PROMATION ENGINEERING

Precision Actuation for Industry

Installation & Operation Manual

This IOM is for the following ProMation Engineering Products:

P13-120PN4
P13-230PN4

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Field Manual
P13 HV PN4
Proportional Control
ISO5211 F25 R72

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Product Specifications

Actuator Specifications	P13	
Torque "lb/Nm	**40000"lbs/4500Nm**	
Supply Voltage	120vac	230vac
Max Inrush Current	8.0A	4.8A
Running Current	3.5A	1.8A
Motor	Split Phase Capacitor	
Runtime (90°@60Hz/vdc)	80 sec	
Runtime (90°@50Hz)	95 sec	
Duty Cycle	30%	
Motor Starts	1200 per hour	
Weight	240lbs/109kg (245lbs/111kg w/ -TS)	
Mechanical Connections	ISO5211 F25 Rnd 72mm	
Electrical Entry	NEMA 4/4X/IP67	
Electrical Terminations	12-16ga	
Environmental Rating	NEMA 4/4X	
Manual Override	15.6" Handwheel	
Control	On/Off-Jog	
Actuator Case Material	Aluminum Alloy, Powder coated	
Motor Protection	230°F/110°C Thermal F* Class *Totally Enclosed Non-Ventilated Motors	
Ambient Temperature Operating Range	-22°F to +125°F -30°C to +52°C	

Introduction

This document provides necessary information for set-up, calibration, testing and use of the P Series quarter-turn electric actuators stated on the cover page. Each unit is shipped from the factory with initial calibration of mechanical stops, cams and switches completed for 0-90 degree operation. However, these are general settings and serve as a starting point for proper calibration of the actuator in its real-world application.

Safety

Safety is a basic factor any time you maintain and operate mechanical equipment. Appropriate handling methods and proper use of tools and personal protective equiptment (PPE) can help prevent serious accidents which can cause injuries to you or a fellow worker. This manual was created to enable a trained user to install, adjust and troubleshoot your ProMation actuator.

Only competent and trained personnel should install, maintain and operate ProMation actuators. Any work related to this actuator must be carried out in accordance with this manual and related codes and regulations. Local workplace health and safety rules must always be followed.

Duty cycle

Duty cycle is the percent of time that an actuator spends running as a fraction of the total time. Duty Cycle is directly related to heat; excessively repositioning an actuator typically results in motor overheating which can cause permanent damage and/or reduced service life.

Duty cycle can be calculated as follows:
(example P2 series actuator running 3 seconds ON and 30 seconds OFF)
Runtime = 3s, Total time = 3s + 30s = 33s, therefore this duty cycle would be 9% (3/33)
Additionally, ProMation P series actuators are designed for a maximum of 1200 starts per hour (one start every 3 seconds maximum).

Shipping and Handling

1. This actuator is shipped in the FULLY CW position (2 color position indicator shows "CLOSE" and the Reference Dimple aligns with "0"). (The "1" mark is the FULLY CCW position).

2. ***NOTE, THIS ACTUATOR MUST HAVE WATER TIGHT EMT FITTINGS, WITH CONDUIT DRAINAGE INSTALLED AND POWER SUPPLIED TO UNIT TO KEEP THE HEATER WARM AT THE TIME OF INSTALLATION.***

3. **Storage: This unit should NOT be stored outside unless it is powered up and has proper conduit terminations. When NOT powered up, it should be stored in a clean, dry environment at all times.**

4. This actuator has been **factory calibrated to operate between 0 degrees and 90 degrees. Most quarter-turn products will not require recalibration of these settings.** If any travel adjustment is necessary, please refer to pages 7-13 for instructions.

5. ***The actuator CANNOT operate with a rotation greater than 95 degrees.***

The actuator is shown in its fully CW position. This view of actuator showing the two drive keyways machined into the female drive socket.

Product Mounting and Setup

1. Fully CLOSE the valve or damper to which the actuator is to be mounted.
   - Keep in mind this actuator rotates CW (as viewed from above the unit) when driving CLOSED.
2. Assemble necessary linkage components and attach the actuator to the driven device.
3. Tighten mounting bolts, making sure actuator is centered on the device drive shaft.
4. Utilize the handwheel to check for unobstructed manual operation from fully CCW to fully CW positions BEFORE applying power to the unit.
5. Make the electrical connections per wiring diagram on page 4.
   - Connect POWER to terminals marked 1 and 2.
   - Actuator accepts a 4-20mA (default), 0-10VDC, 1-5VDC, or 2-10VDC signal.
   - Connect CONTROL wires on the control card (430-10102) to terminals marked ANALOG: IN and COM. The positive wire MUST connect to IN or the controller will not function.
   - Wires may be connected on the control card (430-10102) to ANALOG: Out and COM for remote position sensing.
   - Terminals 7-12 on the switch card (430-10100) are for the (adjustable) aux switches. They are dry type Form C rated 10A @ 250vac MAX.
   - The drain wire on the signal cables must be grounded at ONE END ONLY! (Preferably at the supply end).
6. Do NOT apply power at this time.

Installation Notes

- These actuators are designed to be used between a horizontal and upright position. Do NOT mount the assembly with the actuator top below a horizontal position.
- When installing conduit, use proper techniques for entry into the actuator. Use drip loops to prevent conduit condensate from entering the actuator.
- Mechanical travel stops are factory calibrated for 90 degree operation. These stops are NOT designed to adjust mechanical rotation by more than +/- 3 degrees, they are for positioning the handwheel only.
- Both NPT conduit ports MUST use proper equipment to protect the NEMA 4X integrity of the housing.
- The internal heater is to be used in ALL applications.
- Do NOT install the actuator outdoors or in humid environments unless it is powered up and the heater is functioning.
- Use proper wire size to prevent actuator failure (see chart on page 4 for proper wire sizing).
- All terminals accept 12-16AWG solid/stranded wire.

Identifying Torque Switch Units:
- -TS in Product Name on label.
- Units with Torque Switches have additional switches mounted on the motor plate (see photo).

Profibus Control

Items within dotted line located inside actuator housing

430-10100 Switch Card

NOT OPEN*
OPEN COM*
OPEN*
* CONNECTIONS OPTIONAL
NOT CLOSED*
CLOSED COM*
CLOSED*

AUXILIARY SWITCH (STANDARD) SW4

AUXILIARY SWITCH (STANDARD) SW3

Direct Mount Heater
410-50100
TL25-1800
E2   E1

ALL SWITCHES SHOWN WITH ACTUATOR IN FULL OPEN POSITION

12
11
10
9
8
7
6 GRY RUN OPEN
5 SW2
4 RUN CLOSED SW1 J1
3
2 NEU HEATER E2 E1 J3
1 HOT J2

120VAC LINE IN

BRN
BLU
GRY
RED
ORG
WHT WHT THERMAL SWITCH
BLK BLK
Capacitor 410-30100 12uF/250v
120V AC Motor 410-20100 (P2/3)
M

GND
GND Screw

MAX 5A/250V
1 2 3 4 5 6 7 8 9 10
Closing Opening Tripped Input
Closed Limit Open Limit Input Pin 9 Input Pin 10 Tripped
Run/Error Setup
Current Sensor on DCP120 Controller

Pot Connector
Full Open Manual Open
Full Closed Manual Close

ProfiBus Active
ProfiBus Address
OFF ON 5 4 3 2 1
+1 +2 +4 +8 +16 +32 +64 OFF

Earth Ground

Terminator (by others) DP Compliant

Field wiring and devices by others

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Wire Sizing Chart

Wire Sizing Data

Wire sizing data is provided in the table to assist in the selection of the proper wire size for ProMation P series actuators using various wire sizes over distance.

Please make sure to reference the correct voltage and do not exceed the indicated length of the wire run for each model.

