MPA for Multi-Port
Flow Selector

Multi-Port Actuator

O&M MANUAL

EMERSON. ™
Process Management

WARNING: Use caution when working on, with, or around valves and actuators. High pressures, forces, voltages, and flammable media can be present.

WARNING: Read this manual in its entirety before installing, operating, or performing maintenance on the MPA valve actuator.

WARNING : Failure to follow instructions for proper electrical wiring, storage, setup, and maintenance may cause serious injury, damage equipment, or void the warranty. Refer to Manual E796 for instructions on storage, electrical hook-up, and maintenance.

Ensure that the installation is carried out in accordance with EN 60079-14 and IEC 60079-14.

Regulatory information:

⟨Ex⟩ II 2 GD
EEx d IIB T4 or EEx d IIB 120 degrees C (T4)
Tamb -20degrees C to +60 degrees C

Revision J

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Introduction

The Multi-Port Actuator is an EIM single turn actuator for control of multi-port flow selectors (MPFS) with 3 to 8 ports. A typical application is oil or gas well selection for well production testing as shown in Figure 1. Typically the MPA is the actuator of a Multi-Port Flow Selector as shown in Figure 2. There are applications in other processes where control of multi-port valves is required.

Figure 1 - Typical Well Test Application

Port 0 Inspection Port Selected by User
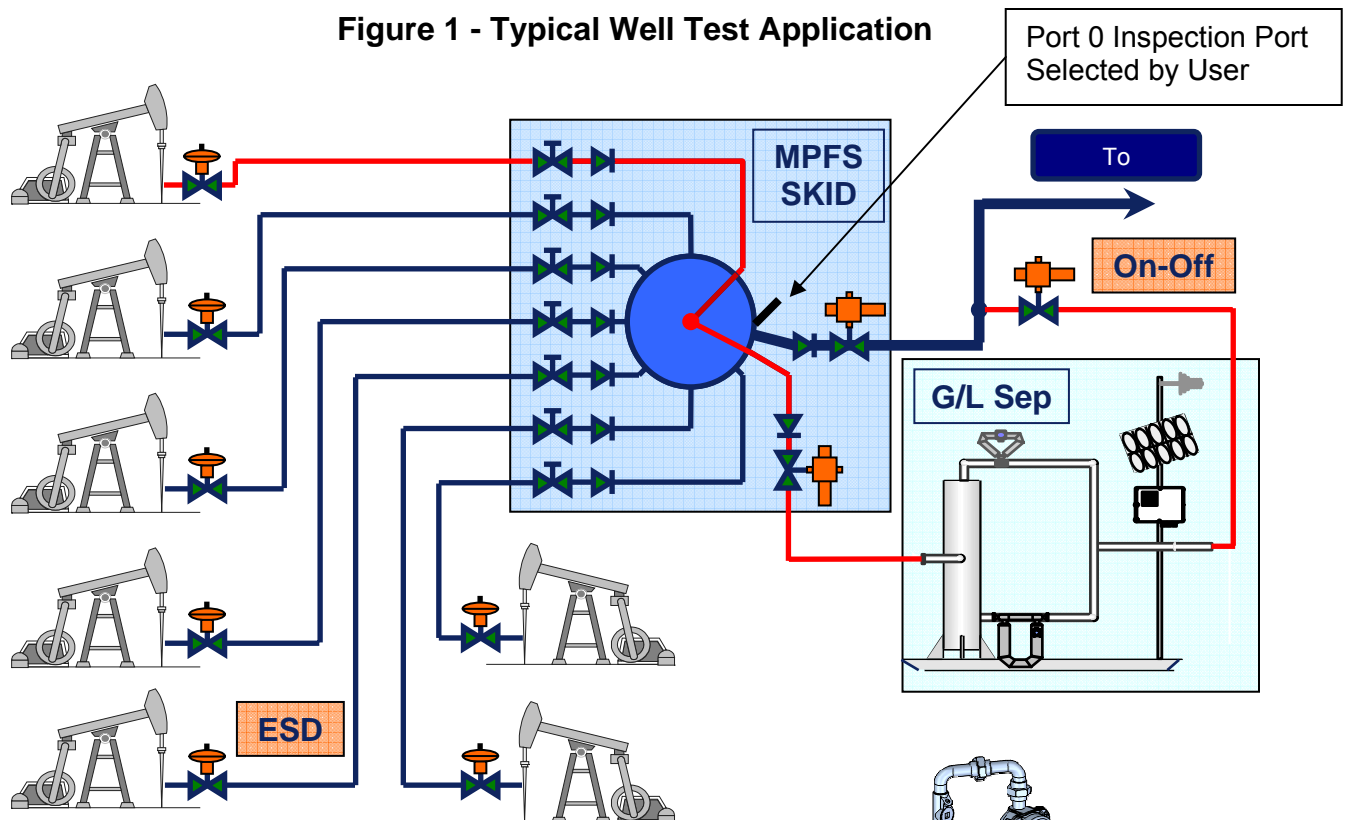
Figure 2 - MPA mounted on 6"x16" MPFS
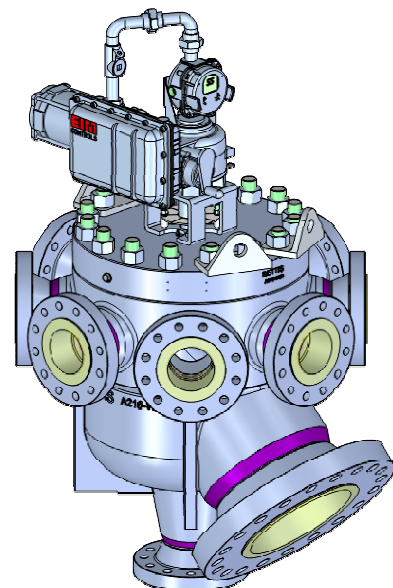
Features

The actuator features several assemblies as shown in Figure 3. Unique features of the actuator are listed below.

Figure 3 - MPA Features

Low Voltage Interfaces between CPU and TBM

Local Display Module (LDM) with Display & Status LEDs, Selector & Control Knobs, CPU Module, Network Communications, Position Encoder.

Motor (not shown)

Electrical Enclosure with Motor Starter, Control Transformer, DC Power Supplies, Power Entry, Termination Panel, User Wiring, I/O Interfaces, Torque Encoder.

Position Encoder Coupling to MPFS Stem.

EIM 3000 Ft-Lb Gearbox Geared for 1.5 RPM

MPA for Multi-Port Flow Selector

Integral Disconnect

- MPA uses EIM's heavy duty gearbox with capacity of 3000' lbs

  ♦ Wide range of motors available for any voltage and torque

- Configurable for multi-port flow selectors from 3 to 8 ports

  ♦ Any port may be selected as home port and any port(s) may be skipped
  ♦ Actuator calibrated at factory for exact match to alignment of flow selector ports
  ♦ Calibration parameters stored in nonvolatile memory and available to DCS

- 12-bit magnetic encoder coupled directly to valve stem for precision position feedback

  ♦ Provides position measurement resolution of 0.088 degrees

Features (Continued)

● EIM's exclusive solid-state motor starter and control software provides precise positioning of flow selector within ±1 degree of selected port

● High performance microcontroller updates motor control output every 4mS for precision motor control

● 12-bit magnetic encoder coupled directly to torque pinion for torque feedback

    ♦ Provides torque measurement resolution of 0.146% of full torque

● MPA supports all network protocols available with all other EIM actuators

    ♦ Modbus   RS485 Bus or E>Net ring available
    ♦ Profibus   Redundancy with Redcom
    ♦ Foundation Fieldbus
    ♦ DeviceNet
    ♦ Ethernet   Modbus TCP/IP

● I/O and alarm monitoring include:

    ♦ Integral circuit breaker/disconnect
    ♦ Motor overload and motor thermal
    ♦ Loss of control voltage
    ♦ Encoder failure
    ♦ Stall detection and alarming (detects mechanical faults)
    ♦ 3-Phase monitoring and phase correction to insure correct motor rotation
    ♦ ESD to send selector to home port (also goes to home port on fault)
    ♦ Monitor relay for hardwired relay contact status on fault

● Four models support five 8-port MPFS (Also see motor type on Page 16)

Model	MPFS	Capacity		RPM		
		Lb/Ft	Nm	1Ph	3Ph	DC
MPA 150	2x4	150	203	1.0	1.0	1.0
MPA 650	3x6 & 4x8	650	881	0.7	1.0	0.5
MPA 800	4x10	800	1085	0.6	0.9	0.5
MPA1500	6x16	1500	2034	0.3	0.5	0.3

Features (Continued)

● MPA includes local display module (LDM) standard

♦ Uses rugged, high visibility LED display for port number, torque, and alarms
  (also displays setup menus and setup parameters)
♦ Multiple color LEDs display
     - Port position within 1° of port
     - Port position within 2° of port
     - Motor running
     - Alarm
     - Over torque
     - Position within 0.25^o of home port
     - Local mode |
     - Off mode | Combined detection logic for two selector switches
     - Remote mode |
♦ Includes Local Off Remote selector switch
♦ Local control knob for Port selection and Jog control when enabled by User

