MAXITROL®

EXA E41, E51, E61 Series Modulating Valve

OPERATING INSTRUCTIONS

⚠ WARNING

Read these instructions carefully and completely before installing or operating. Failure to follow them could result in a fire or explosion causing property damage, personal injury, or loss of life. Service and installation **must** be performed by a trained/experienced service technician.

Disconnect power before installation to prevent electrical shock, equipment or control damage.

WHAT TO DO IF YOU SMELL GAS

- Do NOT operate any appliance.
- Do NOT touch any electrical switch; do NOT use any phone in your building.
- Immediately evacuate the area and contact the gas supplier. Follow the gas supplier's instructions.
- If you can NOT reach the gas supplier, call the fire department.

⚠ WARNING

This control **must** be installed and operated **strictly** in accordance with the instructions of the OEM and with all applicable government codes and regulations, e.g. plumbing, mechanical, and electrical codes and practices. These instructions do not supersede OEM's installation or operating instructions.

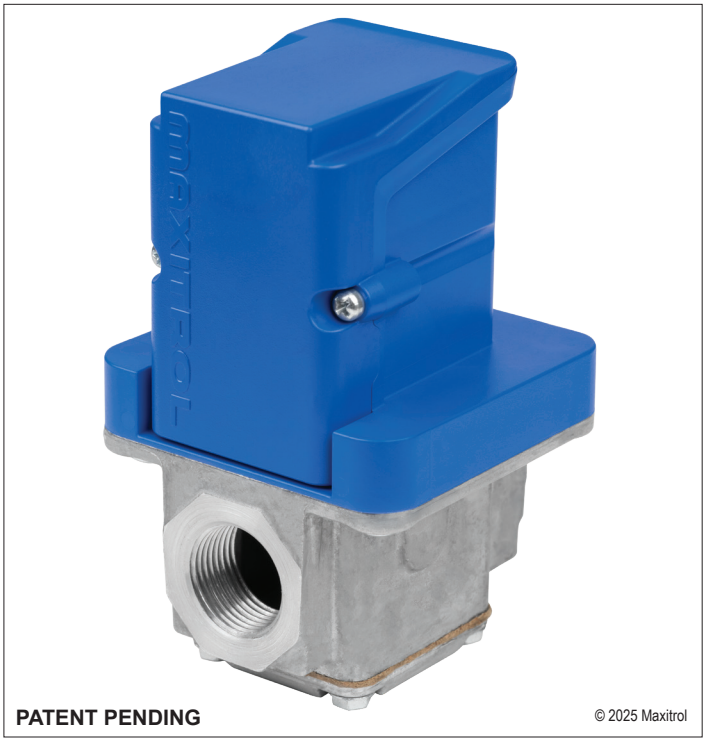

Figure 1: EXA Series Modulating Valve

DESCRIPTION

The E41, E51, and E61 Series modulating valves are highly accurate and precise modulating control valves (see figure 1). They provide repeatable process control with minimal hysteresis throughout the entire range of modulation.

The EXA Series modulating valve has a built-in digital controller that provides a seamless interface with a process controller.

The valve can be connected to automation communication systems using the Modbus RTU protocol.

Two fuel specific sets of high and low limits can be programmed manually or over Modbus. This is especially useful when converting from one fuel gas to another. Changing the limits for one fuel to the other is easily done in the factory or field with a dip switch setting.

SPECIFICATIONS

Maximum Inlet Pressure: 5 psig

Power Requirements: 24 VAC +/- 10% 20VA 50/60 hz
24 VDC +/- 10% 5W

NOTE: The E41H, E51H, E61H use half-wave rectifiers. When using a single transformer for powering the E41H, E51H, E61H and devices with half-wave rectifiers, the common for each must be connected to the same leg of the transformer. Control signal devices with full-wave bridge rectifiers require a separate transformer.

See "*Power Supply Compatibility*" bulletin.

Temperature Limits: -40º F to 125º F operating

Control Signal (user selectable)**:** 0-5 VDC, 1-5 VDC, 0-10 VDC, 2-10 VDC, 0-10 mA, 2-10 mA, 0-20 mA, 4-20 mA; 50K Ohm Input Impedance

Mounting: Multipoise

Vent: None

Gases: Suitable for natural, manufactured, mixed gases, liquefied petroleum gases, and LP gas-air mixtures.