Actuator	MAX distance between Actuator and Supply (feet)	
	P13	
Voltage	120VAC	230VAC
Wire Gage \ Amps	8.0A	4.8A
16	-	519
14	262	838
12	401	1281
10	682	2178
8	1018	3251

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Profibus Controller:

Overview

ProMation mAC112 / DPC120 actuator controller is designed for use with a broad range of dual acting and spring return actuators.The position transducer can be a potentiometer or a quadrature optical encoder. The internal Analog to Digital (A-D) converter has 12 bit resolution allowing for position accuracy's of up to 0.1%.

The controller is a fully compliant Profibus DP Slave. It is certified by the PTO under certificate Z00522. The current device GSD file is CMC_088E.GSD, Release date: December 29, 2004. The release information is contained in the file header.

Description of Terminals, Operators and Indicators
MAC112 / DPC120 Actuator Controller
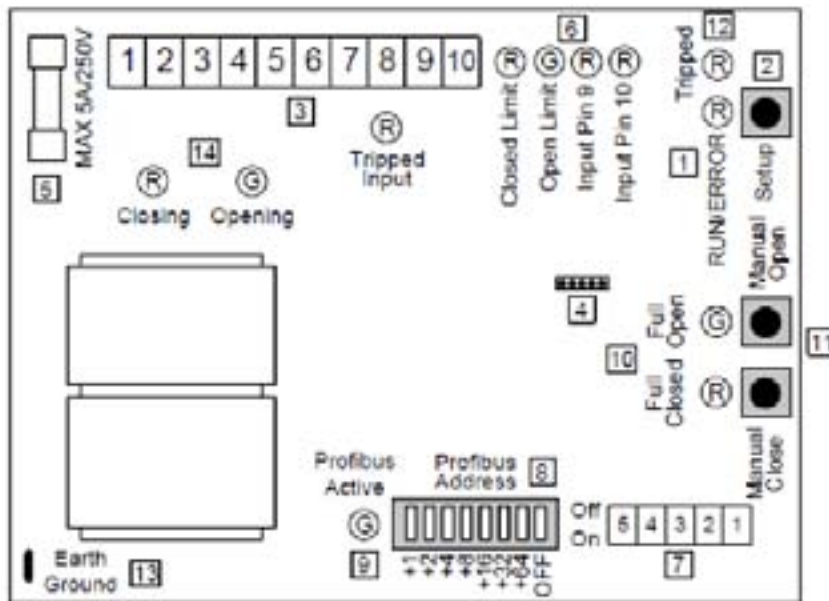
Figure 1 - Terminals, Operators and Indicators

ID	Label	Description
1	**RUN/ERROR**	
	1 / sec -	Controller operating normally
	3 / sec -	Calibration in progress
	10 / sec -	Controller in fault
2	**SETUP**	Pressing while running starts a self calibration cycle Pressed during power-up reloads factory default values Pressed when in manual operation returns controller to remote operation

3	**AC TERMINALS**	AC Field wiring. See "AC Wiring" section.
4	**POT/OPTO**	Connect potentiometer or quadrature optical encoder tothese terminals. See "Position Translator" section.
5	**FUSE HOLDER**	Size fuse to load, maximum fuse 5A / 250VAC
6	**INPUT STATUS LAMPS**	Open, close and general purpose input status lamps. Lamp is on when 120VAC input voltage is applied to input terminal
7	**PROFIBUS TERMINALS**	Profibus network connections, see "Profibus Communications" section.
8	**PROFIBUS ADDRESS**	Controller address selector, add values assigned to "on" switches to determine controller address
9	**PROFIBUS ACTIVE**	Profibus master is connected and active
10	**INPUT STATUS**	Fully open and closed limit switch lamps. In auto operation these lamps indicate when the gate is fully open or fully closed. In manual operation the lamps flash indicating manual operation.
11	**MANUAL OPERATORS**	Push button open and closed manual operators. If either button is pressed, the controller will no longer respond to remote commands. The actuator will open while the OPEN pushbutton is pressed and CLOSE while the CLOSED pushbutton is pressed. Limit switches remain active and will stop rotation active. To terminate manual operation, press the setup push button momentarily.
12	**TRIPPED INDICATOR**	Indicates that the tripped input has been energized. Actuator movement is stopped.
13	**EARTH GROUND**	Earth ground connection using ¼" spade terminal. Indicators for the controller outputs.
14	**OUTPUT INDICATORS**	Running Open / Running Closed

Profibus Communications:

The controller is a fully compliant Profibus DP slave device. Connection is by the 5 position terminal strip. The optional mTB003 Field Wiring Interconnect allows the separate termination of the in and outbound cables. Switches are provided to allow the disconnection of connected controller as well the ending and termination of the bus at this controller. It is recommended that the mTB003 be used for Profibus termination.


Figure 4 – Profibus Connections
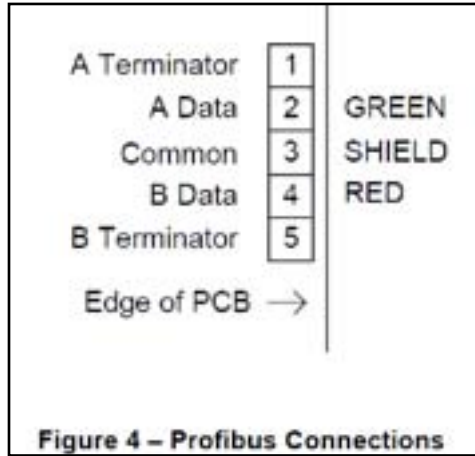
The mTB003 includes a shield grounding kit. The connection of the shields to ground at each controller is optional. All shields should be connected in the same way. If grounding is selected, all shields should be grounded at each controller. If an ungrounded shield system is selected, the shield should only be connected to ground at one end of the cable.

Figure 5 – mTB003 Connections

Set the Profibus address by turning on the switches whose sum equals the required address. Power must be cycled after address selection.

FM_P213 HV PN4 PFB Ver B 121922
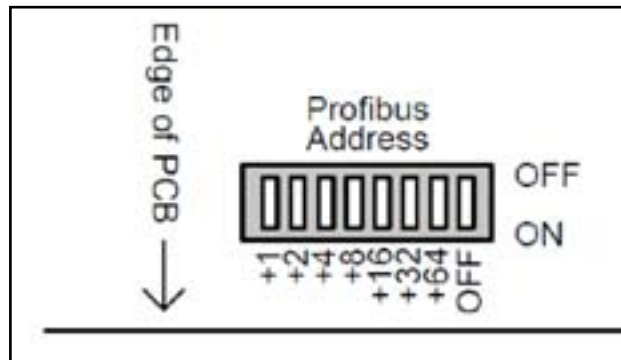
Profibus Communications:

The operation and accuracy of the controller is determined by user configurable parameters. This section describes each of these parameters and the effect they have on the operation of the controller.

Controller parameters on a Profibus system are set during the network configuration procedure. The GSD file provides the configuration software with a description of each of the controller's parameters. Before setting up and configuring your Profibus network determine which of the controller parameters requires setting. Then during network setup, use the network configuration tool to set the required parameters.

The advantage to a Profibus network is that if a controller is replaced on the network, the required operating parameters are automatically transferred to the controller each time the controller goes online.

Some parameters are automatically set during calibration. These parameters have their preset value in the GSD file set to 65535 (0xFFFF) or 255 (0xFF). This value indicates to the controller, that it is to ignore the the parameter value from the Profibus Master and use the value determined during the calibration procedure.

These default calibration values can be changed, however the controller will no longer retain its automatic calibration values. Further discussion of this issue is included in the "Calibration" section of this manual.

Some parameters are arrays of bit flags. The configuration software will automatically select the correct bits based on Yes/No configuration settings.

Reloading Factory Default Values

There are two methods to restore the controller's parameters to the factory default values.

