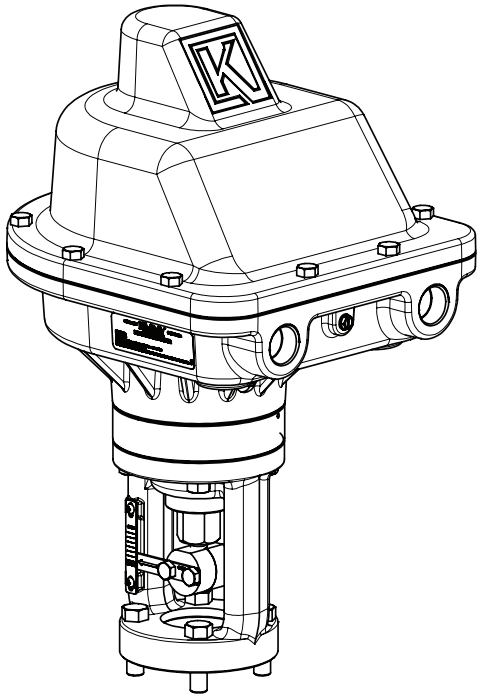
KIMRAY INC.®

INSTALLATION OPERATION & MAINTENANCE GUIDE

ELECTRIC ACTUATOR

Contents

If you have any questions about this manual, contact your Kimray applications support group before proceeding.



A Before you start

CAUTION:
Prior to installing, the instructions provided herein should be completely reviewed and understood before operating or repairing this equipment. All CAUTION and WARNING notes must be strictly observed to prevent personal injury or equipment damage.

A1 Scope

Do not install, operate, or maintain an electric actuator without being fully trained and qualified with the Kimray installation and maintenance manual. To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.
If you have any questions about these instructions, contact your Kimray applications support group before proceeding.

A2 Introduction

This installation manual includes instructions and maintenance information for the Kimray Electric Actuator.

A3 Description

Model Number: KEA
The Kimray Electric Actuator is designed to electrically control valve position. This actuator is ideal for applications within the oil & gas production industry where electric control and remote monitoring is desired to provide automated zero emission solutions.

A4 Maintenance

WARNING:

Explosion Hazard. Do not connect or disconnect this equipment unless power has been removed or the area is know to be nonhazardous.

Maintenance should be performed on a regular basis. An initial inspection interval of 12 months is recommended. Depending on the service conditions of the valve, the inspection interval may be decreased.

WARNING:
Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury. Disconnect any operating lines providing electric power, or a control signal to the pilot.

CAUTION:
Keep cover tight while circuits are alive.

WARNING:
Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

Related Publications
The following publications are applicable for the actuator.
See catalog section CV for product pages.
Abbreviations / Acronyms
The abbreviations that follow are used in this manual.

Term	Definition
PV	Process Value – reported valve position
CV	Control Valve - the desired valve position

A5 Special Tools and Equipment

No Special Tools Needed

A6 Markings

Manufactured by
Kimray, Inc. 52 NW 42nd St, Oklahoma City, OK 73118

24VDC, 10A MAX; TA=-40 to 60C
1500 LBF Continuous, 3200 LBF Peak

WARNING: IGNITION CAPABLE BATTERY ENCLOSED, DO NOT OPEN WHEN IGNITABLE ATMOSPHERE IS PRESENT.
WARNING: KEEP COVER TIGHTLY CLOSED WHEN IN OPERATION.

CAUTION: DO NOT OPEN WHEN EXPLOSIVE ATMOSPHERE IS PRESENT.

CAUTION: SEAL ENTRIES WITHIN 18 INCHES OF ENCLOSURE

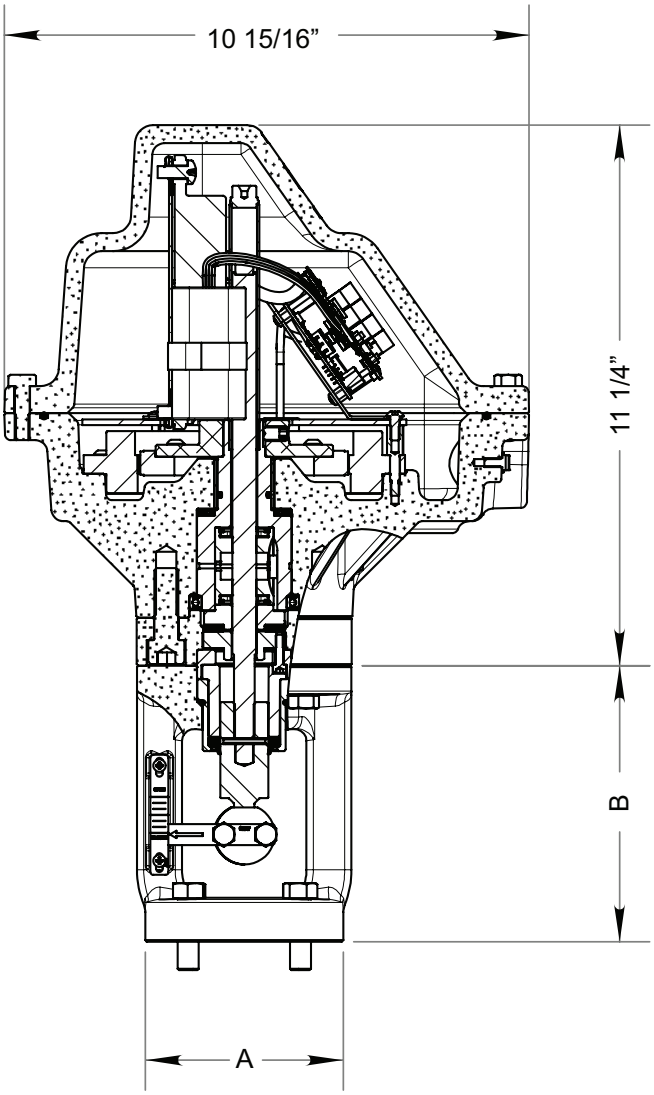
CAUTION: POTENTIAL STATIC HAZARD - CLEAN ONLY WITH A WATER WETTED CLOTH.

CLASS I, DIV 1, Groups C, D; T6; Type 4, IP66
CSA Master Contract 179619

A7 Specific conditions of use

* The linear actuator model KEA-xS-y-mm-nn series is intended to be connected to and supplied by a Class 1 circuit.
* Flameproof joints are not intended to be repaired.
* Potential Static Hazard, Clean only with a water wetted cloth.
* Cable glands and/or blanking elements shall be suitably certified to maintain ratings of the equipment.
* Use only replaceable battery pack Kimray 7715

Configuration & Dimensions



Line Size	A	B
1"	Ø 2 15/16"	4 1/2"
2"	Ø 4 1/8"	5 3/4"
3"-4"	Ø 5 1/8"	9 3/16"
6"-10"	Ø 10 5/8"	7"

A maximum number of four conduit entries are provided. Up to two 3/4" NPT on the side of the housing and up to two 1/2" NPT conduit entries on the lower side of the housing. Each NPT entry allows +1/2 turns to +2 turns using an L1 plug gauge.

