actuator housing for easier valve installation and maintenance.*

*High-strength, bronze alloy stem nut is removable for machining to suit the valve stem.*

*The control chamber includes an electronic control, monitoring, and protection module mounted on steel plate. Plug-in connectors allow fast, error-free removal and replacement of the module.*




*The MX heavy-duty handwheel provides backup for manual operation.*

*Declutch lever enables the MX actuator to be placed in manual, handwheel-drive operation. Lever automatically disengages when motor is energized and can be padlocked in the motor position.*

*Cast aluminum housing powder-coated for extreme environments. Optional coatings are available.*

*Optionally, controls may be powered from an external 24 VDC source as backup for AC power. Controls and display will remain active through loss of AC power.*

*Torque sensor derives output from motor speed, temperature, and voltage—and shuts off the motor to protect the actuator and valve if the set torque is exceeded. This method of torque scanning indicates Limitorque's commitment to be fully electronic.*

*Flowserve Limitorque's uncompromising commitment to "no batteries required" is enhanced with the addition of the optional MX Quik (MX-Q) uninterrupted power transfer when mains power is lost to the actuator. MX-Q powers the S/R contacts for updated status to the control room and also provides limited visibility of the LCD screen. It is configurable for "MX Quik time" and, once main power is restored, is available for the next unforeseen power outage.*

*The absolute encoder, a key that enables MX actuators to achieve 100% repeatable control, provides optical sensing of valve position with 18-bit resolution. The encoder measures valve position in both motor and handwheel operation. No battery or back-up power supply is required. It is now redundant, permitting up to a 50% fault tolerance.*

*Local control switches make setup and calibration easy, using "yes" or "no" responses to straightforward questions, plus they provide the ability to open, stop, and close the actuator and to select remote or local preferences. These switches are magnetically coupled, solid state Hall effect devices, which eliminate troublesome and fragile reed switches.*

*The control panel display delivers instant, up-to-the-minute actuator status and valve position in ten languages. It also provides simple calibration and diagnostic information, including motor, identification, and hardware data, as well as torque profile, log reports, and FDA in graphical formats.*

*The MX now offers Bluetooth technology as optional, up to 10 meters. When used with Flowserve Limitorque's Windows CE and Mobile 5 based graphical interface Dashboard™, diagnostic information can be transferred easily to a PDA, laptop computer or smart cell phone.*

# Control & Diagnostics

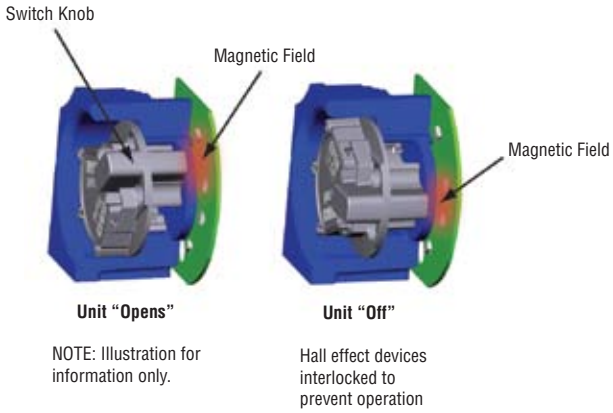
*Control is expected in a smart actuator. The MX is noted for simplifying valve control automation in three critical methods of control:*

- Calibration/set-up
- Normal operation
- Diagnostics & troubleshooting

The MX was the first non-intrusive actuator to equip Users with LCD dialog screens in the language of their choice. MX now uses a graphical dot matrix display that improves the visibility of the display. The use of this type of LCD permits the support of any language. In fact, in addition to English, Spanish, German, French, Italian, and Portuguese, the MX now includes four new languages – Mandarin, Russian, Bahasa Indonesia and Katakana – with a capacity for even more. The orientation of the text can be configured to rotate 180° and diagnostic graphs displayed for clearer data collection.

Simple "Yes" and "No" responses to dialog questions confirm the set-up of the MX via solid state Hall effect devices in both knobs. No special tools or remote devices are required. And the MX is "fit for service", offering the widest range of configuration menus of any non-intrusive, smart actuator.

Diagnostics should be easy to read and decipher. The MX diagnostic enhancements now offer a BIST (Built In Self Test). The BIST feature is also designed into a state-of-the-art controls platform that verifies and validates the integrity of its components. The result is a design which aids the User in meeting the SIL (Safety Integrity Level) requirements of IEC 61508. While an electronic actuator does not have a SIL rating by itself, placing a smart device into any plant system should enhance the ability of a given safety system to achieve its preferred SIL rating. Any device which incorporates fully developed BIST features provides assurance to the User that the device has been designed with plant-wide safety and integrity of operation in mind.

