

**GS-20/25 and GS-40/45 Series  
 Single-block Multi-function Gas Control Valves**

<b>Introduction</b>	<b>Page</b>	<b>3</b>
• <i>Application</i>		3
• <i>Electrical Ratings</i>		3
• <i>Specifications</i>		4
<b>Installation</b>		<b>5</b>
• <i>Mounting</i>		5
• <i>Standard Wiring (From Burner Sequence Control)</i>		6
• <i>4-Pin Connector Plug Wiring (From Burner Sequence Control)</i>		7
• <i>GS-406_ Connection of the Impulse Lines</i>		8
• <i>Checkout Procedure</i>		9
<b>Adjustments</b>		<b>11</b>
• <i>GS-__1_ (On/Off with Flow Adjustment)</i>		11
• <i>GS-__2_ (On/Off Step-slow Opening with Flow Adjustment)</i>		12
• <i>GS-_03_ (On/Off with Pressure Regulator)</i>		12
• <i>GS-405_ (On/Off with Servo Precision Regulator)</i>		12
• <i>GS-406_ (On/Off with Gas/Air Ratio Control)</i>		14
<b>Repairs and Replacement</b>		<b>17</b>



# Introduction

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**Figure 1: GS Series Single-block Multi-function Control Valves**

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## **Application**

The GS Series single-block multi-function gas control valves are intended for use on atmospheric and forced-draft gas burners in heating installations. This multi-functional control on a single-block valve body provides a compact answer to gas train applications. The GS valve replaces multiple gas train components, such as on/off gas valves, gas pressure regulators, and modulating gas valves. Optional sizing of body flanges offers greater adaptation to diversified burner designs and applications. Valves are approved to North American and European standards.

Typical applications include boilers, burners and ovens, rooftop units, makeup air heaters, hot water heaters, kilns, and paint booths.

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## **Electrical Ratings**

**Table 1: Electrical Ratings**

Valve Model	Operating Voltages	Power Consumption
GS-2_ _ _	230 VAC +10/-15%, 50/60 Hz 120 VAC +10/-15%, 50/60 Hz 24 VAC +10/-15%, 50/60 Hz	23 VA
GS-4_ _ _	230 VAC +10/-15%, 50/60 Hz 120 VAC +10/-15%, 50/60 Hz 24 VAC +10/-15%, 50/60 Hz	23 VA

## Specifications

**Table 2: Specifications**

<b>Media</b>	1st (Manufactured Gas), 2nd (Natural Gas), and 3rd (Liquefied Petroleum [LP] Gas) Family Gases
<b>Maximum Inlet Pressure</b>	<p><b>Europe:</b>            GS-_01_ and GS-_02_: 360 mbar            GS-251_ and GS-252_: 200 mbar            All Other Models: 100 mbar</p> <p><b>North America:</b>            GS-_01_ and GS-_02_: 5 psi            GS-251_ and GS-252_: 2 psi            All Other Models: 0.5 psi</p>
<b>Maximum Regulating Setting</b>	20 mbar (8 in. W.C.) (GS-_03_) 50 mbar (20 in. W.C.) (GS-405_ and GS-406_)
<b>Reverse Pressure Rating</b>	150 mbar (60 in. W.C.) minimum; Class A (EN 161)
<b>Regulator Classification</b>	Spring Regulator (GS-_03_): Class B (EN 88) Servo Regulator (GS-405_): Class A (EN 88)
<b>Permissible Ambient Temperature</b>	-15 to 60°C (5 to 140°F)
<b>Body Connections</b>	Detachable flanges with pipe thread 3/8 to 1-1/2 in. NPT or Rp
<b>Valve Torsion Group</b>	Group 2 (EN 88 and EN 161)
<b>Pressure Taps</b>	Flanges: 9.0 mm (0.35 in.) spigot for flexible tubing Body: Rp 1/8 thread standard (multi-position) Rp 1/4 thread special (multi-position) GS-4 only
<b>Materials</b>	Body and Flanges: Die cast aluminum Diaphragms and Seals: Perbunan rubber Solenoid Enclosure: IEC 529 (NEMA 1 and IP 54)
<b>Filter Segment</b>	Standard Dirt Strainer: 0.5 mm (0.02 in.) metal mesh Optional Filter Set: 0.05 mm (0.002 in.) nylon mesh and fleece filter
<b>Operating Time Rating</b>	100% Continuous
<b>Valve Timings</b>	Closing Time: < 1 second Opening Time: < 1 to 15 seconds Dead Time: < 1 second
<b>Electrical Connections</b>	Standard Wiring: PG 13.5 compression fitting with cage-type terminal blocks inside the electrical box Optional Wiring: 1/2 in. NPT conduit adapter or 4-pin connector plug (ISO 4400 [DIN 43650])
<b>Coil Insulation Class</b>	Class F
<b>Agency Listings</b>	IAS (AGA/CGA) Certificate Numbers: C0197002 C0197004 European Certificate Number: CE 0063AN3731
<b>Specification Standards</b>	EN 88, EN 126, and EN 161 Standards Complying with the EMC Directive Standards Complying with the Low Voltage Directive ANSI Standards, Z21.18, Z21.21, and Z21.78 Canadian Standards CAN1-6.3 and CAN1-6.5