Figure 4 – Local Display Module (LDM)
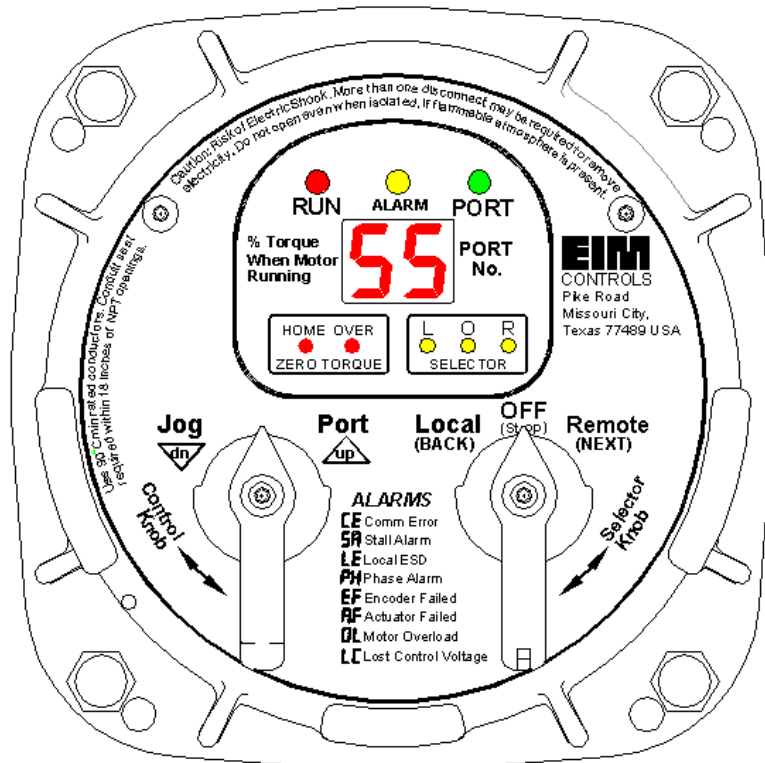
Features (Continued)

● Remote display module (RDM) option available

♦ RDM displays identical information and performs identical control as LDM
♦ EIM's patented combined switch logic allows detection of selector switch position on LDM and RDM
♦ Allows remote control up to 4,000 feet (1,220 meters) away
♦ Alarming includes loss of communication with RDM

Figure 5 – MPA with Remote Display Module (RDM)

MPA for Multi-Port
Flow Selector
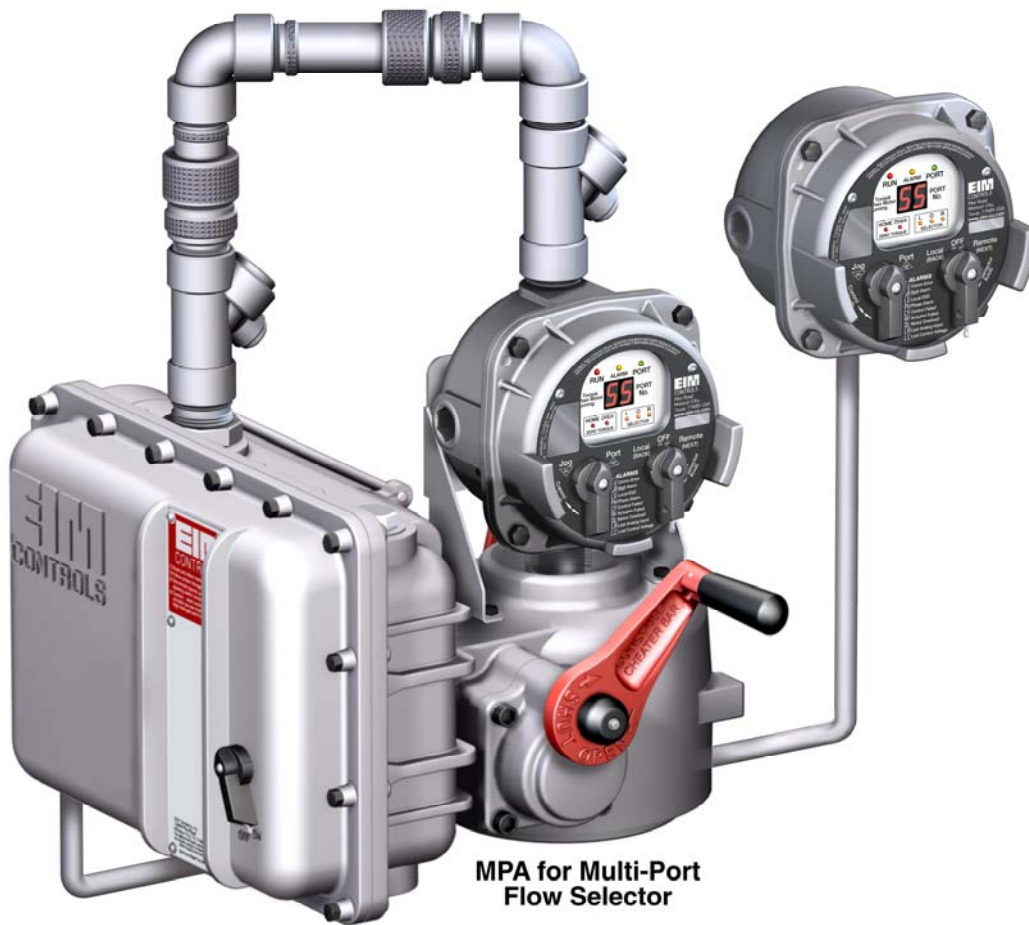
Mechanical and Electrical Installation

Do not connect power until you have gone through the following checklist

1. Does the information given on the nameplate correspond with the application?
2. Have all wire terminations and the equipotential bonding system been connected correctly?
3. EEx d applications: are the cable entries, plugs and adaptors EEx d approved?
4. Are all cable entries of the correct internal diameter providing a good seal around the cable?
5. Do the ambient and process temperatures correspond to the ratings on the nameplate as shown below?

WIRING

All user wiring terminations are made inside the Electrical Enclosure shown in Figure 3 on Page 2. Refer to wiring diagram located at the back of this manual for wiring connections. High voltage power connections are made to the disconnect/circuit breaker located inside the electrical enclosure. All low voltage connections, including network wiring, are made to the Termination Board Module (TBM) located inside the electrical enclosure. Use conduit and seals in accordance with National Electric Code (NEC) and local codes for all wiring entering the electrical enclosure.

Power Wiring

Connect power voltage leads to the circuit breaker located in the main electrical enclosure. Power wires must enter the electrical enclosure at the conduit entry on the lower right side of the enclosure to prevent water from entering. The controller provides automatic phase correction in case three-phase power is connected in the wrong phase rotation.

Network Wiring

If a single bus network connection, such as Foundation Fieldbus, is being made, connect to Network Port A at TBM terminals 24 (-) and 25 (+). If the cable is shielded, connect shield to TBM terminal 23. If redundant or repeater network connections such as EIM E>Net are being made, connect the second network to Network Port B at TBM terminals 23 (+) and 24 (-). Connect cable shield of Port B to TBM terminal 25. Cable shields are isolated from earth in the actuator. Connect shields to only one earth ground point in the network, normally the host location.

Monitor Relay Wiring

The Monitor Relay is used for hardwiring an indication of availability of the actuator for remote control. When the selector switch is placed in the Remote mode and if there are no alarms present that prevent operation, the Monitor Relay is energized. If an alarm occurs or the selector switch is moved from the Remote position, the relay is deenergized. The Monitor Relay is a Form C relay with both normally open (N.O.) and normally closed (N.C.) contacts. Wire to either TBM terminals 31 and 32 if N.O. contacts are desired. Wire to TBM terminals 32 and 33 if N.C. contacts are desired. The relay is shown on the wiring diagram in the deenergized state, meaning that the actuator is not available for remote control.

Local ESD Wiring (Emergency Shutdown)

Remove jumper between TBM terminals 27 and 28. Connect Normally Closed (N.C.) dry contacts to terminals 27 and 28. When the contacts open, ESD is activated, causing the actuator to go to Home Port. The actuator will remain at the Home Port until the ESD contacts are closed and a new command is received from either Local or Remote control. The ESD circuit is a closed loop failsafe circuit. It the circuit is opened for any reason, broken wire, bad contact, 24VDC power supply failure, etc., the ESD function is activated. The closed loop circuit is powered by 24VDC from the actuator.

Optional Remote Display Module (RDM) Wiring

Connect twisted pair RS485 cable from the RDM to TBM terminals 18 (-) and 19 (+). If the RDM is being powered from the actuator 12VDC supply, wire the power wires from the RDM to TBM terminals 16 (-) and 17 (+). The RDM is polarity protected, preventing damage, but will not operate if polarity is reversed.