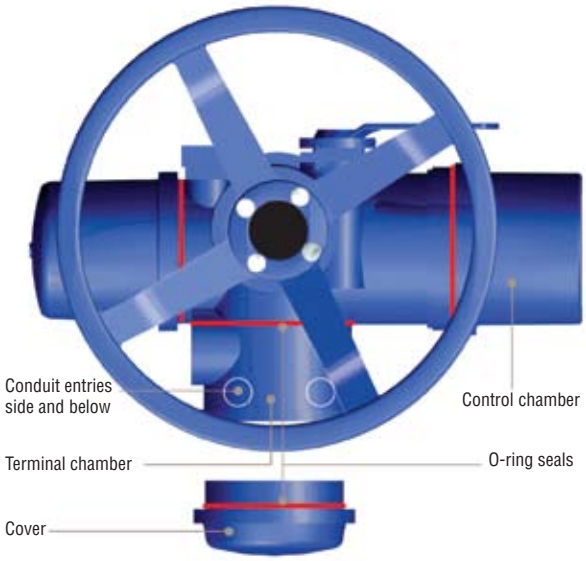



The "View Diagnostics" menu selections now include more definitive routines which can isolate troubleshooting to "root cause" error codes. These root cause codes can be used in conjunction with BIST. A well designed BIST based system can do more than just report failures in the electronic sub-systems.  It can also determine failures or

predict future failures in its associated mechanical system. To further enhance MX diagnostics a new component has been added to the patented Limigard feature – Frequency Domain Analysis.

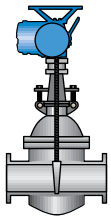
The Frequency Domain Analysis (FDA) methodology for MX is based upon capturing torque, position or speed values at regular time intervals while the actuator is motoring, then calculating the resulting data set with a Fast Fourier Transform (FFT). This converts the actuator's torque, position or speed signature from the time to the frequency domain. The resulting information is very useful at pinpointing any components in the mechanical drive train that have failed, or are about to fail. Only the MX has the FDA feature in its View Diagnostics menus.

The MX now offers Bluetooth technology as optional, up to 10 meters. When used with Flowserve Limitorque's Windows CE based graphical software interface Dashboard™, diagnostic information can be transferred easily to a PDA with Winows Mobile 5 platform, laptop computer or smart cell phone. In addition, new firmware can be uploaded and actuator configurations transferred from one device to any number of subsequent actuators.

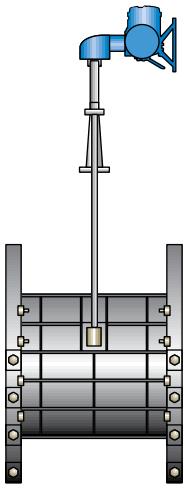



Double-sealed protection from dust and moisture

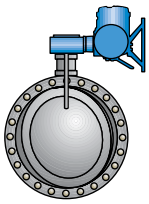
# Nothing exceeds Limitorque MX actuators for ease and compatibility with valves of all types



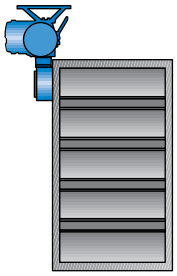
MX mounted to wedge gate



MX/B320 mounted to sluice gate



MX/HBC mounted to butterfly valve



MX/PT mounted to damper

## Valves

Limitorque MX actuators have been designed to accommodate today's wide variety of valve designs and to meet international standards for valve and actuator interfaces, including ISO 5210 and MSS SP-102.

MX actuators are available in a wide variety of configurations to accommodate various applications and valve designs:

**Direct mounting** The MX can be directly coupled with valves for torque-only applications. For thrust applications, a separate thrust base is used.

**MX/HBC** The MX can be coupled to a PT or HBC worm gear reducer for operation of part-turn valves, such as butterflies, balls, plugs, and dampers. This combination provides an output torque capacity of up to 136,000 ft-lb/184,280 N m.

**MX/B320** Rising stem valves may be operated by an MX coupled to a B320 bevel gear reducer. Thrusts up to 325,000 lb/1,445 kN and torque up to 12,000 ft-lb/16,320 N m can be accommodated.

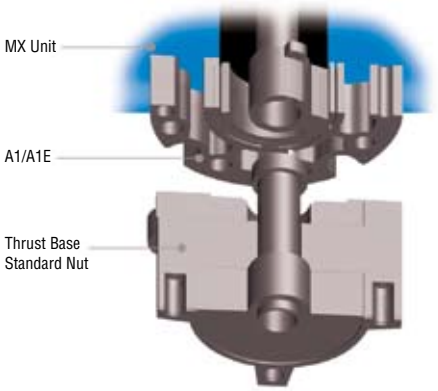
## Couplings

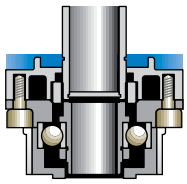
Thrust actuator drive couplings:

- Type A1 – Alloy bronze (thrust)
- Type A1E – Extended bronze nut

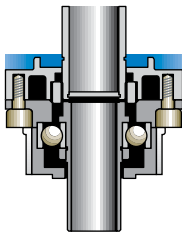
Torque-only actuator drive couplings:

- Type B4 – Standard steel bushing
- Type B4E – Extended steel bushing
- Type B1 – Large fixed-bore keyway steel bushing (ISO 5210)
- Type BL – Splined steel bushing for rising rotating stem valves