Using the SETUP Push Button

Pressing and holding the SETUP push button during a power-up sequence will restore factory default values. The RUN/ERROR indicator will flash at a 10/sec rate when the parameters have been reloaded.
Power should be cycled after a factory reload procedure. Note that these values will be overwritten the next time the controller comes online through
the Profibus network.

The Default Values

The default values are overwritten whenever the controller is connected to the Profibus Master. Once connected, the master's parameters are saved in non-volatile memory in the controller and become the operating parameters. See Appendix 1 – GSD Files for further details. The default values described in the parameter descriptions are the defaults from the latest GSD file. The following factory values will be loaded and remain in effect until a Profibus connection is established:

PARAMETER	VALUE
Zero offset	0
Span factor	101
Open setback	0
Close setback	0
Seek tolerance	1
Full scale value	100
Maximum load current	200
Idle load current	5
Jog movement tolerance	1
Load zero offset	300
Load span factor	2038
Profibus failed position	0
Update time	1
Turn around time	10
Command failed time	120 *
Jog wait time	10
Jog on time	5
Current calc time	4
Over current delay	5
Idle current delay	10
Minimum jog on time	1
Maximum jog on time	5 **
Profibus fault time	10
Seek options	125
Encoder options	0

* This parameter was 20 for software versions 1.02 and earlier
** This parameter was 50 for software versions 1.02 and earlier

Profibus Parameters

Profibus failed position

In the event of a communication interruption, the controller can be programmed to go to a preset position. The value set by this parameter determines the position set. The default value is 0.

Profibus fault time

If a communications interruption should occur the controller will wait the time specified in this parameter before setting the position to the Profibus failed position. Setting this value to 0 disables this function. The default value is 10, for 10 seconds.

Extended diagnostic on

Profibus has an extended diagnostic system. This system allows the immediate notification of the master station on a slave fault. Each master handles extended diagnostic messages in a unique manner. Contact the master station vendor for information on processing extended diagnostic messages on your master station. This flag allows the disabling of extended diagnostic messages for controllers that cannot manage them. If your master station can use extended diagnostics it is recommended that this feature be enabled. The default is Yes, extended diagnostic on.

Position Translator

Input source selection

The position input source can be either a potentiometer or optical encoder. When using an optical encoder, a fully closed limit switch must be supplied. The controller uses this limit switch to determine the actuator fully closed position. Each time an operation completes, the closed limit switch is monitored. Upon expiry of the turnaround timer, the position is set to 0 if the closed limit switch is detected. The following options are available:

Option	Description
Optical encoder used?	Set to Yes for encoder, No for potentiometer. If an encoder is used, limit switches are required. (Default is no, potentiometer used)
No position input used?	Set to Yes for simple open/close actuators that do not have a position potentiometer or encoder. Limit switches must be provided if no encoder is used. The zero closes to limit and full scale opens to limit options must selected for this option to operate properly. No calibration procedure is required if this option is selected. (Default is no, position input used)

The Force Close/Open System

The controller can be set to automatically force the actuator to full open or full closed regardless of the position input from the potentiometer or encoder. The following are the available options:

Option	Description
Zero closes to limit?	When the position input from the Master is set to 0, the controller will drive the close output until the fully closed limit switch is reached. (Default is Yes, force closed)
Full scale opens to limit?	When the position input from the Master is set to full scale, the controller will drive the open output until the fully open limit switch is reached. (Default is Yes, force open)
Force causes fault?	When a force to position operation is in progress and the command does not complete in the "Command failed time" the controller will declare a "Position Fault". (Default is Yes, declare fault)
Force fault stops motor?	When a force to position operation is in progress and the command does not complete in the "Command failed time" the controller will stop the motor output. (Default is Yes, stop the motor)
Force close on powerup?	During a powerup sequence, run the actuator closed until the fully closed limit switch is reached. This option is required for optical encoder systems to determine the zero starting point. (Default is No, no force close on powerup)

Positioning Accuracy

The following parameters determine the accuracy of the final position achieved by the controller. These parameters should be configured before an automatic calibration sequence is initiated.

The controller uses a two step process to position the actuator. The first step runs the actuator until the position reaches the requested position less a setback tolerance. If jogging is disabled, the operation completes at step 1 with the actuator at the current position. If jogging is enabled, step 2 uses a series of timed pulses to achieve the final position of the actuator.

Turn clockwise to open

The controller operating direction can be changed without rewiring the controller. Normally the controller is wired to turn counter-clockwise to open as viewed from above the actuator. By setting this parameter to yes, the direction and all related inputs and outputs will be reversed and the actuator will turn clockwise to open. The default is No, turn counter-clockwise to open. and the actuator will turn clockwise to open. The default is No, turn counter-clockwise to open.

Full scale value

The full scale value determines the number of divisions displayed for a fully open actuator. The controller can be setup to use any units for full scale (i.e. inches, millimeters, etc.) For the purpose of this manual the controller is configured using % of full scale.

The controllers A-D converter delivers up to 4096 counts at full scale. The number of counts available in any specific application using a potentiometer is [4096 X (% of potentiometer used / 100)].

When using an encoder, the number of input counts available is [encoder pulses per turn X number of turns]. Maximum counts remains 4096 for the encoder. At least 2 input counts are required for each full scale division. The default value is 100 for 1% accuracy.

Jogging is on

The controller can use jogging to achieve higher accuracy. Jogging uses precisely timed pulses to move the actuator. During calibration, the controller determines if jogging is required to achieve the selected accuracy. If required, jogging is automatically enabled and calibrated. The default is Yes, jogging enabled.

Seek tolerance

This parameter determines the position accuracy when jogging is enabled. The controller will continue to jog the actuator until the difference between the current position and the requested position is less than or equal to this value. The default value is 1.

Jog on time

This parameter specifies the jog on time to be used after a power-up sequence. The controller moves the value from this parameter to an internal working variable during the power-up sequence. The controller automatically modifies the internal working variable after each jog sequence to ensure high accuracy movements. The default value is 255, which retains the controller's calibration value.

Jog wait time

After each jog, the controller waits for this time interval before calculating how far the actuator has moved. This time should be set to a value longer than the settle time of the actuator. This parameter must be longer than or equal to the Turn around time parameter. The default value is 10 for 1.0 second.

Minimum jog on time

After each jog the controller adjusts the jog on time. This value is the shortest jog on time the controller will allow. The actuator should just not move when a pulse of this time is applied. The default value is 1 for 0.025 seconds.

Maximum jog on time

After each jog the controller adjusts the jog on time. This value is the longest jog on time the controller will allow. The actuator should move more than one division when a pulse of this time is applied. The default value is 5 for 0.125 seconds.

Continuous seek on

The controller will terminate a seek operation after the requested position is attained. Some actuators (i.e. Hydraulic) can drift from the selected position over time. Enabling this option will cause the controller to continuously monitor the position. If the actuator drifts from the current seek position, a new seek operation is initiated. The new seek will only utilize the jogging function to position the actuator. The default value is No, continuous seek off.

Calibration Parameters

The controller can perform an automatic calibration sequence. This sequence automatically sets the controller's calibration parameters. See Calibration for details on initiating a calibration sequence.

Zero offset

During calibration, the actuator is run in the close direction until no further motion is detected. The raw position value is captured as the zero offset. This offset is subtracted from the raw position value in the position calculations. The default value is 65535, which retains the controller's calibration value.

Span factor

During calibration, the actuator is run in the open direction until no further motion is detected. The raw position value is captured and used to calculate the span. The calculations used are detailed in Appendix 1 - Positioning System Calculations. The default value is 65535, which retains the controller's calibration value.

Open Setback

During calibration, the actuator is run in the open direction to 75% open. The amount of over travel is calculated. This amount is subtracted from the position to be attained on a open operation. The default value is 65535, which retains the controller's calibration value.