Cover bolt torque rating of 12 ft-lbs. Fastener type ASTM 593C, 8 threads minimum engagement.

Installation

Before installing the Kimray Electric Actuator, inspect it for shipment damage and for foreign material that may have collected during shipment.
Verify all pressure connections are tight before pressurizing the system.
Be sure you fully understand the application, operation, and connection of the device before installing.

NOTE:
Use good electrical wiring practices and consult with electrician.

Power requirements:
Ensure a stable DC Power source is available for the application. Power supply must be a certified class 1 or ELV (Extra-Low Voltage) power supply with transient protection. A 10A power supply is required. If the discrete output is used, then the power supply must also be capable of providing the additional current demand of the load at the discrete output – up to 500mA maximum. Input voltage is designed to be 24 VDC and has been tested for maximum continuous force when supplied with 24 VDC ± 10%. Lower voltage operation may be possible, but the continuous force of 1500 lbs may not be achievable. If input voltage is reduced below 18 VDC, the internal battery will fully discharge and will not recharge until the input voltage is increased.

Wiring / Installation Notes:
1. If installing in a classified Hazardous location, wiring practices must meet the requirements of the NEC and CEC Class I, Division 1 hazardous locations.
2. Conduit seals are required within 18 inches of the enclosure port for explosion-proof installations.
3. Fuse input power to 10A recommended.
4. Wire size requirements: Use wiring from 12AWG to 18AWG for input power. All other wiring can be 12AWG to 30AWG.
5. Ensure power is off before connecting or removing wires.
6. All wiring inside the actuator should meet or exceed 90°C temperature rating.
7. All cable glands/and or blanking elements must be rated to a minimum of Class I, Div1, Group C.
8. To meet IP66 rating, all cable glands/and or blanking elements must be rated to a minimum of IP66 or better.
9. Both internal and external green grounding screws are provided to facilitate user grounding of the equipment.

NOTE:
For longer wire runs, be mindful of voltage drop at the higher currents. For example, if 100' of cabling is needed to supply 24V power, then use 12AWG to drop the voltage by less than 10% as seen at the device.

NOTE:
If the equipment is used in a manner not specified by the manufacture, the protection provided by the equipment may be impaired.

WARNING:
To reduce the risk of ignition of hazardous atmospheres, conduit runs must have a seal fitting within 18 inches of the enclosure

ENVIRONMENTAL CONDITIONS:
This equipment is intended for operating in the following environmental conditions:
- Pollution degree 2
- Max humidity 80% RH, non-condensing
- Temperature -40°C to 60°C (-40°F to 140°F)

INSTALLATION AND COMMISSION:
1. Mount appropriate hardware.
2. Calibrate the valve.
3. Setup appropriate CONTROL input (default is analog in with discrete overrides).
4. Setup appropriate VALVE settings.
5. Test Valve for proper operation.

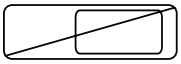
ACTUATOR CALIBRATION:
All Actuators must be calibrated to identify the location of the hard stops and range of motion
The Actuator is automatically in calibration mode from factory default and the display reads “CALIBRATE, PRESS RIGHT”. To calibrate the Actuator;

1. Press the RIGHT button.
2. The Actuator will slowly cycle to full open.
3. The Actuator will slowly cycle to full close.
4. The Actuator will begin operating normally.

If the Actuator is not attached to a valve – the full close operation will fail and will move the Actuator to a safe position.

To recalibrate a Actuator, perform a factory reset or cycle through the menus to RESET_MENU>CALIBRATE
To stop a calibration in progress – press the LEFT button. The Actuator will stop and clear any saved calibration values.

When calibration is completed, the display will show something similar to:



The diagonal line represents the full range of the linear sensor. The box represents the calibrated range for this actuator/valve combination. This display can be helpful to diagnose issues with the magnet and/or sensor. After a few seconds, the display will time out and return to the home screen.

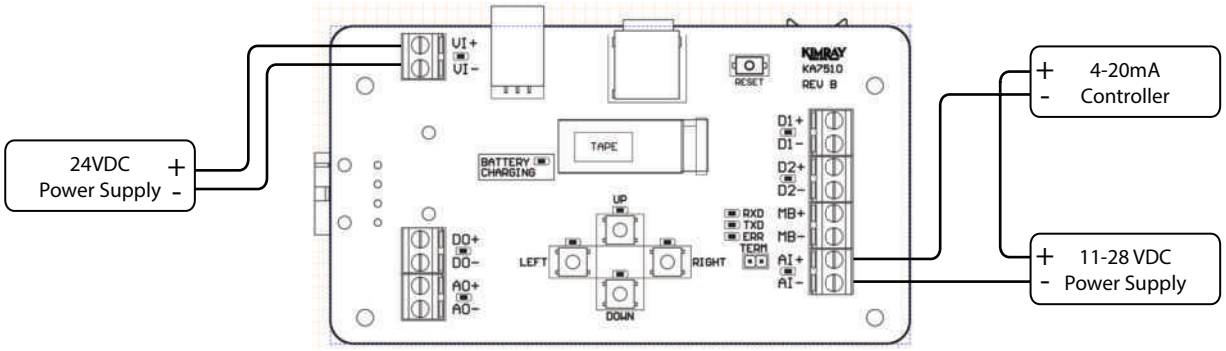
FACTORY RESET
To perform a factory reset:

1. Press the RIGHT button until the display reads “RESET MENU”.
2. Press the DOWN button to enter the sub-menu
3. Press the RIGHT button until “FACTORY RST – HOLD UP/DN” appears.
4. Hold the UP and DOWN buttons for about 5 seconds until the display reads “RELEASE”
5. Calibrate the valve as stated above.

Kimray is an ISO 9001- certified manufacturer.

