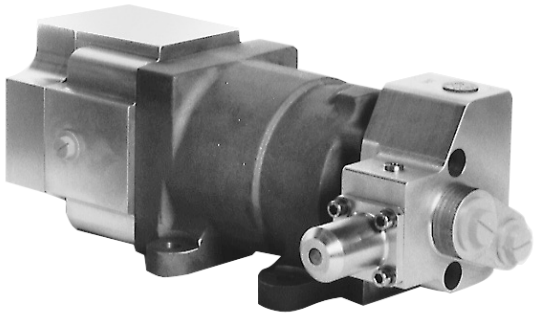
WOODWARD

Product Manual 26087
(Revision F, 5/2013)
Original Instructions



LQ3 Valve Actuator Assembly

Installation and Operation Manual

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:

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Proper Use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

Manual 26087

Contents

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Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

⚠WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE

Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Regulatory Compliance

European Compliance for CE Marking:

These listings are limited only to those units bearing the CE Marking.

ATEX – Potentially Explosive Atmospheres Directive: Declared to 94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres.
LCIE 03 ATEX 6375 X
Zone 1, Category 2, Group II G, EEx d IIB T3

Other European and International Compliance:

Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking:

EMC Directive: Not applicable to this product. Electromagnetically passive devices are excluded from the scope of the 89/336/EEC Directive.

Machinery Directive: Compliant as a component with 98/37/EC COUNCIL DIRECTIVE of 23 July 1998 on the approximation of the laws of the Member States relating to machinery.

Pressure Equipment Directive: Compliant as "SEP" per Article 3.3 to Pressure Equipment Directive 97/23/EC of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment.

North American Compliance:

These listings are limited only to those units bearing the CSA identification.

CSA: CSA Certified for Class I, Division 1, Groups C & D, and Division 2, Groups A, B, C, D, T3C at 103 °C ambient. For use in Canada and the United States per Certificate 160584-1136436.

Wiring must be in accordance with North American Class I, Division 1 or 2, or European Zone 1, Category 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Special Conditions for Safe Use:

- Use supply wire suitable for at least 90 °C and 10 °C above maximum fluid and ambient temperature.
- Ambient operating temperature: –28 to +103 °C

For Zone 1 / Division 1 products applied in a Zone 2 / Division 2 atmosphere:
The LQ3 Valve Actuator is certified to a Zone 1-Category 2 method of protection. Wiring methods must comply with the Zone 1-Category 2 method of protection when installed in a Zone 2 classified atmosphere.

⚠WARNING

EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 2 or Zone 2.

⚠AVERTISSEMENT

RISQUE D'EXPLOSION—Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous vous situez bien dans une zone non explosive.

Le remplacement de composants peut rendre ce matériel inacceptable pour des applications de Classe I, Division 2 ou Zone 2.

Chapter 1.
General Information

Introduction

The LQ3 Valve/GS Actuator Assembly integrated liquid fuel metering system features valve position control, all-electric actuation, fuel bypass, fuel flow regulation, and fault indication for industrial and aero-derivative gas turbines. This system may allow multiple independent metered flow paths with a single pump.

The LQ3 Valve assembly is a brushless dc limited-angle torquer which positions a metering port for liquid fuel control. The LQ3 actuator is directly coupled to both the metering port and a position feedback resolver. There are no intervening gears, linkages, or flex couplings. The high torque actuator and shearing action of the shoe on the rotor valve provide a high degree of contamination resistance.

⚠WARNING

The controlling device, not the driver(s) or valve(s), sets turbine stability and response. Follow the instructions for the controlling device while setting up the turbine control system. Failure to follow instructions can cause personal injury and/or property damage.

Turbine manufacturer's requirements for fuel flow to the turbine can vary considerably depending on fuel pressures, fuel types, fuel and ambient temperatures, turbine size, etc. Information on predicting fuel flow through the LQ3 Valve as a function of command input signal can be obtained from the flow calibration data supplied with each valve and, for nominal flow data, from information given in the following section. This fuel flow information may be critical to the proper operation of your gas turbine and may be required information for the electronic control system to accelerate and/or decelerate the turbine properly.