Close Setback

During calibration, the actuator is run in the close direction to 25% open. The amount of over travel is calculated. This amount is subtracted from the position to be attained on a close operation. The default value is 65535, which retains the controller's calibration value.

Timing

The controller uses a series of timers during a positioning operation.

Turn around time

Most actuators require a delay between open and close operations. The turnaround timer forces a delay between all operations. Anytime an output is turned off, both outputs will remain off until this timer has expired. When jogging is enabled this time must be less than or equal to the Jog wait time or no jogging will occur. The default value is 10 for 1.0 second.

Command failed time

Each time a motion command is executed this timer is reset. The command will continue until this timer expires, at which point the command will stop and an error will be indicated. Setting this parameter to 0 disables command faults. The value should be set to 1.5 times the maximum actuator run time for a 100% move. The default value is 120 for 120 seconds.

Update time

The controller will process new A-D or encoder values at intervals set by this timer. The default value is 1 for 8.33 milliseconds.

The Load Monitoring System

The controller continuously monitors the current flowing through the output terminals. The load monitor can be used to disable the outputs should the output current exceed a preset value during an actuator movement. Additionally the current measured while the controller is idle can be used to set an alarm should the current exceed a preset value. The average load current for the last movement and the idle load current can be read from the controller).

Maximum running load

During an actuator movement, the controller calculates the continuous average current for the movement. If the average running load current exceeds this value, the over current delay timer will be started. If the load remains over the maximum allowed for the duration of the timer, the actuator is stopped and the overload fault bit is set in the status register. The default value is 500 for 5.00A.

Maximum idle load

While the controller is idle, with no outputs active, the idle load current is measured. If the idle load current exceeds this value, the idle current delay timer will be started. If the load remains over the maximum allowed for the duration of the timer, the idle load fault bit is set in the status register. The default value is 5 for 0.05A.

Over current delay

During an actuator movement, the controller calculates the continuous average current for the movement. If the maximum running load current is exceeded, the over current delay timer will be started. If the load remains over the maximum allowed for this time duration, the actuator is stopped and the overload fault bit is set in the status register. A time of 0 disables the over current fault. The default value is 0, for over current monitoring disabled.

Idle current delay

While the controller is idle, with no outputs active, the idle load current is measured. If the idle load current exceeds the maximum idle load, the idle current delay timer will be started. If the load remains over the maximum allowed for this time duration, the idle load fault bit is set in the status register. A time of 0 disables maximum idle load fault. The default value is 0, for idle current monitoring disabled.

Current calc time

The load current monitoring system reads the load at intervals set by this timer. The load monitor utilizes a peak detector that is reset after each measurement. This timer should be set to record the peak current for at least 4 cycles of the AC line. The default value is 4 for 8.33 millisecond.

Load offset

During the load calculations this value is used to remove any zero offsets from the detector. This value is automatically determined during a calibration sequence. The default value is 65535, for use controller calibration value.

Load span

During the load calculations this value is used to convert the raw peak detector output to load current in amps. See Appendix 3 - The Load Current Monitoring System Calculations for details on how the load current is calculated. The default value is 2038.

Unused Parameters

The GSD file for this controller is shared with the DC version of the controller. There are 2 parameters in the GSD file used only by the DC controller. Adjusting these parameters will not affect the operation of the AC controller. The parameters are "Dynamic brake force" and "Dynamic break time".

Profibus Auto Calibration:

Initiating an Automatic Calibration

The mAC112 Actuator Controller has an automatic calibration system. The calibration sequence can be
run with or without a Profibus connection. Calibration is only required for actuators with position feedback. Simple open/close actuators will not complete a calibration cycle and should not be calibrated.

To initiate the calibration sequence:

Press and hold the Setup push button. After 2 seconds, the Run/Error indicator will begin flashing at a 3 per second rate. Release the push button and the calibration sequence will begin. To stop the calibration cycle, press the Setup button again for 1 second.

The calibration sequence can also be issued over the Profibus network. To start the calibration issue a command 11 (0BH) with the setpoint set to 11 (0BH). To stop the calibration issue a command 4 with the setpont set to 4. A command 21 (15H), setpoint 0, should be issued immediately after each motion command. Commands are only recognized on change.

The controller saves the calculated calibration parameters at the end of the calibration cycle. Aborting a calibration sequence will return the controller to the previous calibration. The calibration sequence is as follows:

1. Capture current monitor load offset

2. Open the actuator for 2 seconds

3. Close the actuator and capture zero offset

4. Open the actuator fully and capture span

5. Close the actuator to 25% and calculate close offset

6. Open the actuator to 75% and calculate open offset

7. Jog the actuator if enabled and determine jog on time

8. Save all parameters to EEPROM

9. Close the actuator and exit calibration

The parameters modified by a calibration sequence are detailed in Controller Parameters - Calibration Parameters.

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Controller Commands:

There are 3 read and 2 write words in the controller. The addresses of these words are determined during the Profibus setup by the master station. Each of the registers is a single 16-bit word. The read/write references refer to operations by the master station. The register layout is as follows:

Register	Description	Type
0	Command word	Read
1	Process value	Read
2	Status word	Read
0	Command word	Write
1	Set-point	Write

*** Caution ***
PLC's from different manufacturers process
the data from Profibus I/O differently. Depending on
the PLC, the byte order in the registers can be reversed. The mAC112/DPC120 is big endian and places the high byte of the register in the even I/O byte and the low byte of the register in the odd I/O byte. Most PLC's offer a byte swap instruction that can be used to correct the register byte order.
****

Commands are executed by writing a word to the command word. There are 2 classes of commands; operation commands and value read commands. The following is a table of the operation commands:

In the event of a Profibus communications loss, the controller will position the actuator to the setpoint determined by the settings in the master's parameters, after the requested delay. This function can be disabled if the delay is set to 0. When communications resumes, the master will immediately write the contents of its I/O map to the field devices. Should the I/O map contain a seek to position command when communications resumes, the command will be immediately executed.

Decimal	Hex	Command	Set-point	Process value	Units	Range
21	15	Read Current Position	always 0	Current position	%	0-FS
22	16	Read Average Load	always 0	Average load current	0.00 A	0-9.99
23	17	Read Peak Load	always 0	Peak load current	0.00 A	0-9.99
24	18	Read Idle Load	always 0	Idle load current	0.00 A	0-9.99
25	19	Read Raw Position	always 0	The raw position	counts	0-4095
26	1A	Read Raw Load	always 0	The raw load current	counts	0-4095
27	1B	Read Seek Value	always 0	Current seek position	%	0-FS
28	1C	Read Jog On Time	always 0	Jog on time	25 ms	0-255
29	1D	Read Software Revision	always 0	Software revision	0.00	n/a

These commands allow the retrieval of the internal operating registers of the controller and are useful for diagnostic functions. Issuing a Read Current Position command 21 (15H) will not reset the bad command diagnostic bit. Any other valid command will reset this bit. This is provided to ensure that the master is informed of the bad command even if Read Current Position is reselected.

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Controller Commands Cont:

The following table describes the bits in the status word:

Bit	Description
0	1 = at closed limit switch (switch not energized)
1	1 = at open limit switch (switch not energized)
2	1 = auxiliary limit 1 energized
3	1 = auxiliary limit 2 energized
4	1 = seek in progress
5	1 = motor running
6	1 = direction is closed
7	1 = in manual operation
8	1 = failed to reach position
9	1 = motor over current
10	1 = current to high when idle
11	1 = saved parameter table corrupted
12	1 = system firmware corrupted
13	1 = last command received invalid
14	1 = in calibration
15	1 = motor too hot

The following table describes the diagnostic bits returned if extended diagnostics is enabled:

Bit	Description
0	Failed to reach position
1	Motor over current
2	Idle current too high
3	Setup parameter fault
4	Controller firmware bad
5	Last command invalid
6	In calibration
7	Motor too hot or tripped

PROMATION
ENGINEERING

GSD Files:

All Profibus slave devices are setup using standard Profibus Configuration Tools that are supplied by the manufacturer of the Profibus master. These tools utilize a set of files called GSD files to provide the parameter table information for the configuration tool. The GSD file provides a list of parameters, their default settings and ranges. The GSD file is a simple text file that can be edited by the user to make the task of configuring multiple copies of a device easier. Many of the configuration tools allow for the copying of a fully parameterized slave to a second address also reducing the setup time.