Certifications:
- UL Recognized
- CE

SPECIFICATIONS CONTINUED

Enclosure: IP40

Electrical Connection:
Standard: Amphenol Anytek TJ0811530000G with screw terminals.

Sizes: E41: 3/8", 1/2" NPT or Rp ISO 7-1
E51: 1/2", 3/4" NPT or Rp ISO 7-1
E61: 3/4", 1" NPT or Rp ISO 7-1

Power Supply: H-Suffix: Half Wave
Non-H Suffix: Full Wave

Sizing
Valve sizing and selection is based on the typical 1.0" w.c. pressure drop allowance at maximum flow rate. Using the Sizing Chart (Table 1, page 2), find the closest flow rate which meets or exceeds the appliance's maximum modulated flow rate.

Flow Capacity in Btu/h @ 1" w.c. Pressure Drop:		
Non Linear Model	**Nat Gas**	**LP**
E41 (3/8")	190K	315K
E41 (1/2")	215K	355K
E51 (1/2")	385K	640K
E51 (3/4")	435K	725K
E61 (3/4")	670K	1115K
E61 (1")	780K	1300K

Table 1: Sizing Chart for Non Linear Models

MODBUS DEFAULT

Slave Address:	50
Baud Rate:	19.2K bps
Transmission Mode:	RTU
Electrical Interface:	RS485 (half duplex) **NOTE:** integral software interface: USB converter with virtual COM port.
Data Bits:	8
Stop Bits:	1
Parity:	None

SUPPORTED MODBUS FUNCTIONS

Function Code	Register Type
0x01	Read Coil
0x02	Read Discrete Input
0x03	Read Holding Registers
0x04	Read Input Registers
0x05	Write Single Coil
0x06	Write Single Holding Register
0x0f	Write Multiple Coils
0x10	Write Multple Holding Registers

Table 2: Supported Modbus Functions

HOLDING REGISTERS

Parameter Name	Access**	Address***	Data (dec)**
Position (target)	R/W	40000	LL ≤ target ≤ HL
Percent Open %	R/W	40001	0 - 10000
Low limit setting - Fuel 1	R/W	40002	0 - (HL-1)
High limit setting - Fuel 1	R/W	40003	(LL+1) - X*
Low limit setting - Fuel 2	R/W	40004	0 - (HL-1)
High limit setting - Fuel 2	R/W	40005	(LL+1) - X*
Slave Address	R/W	40007	50 - 59
Baudrate	R/W	40008	9600, 19200
Parity	R/W	40009	0, 1 or 2
Stop Bits	R/W	40010	1 or 2

Table 3: Holding Registers

* X = 340 (E41), 540 (E51), 775 (E61)

** **R**ead and/or **W**rite; **LL** = Low limit setting; **HL** = High limit setting

*** The register addresses correspond to offset "0" within the given function and base 0.

INPUT REGISTERS

Parameter Name	Access**	Address***	Data (dec)**
Position (actual)	R	30000	0 - X*
Low Limit Setting - Active	R	30001	0 - (HL-1)
High Limit Setting - Active	R	30002	(LL+1) - X*
PCB Junction Temp	R	30004	(Ta) C
Firmware Major Version	R	30005	
Firmware Minor Version	R	30006	
Firmware Patch Version	R	30007	

Table 4: Input Registers

COILS

Parameter Name	Access**	Address***	Data**
Home	R/W	0	0 or 1

Table 5: Coils

DISCRETE INPUTS

Parameter Name	Access**	Address***	Data**
Fuel Type	R	10000	0 or 1

Table 6: Discrete Inputs

* X = 340 (E41), 540 (E51), 775 (E61)

** **R**ead and/or **W**rite; **LL** = Low limit setting; **HL** = High limit setting

*** The register addresses correspond to offset "0" within the given function and base 0.

PARAMETER NAMES

Position (target)
Step count number valve element will travel to

Percent Open
Percent open of active low to high operating limits

Low limit setting - Fuel 1
Step count number at low fire position - Fuel 1

High limit setting - Fuel 1
Step count number at high fire position - Fuel 1

Low limit setting - Fuel 2
Step count number at low fire position - Fuel 2

High limit setting - Fuel 2
Step count number at high fire position - Fuel 2

Slave Address
Address assigned to EXA "A".