*The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult the local Johnson Controls office. Johnson Controls, Inc. shall not be liable for damage resulting from misapplication or misuse of its products.*

Refer to the GS-20/25 and GS-40/45 Series Product Bulletin (LIT-4350240) for necessary information on operating and performance specifications of this product.


# Installation

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## Mounting

**IMPORTANT:** This technical bulletin is intended as a guide for authorized service personnel installing or servicing Johnson Controls products. Carefully follow all instructions in this sheet and all instructions on the appliance. Limit repairs, adjustments, and servicing to the operations listed in this sheet or on the appliance.

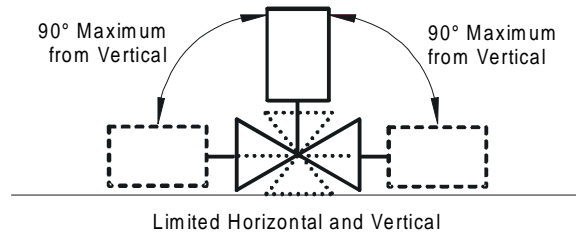
 **WARNING:** The system must meet all applicable codes. Improper installation may cause fire, explosions, property damage, and injuries or death.

Carefully follow all instructions in this sheet and all instructions on the appliance. Limit repairs, adjustments, and servicing to the operations listed in this sheet or on the appliance.

 **WARNING: Fire or explosion hazard.** Shut off the gas supply at the main manual shutoff valve before installing or servicing the GS Series valve.

1. Ensure that the maximum ambient temperature is not exceeded (see Table 2).
2. Check the power supply voltage for compatibility with the required valve voltage. All wiring must conform to national and local electrical codes and regulations.
3. When installing the valve on the manifold, the gas must flow through the valve body in the direction indicated by the arrow on the body. If the valve is installed with the gas flow opposite the arrow, leakage can occur.
4. Shut off the gas at the main manual shutoff valve.
5. Mount the valve. It is recommended that the flanges be mounted to the pipe separately with the valve then mounted between the two flanges. For valves supplied with a filter set and filter plate as standard, the assembly should be installed (using the longer bolts) between the inlet flange and the valve.

The GS Series valve may be mounted on a horizontal manifold with the magnetic operator pointed up (vertical) or in any position not exceeding 90° from the vertical. The valve may also be mounted on a vertical manifold in any position around its axis (see Figure 2). Do not install the solenoid actuator upside down. Install vertically wherever possible.



**Figure 2: GS Series Valve Mounting Position**

Use an approved pipe joint sealing compound on male threads before assembly.

6. Remove excess compound after mounting the flanges to the pipe. Threads of pipe and nipples must be smooth and free of tears and burrs. Steam clean all piping to remove foreign substances such as cutting oil or thread chips.

**Standard Wiring  
(From Burner  
Sequence  
Control)**

**WARNING: Shock hazard.** Avoid electrical shock and equipment damage by disconnecting electrical power to the valve before proceeding.