The current controller GSD file is:

CMC_088E.GSD, Release date: December 29, 2004

The file release date is contained in the file header. Confirm the file release date before using the GSD file. The Profibus Trade Organization provided the file designator at the time of certification. The current GSD file can be used with any version of the controller firmware. A copy of the current file is included in this appendix.

A second GSD file, cmc0088e.gsd, was produced at the same time. This file is a simplified version of the GSD file for masters that do not support the parameter setup functions. This file is not recommended for new installations.

Certain parameters are set by the controller during calibration and are not normally overwritten by the Profibus Master. These files have the GSD default set to the maximum value of 65535 for word values and 255 for byte values. Changing these defaults will overwrite the calibration values and is not recommended.

The new GSD file, CMC_088E.GSD, was published on December 29, 2004. The new file modifies the default values as shown in the tables below. These changes were made to update the GSD file to the defaults most commonly used in the field. The units' entries were also corrected as shown, to reflect the correct increments.

Parameter	GSD Entry	Actual Value	Units
Zero offset	65535	No change	a-d counts
Span factor	65535	No change	n/a
Open setback	65535	No change	% FS
Close setback	65535	No change	% FS
Seek tolerance *	1	0 %	% FS
Full scale value	100	100 %	% FS
Maximum load current *	500	5.00 A	0.00 A
Idle load current	5	0.05 A	0.00 A
Jog movement tolerance	1	1 %	% FS
Load zero offset	65535	No change	a-d counts
Load span factor	2038	2038	n/a
Profibus failed position	0	0 %	% FS
Update time	1	8.33 msec	8.33 msec
Turn around time	10	1.0 sec	0.1 sec
Command failed time *	120	120 sec	1 sec
Jog wait time	10	1.0 sec	0.1 sec
Jog on time	255	No change	0.025 sec
Current calc time	4	8.32 msec	2.08 msec
Over current delay *	0	Disabled	0.1 sec *
Idle current delay *	0	Disabled	1 sec
Minimum jog on time	1	0.025 sec	0.025 sec
Maximum jog on time *	5	0.125 sec	0.025 sec
Profibus fault time	10	10 sec	1 sec
Dynamic break force	n/a	n/a	n/a
Dynamic brake time	n/a	n/a	n/a
Turn clockwise to open?	No	No	Yes/No
Continuous seek on? *	No	No	Yes/No
Jogging is on?	Yes	Yes	Yes/No
Zero closes to limit?	Yes	Yes	Yes/No
Full scale opens to limit?	Yes	Yes	Yes/No
Force causes fault?	Yes	Yes	Yes/No
Force fault stops motor?	Yes	Yes	Yes/No
Force close on powerup?	No	No	Yes/No
Optical encoder used?	No	No	Yes/No
No position input used?	No	No	Yes/No
Extended diagnostics on? *	Yes	Yes	Yes/No

* Indicates parameters and units that were changed in this file version

PROMATION
ENGINEERING

Parameter	GSD Entry	Actual Value	Units
Zero offset	65535	No change	a-d counts
Span factor	65535	No change	n/a
Open setback	65535	No change	% FS
Close setback	65535	No change	% FS
Seek tolerance	0	0 %	% FS
Full scale value	100	100 %	% FS
Maximum load current	200	2.00 A	0.00 A
Idle load current	5	0.05 A	0.00 A
Jog movement tolerance	1	1 %	% FS
Load zero offset	65535	No change	a-d counts
Load span factor	2038	2038	n/a
Profibus failed position	0	0 %	% FS
Update time	1	8.33 msec	8.33 msec
Turn around time	10	1.0 sec	0.0 sec *
Command failed time	20	20 sec	1 sec
Jog wait time	10	1.0 sec	0.0 sec *
Jog on time	255	No change	0.025 sec *
Current calc time	4	8.32 msec	2.08 msec
Over current delay	5	5 sec	1 sec
Idle current delay	6	6 sec	1 sec
Minimum jog on time	1	0.025 sec	0.025 sec *
Maximum jog on time	50	1.25 sec	0.025 sec *
Profibus fault time	10	10 sec	1 sec
Dynamic break force	n/a	n/a	n/a
Dynamic brake time	n/a	n/a	n/a
Turn clockwise to open?	No	No	Yes/No
Continuous seek on?	Yes	Yes	Yes/No
Jogging is on?	Yes	Yes	Yes/No
Zero closes to limit?	Yes	Yes	Yes/No
Full scale opens to limit?	Yes	Yes	Yes/No
Force causes fault?	Yes	Yes	Yes/No
Force fault stops motor?	Yes	Yes	Yes/No
Force close on powerup?	No	No	Yes/No
Optical encoder used?	No	No	Yes/No
No position input used?	No	No	Yes/No
Extended diagnostics on?	No	No	Yes/No

* Indicates the correct units for this file version

FM_P213 HV PN4 PFB Ver B 121922

; ExtUserPrmData-Block:
ExtUserPrmData=21 "Minimum jog on time (0.025s)" Unsigned8 1 001-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=22 "Maximum jog on time (0.025s)" Unsigned8 5 001-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=23 "Dynamic break force (20-80%)" Unsigned8 40 020-080
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=24 "Dynamic break time (2.08ms)" Unsigned8 20 000-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=25 "Profibus fault time (s)" Unsigned8 10 000-255
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=26 "Turn clockwise to open?" Bit(1) 0 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=27 "Continuous seek on?" Bit(0) 0 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=28 "Jogging is on?" Bit(3) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=29 "Zero closes to limit?" Bit(2) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=30 "Full scale opens to limit?" Bit(6) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=31 "Force causes fault?" Bit(4) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData

; ExtUserPrmData-Block:
ExtUserPrmData=32 "Force fault stops motor?" Bit(5) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=33 "Force close on powerup?" Bit(1) 0 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=34 "Optical encoder used?" Bit(0) 0 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=35 "No position input used?" Bit(2) 0 0-1
Prm_Text_Ref=1
EndExtUserPrmData
; ExtUserPrmData-Block:
ExtUserPrmData=36 "Extended Diagnostic on?" Bit(3) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData

```
;--Slave Parameters--
Freeze_Mode_supp = 1
Sync_Mode_supp = 1
Auto_Baud_supp = 1
Set_Slave_Add_supp = 0
Min_Slave_Intervall = 5
Max_Diag_Data_Len = 8
Max_User_Prm_Data_Len = 40
Ext_User_Prm_Data_Const(0)=0x00,0xFF,0
xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0xFF,0x00,\
0x00,0x00,0x64,0x00,0xC8,0x00,0x05,0x00,
0x01,0xFF,0xFF,0x07,0xF6,0x00,0x00,\
0x01,0x0A,0x14,0x0A,0xFF,0x04,0x05,0x0A
,0x01,0x05,0x28,0x20,0x0A,0x3D,0x00
Ext_User_Prm_Data_Ref(1)=1
Ext_User_Prm_Data_Ref(3)=2
Ext_User_Prm_Data_Ref(5)=3
Ext_User_Prm_Data_Ref(7)=4
Ext_User_Prm_Data_Ref(9)=5
Ext_User_Prm_Data_Ref(11)=6
Ext_User_Prm_Data_Ref(13)=7
Ext_User_Prm_Data_Ref(15)=8
Ext_User_Prm_Data_Ref(17)=9
Ext_User_Prm_Data_Ref(19)=10
Ext_User_Prm_Data_Ref(21)=11
Ext_User_Prm_Data_Ref(23)=12
Ext_User_Prm_Data_Ref(25)=13
Ext_User_Prm_Data_Ref(26)=14
Ext_User_Prm_Data_Ref(27)=15
Ext_User_Prm_Data_Ref(28)=16
Ext_User_Prm_Data_Ref(29)=17
Ext_User_Prm_Data_Ref(30)=18
Ext_User_Prm_Data_Ref(31)=19
Ext_User_Prm_Data_Ref(32)=20
Ext_User_Prm_Data_Ref(33)=21
Ext_User_Prm_Data_Ref(34)=22
Ext_User_Prm_Data_Ref(35)=23
Ext_User_Prm_Data_Ref(36)=24
Ext_User_Prm_Data_Ref(37)=25
Ext_User_Prm_Data_Ref(38)=26
Ext_User_Prm_Data_Ref(38)=27
Ext_User_Prm_Data_Ref(38)=28
Ext_User_Prm_Data_Ref(38)=29
Ext_User_Prm_Data_Ref(38)=30
Ext_User_Prm_Data_Ref(38)=31
Ext_User_Prm_Data_Ref(38)=32
Ext_User_Prm_Data_Ref(39)=33
Ext_User_Prm_Data_Ref(39)=34
Ext_User_Prm_Data_Ref(39)=35
Ext_User_Prm_Data_Ref(39)=36
```

```
Modular_Station = 0
;
Fail_Safe= 1
Slave_Family = 4
;
Unit_Diag_Bit(0) = "Failed to reach position"
Unit_Diag_Bit(1) = "Motor overcurrent"
Unit_Diag_Bit(2) = "Idle current too high"
Unit_Diag_Bit(3) = "Setup parameter fault"
Unit_Diag_Bit(4) = "Controller firmware bad"
Unit_Diag_Bit(5) = "Last command invalid"
Unit_Diag_Bit(6) = "In calibrate mode" Unit_
Diag_Bit(7) = "Motor too hot or tripped"
;
; Module I/O Configuration
;
Module = "2 Words Out, 3 Words In"
0xE1,0xD2
EndModule
```

Cams: Adjusting the actuator CW position

Serious Damage to the actuator will result if the motor is allowed to drive the gear train into the mechanical stop!! Remove power from this device BEFORE making any travel adjustments.

This actuator has been factory calibrated to operate between 0 degrees and 90 degrees. Most quarter-turn products will not require recalibration of these settings. Proceed ONLY if adjustments are required.


CW Mechanical Stop

Loosen Mechanical Stop

1. BEFORE power is applied, use a 35mm wrench (or channel locks) and a 12mm hex key to loosen the RIGHT SIDE mechanical stop. This is the CW stop limit adjustment. Turn the stop screw 5-6 turns CCW to allow electrical cam stop adjustment without running into the mechanical stop screw.

2. Use the manual hand wheel to position the actuator to your required CW position. This must be within +/- 3 degrees of the factory setting.

Adjust Cam 1

3. The lower cam is Cam 1, the CW end-of-travel adjustment. Once the actuator is at its required CW position, with POWER OFF, use a 2.5mm hex key to free up the cam set screw. Once it is free, rotate the hex key to the RIGHT 10-15 degrees to reset the switch roller arm. Then snug the set screw up against the camshaft (CW) until slight pressure is felt. Then SLOWLY rotate the hex key pushing the cam to the LEFT until you hear the "click" on the bottom switch indicating that correct adjustment has been achieved. Tighten the set screw.

Cam 1

COM
NO
NC
CW LIMIT SWITCH
FURTHER CW
LESS CW
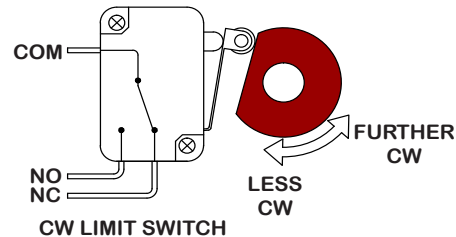
4. Apply power to the actuator and drive CCW at least 15-20 degrees. Then drive the actuator CW until the cam stops the electrical travel. Check to be sure this is the correct CW position you require. Repeat step 3 if further adjustment is needed.

Tighten Mechanical Stop

5. While holding the 35mm wrench (or channel locks) on the RIGHT SIDE jam nut to prevent the jam nut from locking, turn the 12mm hex key CW until the end of the stop screw bottoms out against the internal stop boss. Then turn the hex key ONE FULL TURN CCW before locking that adjustment with the jam nut. This procedure assures that the actuator reaches its end of travel electrically before there is any interference from the mechanical stop.

6. This completes the CW position calibration.

CW Mechanical Stop

The mechanical stop screw limits handwheel operation ONLY and is NOT to be used as an electrical travel limiting device.

Cams: Adjusting the actuator CCW position

Serious Damage to the actuator will result if the motor is allowed to drive the gear train into the mechanical stop!! Remove power from this device BEFORE making any travel adjustments.

This actuator has been factory calibrated to operate between 0 degrees and 90 degrees. Most quarter-turn products will not require recalibration of these settings. Proceed ONLY if adjustments are required.

CCW Mechanical Stop

Loosen Mechanical Stop

1. BEFORE power is applied, use a 35mm wrench (or channel locks) and a 12mm hex key to loosen the LEFT SIDE mechanical stop. This is the CCW stop limit adjustment. Turn the stop screw 5-6 turns CCW to allow electrical cam stop adjustment without running into the mechanical stop screw.

2. Use the manual hand wheel to position the actuator to your required CCW position. This must be within +/- 3 degrees of the factory setting.

Adjust Cam 2

3. The second cam is Cam 2, the CCW end-of-travel adjustment. Once the actuator is at its required CCW position, with POWER OFF, use a 2.5mm hex key to free up the cam set screw. Once it is free, rotate the hex key to the LEFT 10-15 degrees to reset the switch roller arm. Then snug the set screw up against the camshaft (CW) until slight pressure is felt. Then SLOWLY rotate the hex key pushing the cam to the RIGHT until you hear the "click" on the second switch indicating that correct adjustment has been achieved. Tighten the set screw.

Cam 2

COM

NO
NC

CCW LIMIT SWITCH

LESS CCW
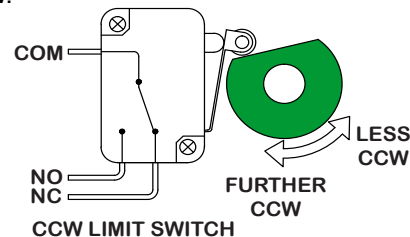
FURTHER CCW

4. Apply power to the actuator and drive CW at least 15-20 degrees. Then drive the actuator CCW until the cam stops the electrical travel. Check to be sure this is the correct CCW position you require. Repeat step 3 if further adjustment is needed.

Tighten Mechanical Stop

5. While holding the 35mm wrench (or channel locks) on the LEFT SIDE jam nut to prevent the jam nut from locking, turn the 12mm hex key CW until the end of the stop screw bottoms out against the internal stop boss. Then turn the hex key ONE FULL TURN CCW before locking that adjustment with the jam nut. This procedure assures that the actuator reaches its end of travel electrically before there is any interference from the mechanical stop.

6. This completes the CCW position calibration.

CCW Mechanical Stop

The mechanical stop screw limits handwheel operation ONLY and is NOT to be used as an electrical travel limiting device.