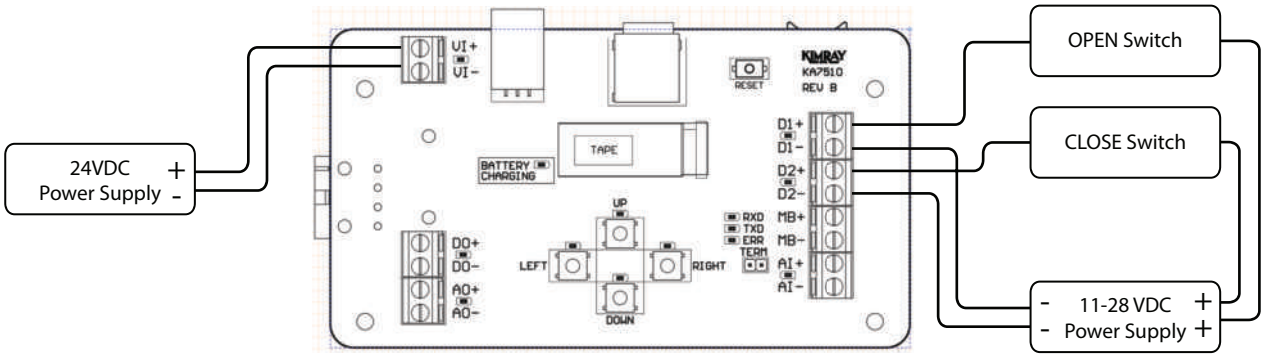
Wiring Diagrams

Analog Control



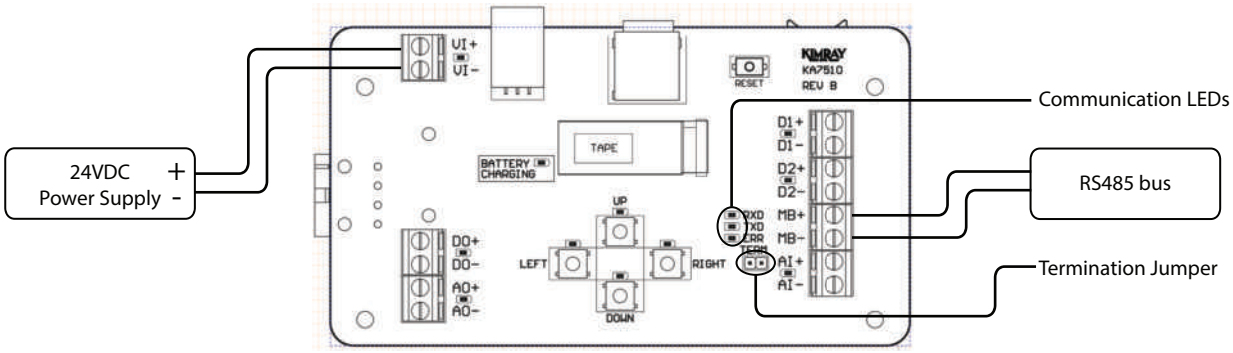
Analog input current control wires (if used) should have loop power provided by the user or the controller. Because this actuator implements an isolated 4-20mA input loop, the same power supply for VIN can provide loop power.

Discrete Control



Discrete inputs (if used) should have voltage provided by the user or the controller. Because isolated discrete inputs are provided, the same power supply for VIN can be used to provide the discrete power.

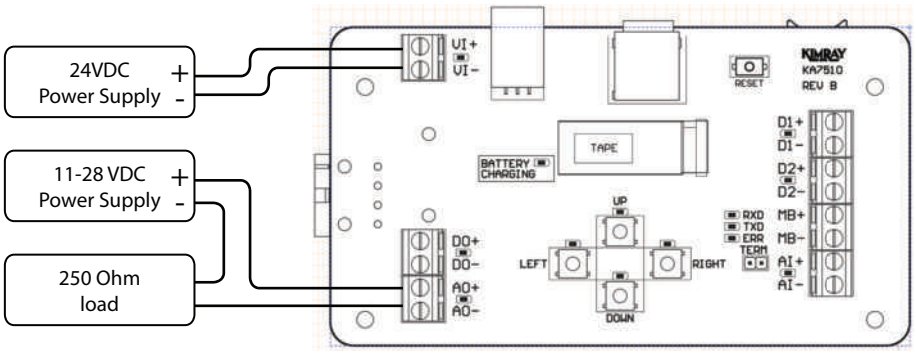
Modbus Communication



MODBUS RTU communication is accomplished over an RS-485 bus. The actuator includes internal 120ohm termination. If multiple devices are on the bus and the actuator is NOT an end device, then, the 120 ohm termination jumper should be removed.

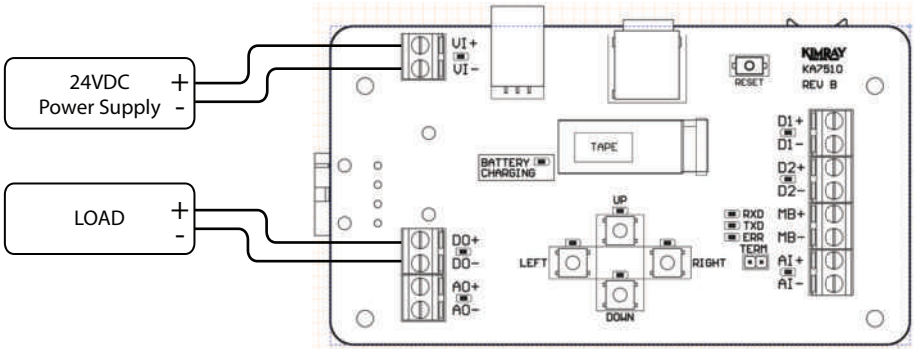
Wiring Diagrams continued

Analog Feedback Output



Analog output current feedback (if used) should have loop power provided by the user or the controller that is reading the feedback signal. Because the analog output is isolated, the same power supply that provides VIN can be used for the analog output loop current.

Discrete Output



The discrete output provides voltage slightly less than VIN (approximately VIN – 1V), and current up to 500mA when ON.

Start-up and Test

⚠ WARNING:
Follow strict safety precautions when energizing and de-energizing any system. Permits may be required when commissioning or performing maintenance of electrical devices. Live circuits may generate a spark necessary to ignite flammable or combustible gas and vapors.

1. Properly attach the actuator to a valve body.
2. Apply power to the actuator.
3. Calibrate the valve as described earlier in this document.
4. Connect appropriate control devices.
5. Fully test the valve throughout its control range.

Terminal Descriptions

VIN +/- Power connections
Two terminals VI+/VI- are used to provide power to the actuator control board. This voltage is also used to directly power the motor. The maximum current draw for the control board is approximately 100mA. The motor can draw an additional 5A-10A depending on torque settings and speed settings.
A green LED is provided to show the status of the input voltage. The LED is illuminated solidly when VIN is present and is flashing when the backup battery is discharging to provide power to the control board and the motor.
Reverse protection is included in the hardware so that if the inputs are connected in reverse, the board will not function, but it will not sustain any damage from the incorrect hookup.