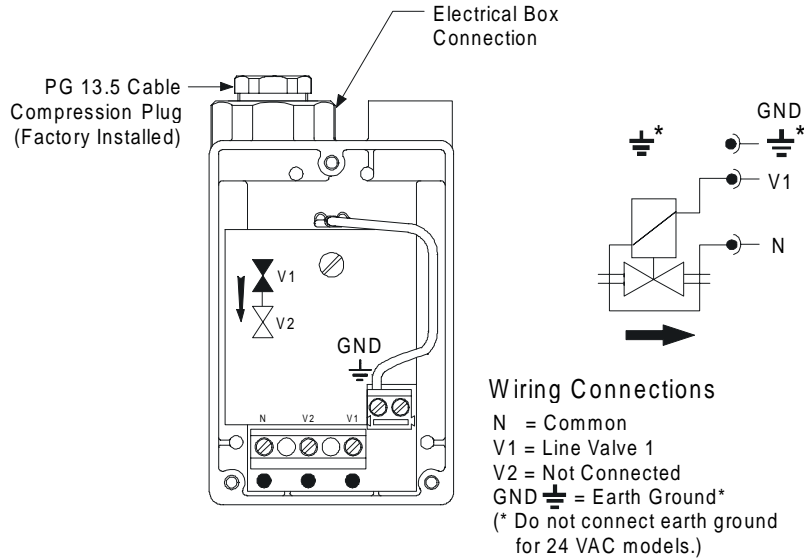
**CAUTION: Equipment damage hazard.** To prevent possible grounding of the 24 VAC transformer secondary, do **not** connect the ground wire on 24 VAC models.

Follow the procedure below to wire the valve when using the standard PG 13.5 cable compression electrical connection.

1. Observe that the operating voltage is identical to the information on the product identification label.
2. Route the electrical cable for the valve solenoid from the burner sequence control to the valve.
3. Remove the cover of the electrical box and make wiring connections in accordance with Figure 3.
4. Reattach the electrical box cover.

- Use a wrench to tighten the PG 13.5 cable compression plug to secure wires and prevent moisture from entering the terminal box.

Note: If an optional 1/2 in. NPT thread electrical connector or 4-pin DIN 43650 (ISO 4400) electrical connector (each ordered separately) is used for wiring, refer to the documentation supplied with the electrical connector for specific wiring instructions.



**Figure 3: Standard Wiring Electrical Connections**

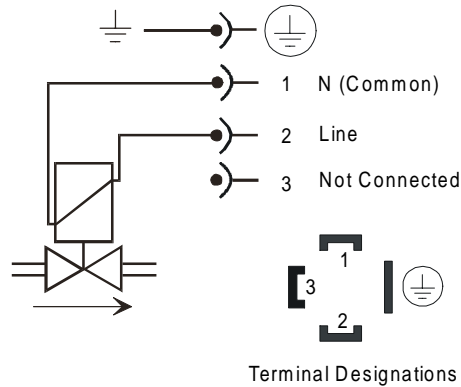
**4-Pin Connector Plug Wiring (From Burner Sequence Control)**

**WARNING: Shock hazard.** Avoid electrical shock and equipment damage by disconnecting electrical power to the valve before proceeding.

**CAUTION: Equipment damage hazard.** To prevent possible grounding of the 24 VAC transformer secondary, do **not** connect the ground wire on 24 VAC models.

Follow the procedure below to wire the valve when using a factory-installed 4-pin DIN 43650 (ISO 4400) electrical plug connection.

- Observe that the operating voltage is identical to the information on the product identification label.
- Route the electrical cable for the valve solenoid from the burner sequence control to the valve.
- Make wiring connections in accordance with Figure 4.