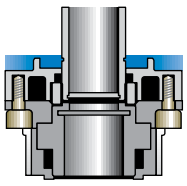


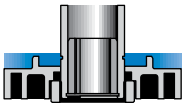
Type A1



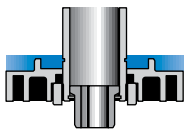
Type A1E



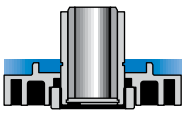
Type B1



Type B4



Type B4E



Type BL

# Integrity and Predictable Performance

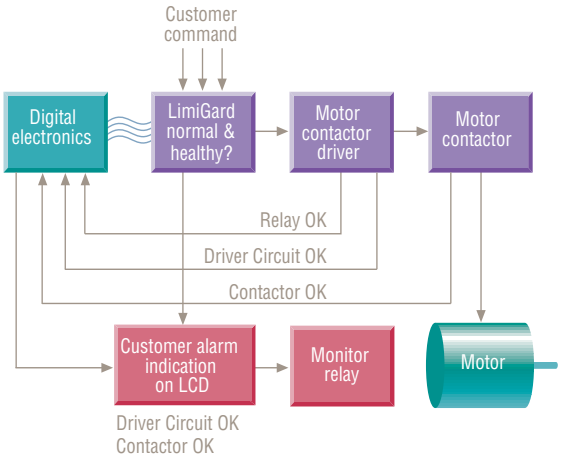
*Smart actuators should have enabling technologies that ensure integrity and dependability. The MX offers three.*

## Limigard — now with BIST and FDA

Enhanced reliability for optimal plant operations and reduced troubleshooting costs are the primary benefits of Limitorque's patented smart actuator monitor: LimiGard.

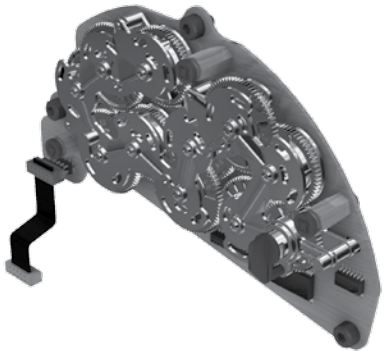
When LimiGard wiring diagrams are followed, LimiGard continually monitors the control relays, internal logic circuits, and external command signals, comparing them to reference conditions. This virtually eliminates the possibility that an actuator malfunction can occur without prompt detection and alarm communication. In the event of a malfunction, LimiGard takes over and supervises the actuator's response characteristics, maximizing safety and predictability. Fault Insertion Tests confirm this Fail/No-Action philosophy built into every MX actuator.

A state-of-the-art electronic actuator such as the MX should include means for verifying and validating that its components are designed with Built-In-Self-Test (BIST) capabilities. Selecting the MX, which incorporates a high level of BIST, can contribute greatly to the integrity and reliability of process applications and enhance the ability of a safety system to achieve its highest possible SIL rating.



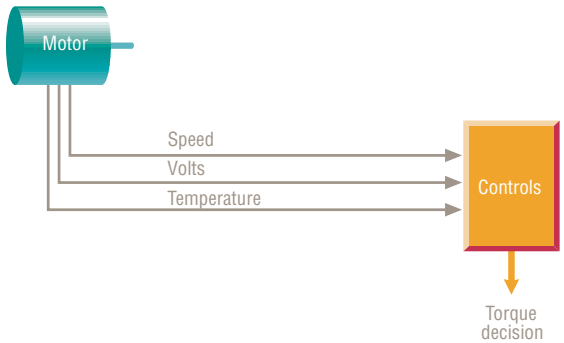

## Absolute position encoder

Limitorque was the first electronic actuator supplier to use an absolute encoder which doesn't require battery back-up for positioning. Customers specify absolute encoders for uninterrupted performance and the MX meets customer expectations with an improved, 18-bit optical, 100% repeatable device. Position information is accurate with or without electrical power. The 18 bits also means that the span of the MX encoder is now almost 10x the original – good for ~10,000 drive sleeve rotations. The encoder has redundant circuits ensuring performance even in the event of up to 50% component failure, continuing to provide reliable data while alerting the user to any faults.



## Torque sensing

Torque limiting has been a Limitorque feature for better than 75 years. In fact, the name Limitorque was coined to identify the ability of an electric actuator to "limit torque" to a valve. In the past, electromechanical actuators have sensed torque using a complicated system of springs, switches and cams. The MX actuator senses torque electronically for use in valve control, overload protection, and torque trending. In conjunction with the Limigard feature, torque is sensed from motor speed, with compensation performed for voltage and temperature variations. The result is highly reliable and predictable torque sensing without the need for the extra components associated with electromechanical torque switches. The MX is a true smart actuator.



# MX Control, Indication, Protection and Optional Features

## Standard features

- Direct-wired remote control – Wiring flexibility includes the following standard alternatives to open-stop-close the actuator:
  - Four-wire – Valve can be opened, closed, or stopped.
  - Two-wire switched – Single open or closed contact; valve can be opened or closed, but not stopped.
  - Three-wire maintained – Two momentary contacts for self-maintained control. Valve can be opened or closed but not stopped in mid-travel.
  - Three-wire inching – Two "push-to-run" contacts; valve can be opened, closed, and stopped in mid-travel.
- Monitor relay – Provides an N/O and N/C contact representing "Actuator available for remote operation."
- Emergency Shutdown (ESD) – A remote, external ESD signal may be applied to the actuator to move the valve to a predetermined user-configured shutdown position, overriding existing control signals.
- User defined inputs – Three user defined inputs are supplied.
- Inhibit signals – External signals may be used to inhibit actuator opening, closing, or both.
- Control signals – The control signal can be either 24 VDC or optional 125 VAC; it can be sourced from the actuator or customer supply.
- Status contacts (4) – May be set to represent up to 25 actuator conditions.

## Protection features

- Autophase protection and correction – Assures proper open/close directions and monitors and corrects phasing if connected improperly. Prevents operation if a phase is lost.
- Jammed valve – Automatically initiates a forward/reverse cycle to free jammed valves.
- Instantaneous reversal protection – Incorporates the proper time delay between the motor reversals to reduce current surges and extend contactor life.
- Motor thermal protection – A thermistor, placed within the motor, protects against overheating.