Analog Input
Two terminals AI+/AI- are provided for an isolated analog 4-20mA control input. Loop voltage is not provided internally and must be provided by the external controller. When a powered loop is present, a green LED next to the AI+/AI- terminal block will illuminate.

Discrete Input
Four terminals (D1+/D1-, D2+/D2-) are provided for isolated Discrete input control. These are active inputs that require an input voltage 8-30V for an “ON” condition. When a discrete input is “ON”, it’s corresponding LED is illuminated to show that a signal is active.
The discrete inputs can be programmed through the user interface or through MODBUS for the following behaviors.

1. Discrete override during analog operation (D1 = OPEN, D2 = CLOSE) (DEFAULT)
2. Discrete input latched (D1 = OPEN, D2 = CLOSE)
3. Discrete input momentary (D1 = OPEN, D2 = CLOSE) (not yet implemented)
4. Discrete input momentary (D1 = OPEN, normally closed).
5. Discrete input momentary (Normally open, D2 = CLOSE)

MODBUS/RS-485 (optional)
Two terminals MB+/MB- are provided for MODBUS RTU communication over isolated RS-485 lines.
Three LEDs (RX, TX, ER) are provided to visually see the traffic and help diagnose any communication issues.
A termination jumper is installed on the actuator board. If termination is not needed, the jumper should be removed.

Analog Output (optional)
Two terminals AO+/AO- are provided for an isolated analog 4-20mA feedback circuit. Loop voltage is not provided internally and must be provided elsewhere. Since it is an isolated analog output, the same power supply used at the VIN terminals can be used to provide the loop voltage. This feature can be disabled from the user interface or through MODBUS.
A green LED is provided to indicate when the analog output loop is active.

The analog output should be connected to the positive end of the loop voltage. Any external current load should be connected between AO- and the negative end of the loop voltage.

Discrete Output (optional)
Two terminals DO+/DO- are provided for an optional discrete output. When active, the DO terminals provide an output voltage within 1V of the input voltage.
An LED is provided to indicate when DOUT voltage is present.
The discrete output can be programmed through MODBUS or the user interface to any of the following:

0. HEALTH - ON when the valve is HEALTHY, OFF if power or signal is removed.
1. CLOSE - ON when the valve is fully closed.
2. OPEN - ON when the valve is fully open
3. NOT CLOSED ON when the valve is not fully closed.
4. NOT OPEN - ON when the valve is not fully open
5. STALLED - ON when the valve is in a stall condition.
6. OFF – DOUT will remain off

Backup Battery (Optional)

A 14.4V nominal Li-Ion battery can be used to safely move the valve to fail position in the case of power loss. The battery is not designed to operate the valve indefinitely. The motor will not start up when only battery power is present. The charging circuit for the battery requires a minimum of 16.8V to function. If the actuator is used with a 12V supply, then the backup battery cannot be used. Use only Kimray 7715 battery pack

Battery Charging:
When VIN is greater than 16.8V, the backup battery will begin charging with approximately 400mA. A completely depleted battery will need about six hours to fully charge. A red LED is provided to indicate charge status. A solid red LED indicates the battery is charging will full current and the remaining battery capacity is less than 95%. A flashing LED indicates the battery is finishing it's charging. The LED will remain off when the battery is fully charged or if the battery is not connected.

Battery Discharging
If the input voltage is below 16.8V, the battery will begin discharging to run the internal circuits and the motor if required. The battery will shut off when battery voltage reaches 12.8V and will remain off until an appropriate charging voltage is available.

Fail Modes
The user can specify through the user interface or MODBUS what fail position (0-100%) to park the valve if input voltage is lost and enough battery charge remains to move it to that position.

Special considerations
In a 12Volt application, the battery will first discharge until it reaches shutoff voltage. It will remain off indefinitely and will not recharge as a 12V application does not provide adequate charging voltage.

User Interface

A user interface consisting of an OLED display and four on-board tactile buttons is provided for commissioning and debug of the actuator. After inactivity, the display turns itself off. Any button press will revive the display.

Kimray Actuator Menus

Button functions:
Use the RIGHT button to cycle through the menus.
Use the LEFT button to cancel and back up one menu level
Use the UP or DOWN button to enter the menu or to change the stored value.
Top Level menus

- CONTROL SETUP
- VALVE SETUP
- COMM SETUP
- DATALOG SETUP
- FAIL MODE SETUP
- POWER CHECK
- SYSTEM HEALTH
- SYSTEM I/O CHECK
- SYSTEM INFO
- CALIBRATION SETUP
- RESET MENU
-

Control Setup Menu

Control Input (MODBUS register 143)

0. Analog Control with Discrete override.
   In this mode, the analog 420mA signal is used to proportionally control the valve from 0-100%. The discrete inputs can be used to override the analog signal. (D1 = OPEN, D2 = CLOSE).
1. Discrete control with latched inputs.
   In this mode, a momentary signal from the D1 input will cause the valve to open to it's maximum. A momentary signal from the D2 signal will cause the valve to close to full seat.
2. Discrete control with momentary inputs.
   The valve will open only while D1 is present and will close only when D2 is present. It will remain in place when both inputs are absent.
3. Discrete control: D1 OPEN, Normally Closed
   The valve will open while D1 is present and will close when it is absent.
4. Discrete control: D2 CLOSE, Normally Open
   The valve will close while D2 is present and will open when it is absent.
5. MODBUS Control
   Write desired CV (x10) to MODBUS register 20.
6. Manual control
   The user-interface UP/DOWN buttons will manually OPEN/CLOSE the valve. This is intended only for device commissioning and device debug.
7. Control Off
   Drive control is disabled. No movement will be commanded.
8. Time Toggle (ONLY AVAILABLE WHEN PASSWORD HAS BEEN ENTERED).
   The valve will cycle every N-seconds (register 208) through X-positions (register 209). Registers 210-219 set the target positions. NOTE: It is possible that the valve does not reach the target position before a new position is given if the toggle time is faster than the reaction speed of the valve.
9. Position Toggle (ONLY AVAILABLE WHEN PASSWORD HAS BEEN ENTERED).
   The valve will cycle through X positions (register 209). Registers 210-219 set the target positions. A new position is not commanded until the target position is reached.
10. Toggle Time (ONLY AVAILABLE WHEN PASSWORD HAS BEEN ENTERED).
    Register 208. The amount of time in seconds between positions when in t Time Toggle mode.
11. Toggle Count (ONLY AVAILABLE WHEN PASSWORD HAS BEEN ENTERED).
    Register 209. The umber of position (1 through 10) use in toggle mode.
12. Step X (ONLY AVAILABLE WHEN PASSWORD HAS BEEN ENTERED).
    Registers 210 through 219. The desired toggle positions when in toggle mode.