IMPORTANT

For complete information on the GS3/LQ Driver, see manual 40175 for the analog driver.

LQ3 Valve Flow Accuracy

The metering flow accuracy of the LQ3 valve is ±5% of nominal flow point or ±0.5% of maximum rated flow, whichever is greater. The maximum rated flow is based on metering port size: the 21.29 mm^2 (0.033 in^2) port is 1134 kg/h (2500 lb/h), and the 43.23 mm^2 (0.067 in^2) port is 1814 kg/h (4000 lb/h). These flow rates are based on a fuel specific gravity of 0.77.

During calibration, each LQ3 valve is set up at a nominal "rig flow point" which corresponds to a specific milliamp demand signal. Each valve is then flow tested to ensure compliance with the above mentioned flow tolerance bands. This procedure ensures excellent valve to valve flow repeatability.

See Figures 1-1 or 1-2 to predict the metered fuel flow through the LQ3 as a function of Demand Input and metering port size. Note: These curves represent the "nominal" flow based on statistical data. Flow variation from valve to valve will occur within the stated accuracy limits of the product and should be considered in the control application. To determine the exact flow curve of a particular valve, reference the flow test data sheet that accompanies each valve. This data can also be requested through Woodward by providing the valve serial number and part number.

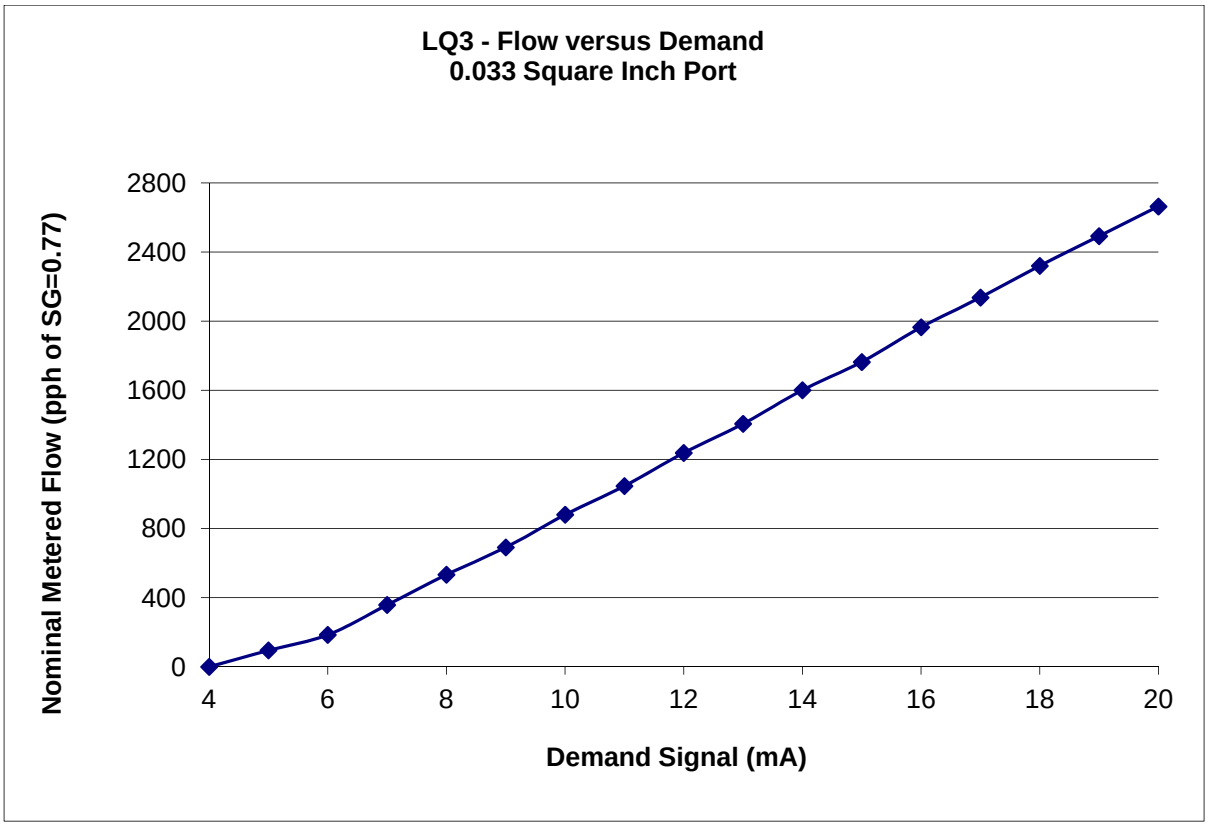


Figure 1-1. LQ3 Flow vs Demand (0.033 in² port)