## Optional features

- Alarm contacts – Up to eight latched contacts may be set to represent up to 25 key actuator conditions.
- Two-speed timer – A two-speed pulsing timer may be incorporated to support variable stroke times as configured by the user.
- Analog Position Transmitter (APT) – The APT is an internally powered, non-contacting valve position transmitter that provides a 4-20 mA signal proportional to valve position.
- Analog Torque Transmitter (ATT) – The ATT is a non-contacting, internally powered transmitter that provides a 4-20 mA signal that is proportional to actuator output torque.
- Modutronic controller – The Modutronic controller positions the valve in response to an external 4-20 mA command signal. It includes automatic pulsing mode to prevent overshoot at the set point. Parameters that may be set easily during configuration include proportional band, dead band, polarity, and action on loss of command signal.
- Solid State Motor Reverser (SSMR) – An SSMR is available when severe operating conditions demand continuous operation.
- Arctic temperature – The MX is suitable for installation and operation in severely cold climates to -50°C (-58°F). There is no need for external heat sources to supplement the internal power—the MX is predictable and reliable even in the most rugged applications.
- Control Station (CSE) – The CSE is a separate control station designed for the operation of inaccessible actuators. It is available with LEDs, Remote/Local and Open/Close selector switches. The CSE may be powered by the actuator internal supply, provided wire resistance and other external loads do not limit the available signal power presented to the MX.
- Isolation and Load Break Switches – Isolation and Load Break Switches can be supplied for the incoming three-phase supply to the actuator. These may be coupled directly to the actuator for weatherproof (WP) applications only or supplied separately for mounting by user. The enclosure is suitable for weatherproof or temporary submersion service. An explosion-proof (XP) isolation switch is also available for user mounting and is suitable for mounting with all MX actuators. Please contact factory for availability.

- Negative Switching – When remote control systems require the negative pole of the circuit supply to be switched to positive earth, an optional board is supplied.
- MX Quik – After the actuator has been powered by line power for one hour, it will automatically withstand most power outages while maintaining the correct state of the S or R status contacts—even if the user repositions the actuator manually with the handwheel. To maximize its self-power time while the line power is lost, the actuator places itself in its lowest possible power usage mode. The LCD will darken (sleep mode) until it is activated for viewing. The LCD can be activated by moving the black knob to OPEN (YES) or by moving the actuator with the handwheel. After 10 seconds of inactivity, the LCD will return to sleep mode. (Available 2007)

### Bluetooth capable options

Standard low power wireless communication path to the actuator enables monitoring and configuration of the unit up to 10m in any direction via a Bluetooth equipped PC, PDA, smart cell phone, etc. FHSS (Frequency Hopping Spread Spectrum) allows a reliable communication link even in a "noisy" environment and 128 bit data encryption can be enabled to protect the privacy of the link. MX Dashboard configuration / diagnostics tools can use the Bluetooth link as a means for communicating with the actuator. A visible blue LED in the controls LCD window on the face of the actuator signifies an active Bluetooth link to the actuator has been established.

## Network Communications

*The MX provides a comprehensive network option portfolio to the User. Network solutions are improved with the addition of DeviceNet to complement Modbus, FOUNDATION Fieldbus H1, Profibus DP_V1/V2 and Profibus PA. MX provides the User with predictable, reliable, and safe operation for years to come, in applications which are subject to the most rigorous requirements and environmental extremes.*

### DDC Modbus (Distributed Digital Control) Communication

DDC is Flowserve Limitorque's digital communication control system that provides the ability to control and monitor up to 250 actuators over a single twisted-pair cable. The communication network employs Modbus protocol on an RS-485 network and is redundant. Redundancy assures that any single break or short in the communication cable will not disable any actuators. Each actuator has included an addressable field unit that communicates over the twisted pair network and executes open, close, stop, ESD, and GO TO position commands. The field unit also communicates all actuator status and alarm diagnostic messages over the same communication network.

**DDC Network**

- Single-ended loop (consult factory)
- Modbus protocol
- High speed – up to 19.2 k baud

### Master Station II

MX units equipped with DDC can be controlled via Flowserve Limitorque's Master Station II. It includes;

- Host interface – RS-232 or RS-485 with TCP-IP (Ethernet) as standard (Modbus™ protocol)
- LED indicator for network status
- Configurable polling sequence priority
- Configurable bitmap to host
- Redundant RS-485 network ports
- High-level surge protection on network
- Logging port for maintenance PC

## *FOUNDATION Fieldbus Communication*

MX can be fitted with FOUNDATION Fieldbus protocol that complies with the IEC 61158-2 Fieldbus H1 standard. The field unit device is able to support several topologies, such as, point-to-point, bus with spurs, daisy chain, tree, or a combination of these. The FF device has network features that include:

- Link Active Scheduler that controls the system
- High-speed communications up to 31.25 kbits/sec
- Peer-to-peer communication
- Input and output function blocks
- Device descriptions
- Network communication
- Configurable by user

Link Active Scheduler communication: Fieldbus segments have one active Link Active Scheduler (LAS) at a given time, which is 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