LOCAL DISPLAY MODULE

Figure 6

Contains microprocessor controller, position encoder, and network interface. This is the main controller used to setup and operate the actuator.

This module displays operating parameters, port position, torque, and alarms. It also provides a means to configure the actuator by using the local controls.

To use the Local Control and Selector Knobs refer to the following table.

NOTE: Actuator moves in only the counterclockwise direction.
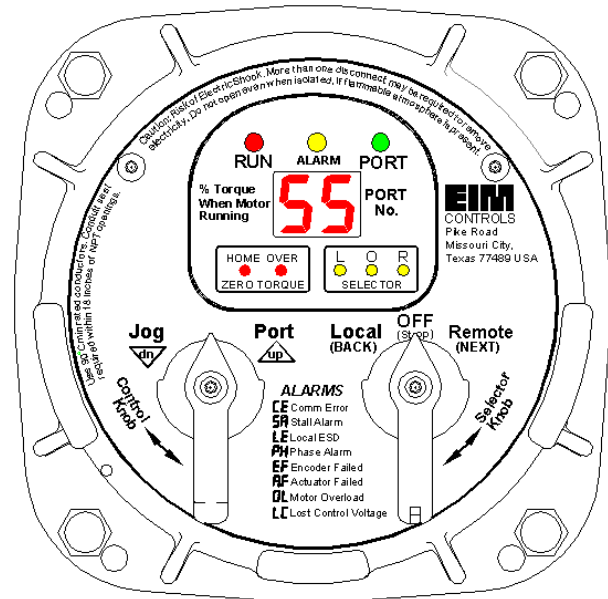
SELECTOR KNOB (right)	Rotate	Function	Results
OFF (Stop)	[return position]	Stop movement	Prevents motor operation.
REMOTE (Auto)	Clockwise	Remote control	Allows control from remote location.
LOCAL (Hand)	Counter-clockwise	Hand Operation	Allows Control from the local control knob or the control knob of the RDM, if connected.

CONTROL (while selector is in LOCAL (Hand) mode)

KNOB (left)	Rotate	Function	Results
Spring return	Neutral position	No operation	Releases a local command when Local control is used.
PORT (up)	Clockwise	Local command to go to next port.	Commands actuator to move to the next port. Momentary knob control.
Jog (dn)	Counter-clockwise	Local command to micro-step.	Commands actuator to move only while knob is being held , i.e. maintained knob control.

OPERATION

Place the "Selector Knob" in the desired operating position –

> **LOCAL** – hands on operation at the actuator by manipulation of Control Knob.

> **REMOTE** – used within the context of plant operation, i.e. Remote Control Panel, PLC, DCS, etc. See wiring diagram for typical user wiring for remote control.

> **OFF (Stop)** – to prevent local or remote operation.

Figure 7
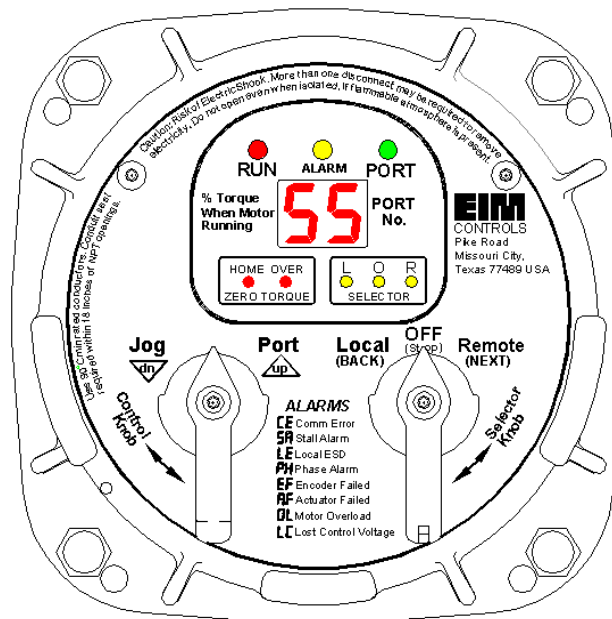
LOCAL OPERATION

Place the "Selector Knob" in the "Local" position. If a remote display is connected, the remote selector switch must <u>not</u> be in the "Off" position. Verify that the selector "L" amber light is on. The actuator may now be operated using the port and jog Control Knobs. Jog control is normally disabled and must be enabled in the setup menu.

To jog or micro-step the actuator toward the next port, rotate the control knob in the counterclockwise direction. Jog to position and release when the desired position is reached. When using jog for calibrating the actuator, always stop short of the desired port and use the hand wheel to complete accurate positioning to center of the port.

To move only to the next port, momentarily rotate the control knob in the clockwise direction to the Port position and release.

To Stop or prevent actuator movement, move Selector knob to the OFF (Stop) position.

Operational Display

Operational indicators for RUN / ALARM / PORT position use long lasting LED's. Run torque and port position are shown on the digital readout during normal operation. Torque in percent of maximum is displayed as a 2-digit number only while the motor is running. Port position is displayed as a single digit when the motor stops. If the actuator stops between two ports, the two corresponding port numbers will alternate. Torque less than 10% is displayed as 0% because torque between 0 and 10% cannot be accurately measured.

RUN LED flashes Green while the actuator is moving to the next port and flashes Red while running within 2° of the selected port position.

PORT LED flashes Green when the actuator is within 2° and outside 1° prior to the setpoint of the selected port. The port LED flashes Red when within 2° and outside 1° beyond the setpoint. The port LED illuminates steady Green while within 1° of the selected port position.

ALARM (Yellow) LED flashes when any alarm is present, otherwise it remains off.

OVER TORQUE alarm condition is indicated when a torque alarm occurs in mid-travel. The over torque LED will flash so long as the over torque condition exists.

HOME PORT LED will light when the actuator is within 0.25^o of the user selected Home Port position.

Selector switch LEDs are also made available for operational use in the bottom right corner. The selector LEDs are important when using a Remote Display Module (RDM) because these LEDs indicate the combined logic of the two selector switches, i.e. the selected mode of operation of the actuator. All three LOR LEDs flash while the actuator is in setup mode.

Alarms Display

When an alarm occurs, it is automatically displayed by the two character LED display. The yellow ALARM LED will flash while any alarm is present. The display will alternate between the current port position and the active alarm(s). If more than one alarm is active, the display will cycle through a sequence of Port Position, newest alarm, Port Position, next oldest alarm and so on until all active alarms are displayed. The cycle is continuously repeated until all alarms are cleared. Each alarm is recorded in an Alarm History. The alarm history may be viewed by entering setup mode (see next section).

All possible alarms that may be displayed are listed on the name plate of the Local Display Module (LDM). Following are definitions of the listed alarms.

CE	**Communication Error**	Lost communication with the Remote Display Module (RDM) when configured.
SA	**Stall Alarm**	Actuator failed to move within 8 seconds after commanded by either local or remote controls.
LE	**Local ESD**	Hardwired Local Emergency Shut Down is active.
PH	**Phase Alarm**	Loss of one phase when configured for 3-Phase.
EF	**Encoder Failed**	Failure of either the position or torque encoders.
AF	**Actuator Failed**	A fault is detected by hardware electronics fault monitor. This is a non-recoverable condition that requires actuator service.
OL	**Motor Overload**	Motor thermals or motor overload relay has tripped.
LC	**Lost Control Voltage**	Loss of power to the motor control circuits. The control voltage supply has an automatic resetting fuse.

> **NOTE:** *Over torque alarm is displayed by dedicated LED. See Operational Display section above.*

FIELD SETUP USING MPA Config Software

MPA Config is a Windows application for configuration, calibration, test, and operation of the MPA. MPA Config is compatible with Windows XP, Windows 7, and Vista. Connection to the MPA requires a RS485 link. It may be necessary to use a USB to RS485 converter for connection of a PC to the RDM port of the actuator. RDM port is TBM terminals 18 (-) and 19 (+). Load the software to a laptop or other compatible PC device and connect the RS485 link to the TBM in the electrical enclosure. If opening the enclosure is undesirable, configuration may be performed using the local control knobs of the actuator as described in the next section of this manual. If the system is configured for Modbus networking, the PC may be connected to the local area network at any location in the network. The MPFS factory uses this software to configure and calibrate the MPA and saves the configuration to a ".mpa" file by MPFS serial number. Should loss of factory configuration or port calibration occur due to failure of a CPU module or user error, a copy of the file may be obtained from the MPFS factory and loaded to the actuator using MPA Config Software.

Figure 8

CommSetUp

First select the CommSetUp screen shown in Figure 8 to configure the network communication link.

If connected to the RDM port, set the computer Baud Rate to 9600, Parity None and Stop Bits to 1. Set the Slave Address to 254. The RDM port configuration of the MPA is fix at 9600,N,8,1, address 254 and may not be changed by the user.

If connected to a Modbus local area network, the baud rate and slave address configured for the actuator must be known in order to setup the computer communication port. Default configuration for the MPA network port is 19,200 baud and slave address 254.