Demand Signal (mA)	Nominal Flow (pph of SG=0.77)
4	0
5	95
6	185
7	358
8	533
9	691
10	880
11	1046
12	1238
13	1406
14	1601
15	1764
16	1965
17	2137
18	2320
19	2492
20	2664

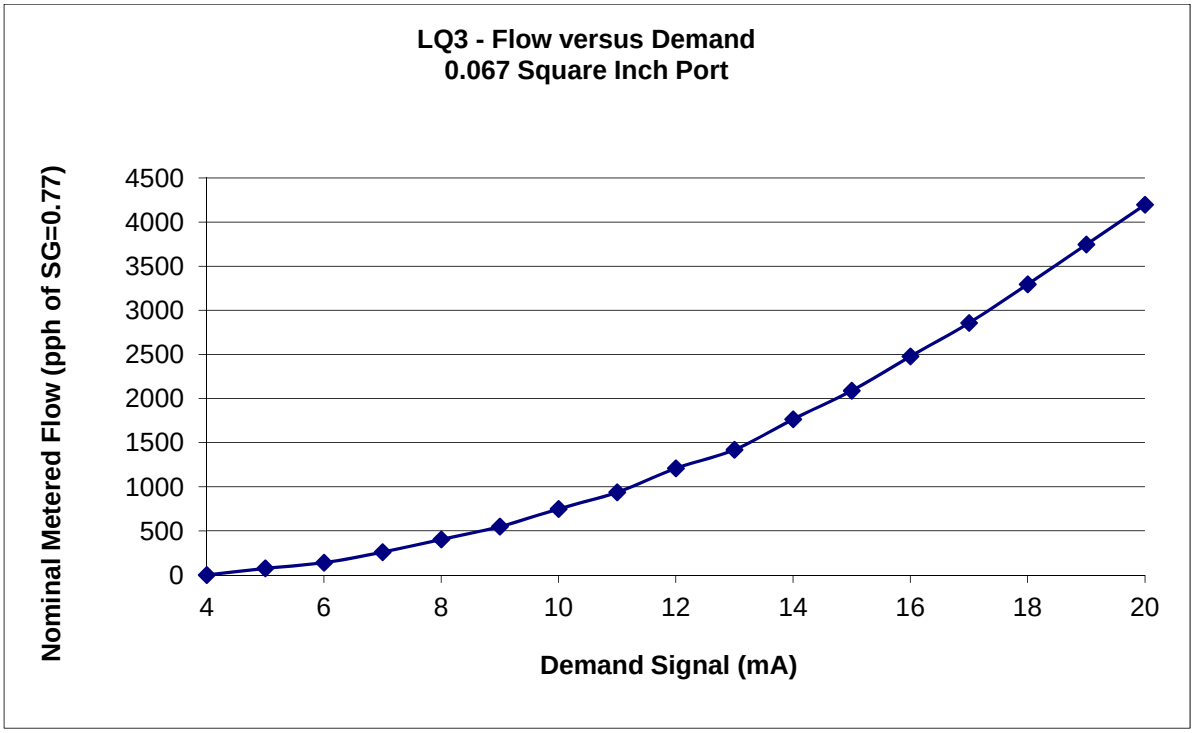


Figure 1-2. LQ3 Flow vs Demand (0.067 in² port)

Demand Signal (mA)	Nominal Flow (pph of SG=0.77)
4	0
5	75
6	140
7	259
8	403
9	549
10	749
11	938
12	1209
13	1420
14	1765
15	2089
16	2478
17	2857
18	3295
19	3746
20	4197