Baud Rate
Data signaling rates

Parity
Parity bit specified by master

Stop Bits
Number of stop bit(s) specified by master

Position (actual)
Real time step count number of valve element position

Low limit setting - Active
Step count number at low fire position - Active Fuel

High limit setting - Active
Step count number at high fire position - Active Fuel

PCB Junction Temperature
Ambient temperature degrees C sensed at pcb board

Firmware Version
Major, minor and patch versions of the operating system

Home (Reset)
Valve will cycle from current position step count to home position (see note) and back to previous position step count

NOTE: Home position is not within the operating set range. Homing while heater is in operation may cause a momentary decrease in pressure or heater shutdown.

Fuel Type
Indicates which set of fuel limit settings is active

DIP SWITCH FUNCTIONS

Dip Switch 1 (DS1)	Function	OFF	ON	Comments
DS1-1	Modbus control (direct)		Enabled	Control Signal made inactive
DS1-2	Fuel Type - Active	Fuel 1	Fuel 2	Fuel 1 - 0, Fuel 2 - 1
DS1-3	Not Used			
DS1-4	Control Signal - 20% Offset		Enabled	See Table 8
DS1-5	Control Signal - Type	Voltage	Current	
DS1-6 & DS1-7	Control Signal - Half Range		Enabled	

Table 7: Dip Switch Function Table

Modbus Control

DS1-1 is ON to enable. Control signal input is disabled. Valve movement is controlled directly through Modbus communication. Write to holding register address 40000 or 40001 to control valve position.

NOTE: For proper operation, number written to holding register address 40000 must be ≥ low setting and ≤ high setting.

Fuel Type-Active

DS1-2 position sets which fuel type is active. DS1-2 OFF, Fuel 1 is active. DS1-2 ON, Fuel 2 is active. A fuel specific set of upper and lower limits can be assigned to Fuel 1 and Fuel 2. The DS1-2 setting automatically inputs* the programmed limits assigned for the fuel. This feature allows various fuels (e.g. Natural Gas and LP) to operate over the same Btu/h range simply by changing DS1-2 status. The selected fuel type can be read in discrete input address 10000. Fuel 1: 0, Fuel 2: 1

***NOTE:** power cycle is required for fuel change.

CONTROL SIGNALS

The control signal indicates a position within the valve's programmed range of modulation. The control signal is "scaled" between the high and low fire setting of the valve. See Table 8, below, for control signal dip switch configuration.

NOTE: Control signal is polarity sensitive (see CONNECTIONS, page 5).

Control Signal Input - Dip Switch Configuration			
Control Signal Input	**DS1-4**	**DS1-5**	**DS1-6 & DS1-7**
0-5 V	OFF	OFF	ON
1-5 V	ON	OFF	ON
0-10 V	OFF	OFF	OFF
2-10 V	ON	OFF	OFF
0-10 mA	OFF	ON	ON
2-10 mA	ON	ON	ON
0-20 mA	OFF	ON	OFF
4-20 mA	ON	ON	OFF

Table 8: Control Signal Input - Dip Switch Configuration Table

Control Signal (20% offset)

DS1-4 is ON for all 20% offset control signals.

Control Signal (5V, 10 mA max)

DS1-6, DS1-7 are ON for all 5V and 10 mA maximum control signals.

Control Signal (Type)

DS1-5 is OFF for all voltage control signals and ON for all current control signals.

NOTE: Multiple dip switch settings are used with some control signals (See Table 8).