## *PROFIBUS DP V1/V2 Communication*

MX can be fitted with Profibus DP_V1/V2 protocol field units that comply with EN50170 Fieldbus Standard for RS-485 communications. The device supports several topologies, such as, point-to-point, bus with spurs, daisy chain, tree, or a combination of these. The PB device has network features that include:

- High-speed communications up to 1.5 m/bits/s
- Master-to-slave and peer-to-peer communication
- Stand-by communication channel
- Analog & digital input and output function blocks
- Device descriptions configurable by user

High-Speed Data Exchange – Startup Sequence

- Power ON / Reset – Power On / Reset of master or slave
- Parameterization – download of parameters into field device (selected during configuration by the user)
- I/O Configuration – download of I/O configuration into the field device (selected during configuration by the user)
- Data Exchange – cyclic data exchange (I/O Data) and field device reports diagnostics

## *PROFIBUS PA Communication*

A Profibus PA protocol is available and complies with EN50170 Fieldbus Standard and Fieldbus physical layer per IEC 61158-2 for communications. The device supports several topologies, such as point-to-point, bus with spurs, daisy chain, tree, or a combination of these. The PB device has network features that include:

- High-speed communications up to 31.25 kbits/s with Manchester coding
- Peer-to-peer communication
- Bus powered for 9-32 VDC and 15 mA per actuator
- Stand-by communication channel
- Analog & digital input and output function blocks
- Device descriptions
- Configurable by user

## *DeviceNet*

DeviceNet complies with CAN based protocol and provides the following features:

- DeviceNet Group 2 Server implementation.
- Bus Powered Network Interface allows power alarm information to be communicated when actuator looses main power. The actuator does NOT drop off the network when 3-phase power is lost.
- Standard Polled I/O Connection
- Standard Bit Strobed I/O Connection
- Standard Change of State / Cyclic I/O Connection
- Standard explicit connections defined as:
  - Various Assembly Objects and sizes that allow the network user to determine how much data to transfer to accommodate network installation data throughput requirements.
  - Automatic BAUD rate detection.
  - Node Address configurable via local setup menu, or via the remote network user.
  - Broadcast or group network originated ESD support.

# MX Series Performance Ratings for Units 05–140

*MX-05 through MX-40 (three-phase: 50 Hz/380, 400, and 415 Volt: 60 Hz/208, 230, 380, 460, 525, 575 Volt)*

*MX-85 through MX-140 (three-phase: 50 Hz/380*, 400, and 415 Volt: 60 Hz/380, 460, 525, 575 Volt)* *380/50 multiply by 0.9

| Output Speed (RPM) | | | | MX-05 | | MX-10 | | MX-20 | | MX-40 | | MX-85 | | MX-140 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rated Output Torque | | | | | | | | | | | |
| 60 Hz | | 50 Hz | | ft-lb | N m | ft-lb | N m | ft-lb | N m | ft-lb | N m | ft-lb | N m | ft-lb | N m |
| 18 | | 15 | | 55 | 75 | 125 | 170 | 225 | 305 | 440 | 597 | N/A | N/A | N/A | N/A |
| 26 | | 22 | | 55 | 75 | 125 | 170 | 225 | 305 | 440 | 597 | 850 | 1153 | 1500 | 2036 |
| 40 | | 33 | | 55 | 75 | 125 | 170 | 225 | 305 | 440 | 597 | 1225 | 1662 | 1700 | 2307 |
| 52 | | 43 | | 55 | 75 | 125 | 170 | 225 | 305 | 440 | 597 | 1150 | 1561 | 1600 | 2171 |
| 77 | | 65 | | 48 | 65 | 107 | 145 | 178 | 241 | 345 | 468 | 850 | 1153 | 1200 | 1628 |
| 100 | 131[1] | 84 | 110[1] | 39 | 53 | 89 | 121 | 148 | 201 | 286 | 388 | 600 | 814 | 739 | 1003 |
| 155 | 170[1] | 127 | 143[1] | 41 | 56 | 89 | 121 | 140 | 190 | 260 | 353 | 450 | 611 | 650 | 882 |
| 200 | | 165 | | 34 | 46 | 73 | 99 | 114 | 155 | 210 | 285 | N/A | N/A | N/A | N/A |

*Note 1: MX-85 and MX-140*

| | lb | kN | lb | kN | lb | kN | lb | kN | lb | kN | lb | kN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thrust Ratings (lb/kN) | 8000 | 35 | 15000 | 66 | 25000 | 111 | 36000 | 160 | 50000 | 222 | 75000 | 333 |
| | lb | kg | lb | kg | lb | kg | lb | kg | lb | kg | lb | kg |
| Weights (lb/kg) | 52 | 24 | 65 | 29 | 109 | 49 | 133 | 60 | 250 | 114 | 300 | 136 |