LQ3 Fuel Metering Valve

The LQ3 valve is suitable for use on gas turbines in the 1000 kW to 6000 kW output power range, depending on available fuel properties and conditions. There are two port sizes for the LQ3: the 21.29 mm² (0.033 in²) port is designed for maximum fuel flows of 454 to 1134 kg/h (1000 to 2500 lb/h), and the 43.23 mm² (0.067 in²) port is designed for maximum fuel flows of 907 to 1814 kg/h (2000 to 4000 lb/h). The minimum metered flow of the LQ3 is 36 kg/h (80 lb/h). These flows assume a specific gravity of 0.77. All materials in the LQ3 are corrosion resistant.

The LQ3 Liquid Fuel Valve has all electric actuation. The actuation, metering, and feedback are integrated on the motor rotor. Feedback is given by one single-speed resolver. Regulation is achieved through an integral, single-stage, spring-loaded piston and diaphragm-type pressure regulator. This maintains the differential pressure across the metering port at approximately constant, and the only factor affecting the output flow is the port area. The nominal set point for the LQ3 differential pressure is 276 kPa (2.76 bar/40 psid). The actual regulated differential pressure will vary somewhat with varying inlet and outlet flows and with varying outlet pressures.

The LQ3 is a bypassing-type fuel metering valve. This means that it is intended for use with positive displacement pumps. The pump flow provided by the pump is either metered to the gas turbine combustors or it is bypassed back to the tank. The valve is not intended for use with any pump types other than positive displacement pumps.

Operation Of The LQ3 Valve

The LQ3 Liquid Fuel Metering Valve meters fuel as a function of the angular position of its ported metering sleeve/shaft. The metering sleeve/shaft is positioned by the integrated, brushless, dc, limited-angle torquer motor (LAT). A resolver mounted directly on the shaft of the valve provides valve position feedback.

To accurately meter fuel, the valve maintains a constant pressure drop across the fuel metering port in the metering sleeve/shaft. The valve regulates the intermediate pressure to maintain this constant pressure differential by positioning the bypass regulator piston to spill flow to the return line.

Given the constant pressure differential within the fuel valve, the fuel flow through the metering port is always proportional to the area of the port opening. Fuel flow through the metering port of the valve is described by the following equation:

$$MassFuelFlow = k \times Area \times \sqrt{\Delta P \times SG}$$

Under operating conditions, fuel at the system pressure (P1) flows to the metering sleeve/shaft and to one side of the regulator piston. Metered fuel at the nozzle pressure (PN or P2) is directed to the turbine and to the other side of the regulator piston.

The piston takes a position at which the force from pressure P1 acting on the piston's effective area is equal to the sum of the forces from the pressure (PN or P2) at the other side of the regulator metering ports acting on the piston's effective area and the force from the ΔP spring. All excess supply pressure (P1) is directed back to the tank in return as PR allowing the pressure between P1 and PN to remain regulated.