CONNECTIONS

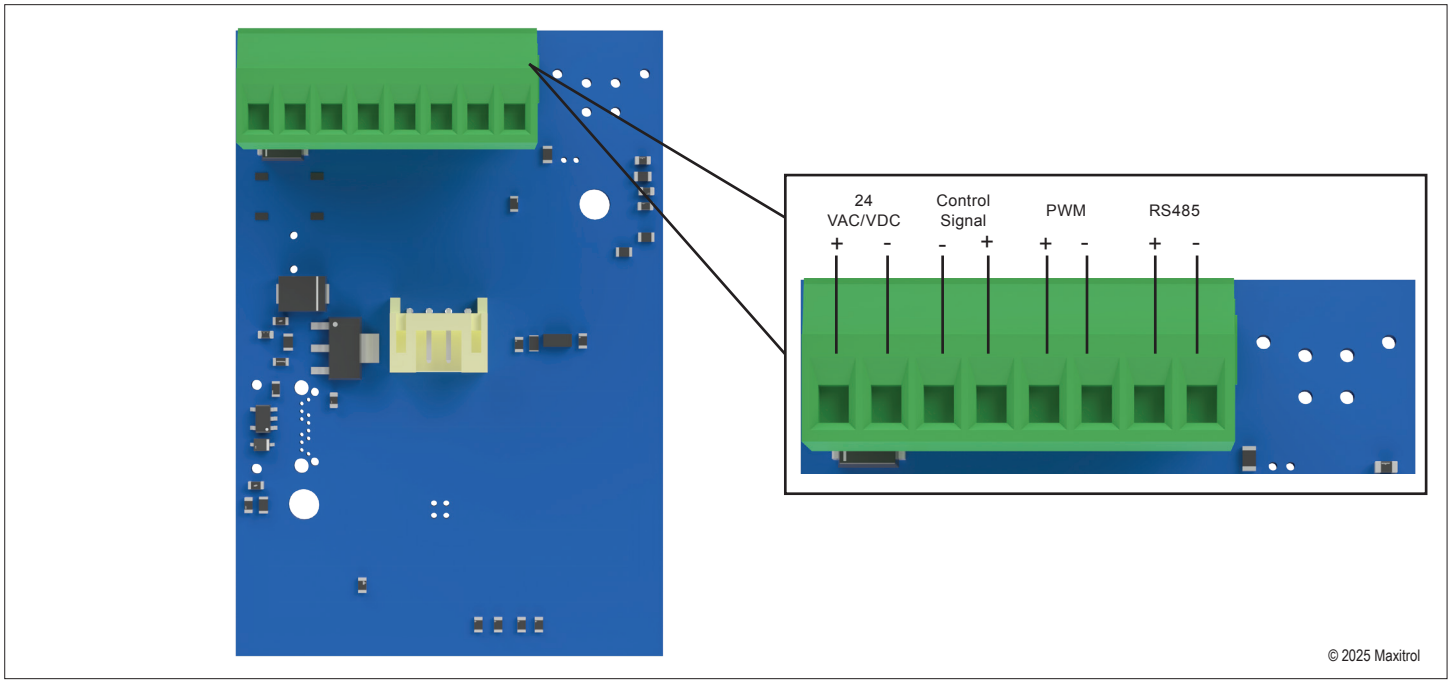

Figure 2: EXA Modulating Valve Series Connections

Terminal configuration is as shown.

8 POSITION WIRE TERMINAL BLOCK OR HEADER*							
Terminal 1	Terminal 2	Terminal 3	Terminal 4	Terminal 5	Terminal 6	Terminal 7	Terminal 8
Power (+)	Power (-)	Signal (-)	Signal (+)	PWM	GND	RS485 +	RS485 -

*See page 2 for electrical connection.