## Maximum Stem Capacity

| Type A Couplings | in. | mm | in. | mm | in. | mm | in. | mm | in. | mm | in. | mm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type A1 | 1.26 | 32 | 1.57 | 40 | 2.36 | 60 | 2.64 | 67 | 3.50 | 88 | 3.50 | 88 |
| Type A1E (Extended Nut) | 1.26 | 32 | 1.57 | 40 | 2.36 | 60 | 2.64 | 67 | 3.50 | 88 | 3.50 | 88 |
| **Type B Couplings (Torque Only)[2]** | **in.** | **mm** | **in.** | **mm** | **in.** | **mm** | **in.** | **mm** | **in.** | **mm** | **in.** | **mm** |
| Type B4 | 1 | 25.4 | 1.25 | 30 | 1.94 | 50 | 2.2 | 55 | 2.88 | 73 | 2.88 | 73 |
| Type B4E (Extended) | 0.75 | 19 | 0.91 | 22 | 1.56 | 41 | 1.78 | 46 | 2.25 | 57 | 2.25 | 57 |
| Type B1 (Fixed Bore)[3] | N/A | 42 | N/A | 42 | N/A | 60 | N/A | 60 | N/A | N/A | N/A | N/A |
| Type BL (Splined) | 6 & 38 Splines | | 6 & 38 Splines | | 6 & 36 Splines | | 6 Splines | | N/A | N/A | N/A | N/A |
| **Maximum Bore and Keyway** | **in.** | **mm** | **in.** | **mm** | **in.** | **mm** | **in.** | **mm** | **in.** | **mm** | **in.** | **mm** |
| Maximum Bore (B4) | 1 | 25 | 1.25 | 30 | 1.94 | 50 | 2.2 | 55 | 2.88 | 73 | 2.88 | 73 |
| Maximum Keyway | ¼ sq. | 8 x 7 | ¼ sq. | 10 x 8 | ½ x ⅜ | 14 x 9 | ½ x ⅜ | 16 x 10 | ¾ x ½ | 20 x 12 | ¾ x ½ | 20 x 12 |
| Maximum Bore (B4E) | .75 | 18 | 0.91 | 22 | 1.56 | 41 | 1.78 | 46 | 2.25 | 56 | 2.25 | 56 |
| Maximum Keyway | 3⁄16 sq. | 6 x 6 | ¼ sq. | 8 x 7 | ⅜ sq. | 12 x 8 | ½ x ⅜ | 14 x 9 | ½ x ⅜ | 16 x 10 | ½ x ⅜ | 16 x 10 |

*Note 2: Maximum bores for Type B couplings may require rectangular keys.*

*Note 3: Available in ISO base only.*

| | MX-05 | MX-10 | MX-20 | MX-40 | MX-85 | MX-140 |
|---|---|---|---|---|---|---|
| Mounting Base (MSS SP-102/ISO 5210) | FA10/F10 | FA10/F10 | FA14/F14 | FA14/F14 | FA16/F16 | FA25/F25 |
| Handwheel Ratio (STD/Optional) | Direct | Direct/8:1 | Direct/12:1 | Direct/24:1 | 16/48 | 16/48 |
| Side-Mounted Handwheel Efficiencies | N/A | 52% | 54% | 51% | 53%/51%[4] | 53%/51%[4] |

*Note 4: Efficiencies for MX-85 and 140 are 51% with SGA and 53% without SGA.*

# MX Standard Features

*Limitorque MX electronic valve actuators are designed for the operation of ON-OFF and modulating valves. They include a three-phase electric motor, worm gear reduction, absolute encoder, electronic torque sensor, reversing motor contactor, electronic control, protection and monitoring package, handwheel for manual operation, valve interface bushing, 32-character LCD, and local control switches—all contained in an enclosure sealed to NEMA 4, 4X, 6, and IP68. Explosionproof (XP) enclosures can also be provided when required. All MX actuators comply with applicable European Directives and exhibit the CE mark.*

### Gear drive

- Bearing-supported worm gear reduction, lubricated with an extended-life synthetic oil, Mobil SHC 632.
- A FGL (Food Grade Lube) is available as an option – Dow Molykote.
- Artic lube is available – Petro Canada Syngear 75W-90.

### Motor

- Three-phase squirrel cage induction type, designed for valve actuator service. Supplied with a solid state thermistor to prevent damage due to temperature overloads.
- Available as 50 Hz/380, 400, or 415 Volts and 60 Hz/208, 230, 380, 460, 525, or 575 Volts.
- Bolt-on design with plug-in connector allows easy removal.

### Controls

- Power and logic circuit boards, a control transformer, and fuses are mounted to a steel plate that is attached in the control compartment with captive screws. Plug-in connectors allow for easy removal.
- Reversing contactor is interlocked to prevent simultaneous energizing of the open and closed coils and supplied with control logic to extend contactor life by inhibiting high current surges caused by rapid motor reversals.
- Phase correction circuit detects and corrects motor rotation faults caused by incorrect site wiring and also prevents operation of the motor due to a loss of phase.
- Control transformer powers actuator controls and minimal external loads from the site's three-phase power supply. It includes vacuum-impregnated coils for moisture resistance and dual fuse protection.
- Internal 24 VDC power supplies for remote control functions are fuse protected. 110 VAC is an available option.
- Terminals for optional auxiliary 24 VDC supply provide the ability to externally power the electronic control package and graphical LCD display without AC power.
- LimiGard is protection circuitry that continually monitors motor controls, internal logic circuits, and external command signals to all but eliminate the possibility of actuator malfunction due to internal component failures or erratic command signals.

### Control panel (local control and indication)

- 32-character graphical LCD displays valve position (0–100%), current actuator status, and provides dialog for calibration. Available languages include English, Spanish, German, French, Italian, Portuguese, Mandarin, Russian, Bahasa Indonesia, and Katakana.
- Green, red, and yellow LEDs for local position indication; LOCAL-STOP-REMOTE and OPEN-CLOSE switches provide local valve control and are magnetically coupled to solid state Hall effect devices under the controls cover for environmental security.
- LOCAL-STOP-REMOTE switch is padlockable in each position.
- OPEN-CLOSE switch is spring-return-to-center and may be configured for maintained or push-to-run (inching) control.