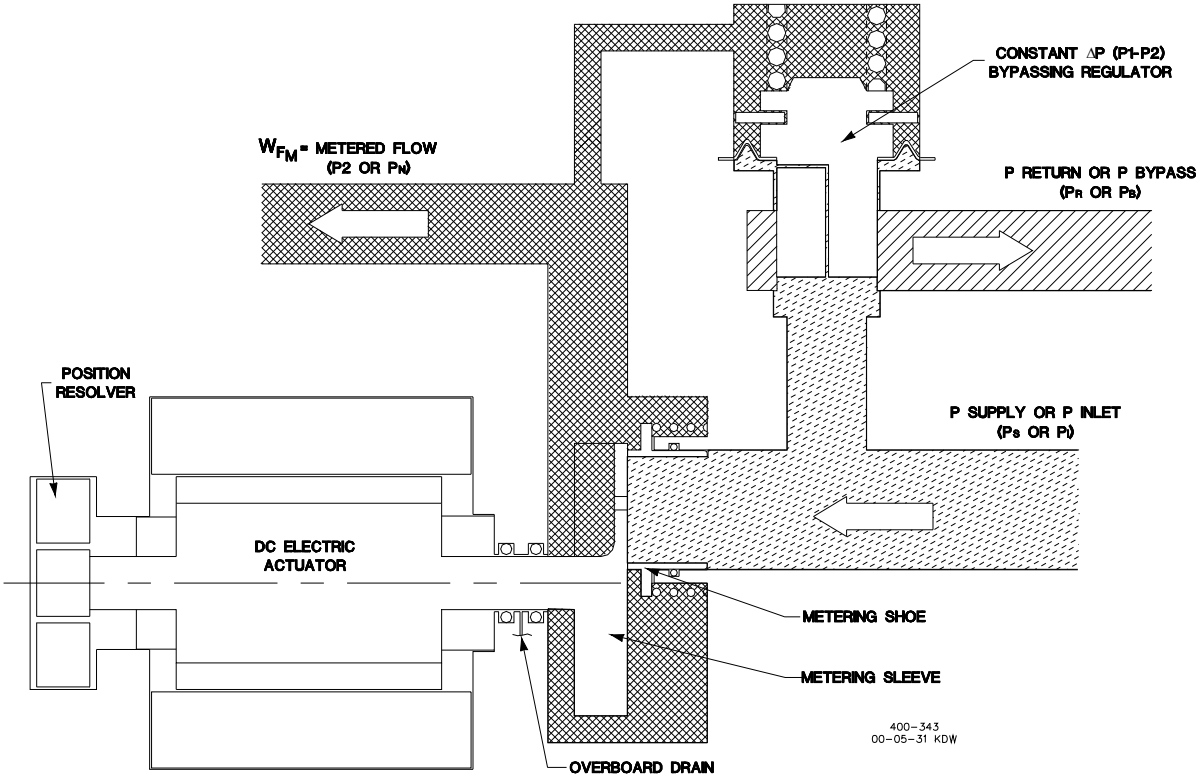


Figure 1-3. LQ3 Schematic

Chapter 2. Installation

Terminal Blocks

Terminal blocks are used on the LQ3 valve. These terminal blocks are top load, cage clamp style, and are actuated by inserting a DIN 5264 screwdriver into the opening behind the wire slot. Once the cage clamp has been opened, the wire can be inserted and the screwdriver removed. Please see the illustration and instructions below:

- The screwdriver is inserted into the operating slot up to the stop.
- The screwdriver blade holds the clamping spring open automatically so that the conductor can be introduced into the clamping unit.
- The screwdriver is withdrawn. The conductor is automatically clamped.

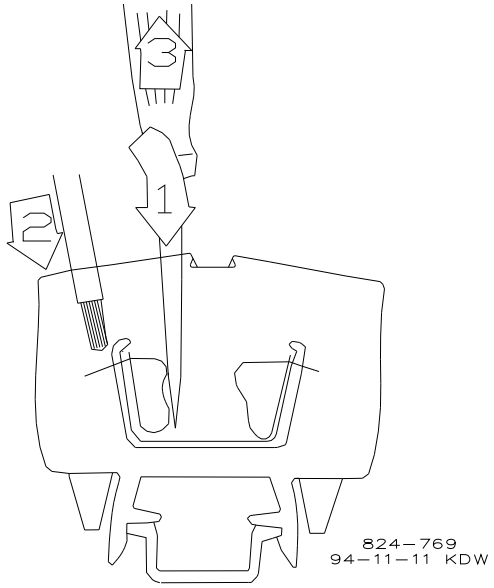


Figure 2-1. WAGO 264 Series Terminal Block

LQ3 Valve Unpacking

Use care when unpacking the LQ3 Valve. Abuse can damage seals, installation surfaces, and factory adjustments. Notify the shipper and Woodward if damage is found.

IMPORTANT **The LQ3 Valve Actuator assembly weighs 13 kg (29 lb). Lift carefully using proper lifting techniques.**

LQ3 Valve Mounting

The valve should be mounted as close to the turbine as practical in order to minimize the volume of fuel between the valve and the turbine. Ensure that the valve is not mounted in an area that would exceed the temperature limits specified in Chapter 3: Detailed Specification. The LQ3 valve should be mounted to a thermally conductive surface to conduct heat away from the actuator to maintain proper coil temperature.