DISCRETE INPUT PRIORTY (MODBUS register 44

0 D1 has priority over D2 (default)
1 D2 has priority over D1.
2 Discrete override off (not available if a Discrete control method was chosen).

ANALOG OUT (MODBUS register 91)

0 ENABLED (default)
The analog output will send a 4-20mA signal to indicated the valve position.
1 DISABLED
The analog output is not used.

DISCRETE OUT (MODBUS register 43)

0 HEALTH (default)
The discrete output is ON when the system indicates good health: Input voltage is good, Analog signal is good (if applicable), Backup battery is present.
1 ON AT CLOSE
The discrete output will be ON when the valve is fully closed.
2 ON AT OPEN
The discrete output will be ON when the valve is fully open.
3 OFF AT CLOSE
The discrete output will be OFF only when the valve is fully closed.
4 OFF AT OPEN
The discrete output will be OFF only when the valve is at full open.
5 ON AT STALL
The discrete output is ON when the valve has stalled and was unable to reach it's commanded value.
6 DISABLED
The discrete output is not used and is always off.

Valve Setup Menu

MAX OPEN (MODBUS register 120)
Allowable values are 10 to 100% (default is 100%) Max open is the maximum allowed open position. Once set, an open command (20mA analog or D1 discrete) will open the valve to that value. The analog input and output signals are not re-mapped. If the valve is limited to 50% open, then the analog input will make no changes between 12 and 20mA and the analog output will not exceed 50% (12mA). MODBUS registers are scaled by 10 (i.e. 1000 = 100.0%).

SOFT CLOSE (MODBUS register 123)
0. Enabled (DEFAULT)
   When the valve get close to the close position, the current will be reduced for the last movement to close with a lower force. This feature is to prevent unnecessary damage to valve seats.
1. Disabled
   No current reduction is used and the valve will close to hard seat with the maximum force it can.

OPEN SPEED (MODBUS register 145)
Allowable values are 50 to 1000 RPM (default is 250 RPM). Open speed is the maximum allowed speed during an open movement.

CLOSE SPEED (MODBUS register 146)
Allowable values are 50 to 1000 RPM (default is 250 RPM). Close speed is the maximum allowed speed during a close movement.

OPEN CURRENT (MODBUS register 147)
Allowable values are 3-10Amps (default = 10Amps). Open current is the maximum allowed open current to the motor before a torque limit is reached. If this is reduced, then the maximum achievable force will also be reduced. MODBUS registers are scaled by x10 (i.e. 90 = 9.0 Amps).

CLOSE CURRENT (MODBUS register 148)
Allowable values are 3-10Amps (default = 10Amps). Close current is the maximum close current allowed to the motor before a torque limit is reached. MODBUS registers are scaled by x10 (i.e. 90 = 9.0Amps).

ACCELERATION (MODBUS register 149)
Allowable values are 1 to 50 (Default = 15). The higher the number, the longer the motor takes to get to maximum velocity.

LINEAR SENSOR (MODBUS register 220)
0 DISABLED
   The linear sensor is no longer considered for positioning. Once disabled, only a re-calibration can re-enable it. Positional accuracy may be affected with the linear sensor disabled.
1 ENABLED
   Linear sensor was properly calibrated and is considered for positional accuracy.

OPEN RETRY LIMIT (MODBUS register 295)
Allowable values are 0 to 50 (default = 15). Open retry limit is the number of times the valve will retry should it experience a physical stall during an open movement.

CLOSE RETRY LIMIT (MODBUS register 294)
Allowable values are 0 to 50 (default = 15). Close retry limit is the number of times the valve will retry should it experience a physical stall during a close movement.

STALL RETRY DELAY (MODBUS register 293)
Allowable values 0 to 2000ms (default = 500). Allows the amount of time delay between stall retries.

REDUCE RETRY SPEED (MODBUS register 121)
0 DISABLED
   Motor speed is not changed during retry.
1 ENABLED (Default)
   Motor speed is reduced by 20RPM (down to 50 RPM minimum) for each stall retry. After successful movement, the speed is reset to its default setting.

INCREASE RETRY CURRENT (MODBUS register 122)
0 DISABLED
   Current is not changed during retry.
1 ENABLED (Default)
   Current is increased by 2 AMPS (up to 14 AMPS) for each stall retry. After successful movement, the current is reset to its default setting.

COMM SETUP MENU

MODBUS ADDRESS (MODBUS register 15)
Allowable values are 1 to 247 (default = 1). MODBUS address of the actuator. If multiple actuators are placed on the same RS-485 bus, they must all have unique addresses.

BAUDRATE (MODBUS register 11)
Allowable values are: 4800, 9600, 14400, 19200 (default), 38400, 57600, 115200 bits per second. MODBUS register is scaled by /10 (i.e. 1920 = 19200 bps).

DATABITS (MODBUS register 12)
Fixed at 8 data bits. Not user selectable.

PARITY (MODBUS register 13)
0. No parity (default).
1. Odd parity
2. Even parity

STOP BITS (MODBUS register 14)
1. One stop bit per frame (default).
2. Two stop bits per frame.

DATALOG SETUP MENU

SD CARD STATUS (MODBUS register 373)
0. SD OKAY – An SD card is inserted and is communicating successfully.
1. SD NO CARD – No SD card is detected.
2. ERROR – A communication error has occurred with the SD card/port.

DATALOGGING (MODBUS register 270)
0. Datalogging is disabled
1. General datalogging (default). Saved fields are: Date, time, CV, PV, temp, humidity, VIN, Battery-voltage, battery temperature, close count, open count, stall close count, stall open count, drive temp, cumulative travel (feet).

Additional datalogging methods may be added in the future.

DATALOG SAMPLE RATE (MODBUS register 271)
Allowable values are 1 to 43200 (default is 600). Sample rate for datalogging. Maximum is 12 hours (43200 seconds).

TIME/DATE (MODBUS registers 30-37)
Press the UP or DOWN button to change to the TIME screen. Date and time fields are reported in MODBUS registers 30-37:

30. Hours (1 to 12)
31. Minutes (0 to 59)
32. Seconds (0 to 59)
33. AM = 0, PM = 1
34. Month (1 to 12)
35. Date (1 to 28, 29, 30, or 31 based on Month)
36. Year (0 to 99)

SET TIME

- Use the LEFT/RIGHT buttons to change fields.
- Use the UP/DOWN buttons to change each field.
- Hold down on the LEFT button to cancel and return to the TIME/DATE screen.
- Hold down on the RIGHT button to accept and move to the DATE screen.