HELP: Clicking the **?** button at the top of the screen and then passing the cursor across each button will cause a description of that button to be displayed.

User SetUp Menus

Figure 9

To configure the actuator, select the User Setup Menus tab shown in Figure 9. From this screen Alarm History of the last eight accumulated alarms may be viewed. Configuration may also be viewed without a passcode. In order to change configuration, a valid passcode must be entered. Click on "Enter User Password" button near the bottom of the screen and the screen shown in Figure 10 will display. Enter the 4-digit passcode and click Enter. You may now edit configuration, including a new passcode as shown in Figure 9. If the passcode is changed, be sure it is recorded and kept in a safe place. The default passcode is 0000.

Figure 10
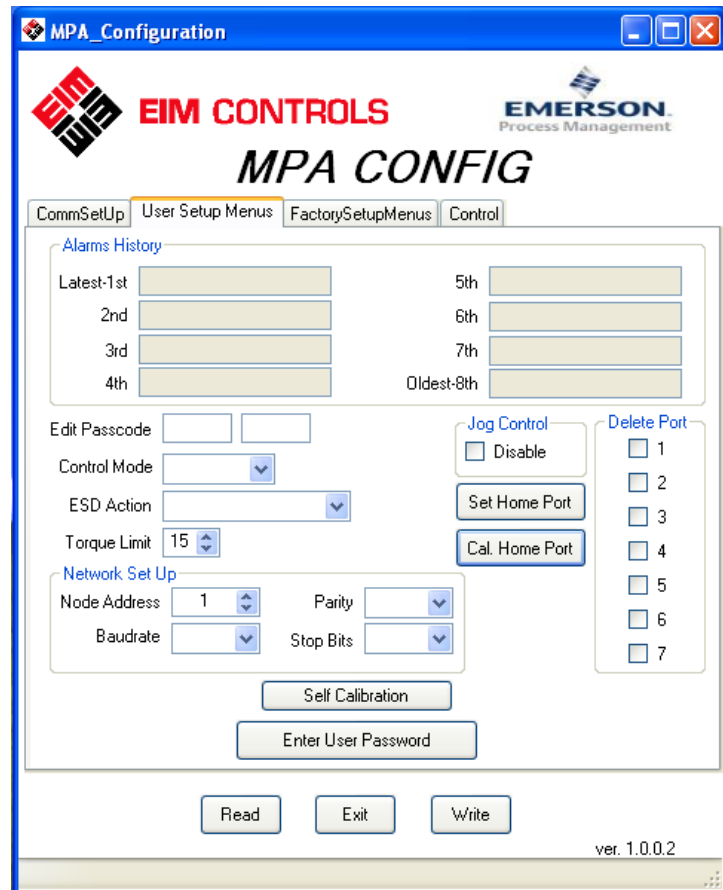
Notice: To calibrate the actuator to the MPFS load characteristics, select "Self Calibration" and place selector switch in the Local mode. This will cause the actuator to move. Wait until the actuator stops moving or pulsing before returning selector switch to Stop mode.

The Network SetUp changes configuration only for the network ports. It does not affect the RDM port. If a pipeline is not connected to any one or more ports, or if it is desirable to skip any one or more ports, click on the "Delete Port" number. The deleted ports will be skipped when a next port command is issued in either local or remote control modes.

Notice: When configuration changes are made, click the "Write" button at the bottom of the screen to transfer the new parameters to the actuator. The "Read" button may be used to refresh the screen to verify the parameters have been properly written and stored in the actuator. Do not turn off power for at least 10 seconds after changing configuration to allow the actuator to write the new configuration parameters to EEPROM.

Selecting New Home Port (HP command using Control Knob setup)

Figure 11

The User may select any port as the new "Home Port" in the field. When a new home port is selected, the new home port is identified as Port 0 and the MPA reassigns all other port numbers (1-7) in a counterclockwise sequence around the MPFS. The MPA recalculates the exact calibrated port position based on factory calibration values so no accuracy is lost.

To select a new home port, click on the "Set Home Port" button shown in Figure 9. The Pop-Up shown in Figure 11 will appear. Enter the new home port number 1-7 relative to the factory calibrated port assignments and click "Enter".

Note:

When a new home port is selected, it must be a port without piping connected and must be fitted with a blind cover to allow for future seal inspection and visual port alignment. Selecting a new home port will cause the MPA to recalculate all calibration parameters based on the factory calibration and store the new values to EEPROM.

Home Port LED Function

The home port LED on the LDM will now identify the newly selected home port position. This LED is on when the actuator is within 0.25 degrees of the selected home port. When the blind cover of the home port is removed in the field to inspect the seals, the home zero may be verified and corrected if an error is detected.

Home Port Calibration (HC command using Control Knob setup)

Figure 12

If maintenance is performed on the actuator that can cause loss of calibration, the home port must be recalibrated. Examples of maintenance that affect calibration are removal of the actuator from the MPFS and replacement of the position encoder. If a MPA is removed from one MPFS and installed on another or if a CPU module is replaced, the factory configuration (.mpa) file for the MPFS must be loaded to the new actuator and the selected home port calibrated. To calibrate the home port position, remove the blind cover from the selected home port. Use the hand wheel of the MPA to position the plug seal over the port as precisely as possible. Click on the "Cal Home Port" button shown in Figure 9. To avoid accidental setting of a new home port, the user is required to enter a passcode of 43 to gain access. A Pop-Up will appear as shown in Figure 12, providing a warning and allow entry of the passcode.

Factory SetUp Menus
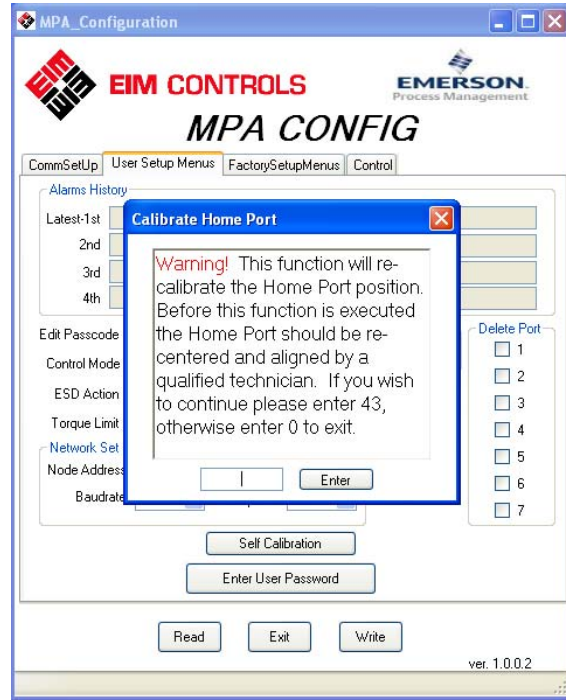
Figure 13

Factory setup configuration parameters may be viewed by the user but may not be changed. This screen requires a factory passcode before editing is allowed. The user may load or save a ".mpa" configuration file from or to a PC.

For precise MPFS port alignment, the factory calibrates each actuator to each of the ports of the mated MPFS. The calibrated values are displayed on this screen and may be compared to the current position (Encoder Feedback) to determine accuracy. When a new home port is selected by the user, these calibration values are recalculated and stored to EEPROM.
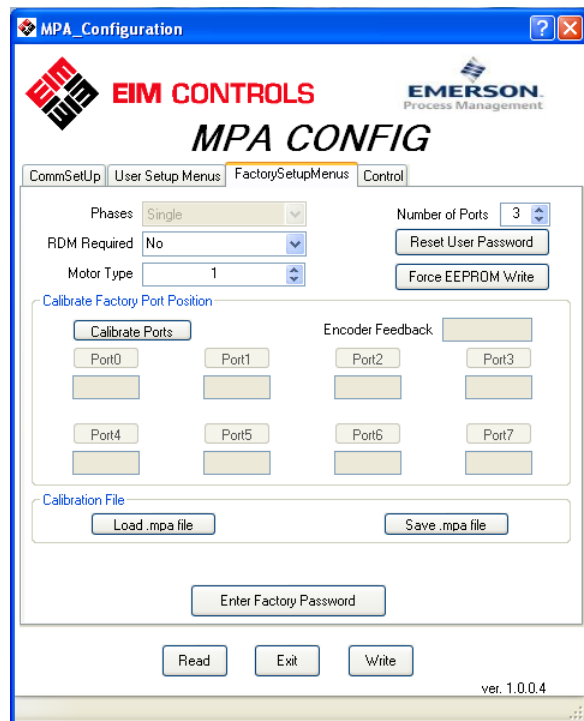
Motor Type

Motor Type is entered at the factory for the type of MPFS, power supply and motor horse power rating as shown in the table below. Motor type is displayed on the MPA Confg Factory Setup Menu for information only and cannot be edited.