### Remote control

- Remote control can be configured using two, three, or four wires for open-stop-close control.
- Connections are also supplied for ESD (Emergency Shutdown) and inhibit movement commands. The ESD signal will override existing control signal and send the valve to a pre-set position.

### Remote indication

- Four latched contacts (configurable as N/O or N/C and for any valve position) provide remote indication of valve position.
- Alternately, the contacts may be configured to represent other actuator status: overtorque, motor thermal overload, power off, manual operation, local selected, etc.

### Monitor relay

- Will de-energize when the actuator is not available for remote operation. Both N/O and N/C contacts are included.

### Calibration

- Simple, non-intrusive calibration of all actuator settings through the control panel. A password may be user-configured to prevent unauthorized changes. No tools are required.

### Position sensing

- 18-bit, optical, 100% repeatable absolute encoder for measurement of valve position. Open and closed positions are stored in permanent, non-volatile memory. The encoder measures valve movement at all times, including both motor and handwheel operation. Position resolution is better than 0.1% for valves requiring 50 turns or more, with a maximum of 10,000 drive sleeve turns.

### Torque sensing

- A microprocessor calculates output torque from motor speed, voltage, and temperature. Torque limit may be set from 40–100% of rating in 1% increments. A boost circuit is included to prevent torque trip during initial valve unseating and in cold climates. A “Jammed Valve Protection” feature, with automatic retry sequence, is included to de-energize the motor if the output torque requirement exceeds the boost torque.

### Terminal compartment

- Separately sealed terminal chamber for connection of site wiring protects actuator components from the environment. Internal sealing is suitable for NEMA 4, 6, and IP68. Includes three power terminals, a ground screw, and 54 control screw-type terminals.

### Conduit entries

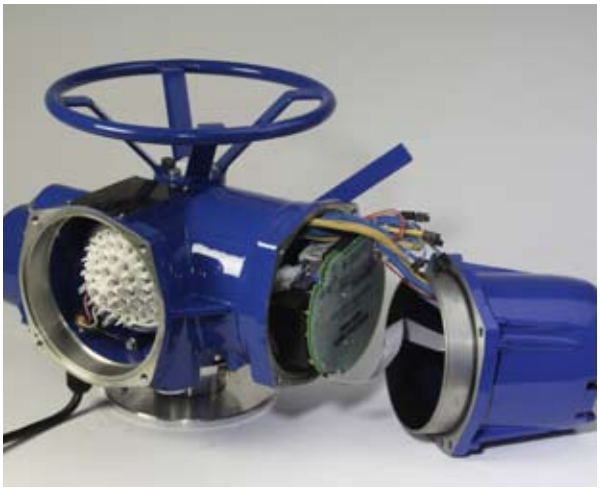
- Three conduit entries, available as NPT, mm, or PG.

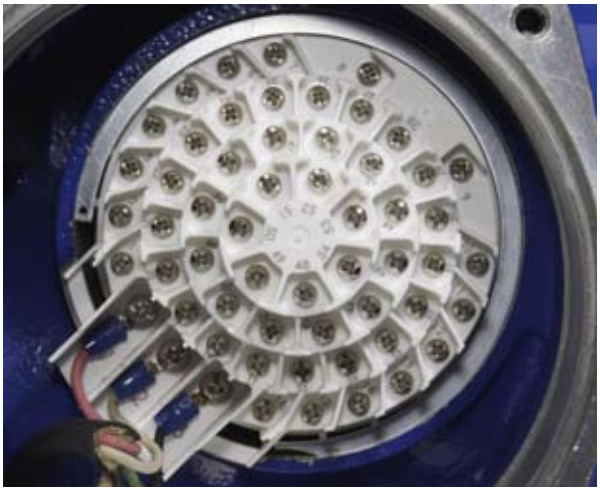
### External corrosion protection

- Primed using high solids epoxy-ecoat and powder top-coated, royal blue color with a DFT of 1–3 mils. The coating is suitable for an ASTM B117 salt spray test of 1500 hours.
- External fasteners are high-strength carbon steel, hexavalent chromate-coated, and top-coated with a high-strength, high-endurance polymer coating.

### Handwheel

- Handwheel with padlockable, manual declutch lever is provided for manual operation.





# MX Specifications

*The MX is the most rigorously tested non-intrusive actuator in the industry and complies with all pertinent global requirements. Please contact the factory should your requirements exceed the listed parameters.*

### Global certifications

Standard Non-hazardous certifications - The normal operating temperature range for weatherproof applications is from -30°C to +70°C (-22°F to +158°F). Options are available to -50°C (-57°F).

- FM – NEMA 3, 4, 4X and 6.
- CSA – Type 3, 4, and 6.
- IEC – IP 68 to 15 m for 96 hours.
- Submersion – NEMA 6 (6 ft–30 min), IEC529, IP68 (15 m–96 h), Limitorque specification (20 ft–24 h)
- Saliferous (Salt) spray – 1500-hour test per ASTM B117-1985.

Standard Explosionproof certifications - The normal operating temperature range for explosionproof applications is from -30°C to +65°C (-22°F to +149°F). Options are available to -50°C (-57°F) for FM and CSA.