SET DATE

- Use the LEFT/RIGHT buttons to change fields.
- Use the UP/DOWN buttons to change each field.
- Hold down on the LEFT button to cancel and return to the TIME/DATE screen.
- Hold down on the RIGHT button to accept and return to the TIME/DATE screen.

FAIL MODE SETUP

VIN FAIL MODE (MODBUS register 194)

0. Fail to position (default)
1. Fail in place
2. Continue operating on battery

VIN FAIL POSITION (MODBUS register 195)
Allowable values are 0 to 100 (default is 0). The position to move the valve to should input voltage fail. This option is only valid when fail mode is set to “FAIL TO POSITION”. The MODBUS register is scaled by x10 (i.e. 1000 = 100.0%)

MINIMUM VIN Voltage (MODBUS register 196)
Allowable values are 11.0 to 26.0V (default is 16.8V). The minimum voltage before VIN is considered lost. The default voltage is 16.8V to reflect the minimum required for battery charging. The MODBUS register is scaled by x10.

AIN FAIL MODE (MODBUS register 28)

0. Fail to position (default)
1. Fail in place

AIN FAIL POSITION (MODBUS register 29)
Allowable values are 0 to 100 (default is 0). The position to move the valve to should the analog input signal fall below 4mA. This option is only valid with AIN FAIL TO POSITION is selected. The MODBUS register is scaled by x10 (i.e. 1000 = 100.0%).

POWER CHECK

VIN/BATTERY Voltage (MODBUS registers 191, 111)
Displays the input voltage (MODBUS register 191, scaled by x10) and the backup battery voltage (MODBUS register 111, scaled by x1000).

BATTERY STATUS:
Displays the batter status (IDLE, CHG, or DISCH) and the battery capacity (MODBUS register 115)

BATTERY CURRENT: (MODBUS register 112)
Displays the battery current. When charging, the battery current will be positive (about 400mA, tapering to zero as the battery completes charging. When discharging, the current will be negative (about 100mA when the motor is not running, no more than 7500mA when discharging). When idle, the battery current is zero.

BATTERY TEMPERATURE
(MODBUS registers 118 and 119)
Displays the battery temperature in Celsius (register 118, scaled by x10) and in Fahrenheit (register 119, scaled by x10).

BATTERY CYCLES (MODBUS register 114)
The number of full Charge/Discharge cycles the battery has recorded.

COIN BATTERY (MODBUS register 381)
Voltage of the coin battery used to keep time for datalogging. Note: reading the coin battery voltage depletes the coin battery much faster than that normally consumed by the real-time clock. A reading is only initiated with the COIN BATTERY display is first loaded. A reading can also be forced by writing a “1” to register 384 or holding down on the UP or DOWN button for three seconds.

SYSTEM HEALTH

These menus can be used to help diagnose issues with individual subsystems if the HEALTH output indicates there is a problem.

VIN POWER (MODBUS register 191)
Displays the input voltage. The MODBUS register is scaled by x10 (i.e. 240 = 24.0V). If the input voltage is below the minimum voltage (MODBUS register 196), then VIN is considered insufficient for a “HEALTHY” system.

ANALOG IN (MODBUS register 81)
Displays the analog input (if applicable) in mA. If a control method other than Analog control is selected “NOT USED” is displayed.

BATTERY STATUS (MODBUS register 111)
Displays the voltage (MODBUS register 111) and capacity (MODBUS register 115) of the backup battery. The user can press the UP or DOWN button to toggle the battery in and out of the HEALTH assessment.

MAINTENANCE STATUS (MODBUS register 394)
Displays "OKAY" if we are still within the maintenance travel interval. Use the UP or DOWN button to change it to NOT USED to remove maintenance from the HEALTH assessment.

SYSTEM I/O CHECK

ANALOG INPUT (MODBUS register 81)
Displays the analog input signal as specified in mA. The MODBUS register is scaled by x10.

AIN ADC (MODBUS register 83)
Displays analog value ADC read at the analog input.

ANALOG OUTPUT (MODBUS register 99)
Displays the status of the analog output (MODBUS register 90) and value being transmitted (MODBUS register 99) if applicable. Register 99 is scaled by x10. Register 90 can be interpreted as follows:

0. Analog output is OK
1. reserved
2. reserved
3. Under current fault
4. Over current fault
5. Over temp fault
6. No loop voltage detected.

DISCRETE INPUTS (MODBUS registers 40, 41)
Displays the status of the discrete inputs as OPEN (no voltage detected) or CLOSED (sufficient input voltage detected).

DISCRETE OUTPUT (MODBUS register 42)
Displays the status of the discrete output as ON (1) or OFF (0).

ENCODER STATUS (MODBUS register 220)
Will display “GOOD” if the linear encoder behaved as expected during calibration and was within a valid range during the last startup cycle.

CALIBRATION STATUS
Displays a graph to represent the linear sensor, calibrated range, and current location.

- A diagonal line represents the entire range of the linear sensor.
- A box is drawn to show where the calibrated range of the sensor is.
- A vertical line displays where the linear sensor is reading.

Pressing and releasing the UP or DOWN button will put the valve into manual adjust mode. In this mode, the user can manually turn the spindle or use the UP/DOWN buttons to reposition the valve. Holding down on the RIGHT button changes the calibration so that the current position becomes the new 100% open position.

SYSTEM INFO

CONTROL FIRMWARE (MODBUS registers 1, 2, 3)
Displays the part number and firmware version of the Kimray control board.

DRIVE BOARD FIRMWARE
(MODBUS registers 360, 361, 362)
Displays the firmware version of the drive board.

DRIVE TEMP (MODBUS registers 365, 366)
Displays the temperature in Celsius (register 365) and Fahrenheit (register 366) as read from the drive board. NOTE: The drive is more concerned with high temps than low and as such does not report temperatures below 0C (32F).

TEMP/HUMIDITY (MODBUS registers 71, 72, 73)
Displays the temperature in Fahrenheit (register 71), Celsius (register 72) and relative humidity (register 73) as read from the on-board sensor. All registers are scaled by x10.

CLOSE COUNT (MODBUS register 132)
Displays the number of times the valve has reached full close since the last power-cycle or reset. Hold down on the UP or DOWN button to reset the close count to zero.

VIN CYCLES (MODBUS register 193)
Displays the number of times that VIN has been lost since the last power cycle. This could be useful in solar powered applications to indicate that primary battery storage is not sufficient to continuously power the actuator.