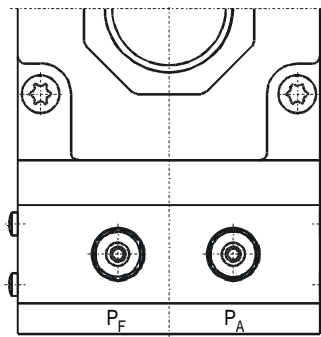


**Figure 4: 4-Pin Wiring Electrical Connections**

**GS-406\_**  
**Connection of**  
**the Impulse**  
**Lines**

The internal diameter of the impulse tubes for the combustion air ( $P_A$ ) and the combustion chamber pressure ( $P_F$ ) should be 4.0 mm (5/32 in.) (see Figure 5). Make the connections as short as possible and route to prevent the entry of condensate into the controller. The installation of a condensation trap in the connection line from the combustion chamber is highly recommended. Do not close the connection for  $P_F$  if not used.

**IMPORTANT:** Avoid sharp bends or kinks in the tubing to avoid damage to the tubing and allow for an accurate pressure reading.



**Figure 5: Impulse Line Connections**



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## Checkout Procedure



**WARNING: Fire or explosion hazard.** Verify that the valve functions properly and there are no gas leaks. Follow this checkout procedure before leaving the installation. Failure to verify proper valve installation, equipment operation, and gas tight connections may result in fire, explosion, property damage, and injuries or death.

1. Shut off the gas at the main manual shutoff valve and open the pressure connection between the manual shutoff valve and the GS valve.
2. Connect air tubing with a maximum pressure of 1-1/2 times the valve's maximum operating pressure (as indicated on the valve) to the opened pressure connection.
3. Paint the pipe connections and flanges of the valve with a rich soap and water solution to check for leakage.

If bubbles occur, this is an indication of a leak. To stop a leak, tighten joints and pipe connections. Replace the part if the leak cannot be stopped.

If bubbles do not occur, remove the air tubing and close the upstream pressure connection.

4. Open the main manual shutoff valve.
5. Refer to the *Adjustments* section to make any necessary valve setting adjustments.



**WARNING: Fire or explosion hazard.** Valve settings must be in accordance with the appliance or equipment manufacturer's specifications.

6. Before leaving the installation, observe at least three complete operating cycles to ensure that all components are functioning correctly.



# Adjustments

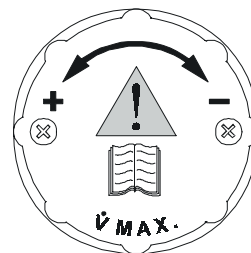
**IMPORTANT:** All adjustments must be made in conjunction with the gas appliance and in accordance with the appliance manufacturer's instructions. Only authorized personnel should make adjustments. See each valve model version for specific adjustments.

**WARNING: Explosion hazard.** The minimum flow rate of the valve must not be adjusted below the minimum safe working rate of the appliance.

It is recommended that the flange pressure tap connections be used to monitor the inlet and outlet valve pressure while performing each of the specific adjustment procedures. These pressure connections are located on the inlet and outlet flanges of the valve in the form of a brass spigot, sealed with a captive brass needle screw. To monitor the inlet or outlet pressure using these taps, turn the appropriate needle screw in a counterclockwise direction one or two turns and fit a 9 mm diameter flexible tube over the spigot. After all valve adjustments have been made, remove the flexible tube and turn the needle screw in a clockwise direction until tight, sealing the spigot.

## **GS-\_\_1\_ (On/Off with Flow Adjustment)**

This valve provides manual flow adjustment throughout the full range of zero to maximum flow. For flow rate adjustment, loosen the unsealed mounting screw on the plastic adjustment knob at the top of the solenoid coil. Hand turn the adjustment knob clockwise to decrease or counterclockwise to increase the flow rate through the valve (see Figure 6). Tighten the mounting screw to secure the adjustment knob at the desired flow rate.



**Figure 6: Manual Flow Adjustment Knob**

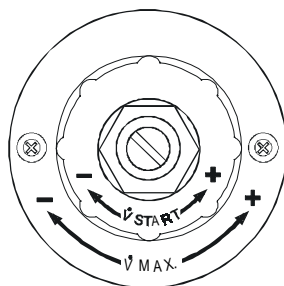
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**GS- 2\_**  
**(On/Off**  
**Step-slow**  
**Opening**  
**with Flow**  
**Adjustment)**

This valve provides adjustable step/slow opening for smooth ignition in a burner application. The valve is factory set to maximum start gas position and maximum flow position. Adjust the hydraulic damper at the top of the solenoid coil to set the desired flow rate through the valve as well as the desired start gas flow rate.