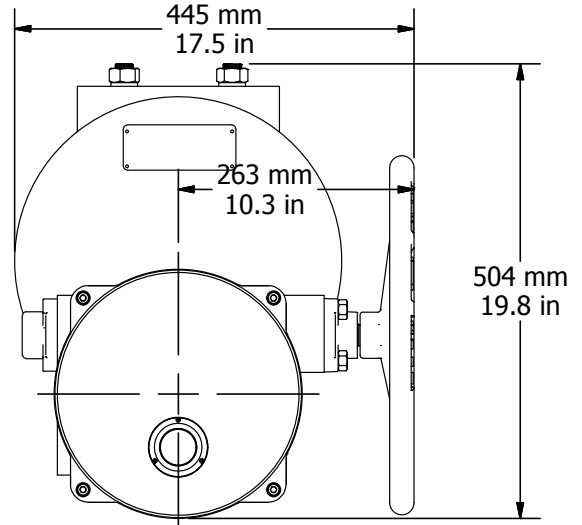FM_P213 HV PN4 PFB Ver B 121922

Cams: Adjusting the actuator Auxiliary Switches

Cam 3

Adjust Cam 3

1. The THIRD cam is Cam 3, the CW auxiliary switch adjustment. Drive the actuator to its CW position. Then use a 2.5mm hex key to free up the cam set screw. Once it is free, rotate the hex key to the RIGHT 10-15 degrees to reset the switch roller arm. Then snug the set screw up against the camshaft (CW) until slight pressure is felt. Then SLOWLY rotate the hex key and cam to the LEFT until you hear the "click" on the third switch. Continue to rotate the cam between 3 and 5 degrees to the LEFT to make sure the auxiliary cam switch changes state before the actuator reaches its end of travel electrically. Tighten the cam set screw.
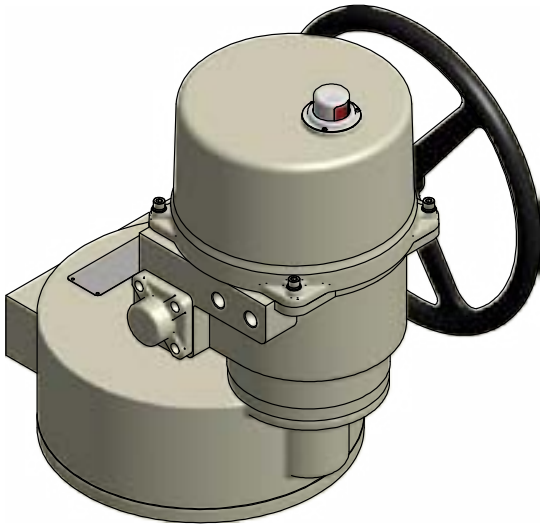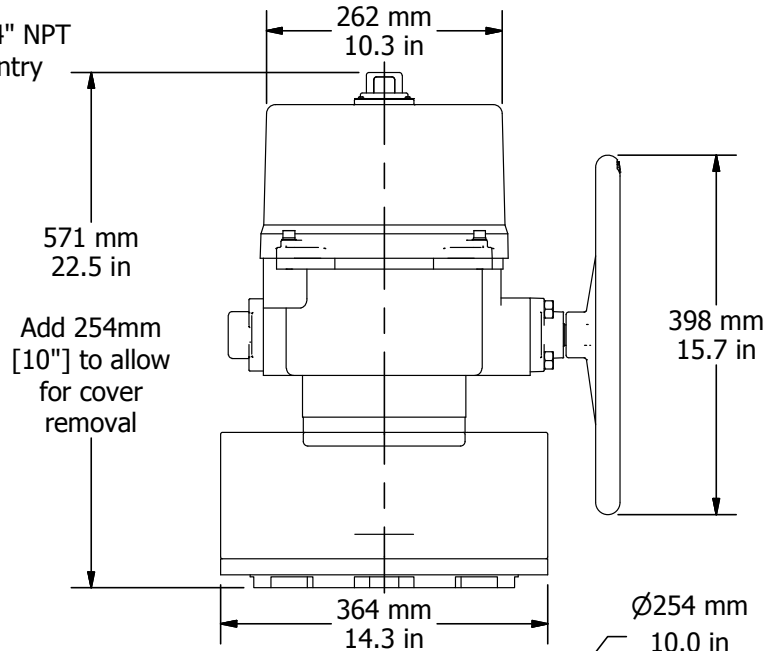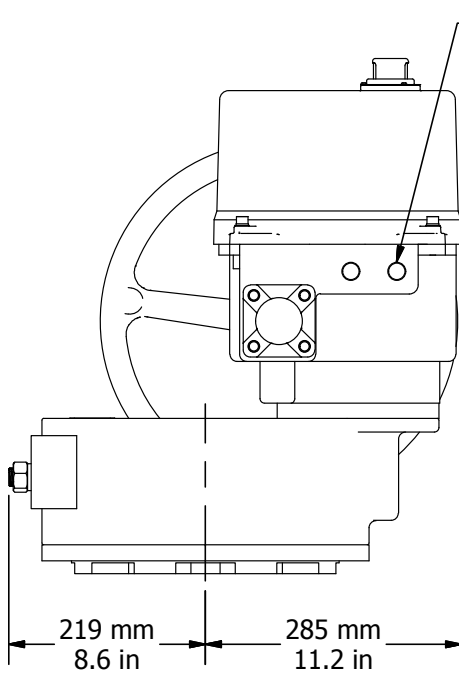

Cam 4

Adjust Cam 4

1. The FOURTH cam is Cam 4, the CCW auxiliary switch adjustment. Drive the actuator to its CCW position. Then use a 2.5mm hex key to free up the cam set screw. Once it is free, rotate the hex key to the LEFT 10-15 degrees to reset the switch roller arm. Then snug the set screw up against the camshaft (CW) until slight pressure is felt. Then SLOWLY rotate the hex key to the RIGHT until you hear the "click" on the fourth switch. Continue to rotate the cam between 3 and 5 degrees to the RIGHT to make sure the auxiliary cam switch changes state before the actuator reaches its end of travel electrically. Tighten the cam set screw.
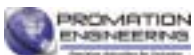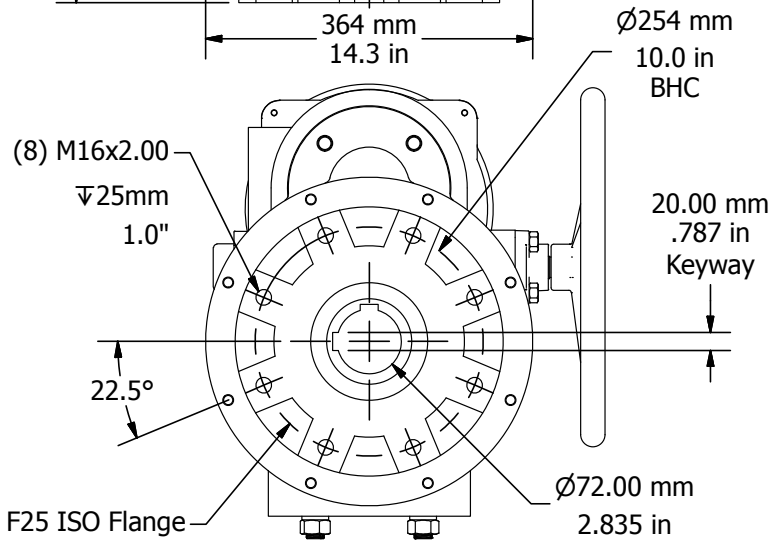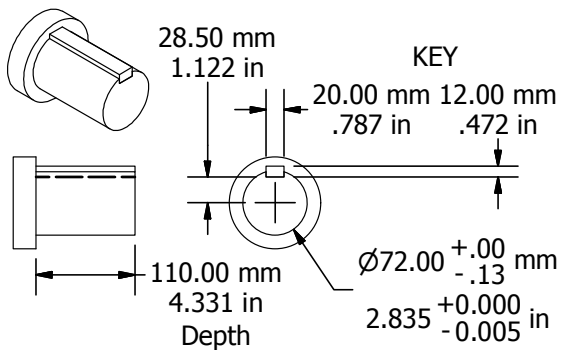
Mechanical Data