Motor Type

MPFS	Motor HP	1 Ph 115 VAC	1 Ph 230 VAC	3 Ph 220/230 VAC	3 Ph 380 VAC	3 Ph 415 VAC	3 Ph 460 VAC	3 Ph 575 VAC	24 VDC
2X4	1/12	2	6	10	14	18	22	26	--------
2x4	1/6	---------	---------	---------	---------	---------	---------	---------	30
3X6	1/6	3	7	11	15	19	23	27	31
4X8	1/6	4	8	12	16	20	24	28	32
6X16	1/6	5	9	13	17	21	25	29	33
6X16	1.5	---------	---------	---------	---------	1	---------	---------	--------

NOTE: The user is not required to select motor type unless qualified to download firmware upgrade to the MPA. If a new HEX file for firmware upgrade is loaded to the MPA in the field, the motor type must be configured before the actuator will operate. When power is first applied to the MPA after a firmware upgrade, in order to know how to initialize the electronics, the Motor Type stored in the EEPROM will be examined. If a new HEX file was just downloaded, it will not yet have a Motor Type (it will be ZERO). When firmware sees that the Motor Type is ZERO, firmware will immediately go to the display entry in the Factory Setup Menu for Motor Type. The user will NOT have to move the left control knob back and forth to go to Setup Mode or enter a passcode. The user will see alternate display of "F1" and "0". The "F1" is the abbreviation for Motor Type in the factory setup menu, and the current value is 0. Then the user (who just now completed the hex file download) will have to use the left hand control knob to increment the display number to the correct Motor Type (from 1 to 33 shown in the table above). Then a move of the right hand selector knob either left or right will force an exit out of the Setup Menu in this unusual one-time circumstance after a HEX file download.

Now the firmware will examine the Motor Type and know how to initialize the electronics.

Normally when power is applied to the MPA, if it is NOT after a new download of the HEX file, the Motor Type will already be non-ZERO so the firmware will know how to initialize the electronics without forcing the user to use the knobs.

Control Screen

Figure 14

The control screen is a valuable tool for commissioning the system. All functions of the system may be tested prior to commissioning with the DCS. This screen may be used to troubleshoot any problems should they occur. Field diagnostic messages are displayed in the "Field Diagnostics Information" box. All active alarms may be viewed at a glance in the "Alarms" section of the Control Screen.

"Mode" displays the mode selected by the selector switch of the LDM or combined logic of both LDM and RDM selector switches.

"Status" displays Running or Stop state of the actuator.

"At Port" displays the port number position of the actuator and whether the MPA is at the port within 1 degree or within 2 degrees.

"Torque" is displayed as percentage of the full torque rating of the actuator. Torque is displayed from 10% to 99% in 1% increments. Torque less than 10% is displayed as zero because torque between 0% and 10% cannot be accurately measured.

"Encoder Value" is the 12-bit raw data from the position encoder in the range of 0 to 4095. This value is also displayed on the Factory Setup screen so it can be compared to port calibration value of each port.

"Valve Control" allows commanding the actuator to go to the next port or go to a desired port number. "Go to Port" is the new setpoint in the range of 0 to 7. "Current Setpoint" is the last commanded value stored in the actuator. Each time the actuator is powered up or it torques out while moving, it loads an invalid setpoint of 255 to the "Current Setpoint". This prevents the actuator from moving until a valid setpoint from 0 to 7 is entered in the "Go to Port" and sent to the actuator. If "Next Port" button is clicked while 255 is in the "Current Setpoint", then the next higher port number from the current position will be loaded to the current setpoint.
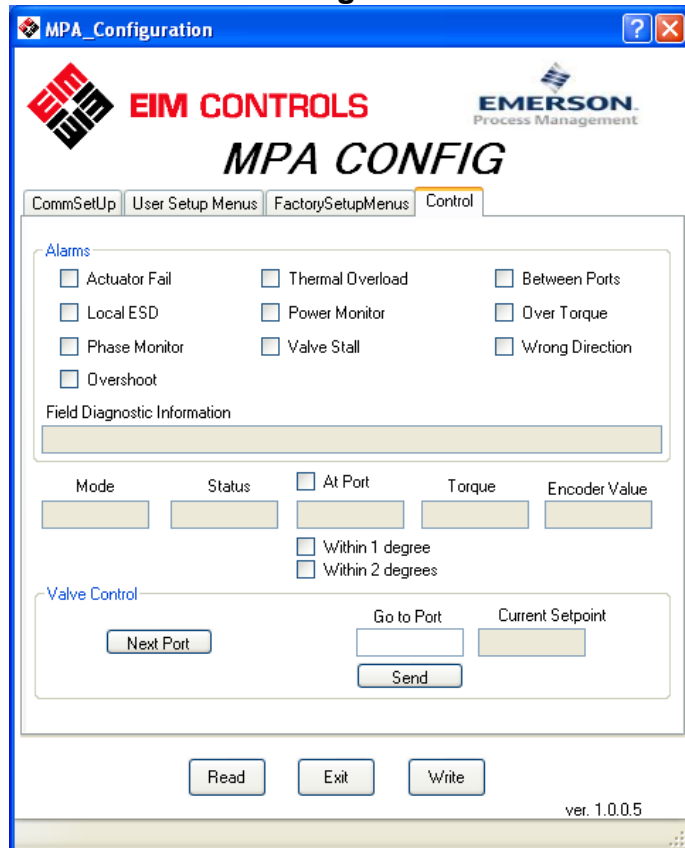
FIELD SETUP USING LOCAL CONTROLS

Use the Local Control (left) knob and Selector (right) knob to enter setup mode and to execute Setup functions. The table below outlines the knob functions for Setup mode.

To access the Field SETUP mode of operation ensure the Selector Knob is placed in the OFF (Stop) position. Once set, rotate the Control Knob to the "UP" & then to the "DOWN" position in right to left succession three times. Keep the knob in each position for at least ½ second but not more than 3 seconds. The display module will flash the (3) amber LOR selector LED's when the SETUP mode is enabled.
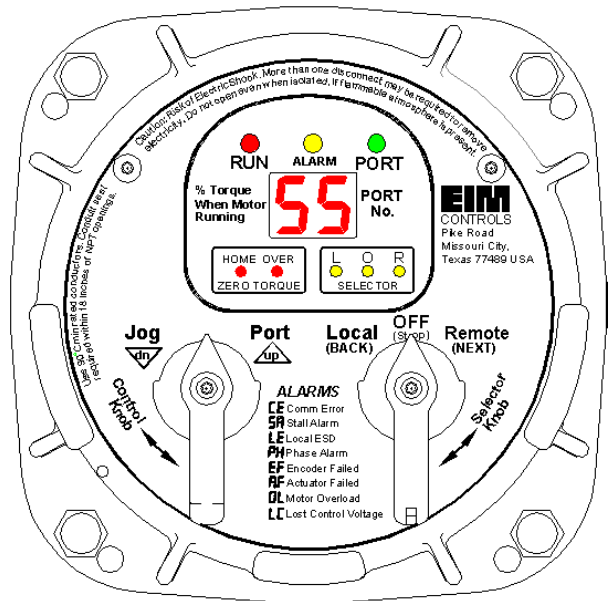
SELECTOR KNOB (right)	Setup Function	Results
OFF (Stop) [return position]	neutral position	**Allows entry to SETUP mode. Completes NEXT, or BACK entry cycle, except when knob is held for scrolling through various menus.**
Clockwise (REMOTE) (Auto)	NEXT	**Advances to the next menu item. Displayed data is accepted.**
Counter-clockwise (LOCAL) (Hand)	BACK	**Backs up to the last menu item.**

CONTROL KNOB (left)	Setup Function	Setup Results
Spring Return to Center	neutral position	**Completes UP or Down entry Cycle except when knob is held for continuous data entry update.**
Clockwise (CLOSE)	UP	**Increments displayed data.**
Counter-clockwise (OPEN)	DOWN	**Decrements displayed data.**

When the actuator LDM is placed in SETUP mode of operation it first displays the Field Diagnostics (Fd) menu item. The second menu item Alarm History (AH) menu. The field diagnostics and alarm history may be viewed without entering a passcode (See Field Diagnostics and Alarm History Display section).

NOTE: *On any setup menu, use up/down to change a parameter and back/next to accept the displayed parameter. All menus and all parameters are wrap around, meaning they will advance from the highest or last value to the lowest or first value.*

To view or change setup parameters of the actuator, Rotate the Selector Knob to the right or NEXT position to cycle through the alarm history display A1 through A8 until P1 is displayed. Alarm history (A1-A8) may be skipped by changing AH(1) to AH(0) and go directly to passcode menu. Passcode menu is displayed as two, 2-digit entries, P1 and P2. The actuator is shipped from the factory with the passcode disabled, meaning that the passcode is 00 00. Until the passcode is changed by the user, the passcode of 00 00 may be accepted by using the NEXT selector knob sequence to accept the passcode and continue to the setup menus. You will now be able to display and/or edit setup data. If you forget your configured passcode, factory trained technicians can reset the passcode back to 00 00.