FEET TRAVELED (MODBUS registers 166, 167
Displays the number of feet traveled. Since EEPROM has a finite number of write operations, this value is saved at about every foot. The actuator should be good for recording about one million feet of travel.

MAINTENANCE MENU

TRAVEL (FT) (MODBUS registers 166, 167)
Displays the approximate travel (in feet) that the valve has moved.

INTERVAL (MODBUS register 391)
Displays the maintenance interval for the valve. The end user may want to change the maintenance interval based on their application. Default is 10,000 FT, allowable values are 100 to 50000 ft.

LAST MAINTENANCE (MODBUS registers 392, 393)
Displays the travel that maintenance was last performed. When maintenance is performed, hold down on the UP or DOWN button to reset this value to the current travel.

CALIBRATION SETUP

CAL SPEED (MODBUS register 342)
Allowable values are 50RPM to 1000RPM (default is 100RPM). The target speed of the actuator when in calibration mode.

CAL CURRENT (MODBUS register 343)
Allowable values are 3 to 10A (default is 3A). The current limit during calibration. This is intentionally set low so that the actuator does not lock up at the travel extents due to excessive force. This value may need to be increased to compensate for internal friction and the weight of large cages. The MODBUS register is scaled by x10.

CAL ACCELERATION (MODBUS register 341)
Allowable values are 1 to 50 (default = 5). The higher the number, the longer the actuator will take to get up to speed.

CALIBRATE ANALOG INPUT
Used to calibrate the analog input. The current ADC value is displayed and will change accordingly with changes to the analog input. The upper value is the 20A ADC value and can be reset to the current value by pressing and holding the UP button (default is 3932). The lower value is the 4A ADC value and can be reset to the current value by pressing and holding the DOWN button (default is 786).

RESET MENU

FACTORY RESET (MODBUS register 319)
Hold the UP or DOWN button for about three seconds to force a factory reset. This can also be performed by writing “6601” to register 319.

UNLOCK ADVANCED MODE (MODBUS register 310)
Use the buttons to change enter the passcode “6601”. Once entered, hold down on the RIGHT button to accept the passcode to unlock the advanced features. The password will clear at the next reset, but any changed values will remain until changed back or factory reset.

Modbus Map

Reg	Type	R/W	Default	Min	Max	Notes
0	uint16_t	R	7510			DEVICE_ID. Control board part number
1	uint16_t	R				Device Firmware – major revision number
2	uint16_t	R				Device firmware – minor revision number
3	uint16_t	R				Device firmware – test revision number
4	uint16_t	R				System Health
11	uint16_t	R/W	1920	480	11520	Baudrate scaled by div10 (1920 = 19200 baud)
						Valid values are:
						480 (4800 baud)
						960 (9600 baud)
						1440 (14400 baud)
						1920 (19200 baud)
						3840 (38400 baud)
						5760 (57600 baud)
						11520 (11520 baud)
12	uint16_t	R/W	8	8	8	Number of databits per communication byte
13	uint16_t	R/W	0	0	2	Parity (0 = none, 1 = odd, 2 = even)
14	uint16_t	R/W	1	1	2	Number of stop bits
15	uint16_t	R/W	1	1	247	MODBUS address – must be unique for every device on the bus
20	uint16_t	R				CV – Control value input scaled by x10
						This value is only write-able when in MODBUS control mode.
21	int16_t	R				PV – Process Value – position feedback scaled by x10
26	uint16_t	R				Analog input fail: “1” if the analog signal falls below 3.0A

Modbus Map continued

Reg	Type	R/W	Default	Min	Max	Notes
28	uint16_t	R/W	0	0	1	Analog input fail mode: 0 = Fail to position 1 = Fail in place
29	uint16_t	R/W	0	0	1000	Analog input fail position: The percentage open (x10) to which the valve should move when the analog input fails in Fail to Position mode.
30	uint16_t	R/W		1	12	Hour of the internal real time clock
31	uint16_t	R/W		0	59	Minute of the internal real time clock
32	uint16_t	R/W		0	59	Second of the internal real time clock
33	uint16_t	R/W		0	1	PM indicator of the internal real time clock
34	uint16_t	R/W		1	12	Month of the internal real time clock
35	uint16_t	R/W		1	31	Date of the internal real time clock. Note: the max allowed value is based on the month and year (to account for leap years)
36	uint16_t	R/W		0	99	Year of the internal real time clock
37	uint16_t	R/W		1	7	Weekday of the internal real time clock
40	uint16_t	R				Status of the D1 discrete input (1 = ON, 0 = OFF)
41	uint16_t	R				Status of the D2 discrete input (1 = ON, 0 = OFF)
42	uint16_t	R				Status of the discrete output
43	uint16_t	R/W	0	0	6	Configuration of the discrete output 0 = Health - ON if valve is “healthy” 1 = DOUT is ON at hard close 2 = DOUT is ON at full open 3 = DOUT is OFF at hard close 4 = DOUT is OFF at full open 5 = DOUT is on when valve is stalled 6 = DOUT is disabled and always off.

Modbus Map continued

Reg	Type	R/W	Default	Min	Max	Notes
44	uint16_t	R/W	0	0	2	Discrete Priority
						0 = D1 has priority over D2
						1 = D2 has priority over D1
						2 = Discrete override is off
71	int16_t	R				Temperature in Fahrenheit (x10)
72	int16_t	R				Temperature in Celsius (x10)
73	uint16_t	R				Relative humidity (x10)
81	uint16_t	R				Analog input (x10) in mA
83	uint16_t	R				Analog input ADC
84	uint16_t	R/W	786	0	4095	Analog input ADC for 4mA
85	uint16_t	R/W	3932	0	4095	Analog input ADC for 20mA
90	uint16_t	R				Analog output faults
						0 = OKAY
						1 = reserved
						2 = reserved
						3 = under current
						4 = over current
						5 = over temperature
						6 = No loop voltage detected
91	uint16_t	R/W	0	0	1	Analog output disable
						0 = ENABLED
						1 = DISABLED
99	uint16_t	R				Analog output (x10) in mA
111	uint16_t	R				Battery voltage in mV