To adjust the maximum flow rate, loosen the unsealed mounting screw on the aluminum hydraulic damper housing. Hand turn the housing clockwise until the desired setting is obtained. Tighten the mounting screw to secure the adjustment knob at the desired flow rate.

To adjust the start gas position, remove the plastic cap from the hydraulic damper housing and turn the brass screw clockwise until the desired setting is obtained (see Figure 7). Replace the plastic cap.



**Figure 7: Hydraulic Damper Housing**

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**GS- 03\_**  
**(On/Off with**  
**Pressure**  
**Regulator)**

This valve provides spring regulation to maintain the gas pressure at the valve outlet. For outlet pressure adjustment, loosen the unsealed mounting screw on the plastic regulator knob at the top of the solenoid coil. Hand turn the regulator knob clockwise to increase or counterclockwise to decrease the outlet pressure of the valve (see Figure 8). Tighten the mounting screw to secure the adjustment knob at the desired outlet pressure.



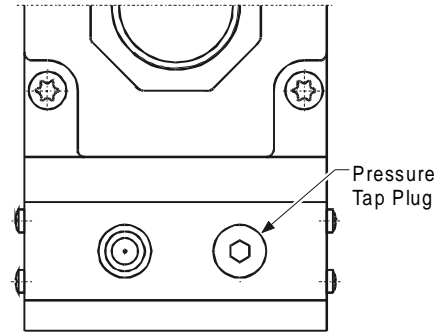
**Figure 8: Spring Pressure Regulator Adjustment Knob**

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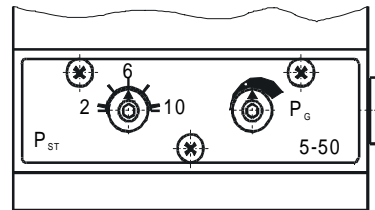
**GS-405\_**  
**(On/Off with**  
**Servo Precision**  
**Regulator)**

This valve provides servo regulation for precision control of the valve outlet pressure. Before setting the valve for the desired outlet pressure, adjust the start gas pressure.

To set the start gas position, energize the solenoid coil to open the valve seats. Remove the pressure tap plug (see Figure 9) located below the gas outlet pipe connection and measure the start gas pressure. The  $P_{ST}$  adjustment scale indicates the factory-set start gas pressure (see Figure 10); therefore, a subsequent fine adjustment may be necessary. Use the hexagonal tool provided (or an acceptable Allen wrench) to adjust the  $P_{ST}$  scale and obtain the desired start gas pressure.



**Figure 9: Valve Outlet Pipe Connection**

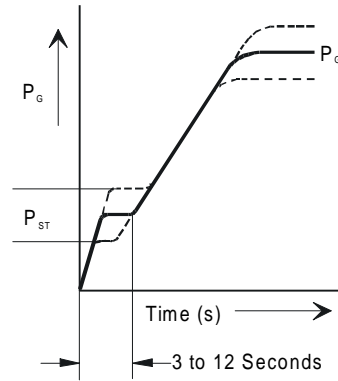


**Figure 10:  $P_{ST}$  and  $P_G$  Adjustment Scales (Metric Shown)**

The start gas pressure ( $P_{ST}$ ) remains at the set level until the pressure tap plug is replaced and tightened. The pressure then rises to the setpoint ( $P_G$ ).

**IMPORTANT:**  $P_G$  must be greater than  $P_{ST}$  in order for the valve to operate properly.

Once the desired start gas pressure has been obtained, the outlet pressure ( $P_G$ ) can be adjusted. For outlet pressure position adjustment, energize the solenoid coil to open the valve seats. Remove an outlet pressure tap plug from the valve body and measure the servo pressure regulator performance and timing characteristics (see Figure 11). The  $P_G$  adjustment scale indicates the factory-set outlet pressure (see Figure 10), which can be adjusted using the hexagonal tool provided (or an acceptable Allen wrench) to obtain the desired servo pressure regulator performance and timing characteristics.