SETTINGS

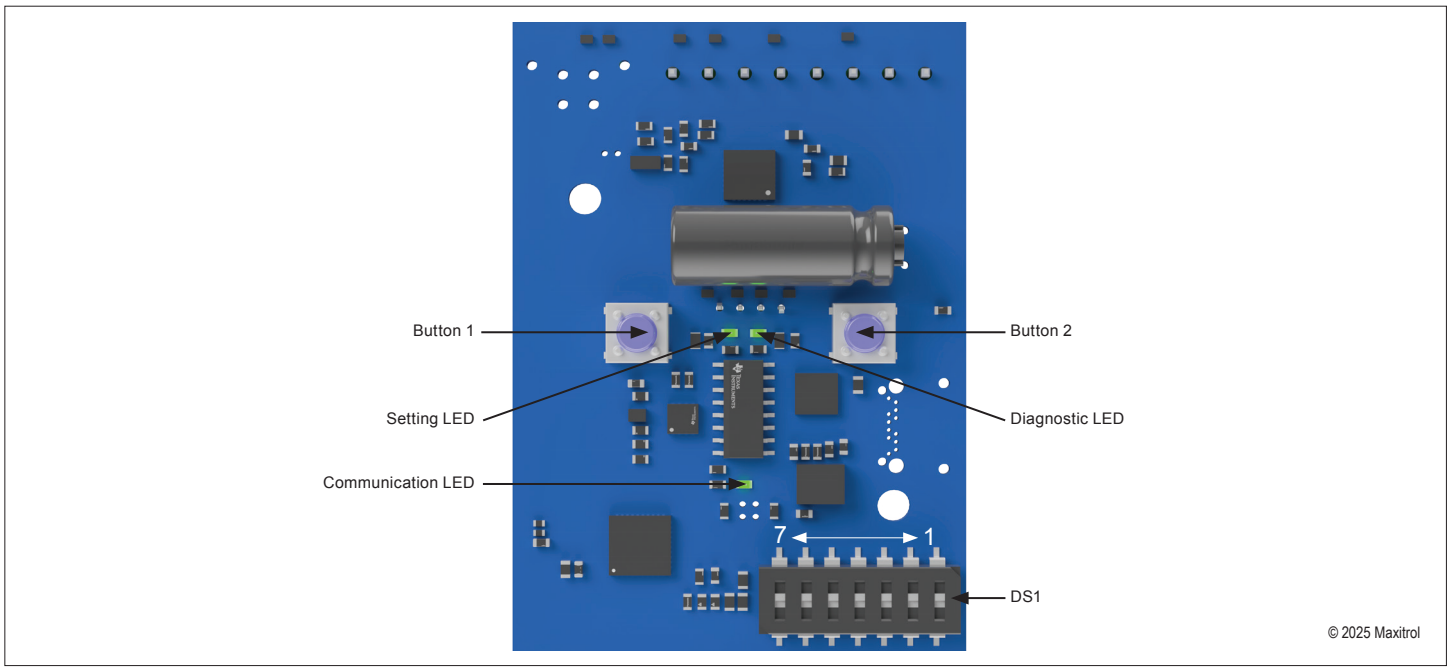

Figure 3: EXA Series Modulating Valve PCB Interface

POSITION FEEDBACK OUTPUT SPECIFICATION

The PWM output will give a feedback to correspond with the current valve position between the programmed minimum and maximum positions. The duty cycle range is always scaled from the programmed minimum to the programmed maximum position.

Frequency
200 Hz

Resolution
9-bit (0.2% duty cycle)

Duty Cycle
3% @ programmed minimum position
97% @ programmed maximum position

Output Impedance
3.2K Ω ± 0.1K Ω

Output High Voltage
5.0V nominal
5.25V maximum

NOTE: Output high level varies with the load current at the PWM output.

Output Low Voltage
0.0V

Connection: Terminals 5 and 6, see page 5.

REFERENCE ON POWER UP

Whenever 24 VAC/DC is initially applied, the valve element moves to the home state position* and then moves to the position determined by the controller input.

Maximum cycle time, maximum position to home position and back to maximum position, is less than 7 seconds.

***NOTE:** The valve's home position is not a setting limit.

CONNECTIONS/INITIAL CONFIGURATION

Step 1: Switch all electrical connections to OFF position

Step 2: Remove cover

Step 3: Set DS1-2 to fuel type (see Figure 3, page 5; Table 7, page 4).
See "Fuel Type-Active", page 4.

Step 4: Set dip switches to match desired control signal input (see Figure 3, page 5; Table 8, page 4).
For Modbus Control see Step 5.

Step 5: Optional ModBus Control - set DS1-1 to ON to enable (see Figure 2, page 5; Table 8, page 4). DS1-1 ON will disable Step 4 setting.

Step 6: Connect 24V (AC/DC) power source to terminals 1 and 2 (see page 5).

Observe polarity when using a DC power source or if one leg of an AC transformer secondary is externally grounded or is sharing power with another half-wave device.

Step 7: Connect control signal, if used, to terminals 3 and 4 (see page 5).

Observe polarity. Note that the return, or signal ground, must be connected to terminal 3.

Step 8: Optional - Connect either A or B.

A. PWM feedback - Terminals 5 and 6.
Observe polarity (see page 5).

B. Modbus using RS485 - Terminals 7 and 8.
Observe polarity (see Figure 2, page 5).

Step 9: Default Baud Rate is 19.2K bps.
To change baud rate to 9600, see "BAUD RATE", page 9, while performing Step 10.