445 mm
17.5 in

263 mm
10.3 in

504 mm
19.8 in

(2) 3/4" NPT EMT Entry

262 mm
10.3 in

571 mm
22.5 in

Add 254mm [10"] to allow for cover removal

398 mm
15.7 in

364 mm
14.3 in

Ø254 mm
10.0 in
BHC

219 mm
8.6 in

285 mm
11.2 in

(8) M16x2.00

▼25mm
1.0"

20.00 mm
.787 in
Keyway

22.5°

Drive Coupling Fabrication Data

28.50 mm
1.122 in

KEY

20.00 mm
.787 in

12.00 mm
.472 in

110.00 mm
4.331 in
Depth

$Ø72.00 ^{+.00}_{-.13}$ mm

$2.835 ^{+0.000}_{-0.005}$ in

F25 ISO Flange

Ø72.00 mm

2.835 in

FM_P213 HV PN4 PFB Ver B 121922

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Mechanical Data

Aluminum Casting
NEMA 4X Protection

Easily distinguishable
yellow/red position
indicator

Heavy Duty
Drive Motor

Modular
Control
Cards

Easily accessible
switch & cam stacks

Aluminum Casting
NEMA 4X Protection

NEMA 4X
Cover Seal

Worm Drive
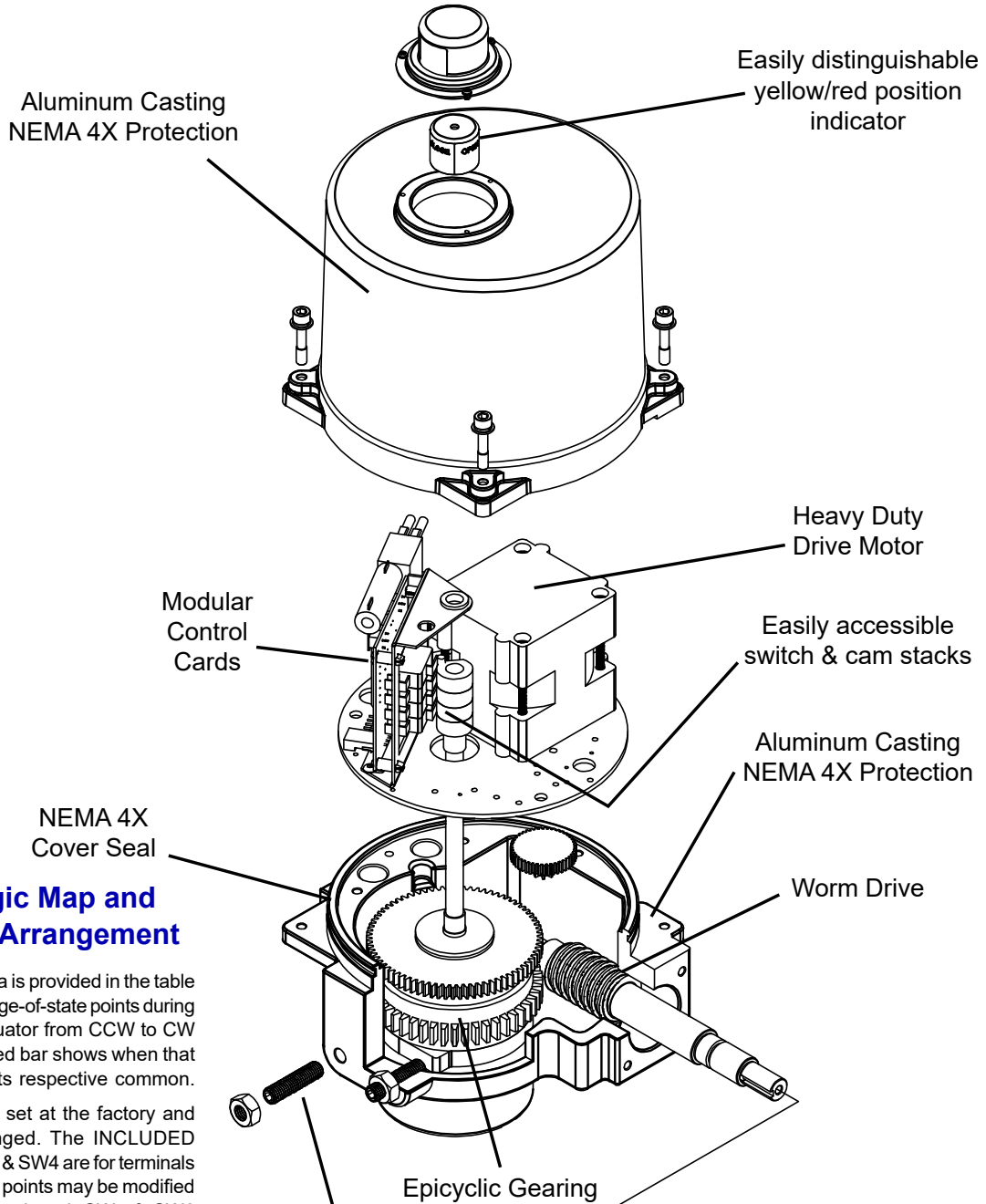
Switch Logic Map and Switch/Cam Arrangement

Switch sequencing data is provided in the table below to show the change-of-state points during the rotation of the actuator from CCW to CW and back again. The red bar shows when that terminal makes with its respective common.

Switches 1 and 2 are set at the factory and should NOT be changed. The INCLUDED auxiliary switches SW3 & SW4 are for terminals 7 thru 12 and those set points may be modified if need be. When so optioned, SW5 & SW6 auxiliary switches are initially set to function the same as auxiliary switches SW3 & SW4.
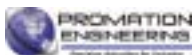
Epicyclic Gearing

Mechanical Stop
Screws (2)

Clutchless
Override
Handwheel

	CW			CCW		
	-5°	0°	5°	85°	90°	95°
12				Not Open		
11			Open Switch Common			
10					Open	
9				Not Closed		
8			Closed Switch Common			
7				Closed		

SW4 CCW AUX
(Factory Set - Adj)

SW3 CW AUX
(Factory Set - Adj)

Used by
Controller

FM_P213 HV PN4 PFB Ver B 121922

PROMATION ENGINEERING

Commissioning

After completing all mounting and wiring procedures and main power is available, it is now possible to commission the actuator.

1. Utilize the handwheel to rotate the actuator and damper, valve or other connected device through its full travel from fully CW to fully CCW and back again to check for any possible interference.
   - Do NOT utilize any mechanical advantage devices to rotate the handwheel (pipes, wrenches, extension bars, etc.).
2. Apply correct power to the unit.
3. Measure correct power on terminals 1 (Hot) and 2 (Neu) on the switch board.
4. Measure correct power on the two heater terminals on the switch board.
5. Command the field device to generate a CCW signal. The actuator rotates in a CCW direction (as viewed from above).
6. Actuator will stop when it reaches it's full CCW position.
7. Command the field device to generate a CW signal. The actuator rotates in a CW direction (as viewed from above).
8. Actuator will stop when it reaches it's full CW position.
9. Command the field device to drive to the 50% position. Check that the indicator is in the mid position.
10. Actuator is now commissioned and operational.

Industrial Applications

ProMation Engineering actuators have been installed to operate process controls such as butterfly valves, ball valves, high performance valves, plug valves, gate valves and dampers, in a broad range of demanding industrial applications.
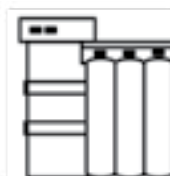
Power Generation	Water Processes	Mining	Oil and Gas	Agriculture	Chemicals

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ProMation Engineering follows a policy of continual product updates and enhancements. Our website is the best place to obtain the latest product documentation, including the wiring diagrams for these controllers. Visit us at www.promationei.com or use the code to link to the site.

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