NOTE: *While in the SETUP mode the actuator will not turn on the motor control circuits & disables all control of discrete outputs until exiting the Setup Mode.*

Alarm History Display

Setup always enters the main menu at the Field Diagnostics (Fd) and the next menu item is Alarm History (AH). The user may view the alarm history without having to enter a passcode. The AH menu will alternately display a value of 0 or 1. Use the Control Knob up or down to change the selection from 0 to 1 or 1 to 0. If display of the alarm history is desired, then the value must be 1. When AH with a value of 1 is displayed, use the Selector Knob REMOTE (NEXT) to advance through the alarms. If it is desirable to skip the alarm history and advance to the setup menus, use the control knob to select a value of 0 and then the Selector Knob Remote(Next) to advance directly to the P1 passcode entry. Alarms are displayed by a sequence number A1 through A8. The display alternates between the alarm sequence number (A1-A8) and the recorded alarm. A1 is the newest alarm and A8 is the oldest alarm. Use the NEXT and BACK selector positions to cycle through the alarms. Blanks are displayed for fewer than 8 alarms. The alarm history is cleared by cycling power to the actuator. If it is desirable to only display alarm history and not go into setup, use the LOCAL(BACK) selection repeatedly to back out of the alarm history and return to normal operating mode.

Setup Mode Display Sequence

The three (3) amber LED's for the LOR section flash to indicate Setup Mode. When in setup mode, the user must enter the REMOTE(NEXT) or LOCAL(BACK) within 120 seconds or the display will revert back to the normal display mode.

Setup data may be changed by using the UP & Down entries of the Control Knob. The UP and Down entries are active only after a valid pass-code is entered and the Selector Switch is in the STOP position. The default pass-code is P1 00 and P2 00. Once the correct passcode is entered and accepted at the actuator controls, the user will then be able to advance thru the displays shown in the Main Menu table on the following page.

The table on the following page shows the sequence of the setup menus. It also shows the selections, units, and defaults. Each time the REMOTE(NEXT) selector knob is selected, the display advances to the next menu item. Each time the LOCAL(BACK) selector knob is selected, the display backs up to the previous menu item. The UP and DOWN control knob is used to increment or decrement the value shown in the table.

Following is an example for changing the Torque Limit. In this example the current torque value is the default value of 60%.

1) Enter setup mode – Selector knob Off – Rock control knob back and forth until 3 selector LEDs begin to flash and Fd is displayed. When using the selector knob to advance to the next menu or back to the previous menu, always return the selector to the Off position to complete the cycle.

2) Use control knob to change the value of AH to 0 – Rotate selector knob clockwise to Remote (Next) to display P1 (1st passcode). The display will alternate between P1 and the value (default is 00). If the passcode has been changed, rotate the <u>control</u> knob clockwise to advance the display to the correct 1st passcode. Rotate the <u>selector</u> knob clockwise to advance to the next display, P2. The display will alternate between P2 and value of the 2nd passcode (default is 00). If the passcode has been changed, rotate the <u>control</u> knob clockwise to increment the display to the correct 2nd passcode.

3) Repeatedly cycle the selector knob clockwise to advance to the next menu item until C2 is displayed. This is the torque limit setting as shown in the following table. The display will alternate between C2 and the value of C2 which we have assumed to be 60.

4) Rotate the <u>control</u> knob clockwise to the "up" position to increase the torque limit setting. Rotate the <u>control</u> knob counterclockwise to the "dn" position to decrease the torque limit setting.

5) Repeatedly cycle the <u>selector</u> knob to the Remote (Next) position and the Off position to advance though the remaining menu items until the EP (Exit Program) is displayed.

6) If it is desirable to exit, use the <u>control</u> knob "up" to display a 1 value. Use the selector knob Remote (Next) to select exit. The system and display will return to normal operating mode.

Note: Use Selector Knob to select Menu and Use Control Knob to select Units

| Menu	Parameter	Value	Units	Default
Fd	Field diagnostics	0-27	Fault code	0
AH	Display Alarm History?	0-1	0=No, Skip to 1st Passcode 1=Yes, Display History	
A1	1st latest alarm	Alarm	None	
A2	2nd older alarm	Alarm	None	
A3	3rd older alarm	Alarm	None	
A4	4th older alarm	Alarm	None	
A5	5th older alarm	Alarm	None	
A6	6th older alarm	Alarm	None	
A7	7th older alarm	Alarm	None	
A8	8th older alarm	Alarm	None	
P1	1st passcode	00-99	None	00
P2	2nd passcode	00-99	None	00
C0	Control Mode	0-1	0=Discrete 1=Network	1
C1	ESD Action	0-1	0=Stop/Stayput 1=Go to Home Port	1
C2	Torque Limit	15-99	Torque in %	60
C3	Network Node Address	1-99	99 = selection of default address 254 for other protocol CAM modules.	99
C4	Network Baudrate	0-3	0=4800 1=9600 2=19200 3=38400	2
C5	Network Parity	0-2	0=None 1=Odd 2=Even	0
C6	Network Stop Bits	1-2	1=1 Stop bit 2= 2 Stop bits	1
C7	Calibrate Motor Characteristics	0-1	0=No, 1=Yes	0
C8	Disable Jog Control	0-1	0=No, 1=Yes	1
HP	Home Port (User selected)	0-7	None	0
HC	Accept Home Port Calibration	0 or 43	0=No, 43=Yes	0
d1	Delete port 1	0-1	0=No, 1=Yes	0
d2	Delete port 2	0-1	0=No, 1=Yes	0
d3	Delete port 3	0-1	0=No, 1=Yes	0
d4	Delete port 4	0-1	0=No, 1=Yes	0
d5	Delete port 5	0-1	0=No, 1=Yes	0
d6	Delete port 6	0-1	0=No, 1=Yes	0
d7	Delete port 7	0-1	0=No, 1=Yes	0
E1	Edit 1st Passcode	00-99	None	00
E2	Edit 2nd Passcode	00-99	None	00
EP	Exit Program?	0-1	0=No, Return to last menu 1=Yes, Exit	

Note: RDM port configuration is fixed at 9600,N,8,1 address 254 and may not be changed by the user. Only the network port configuration may be changed.

FIELD DIAGNOSTICS

Should trouble occur, the Field Diagnostics feature may be used to help diagnose the problem. Field diagnostics provides more detailed and definitive feedback than the alarms, i.e. possible root cause(s) for the alarm. For example, there may be many causes for an Actuator Fail alarm. Field diagnostics may be displayed by MPA Config as shown here.

Field diagnostic may be displayed by the local display by entering setup mode. In Setup Mode, the first entry is Field Diagnostics having visible code "Fd". Its value is 0 if there is no fault. If there is a fault, its code is from 1 to 27. If there are multiple faults, only the first of those faults in the following list will be seen. When that fault is corrected, the next fault will display if present.
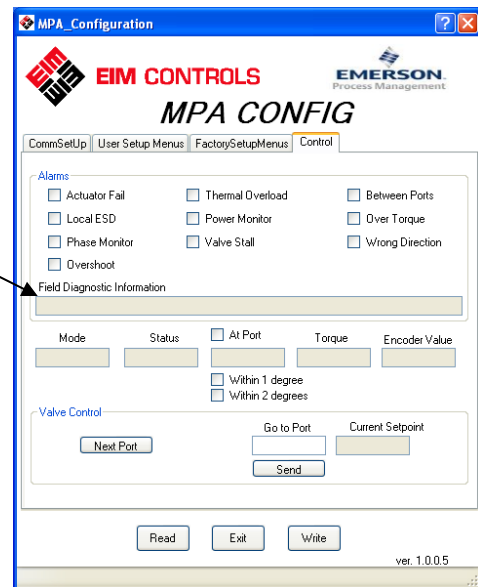
Fd Fault Codes

1 MCP23 Chip will not initialize (pertains to a three phase AC motor type)
2 Motor shaft is wired to turn in the wrong direction
3 Self-detected wiring fault (Emergency Shut Down - LE)
4 Host transmitted ESD command (Emergency Shut Down - LE)
5 Lost Phase, pertains to a three phase AC motor type - PH
6 Motor has over-heated (Motor overload - OL)
7 Stall Alarm. No motor movement after excess time of power applied - SA
8 Lost Control Voltage (Loss of power for motor control - LC)
9 SPI communication failure for GPA chip
10 AUX feed-back alarm
11 Three consecutive overshoots of the port
12 RDM is not communicating and is required (Communication Error - CE)
13 No input from Torque Encoder. Check for cable connection problems or encoder failure
14 Torque OCF bit is low. Power supply to the Torque Encoder is likely at fault
15 Encoder reports that Torque Encoder value is invalid
16 Torque Encoder Parity error
17 Torque Encoder Magnet is out of range
18 Over-Torque. Torque value is greater than the Torque Limit
19 Value from the Torque Encoder is out of range (invalid instead of over-torque)
20 No input from Position Encoder. Check for cable connection problems or encoder failure
21 Position OCF bit is low. Power supply to the Position Encoder is likely at fault
22 Encoder reports that Position Encoder value is invalid
23 Position Encoder Parity error
24 Position Encoder Magnet is out of range
25 Encoder Position inconsistent consecutive times. Expect Position Encoder problem
26 Stopped between ports (non-critical)
27 Port 0 is the last port reached (stopped at Home Port, non-critical and may be normal operation)

REMOTE NETWORK CONTROL

Modbus RTU

The native language of the MPA is Modbus RTU. If other network protocols such as Foundation Fieldbus are used, a Communication Adapter Module (CAM) module is installed to translate between the selected protocol and Modbus. The controller supports Modbus function codes 01,02,03,04,05,06,15,16. Following are the memory maps for discrete I/O and unsigned 16-bit Holding registers used in this application. All memory maps shown are zero based.