Step 10: Switch electrical connections to ON position. Diagnostic LED should light up.

Step 11: Optional - Begin communication with Modbus master (see “ModBus”, page 2 for settings).

For using demonstration software, see "TESTING AND SETTING USING MODBUS", page 10.

Step 12: Set valve limits manually or electronically (see “VALVE SETTING", page 8).

Step 13: Replace cover.

DIMENSIONS

NOTE: Dimensions are to be used only as an aid in designing clearance for the valve. Actual production dimension may vary somewhat from those shown (see Figure 4 and Table 9).

Model	Swing Radius (SR)	Dimensions inches (millimeters)					
		A	B	C	D	E	F
E41	4.0 (102)	4.8 (122)	1.0 (26)	2.1 (54)	2.7 (69)	2.4 (61)	2.4 (61)
E51	4.3 (110)	5.5 (140)	1.3 (31)	3.4 (87)	3.3 (84)	3.3 (84)	2.4 (61)
E61	4.6 (117)	6.0 (153)	1.5 (38)	4.1 (105)	3.7 (94)	3.9 (100)	2.4 (61)

Table 9: Dimensions

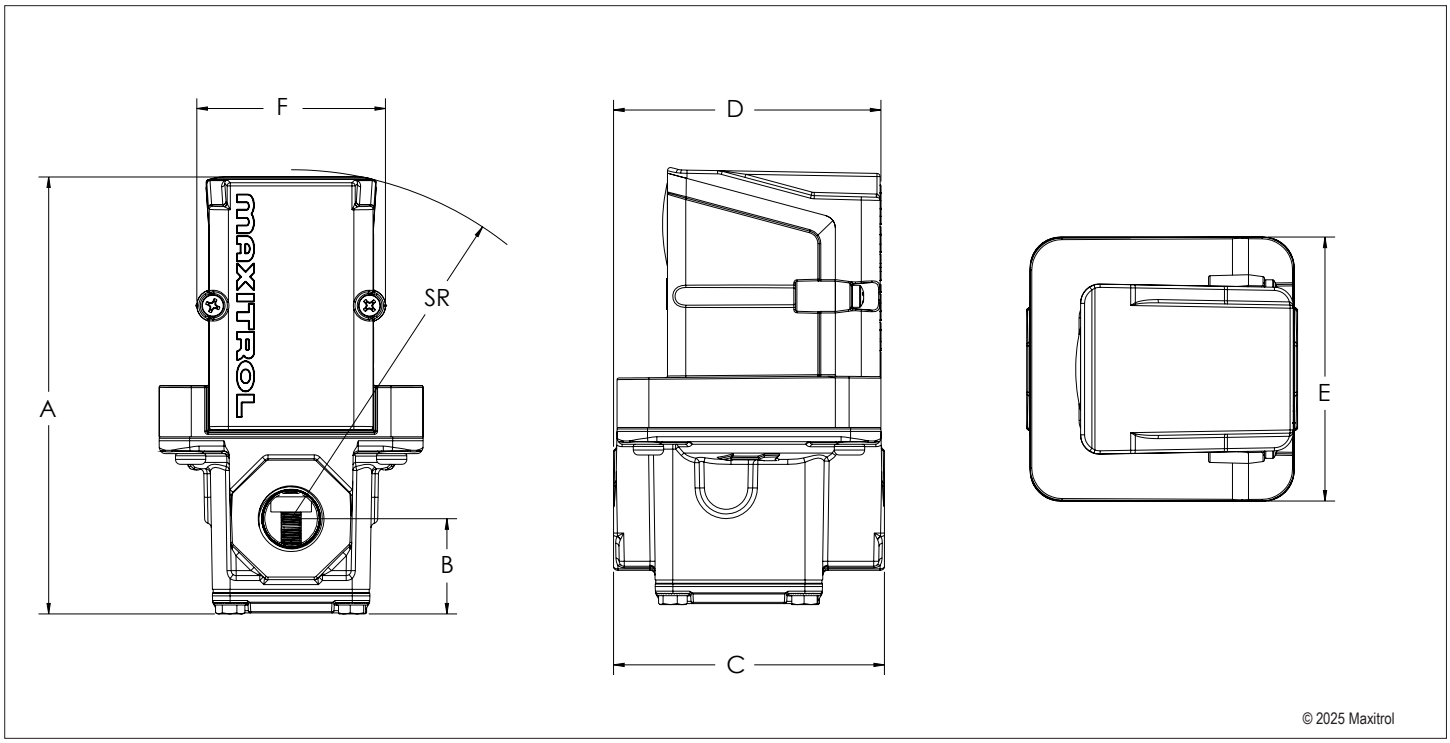

Figure 4: EXA Series Modulating Valve Dimensions

SETTING VALVE LIMITS - MANUALLY

The EXA Series modulating valve has two (2) buttons and a Setting LED for the user interface. The buttons are used to manually set the valve for high and low fire settings.

1. High Fire Setting (LED will be solid green)
2. Low Fire Setting (LED will be blinking green)
3. Operating Mode (LED will be OFF)

High Fire Setting - Button #1

To enter the high fire setting mode, press and hold Button #1 until the LED lights solid green. Release. The valve is now in the high fire setting mode. Buttons #1 and #2 are used to set desired high fire setting.

To increase gas flow slowly, press button #1. Each button press will increase gas flow by the minimum available step size. To increase gas flow rapidlly, hold button #1. Holding the button down allows the valve to auto step and eliminates the need to repeatedly press the button.

To decrease gas flow slowly, press button #2. Each button press will decrease gas flow by the minimum available step size. To decrease gas flow rapidly, hold button #2. Holding the button down allows the valve to auto step and eliminates the need to repeatedly press the button.

To save the high fire setting, simultaneously hold Buttons #1 and #2 until the LED turns OFF.

NOTE: Controls left in manual setting mode will default to the current settings and return to normal operating mode after 5 minutes of inactivity.

Low Fire Setting - Button #2

To enter into the low fire setting mode, press and hold Button #2 until the LED light blinks green. Release. The valve is now in the low fire setting mode. Buttons #1 and #2 are used to set the desired low fire setting.