See Figure 2-2 for dimensions of the LQ3 mounting hole pattern. The valve should be securely attached to a rigid surface that will not exceed the vibration limits specified in Chapter 3: Detailed Specification.

Connect inlet, outlet, and overboard lines to the valve. The inlet port receives pressurized fuel from the pump. The outlet line should be attached to the fuel line(s) going to the turbine combustors. The bypass line must be connected back to the fuel storage tank. The overboard (OVBD) drain port depicted in Figure 2-2 is a vent between dual redundant shaft seals. It must be connected by means of rigid steel piping to a fuel collection, purge, vent, or flare off system so as not to be exposed to danger of obstruction, physical damage, or back pressure in excess of 69 kPa (0.69 bar/10 psig).

⚠WARNING

Do not plug the overboard drain as this may cause fuel to enter the LQ3 actuator, resulting in a hazardous condition with the potential to case personal injury and/or damage to the actuator.

⚠WARNING

External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

⚠CAUTION

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the LQ3 Valve Actuator Assembly.

⚠CAUTION

The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

IMPORTANT

Leakage exceeding 20 cm^3/min from the overboard drain line indicates a worn or damaged shaft seal in the LQ3 valve and should be investigated immediately. Special tooling is required to replace the shaft seal. Contact Woodward for service.

Fuel Connections

Inlet	0.875-14 SAE Straight Thread Port (–10)
Outlet	0.750-16 SAE Straight Thread Port (–08)
Bypass	1.062-12 SAE Straight Thread Port (–12)
OVBD	0.438-20 SAE Straight Thread Port (–04) (Overboard Drain Port)

Cable Connections

Wiring for the driver power output to the actuator must be suitable for at least 90 °C, and 10 °C above maximum fluid and ambient temperature.

Actuator	0.500-14 NPT (Four 4 mm^2/12 AWG wires, 2 for positive and 2 for negative. Additional ground wire provided)
Feedback	0.500-14 NPT (three shielded twisted pairs or one shielded twisted six-conductor cable)
External Grounding Stud	Suitable for wire size 10 mm to 4 mm (8 to 12 AWG)

NOTICE

Take care not to damage the cover seal, the cover surface, or the actuator surface while removing or replacing the cover.

IMPORTANT **The LQ3 Valve Actuator is certified to a Zone 1-Category 2 method of protection. Wiring methods must comply with the Zone 1-Category 2 method of protection when installed in a Zone 2 classified atmosphere.**

IMPORTANT **For Zone 1 / Division 1 products: Proper torque is very important to ensure that the unit is sealed properly. The fasteners for the electrical cover should be torqued to 9.5 ±0.5 N·m (84 ±4 lb-in).**

⚠WARNING **Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.**

⚠WARNING **EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.**

⚠AVERTISSEMENT **RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.**

NOTICE **Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figures 2-3 and 2-4).**

LQ3 Wiring

The driver must be mounted close enough to the LQ3 valve and the driver power supply to meet wire length requirements specified in the driver manual.

Make electrical connections between the valve and driver according to the GS3/LQ Driver manual and Figure 2-4. Figure 2-3 shows the LQ3 valve wiring to its internal terminal blocks.

Connect the ground terminal of the actuator to earth ground. This must be the same grounding system as the driver's earth ground.

The LQ3 has a green lead wire, which must be connected to earth ground. This may be connected to the terminal provided on the driver (TB1-8) or more directly to earth ground near the valve. The earth connections on both the valve and the driver must be connected to the same earth grounding system.

All shielded cable must be twisted conductor pairs with either a foil or a braided shield. All signal lines should be shielded to prevent picking up stray signals from nearby equipment. Connect the shields as shown in the Control Wiring Diagram (Figure 2-4). Wire exposed beyond the shield must be as short as possible.

IMPORTANT **Connect cable shields to earth ground. Do not connect any cable shields to "instrument ground", "control ground", or any non-earth ground system.**

For best noise immunity, run power wires and shielded signal wires in separate conduits or cable trays. See Woodward Manual 50532, *EMI Control in Electronic Governing Systems*, for more information.