Discrete Input Map (Valve Status and Alarms)

Bit	Input	
0	16	At commanded port within 1 degree
1	17	At commanded port within 2 degrees
2	18	Flow selector moving
3	19	Wrong direction alarm
4	20	Selector switch Local/Manual Mode
5	21	Selector switch Remote/Auto Mode
6	22	Over torque alarm
7	23	Stop between ports alarm
8	24	Flow selector stall alarm
9	25	Power monitor alarm
A	26	Motor thermal overload alarm
B	27	Phase monitor alarm
C	28	Local ESD alarm
D	29	Actuator fail alarm
E	30	No input (always zero)
F	31	Unit alarm (above alarms are OR'ed)

These same status and alarm bits are duplicated in Modbus Registers 01, 06, 09 in the same bit sequence shown above.

Coil Map (Discrete Network Control)

There are only two coils used for discrete network control as follows. When Coil 10 is set by the host, the actuator resets the coil automatically when the command is executed. When Coil 11 is set, the host must reset the coil before the actuator will respond to any other command.

Coil
10   Go to next port
11   Host ESD command, Go to Home Port

Holding Register Map

These are the recommended registers to use. Other registers are active but the user is cautioned not to use the data or write to any other registers.

<div align="center">Monitor and Control Registers</div>

Register
01	Actuator status and alarms in the bit sequence shown for the input map
06	Actuator status and alarms in the bit sequence shown for the input map
07	Port position (0-7)
09	Actuator status and alarms in the bit sequence shown for the input map
11	Port position Setpoint (0-7) (Data must be a single digit between 0 and 7)
13	Raw 12-bit position encoder value (0-4095)
14	Port position (0-4095)
15	Torque (0-4095)

<div align="center">Configuration and Calibration Registers</div>

Register
211	Port 0 calibration value (0-4095)
212	Port 1 calibration value (0-4095)
213	Port 2 calibration value (0-4095)
214	Port 3 calibration value (0-4095)
215	Port 4 calibration value (0-4095)
216	Port 5 calibration value (0-4095)
217	Port 6 calibration value (0-4095)
218	Port 7 calibration value (0-4095)

WARNING: *Extreme caution must be used when writing port calibration values to registers 211 through 218 (40212 thru 40219). Only values read from these registers shall be written to them. The purpose of these registers is to allow the network host to store the port calibration values and then write them back to the actuator in case of replacement of the CPU module.*

Foundation Fieldbus (FF)

The MPA uses a CAM18 to convert between Modbus and Foundation Fieldbus. Refer to M2CP CAM18 & TEC2000 CAM218 Installation, Operation and Instruction Manual for installation and setup of the FF link. Relations between the Modbus and FF maps are identified as follows.

Modbus Discrete Input Map

Foundation Fieldbus
Actuator Readback (Channel 2)
Note: Channel 2 has only 1 value

Input		DI PV / Out_D
16	At port within 1 degree	1
17	At port within 2 degrees	2
18	Flow selector moving	4
19	Wrong direction alarm	5

Modbus Discrete Input Map

Actuator Status (Channel 5)
Note: Channel 5 has only 1 discrete value and depends upon Selector Switch position.

		DI PV / Out_D		
Input		AUTO	OFF	LOCAL
20	SS Local/Manual			3
	Selector Switch Off		2	
21	SS Remote/Auto	0		
22	Over torque alarm	60	62	63
23	Stop between ports alarm	56	58	59
24	Flow selector stall alarm	9	11	12
25	Power monitor alarm	28	30	31
26	Motor thermal overload alarm	20	22	23
27	Phase monitor alarm	36	38	39
28	Local ESD alarm	40	42	43
29	Actuator fail alarm	44	46	47

Coil Map (Discrete Network Control)

Actuator Command (Channel 1)

Coil		DO SP / Out_D
10	Go to Next Port	1

Coil Map (Discrete Network Control)

ESD Command (Channel 10)

Coil		DO SP / Out_D
11	Host ESD Command	1

Monitor and Control Registers

Analog input / Output Channels

Register			
11	Port Position Setpoint (0-7)	Setpoint AO (Channel 3)	SP / OUT
14	Port position (0-7)	Position AI (Channel 4)	SP / OUT
15	Torque (0-99%)	Torque AI (Channel 18)	SP / OUT

Modbus
Configuration and Calibration Registers

Foundation Fieldbus
MAO (Channel 19)   MAI (Channel 20)

Register		Parameter	Parameter
211	Port 0 calibration	IN_1	OUT_1
212	Port 1 calibration	IN_2	OUT_2
213	Port 2 calibration	IN_3	OUT_3
214	Port 3 calibration	IN_4	OUT_4
215	Port 4 calibration	IN_5	OUT_5
216	Port 5 calibration	IN_6	OUT_6
217	Port 6 calibration	IN_7	OUT_7
218	Port 7 calibration	IN_8	OUT_8

Note: Input and Output parameters are the number of hardware registers that are connected to the I/O block. They define the transducers to be used going to or from the physical world.

WARNING: *Extreme caution must be used when writing port calibration values to registers 211 through 218. Only values read from these registers shall be written to them. The purpose of these registers is to allow the network host to store the port calibration values and then write them back to the actuator in case of replacement of the CPU module.*

Profibus DP Redundant Networks with Redcom

The MPA uses CAM20 to convert between Mosbus RTU and Profibus DP. This section describes the data mapping between the Profibus DP host and MPA Modbus map. The mapping allows the Profibus DP host to control the Flow Selector and monitor the actuator status. The control information is mapped directly to words in the Profibus Output data and status information is mapped directly to words in the Profibus Input data.

Output Data

Location		Bit							
Word	Byte	7	6	5	4	3	2	1	0
1	1	Not used	Not used						
1	2	Not used	Not used	Not used	Not used	Host ESD Command	Go to Next Port	Not used	Not used
2	3	Flow Selector Port Position Setpoint (0-7) Single Bit							
2	4								
3	5	Not used							
3	6								

Input Data

Location		Bit							
Word	Byte	7	6	5	4	3	2	1	0
1	1	Not used	Not used	Not used	Not used	Not used			Actuator Fail Alarm
1	2	Not used		Not used	Not used	Host ESD Monitor	Not used		
2	3	Unit Alarm	Not used		Local ESD Alarm	Phase Monitor Alarm	Motor Thermal Alarm	Power Monitor Alarm	Flow Selector Stall Alarm
2	4	Stopped Between Ports	Over Torque Alarm	Selector Remote / Auto	Selector Local / Manual	Wrong Direction Alarm	Flow Selector Moving	Within 2 degrees of port	Within 1 degree of port
3	5	Flow Selector Position (0-7) Single Bit							
3	6								
4	7	Torque (0-99%)							
4	8								
5	9	Not used							
5	10								
6	11	Not used							
6	12								

DeviceNet

The MPA uses CAM09 to convert between Modbus and DeviceNet. This section describes the data mapping between the DeviceNet host and MPA Modbus map. The mapping allows the DeviceNet host to control the Flow Selector and monitor actuator status. The control information is mapped directly to words in the DeviceNet Output data and status information are mapped directly to words in the DeviceNet Input data.

Output Data

Location		Bit							
Word	Byte	7	6	5	4	3	2	1	0
1	1	Not used				Host ESD Command	Go to Next Port	Not used	
	2	Not used							
2	3	Flow Selector Port Position Setpoint (0-7) Single Bit							
	4								
3	5	Not used							
	6								

Input Data

Location		Bit							
Word	Byte	7	6	5	4	3	2	1	0
1	0	Not used		Not used	Not used	Not used	Not used	Not used	Not used
	1	Not used	Not used	Not used	Not used	Not used			
2	2	Stopped Between Ports	Over Torque Alarm	Selector Remote / Auto	Selector Local / Manual	Wrong Direction Alarm	Flow Selector Moving	Within 2 Degrees of Port	Within 1 Degree of Port
	3	Unit Alarm	Not used	Actuator Fail Alarm	Local ESD Alarm	Phase Monitor Alarm	Motor Thermal Alarm	Power Monitor Alarm	Flow Selector Stall Alarm
3	4	Flow Selector Position (0-7) Single Bit							
	5								
4	6	Torque (0-99%)							
	7								
5	8	Not used							
	9								
6	10	Not used							
	11								

EC Declaration of Conformity
Emerson Process Management Valve Actuation, LLC

Emerson Process Management Valve Actuation, LLC declares under our sole responsibility that the product(s) listed below conform with the relevant provisions of directive 94/9/EC of 23 March 1994.