To decrease gas flow slowly, press button #2. Each button press will decrease gas flow by the minimum available step size. To decrease gas flow rapidly, hold button #2. Holding the button down allows the valve to auto step and eliminates the need to repeatedly press the button.

To increase gas flow slowly, press button #1. Each button press will increase gas flow by the minimum available step size. To increase gas flow rapidly, hold button #1. Holding the button down allows the valve to auto step and eliminates the need to repeatedly press the button.

To save the low fire setting, simultaneously hold Buttons #1 and #2 until the blinking LED turns OFF.

NOTE: Controls left in manual setting mode will default to the current setting and return to normal operating mode after 5 minutes of inactivity.

Program Second Fuel Specific Set - High and Low Fire Setting

Remove power. Switch DS1-2 position to ON. Restore power. Follow previous procedure for setting the high and low fire limits.

DS1-2 position determines which set of programmed limits are operationally active.

LEDS

Communication LED: Blinks during data transfers

Diagnostic LED: On indicates sufficient voltage for valve operation

Setting LED: Indicates mode when manually setting valve limits and signals slave address on power up

SETTING VALVE LIMITS - ELECTRONICALLY

EXA Series modulating valves connnected to a Modbus communication system can program the high fire and low fire settings by writing to assigned register addresses. Transmission is over RS485. A Communication LED flashes during data transfers (see Figure 3, page 5).

The valve is capable of having two fuel specific sets of limits written to memory. Valves are typically preset from the factory or have known integer inputs to set the desired low and high fire settings for each fuel type.

NOTE: Fuel setting DS1-2 position determines the active set of operational limits (see Table 7, page 4).

If changes to either set of limits is required, proceed with the following:

NOTE: Minimum setting limit = 0
Maximum setting limit = 340 (E41), 540 (E51), 775 (E61)

FUEL 1

Low Fire Setting - Holding Register Address 40002

Read (03) register 40002 and note the number located in the data field.

Optional: Read (03) register 40003 and note the number located in the data field.

If a lower minimum flow rate is desired write (06) a lower number into the data field of register 40002.

If a higher minimum flow rate is desired write (06) a higher number into the data field of register 40002.

NOTE: Number must be less than number observed in register 40003 data field.

Repeat until the desired minimum setting is achieved.

Optional: Read (03) register 40002 to confirm the number has changed to last inputted number.