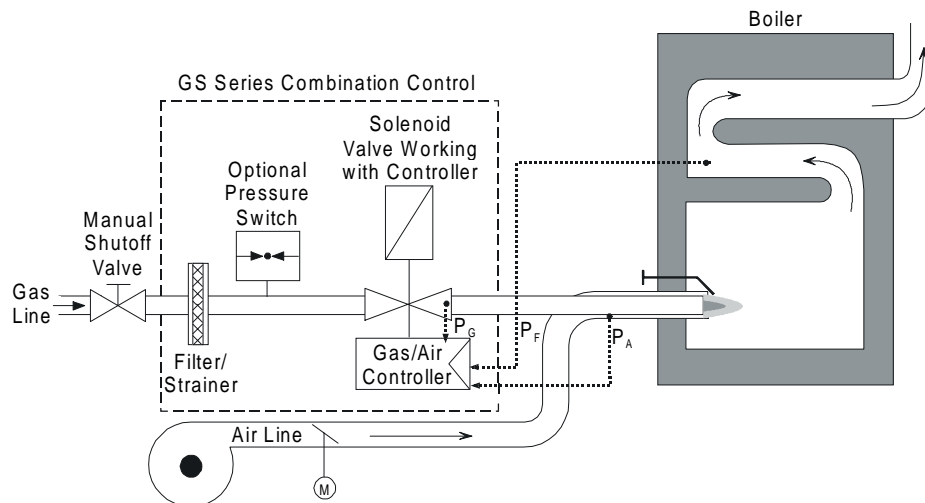
**Figure 11: Servo Pressure Regulator Performance vs. Timing Characteristics**

Cycle the valve three times to check for proper performance, leaving a minimum time of 20 seconds between cycles to evacuate the pressure chamber.

**GS-406\_**  
**(On/Off with**  
**Gas/Air Ratio**  
**Control)**

This valve provides mechanical modulating control of the gas outlet pressure at a consistent ratio to the main air blower pressure. An example of a typical installation is shown in Figure 12. The burner control responds to a higher demand for heat by increasing the amount of air being supplied to the burner, resulting in an increased air pressure. With the air pressure ( $P_A$ ) connected to the valve, the valve seat position is controlled to achieve the optimum outlet gas pressure according to the preset gas/air ratio.

The combustion chamber pressure ( $P_F$ ) can be connected to improve combustion quality in cases where the combustion chamber pressure is significantly higher during operation than atmospheric pressure.



**Figure 12: Typical Application Installation**

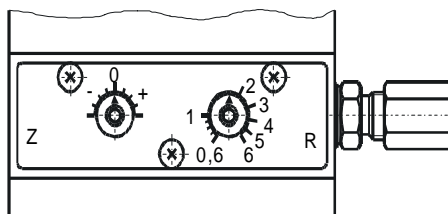
The valve not only allows a gas/air ratio adjustment, but also an offset adjustment (zero set), which allows for fine adjustment at lower ratios. With these adjustments, the outlet valve pressure ( $P_G$ ) calculates to:

$$P_G = R \cdot P_A + Z \quad \text{without combustion chamber pressure } P_F$$

$$P_G - P_F = R \cdot (P_A - P_F) + Z \quad \text{with combustion chamber pressure } P_F$$

To adjust the valve, first check the factory settings. The adjustments for the gas/air ratio (R scale) and zero set (Z scale) are located on both sides of the gas/air ratio control module (see Figure 13). The factory settings are:

- Gas/air ratio (R): 1:2
- Zero set (Z): 0



**Figure 13: Zero Set and Gas/Air Ratio Adjustments**

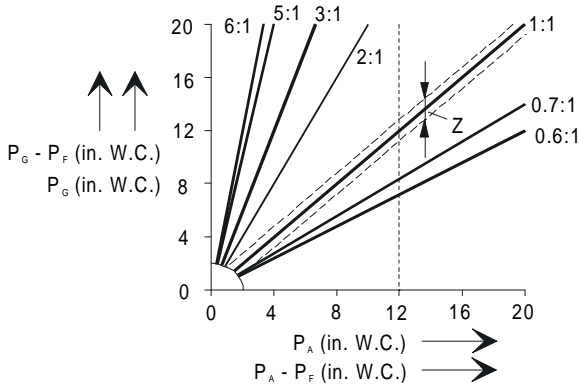
### **Gas/Air Ratio (R) Adjustment**

Before starting the burner, make sure that the gas/air ratio and zero set settings are correct for the specific appliance. If necessary, use the hexagonal tool provided (or an acceptable Allen wrench) to adjust these settings to the appliance manufacturer's recommendations. If the specific ratio settings are not available, ensure that the appliance is safe to operate at the factory settings.

Start the burner and gradually increase the output of the valve. If the burner does not light, check for a flame during the ignition phase. If the flame extinguishes immediately, the system may have excess air. Check again and adjust the gas/air ratio (R) setting if necessary.

With the burner in the maximum output position, adjust the gas/air ratio (R scale) to meet the desired flue gas analysis readings. The ratio (R) of gas outlet pressure ( $P_G$ ) to combustion air pressure ( $P_A$ ) is adjustable within a range of 0.6:1 to 6:1 (see Figure 14).

Check the flue gas analyses on low and high output settings without manipulating the adjustments. Once the readings have been checked, fine tune (by adjusting the zero set) the settings if necessary. In cases where combustion chamber pressure ( $P_F$ ) is used, connect it and repeat the gas/air ratio (R) adjustment.



**Figure 14: Analyses Chart**

### **Zero Set (Z) Adjustment**

With the correct gas/air ratio (R) set, there may be some minor deviations (caused by friction, etc.) at very low pressures. To allow for fine adjustment of the valve, the zero set can be changed. The zero set adds a constant offset to the flue gas analyses, affecting the low output figures more significantly than the high output figures.

Zero set (Z) can be accomplished by a parallel shift of the characteristic curve from -2 to +2 mbar (-0.8 to +0.8 in. W.C.) (see Figure 14).


Set the burner to the low fire position, perform a flue gas analysis, and vary the outlet pressure by adjusting the Z scale until the desired flue gas analysis readings are obtained.

If adjusting the zero set (Z) results in an unacceptable high output figure, repeat the adjustments starting with the gas/air ratio (R) adjustment procedure.




# Repairs and Replacement

Field repairs must not be made, except to replace the filter or strainer. For a replacement part, contact the nearest Johnson Controls representative or the original equipment manufacturer.

 **CAUTION:** Label all wires prior to disconnection when servicing valves. Wiring errors can cause improper and dangerous operation. Verify proper operation after servicing.

Perform the following steps to replace the filter or strainer.

1. Clean or replace the filter or strainer with each recommended inspection or at a minimum each annual functional inspection.
2. Close the main manual shutoff valve and disconnect field wiring. As each wire is disconnected, label it with the correct terminal designation.
3. Remove the screws on the flanges and remove the valve and filter plate.
4. Clean or replace the filter or strainer. Reinstall the filter plate and valve.
5. Refasten the flange screws to the valve and reconnect field wiring.

 **WARNING: Fire or explosion hazard.** Verify that the valve functions properly and there are no gas leaks. Follow this checkout procedure before leaving the installation. Failure to verify proper valve installation, equipment operation, and gas tight connections may result in fire, explosion, property damage, and injuries or death.

6. Open the pressure connection between the manual shutoff valve and the GS valve.
7. Connect air tubing with a maximum pressure of 1-1/2 times the valve's maximum operating pressure (as indicated on the valve) to the opened pressure connection.

8. Paint the pipe connections and flanges of the valve with a rich soap and water solution.

If bubbles occur, this is an indication of a leak. To stop a leak, tighten joints and pipe connections. Replace the part if the leak cannot be stopped.

If bubbles do not occur, remove the air tubing and close the upstream pressure connection.

9. Open the main manual shutoff valve.
10. Observe at least three complete operating cycles to ensure that all components are functioning correctly.

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## Notes

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# Notes



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