- FM – Class 1, Division 1, Group B, C, and D. Class II/III, Division 1, Group E, F, and G – T4
- CSA – Class 1, Division 1, Group C and D. Class II/III, Division 1, Group E, F, and G – T4
- ATEX – EEx d IIB T4 ATEX II 2 G, CENELEC Norm EN50014 and EN50018
  - EEx d IIC T4 ATEX II 2 G, CENELEC Norm EN50014 and EN50018
  - EEx de IIB T4 ATEX II 2 G, Increased Safety, CENELEC Norm EN50014, EN50018, EN50019
  - EEx de IIC T4 ATEX II 2 G, Increased Safety, CENELEC Norm EN50014, EN50018, EN50019
- Anez – Ex d IIB T4 & Ex de IIB T4 and Ex d IIC T4 & Ex de IIC T4

### Wiring

- All internal wiring is flame resistant, rated -40°C to 105°C (-40°F to 221°F), and is UL listed.

### Valve interface

- Mounting base conforms to MSS SP-102 or ISO 5210/1/2/3 as required. Steel torque bushings (type B) and bronze thrust nuts (type A) are removable for machining. Refer to rating chart on page 10 for a listing of couplings available.

### Design life & endurance

- Design Life - One million drive sleeve turns is considered typical life expectancy under normal operating conditions in approved ambient working environments.
- Endurance – 50 million collective drive sleeve turns of endurance testing were performed on the MX for proof of design.
- AWWA C540-02 – “Standard For Power Actuating Devices For Valves and Sluice Gates” – 5,000 cycles with confirmation of specified torque and position accuracy.

### Diagnostic features

Diagnostic facilities are displayed on the LCD by accessing the diagnostic menu or the MX Dashboard™. It includes: motor data (voltage, current, phase rotation, and temperature), hardware status, and identification (tag, serial order, and software revision), torque profile (comparison of last torque to baseline), and operations log (total turns, contactor operations, valve stroke time, and handwheel operations). Diagnostics also includes a Frequency Domain Analysis (FDA) feature. The FDA methodology captures torque, position or speed values at regular time intervals while the actuator is motoring, and calculates the resulting data set with a Fast Fourier Transform (FFT). The resulting information can be used to isolate any components in the mechanical drive train that may exhibit excessive wear or may effect normal actuator operation. FDA and resultant fault indications can be displayed via the graphical LCD. The actuator also contains the ability for diagnostics information to be downloaded to a PC or PDA via both IRDA and Bluetooth ports utilizing MX Dashboard.

### Factory test

Factory testing verifies rated output torque, output speed, motor performance, handwheel operation, local control, control power supply, and control features. A report confirming successful completion of testing is included within the actuator.

### Conduit entries

Three threaded conduit entries are provided tapped: 1 x 1½˝ and 2 x 1¼˝ NPT. Unless otherwise specified, actuator will be dispatched with adapters: 1 x M40 and 2 x M25 metric to BS3643, PG adapters are available upon request.

### European Directives

All MX actuator designs have been tested to comply with pertinent EU Directives and shipped with the Declaration of Conformity listed in the Regulatory Section of LMENIM2306 and LMENIM2314. The actuator is also tagged with the CE mark to demonstrate compatibility with the following European Directives:

*Directives 89/336/EC- Machinery, 98/37/EC- EMC – Electromagnetic Compatibility, 73/23/EC & 93/68/EC – Low Voltage, and 2003/10/EC Airborne Noise.*

*Directives 89/336/EC- Machinery and 73/23/EC & 93/68/EC – LVD; EN 60204 EMC*

- Vibration and seismic capability in accordance with MILSTD-167, IEEE-344-1975, and IEC68-2-6. Vibration consists of 5-200-5 Hz sweeps at 0.75 g acceleration in three axes and 2-35 Hz at 1.0 g acceleration in three axes. Seismic is 5.0 g acceleration from 3.5-35 Hz in three axes.
- Drop test – D3332-88, method A.
- Temperature extremes with humidity – Confirm function of motor, controls, and output torque at -30°C (-22°F) for 72 hours continuous, 70°C (158°F) dry heat for 16 hours continuous and 70°C (158°F) damp heat for 72 hours continuous.
- Di-electric – Motor per NEMA MG1-12.02 and .03 with leakage of less than 10 mA. Control terminals per IEC-1131-2 and CSA C22.2 with check against physical breakdown.

*Directives 98/37/EC- EMC & 73/23/EC & 93/68/EC – LVD; EN 50081-1 & 2*

- Applicable Emissions Standards; EN 50011:1998
- Radiated emissions; EN 55011:1998 & FCC Part 15, subpart J
- Conducted emissions; EN 55011:1998 & FCC Part 15, subpart J
- Applicable Immunity Standards; IEC EN 61000-6-1:2001
- ESD; IEC 61000-4-1:1995
- Radiated RF Immunity; IEC 61000-4-3:1995
- Fast Transients and Bursts; IEC 61000-4-4:1995
- Voltage Surges; IEC 61000-4-5:1995
- Conducted RF Immunity; IEC 61000-4-6:1996
- Magnetic Field Immunity; IEC 61000-4-8:1993
- Voltage Dips and Interrupts; IEC 61000-4-11:1994

*Directive 2003/10/EC Airborne Noise to EN 60204-1*

- Airborne sound – 74 dB (at 200 RPM) per grade A noise requirement of MIL-STD-740 and ANSI/ISA-S82.01-1994 (Harmonized std. to IEC 1010-1).

FLOWSERVE

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