High Fire Setting - Holding Register Address 40003

Read (03) register 40003 and note the number located in the data field.

Optional: Read (03) register 40002 and note the number located in the data field.

If a lower maximum flow rate is desired write (06) a lower number into the data of register 40003 and update the valve.

NOTE: Number must be greater than number observed in register 40002 data field.

If a higher maximum flow rate is desired write (06) a higher number into the data of register 40003 and update the valve.

Repeat until the desired maximum setting is achieved.

Optional: Read (03) register 40003 to confirm the number has changed to last inputted number.

FUEL 2

Low Fire Setting - Holding Register Address 40004
Same procedure as Active Low Fire Setting - Holding Register 40002 with the following exception. Substitute register 40004 wherever register 40002 is referenced and register 40005 wherever register 40003 is referenced.

High Fire Setting - Holding Register Address 40005
Same procedure as Active High Fire Setting - Holding Register 40003 with the following exception. Substitute register 40005 wherever register 40003 is referenced and register 40004 wherever register 40002 is referenced.

BAUD RATE

Manually
Remove power. Press and hold the applicable button while powering on (see Figure 3, page 5).

Button 1: 9600 bps
Button 2: 19.2 K bps

When power is restored, release button.

NOTE: Manual reset of baud rate will also default parity and stop bits settings as follows: Stop Bits - 1, Parity - None

Electronically
9600 bps - Write 9600 to Holding Register Address 40008
19.2k bps - Write 19200 to Holding Register Address 40008

CHANGE ACTIVE FUEL

Remove power. Switch Fuel DS1-2 position (see Figure 3, page 5). Restore power.

HOME (RESET) - COIL 0

Write 1 to Coil 0

SLAVE ADDRESS - HOLDING REGISTER ADDRESS 40007

Write desired address number (51, 52....59) to holding register 40007.

Remove power from valve.

When valve power is restored, the Setting LED (see Figure 4, page 8) will flash the one's place of the address number. (e.g. two flashes designates address 52.)

The default value of 50 does not flash.

PARITY - HOLDING REGISTER ADDRESS 40009

Write desired Parity (NONE: 0; ODD: 1; EVEN: 2) to Holding Register Address 40009.

STOP BITS - HOLDING REGISTER ADDRESS 40010

Write desired Stop Bits (1 or 2) to Holding Register Address 40010.

TESTING AND SETTING USING MODBUS

Modbus master simulators for test and setting purposes can be downloaded from the internet. One such free program is QModBus.

The program is easy to setup, has a graphical user interface and is known to connect and communicate with the EXA.

Setup

Download QModBus from the SOURCEFORGE website.

Follow steps 1-10 in CONNECTIONS/INITIAL CONFIGURATION section (see page 6).

NOTE: If Step 8B is used, a USB to RS485 converter may be required (see Table 10, page 10).

Open program

Main view settings:

Serial Port: USB Serial Port (COMx)
Baud: 19.2K
Data bits: 8
Stop bits: 1
Parity: None
Slave ID: 50
Function code: Read Holding Registers (0x03)
Start Address: 40002
Num of coils: 1

Click “Send”

Register 40002 data displayed in the “Registers” Data box.

By successfully executing the above setup, Holding Register 40002, the Fuel 1 low limit setting data has been read.

Read

To read other registers, coils, descrete inputs, perform the following:

Select desired "Read Function Code" in the dropdown menu.

Change “Start address” to desired parameter (see pages 2 and 3).

Click “Send”

To read multiple registers

Increase “Num of coils”

Ex:
Start Address: 40000
Num of coils: 6

Holding Registers 40000-40005 data is displayed in the “Registers” Data box.

Write

To change data saved in Read/Write or Write registers or Coils, select desired “Write Function Code” in the dropdown menu.

Change “Start address” to desired Write or Read/Write parameter (see pages 2 and 3).

Overwrite existing data with new data

Click “Send”

USB TO RS485 CONVERTER

RS485 Converter Output*	EXA
+	Terminal 7
-	Terminal 8

Table 10: USB to RS485 converter

*Refer to data sheet supplied with converter

MAXITROL®

Maxitrol Company
23555 Telegraph Rd., P.O. Box 2230
Southfield, MI 48037-2230 U.S.A.

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www.maxitrol.com