Products: Series 2000 Valve Actuators

Notified Body: Sira Certification Service (0518)
                   Rake Lane, Eccleston, Chester, CH4 9JN, England

Conformity has been demonstrated with reference to the following documentation:

EC type-examination certification Sira 03ATEX1424, Issue 2 (March 9, 2010)

Compliance with Essential Health & Safety Requirements has been assessed by reference to the following standards:

> EN 60079-0:2009
> EN 60079-1:2007
> EN 60079-31:2009

Actuators conform to the requirements of the European Economic Community EMC Directive 89/336/EEC as amended by 92/31/EEC

Actuators conform to the requirements of the European Economic Community Low Voltage Directive 73/23/EEC amended by 93/68/EEC.

_____   12/5/10
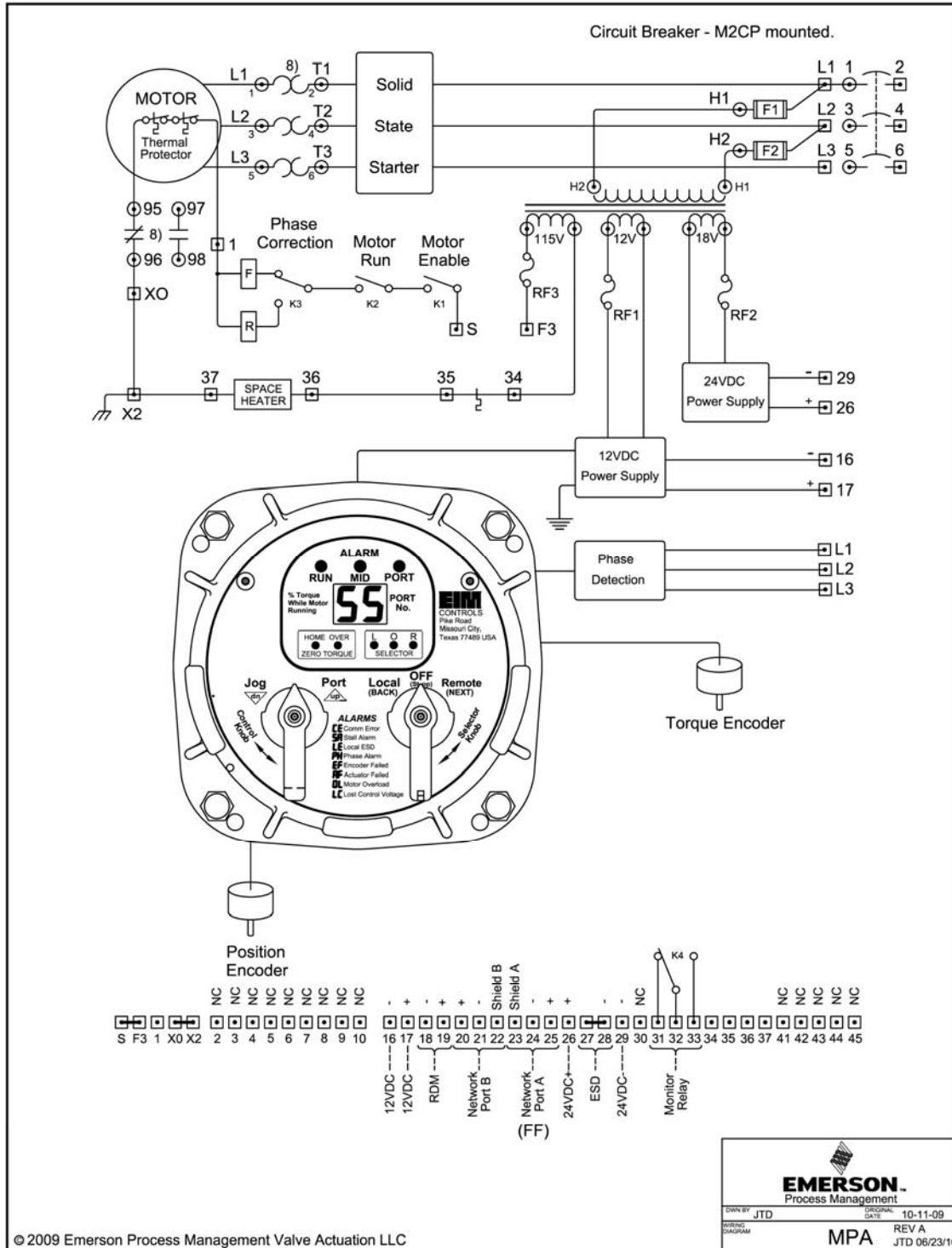Steve Farmer, Engineering Manager   December 15, 2010

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Eastern Hemisphere Sales
Emerson Process Management Valve Actuation, LTD
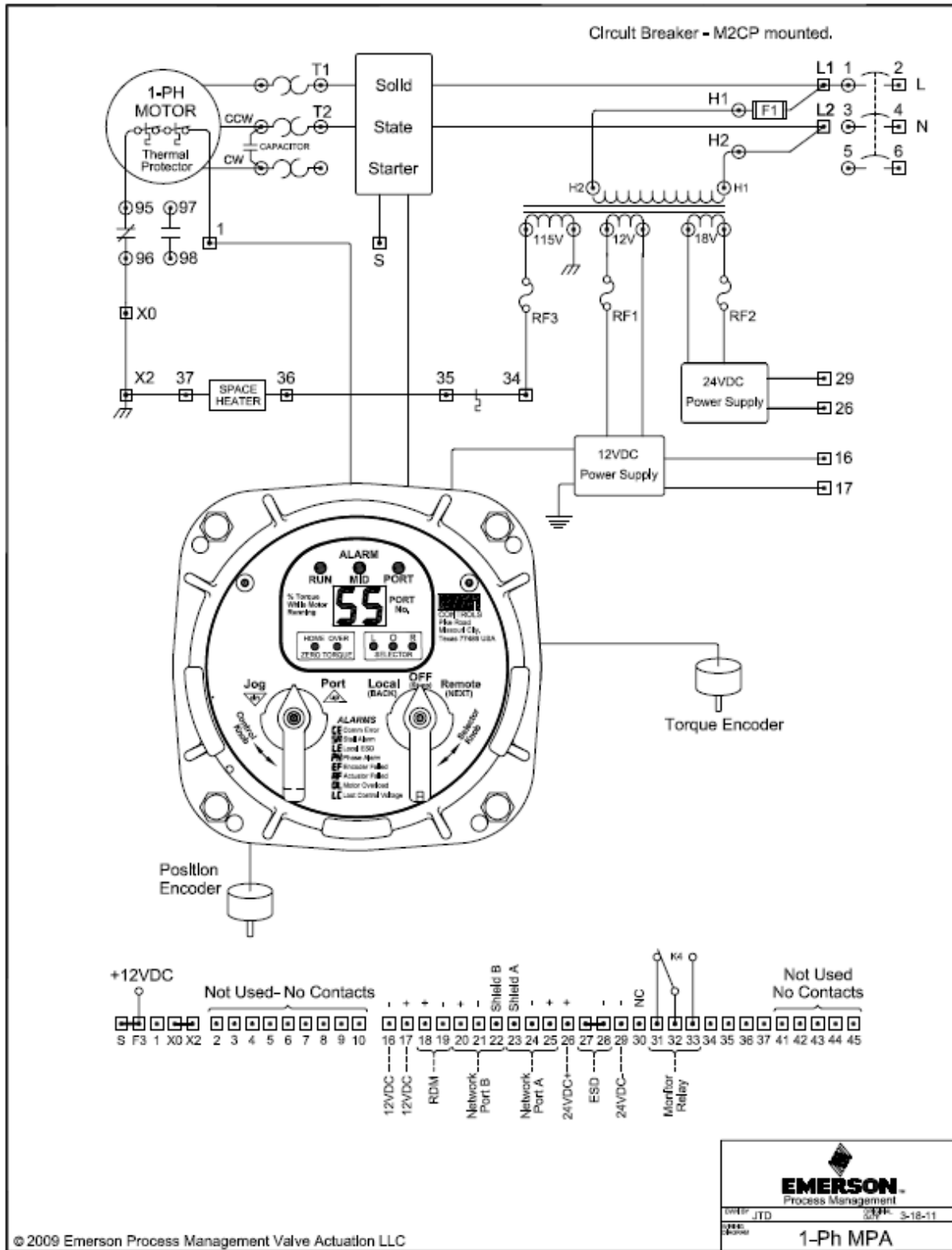**6-7 Galaxy House, New Greenham Park, Newbury, Berkshire RG19 6HW England**

WIRING DIAGRAM

Three Phase Power

WIRING DIAGRAM

Single Phase Power

WIRING DIAGRAM

24VDC Power