Modbus Map continued

Reg	Type	R/W	Default	Min	Max	Notes
112	int16_t	R				Battery current in mA
113	int16_t	R				Average battery current
114	uint16_t	R				Number of battery discharge cycles
115	uint16_t	R				Battery charge percentage
118	int16_t	R				Battery temperature (x10) in C
119	int16_t	R				Battery temperature (x10) in F
120	uint16_t	R/W	1000	0	1000	Max allowed open (x10) in %. Ex. 750 allows the valve to only open to 75% of the calibrated travel.
121	uint16_t	R/W	1	0	1	Reduce speed during stall retry
122	uint16_t	R/W	1	0	1	Increase current during stall retry
123	uint16_t	R/W	1	0	1	Soft closing enabled
130	uint16_t	R/W	0	0	65535	Close count. This number is not retained in memory and will reset to zero after 65535 close cycles.
132 133	uint32_t	R/W	0	0	0xFFFFFFFF	Cycle count (for demo modes)
142	uint16_t	R				Valve movement status
						0 = Hunting the target
						1 = Retrying
						2 = On target
						3 = Hard close
						4 = Hard open
						5 = Stall close
						6 = Stall open
						7 = Hang error during open
						8 = Hang error during close
						9 = Undefined hang error
						10 = Unknown drive fault

Modbus Map continued

Reg	Type	R/W	Default	Min	Max	Notes
143	uint16_t	R/W	0	0	10	Control mode 0 = Analog input with discrete override 1 = Discrete latched (D1 = OPEN, D2 = CLOSE) 2 = Discrete momentary (D1 = OPEN, D2 = CLOSE) 3 = Normally closed, D1 = OPEN 4 = Normally open, D2 = CLOSE 5 = MODBUS control 6 = Manual control (User interface buttons) 7 = Control OFF 8 = Time Toggle (DEMO/TEST mode) 9 = Position Toggle (DEMO/TEST mode) 10 = Factory test mode
145	uint16_t	R/W	250	50	1000	Maximum open speed in RPMs
146	uint16_t	R/W	250	50	1000	Maximum close speed in RPMs
147	uint16_t	R/W	100	30	1000	Maximum open current (x10) in A (ex. 100 = 10.0 Amps)
148	uint16_t	R/W	100	30	1000	Maximum close current (x10) in A
149	uint16_t	R/W	15	1	50	Acceleration. The higher the number, the longer it takes to reach speed.
166 167	float32	R/W		0	3.4e30	Cumulative Feet traveled. This value is only saved at approximately one foot increments.
190	uint16_t	R				VIN Fail. “1” when VIN is below VIN MINIMUM
191	uint16_t	R				VIN voltage (x10) in V (ex. 240 = 24.0V)
193	uint16_t	R				VIN count – the number of times VIN Fail has occurred since last power up.

Modbus Map continued

Reg	Type	R/W	Default	Min	Max	Notes
194	uint16_t	R/W	0	0	1	VIN Fail mode: 0 = Fail to position 1 = Fail in place 2 = Run on battery
195	uint16_t	R/W	0	0	1000	Fail position (x10). Ex 500 = 50.0%
196	uint16_t	R/W	168	0	260	VIN minimum: The minimum voltage to consider VIN as lost
220	uint16_t	R				Linear sensor status. “1” indicates the linear sensor was calibrated properly
221	uint16_t	R				Current position of the linear sensor ADC
242	uint16_t	R				Linear sensor startup status. “1” indicates the linear sensor was valid when the actuator powered up.
270	uint16_t	R/W	1	0	1	Datalogging: 0: off 1: General datalogging
271	uint16_t	R/W	600	1	43200	Number of seconds between datalog samples Note: 600 seconds = 10 minutes 3600 seconds = 1 hour 43200 seconds = 12 hours
290	uint16_t	R				Stall Detect “1” indicates the actuator is currently stalled.
293	uint16_t	R/W	500	0	2000	Stall retry delay in mS
294	uint16_t	R/W	15	0	50	Close retry limit before STALL is declared
295	uint16_t	R/W	15	0	50	Open retry limit before STALL is declared
310	uint16_t	R/W	0	0	9999	Password to unlock advanced mode features (6601)
319	uint16_t	R/W	0	6601	6601	Perform a factory reset by writing “6601”
341	uint16_t	R/W	5	1	50	Acceleration during calibration routine
342	uint16_t	R/W	100	50	1000	Velocity during calibration routine (RPM)

Modbus Map continued

Reg	Type	R/W	Default	Min	Max	Notes
343	uint16_t	R/W	30	30	100	Current limit during calibration routine
360	uint16_t	R				Drive board firmware version (test rev in ASCII)
361	uint16_t	R				Drive board firmware version (minor rev)
362	uint16_t	R				Drive board firmware version (major rev)
365	uint16_t	R				Drive temperature in C (will not report less than 0C)
366	uint16_t	R				Drive temperature in F (will not report less than 32F)
373	uint16_t	R				SD card initialization – the port is working properly
374	uint16_t	R				SD card inserted
381	uint16_t	R				Coin battery voltage
384	uint16_t	R/W	0	0	1	Force an updated read from the Coin battery.
391	uint16_t	R/W	1000	100	50000	Travel interval before maintenance is suggested.
392 393	float32	R/W	0	0	10,000,000	Last travel value when maintenance was performed.
394	uint16_t	R/W	1	0	1	"1" when maintenance is considered part of the HEALTH assessment.

DISASSEMBLY

ASSEMBLY

TROUBLESHOOTING

Problem	Possible Cause(s)	Possible Solution
Valve repeatedly pauses during travel	Valve Obstruction	Clear valve obstruction. Decrease speed limit if problem persists.
	Increased Valve Friction	Decrease speed limit
After Calibration, display indicates "ENCODER ERROR"	Incorrect wiring on encoder terminal block	REMOVE POWER. Correct wiring issue. Re-Apply power. Re-Calibrate. Replace sensor if needed.
	Damaged Linear Sensor Connecting the sensor into a live circuit can damage the sensor and possibly the main board as well.	Move to next screen "LINEAR ENC ADC:" and open/close the valve to see if the ADC value changes linearly. If not, then replace sensor and the main board if needed.
	If it is not possible to quickly replace the sensor and the board, The valve can continue to work in this mode until the repairs can be made. Accuracy may degrade over time but will reset every time the valve homes. A throttling application that rarely closes would be affected most. A snap application will not see any issues.	

Kimray is an ISO 9001- certified manufacturer.

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Kimray quality assurance process maintains strict controls
of materials and the certification of parts used in the Kimray Electric Burner Valve.

Please visit our website for up to date product data www.kimray.com

WHO WE ARE

Kimray is a manufacturer of oil and gas control equipment based in Oklahoma City, Oklahoma, USA.

Trusted for generations, Kimray has been creating simple, effective solutions for temperature, level, flow, and pressure control since 1948. Common applications include separation, heating, compression, dehydration, and artificial lift.

Buying from Kimray is about much more than the product. We are partners with hearts to serve. The relationships between our representatives and our customers extend from before the sale through the life of the product. Our focus is not on short-term profits but long-term growth for our customers.

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