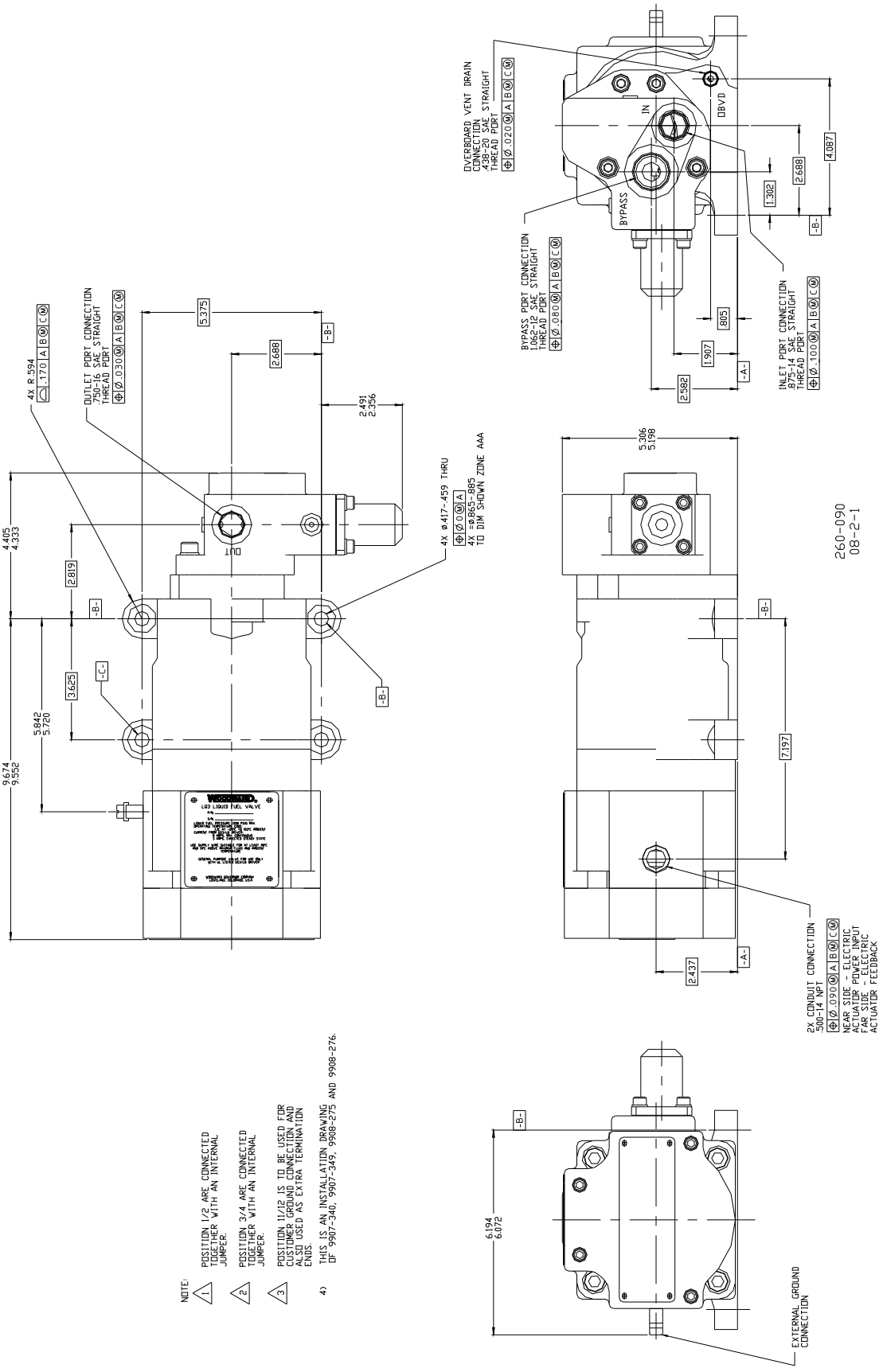
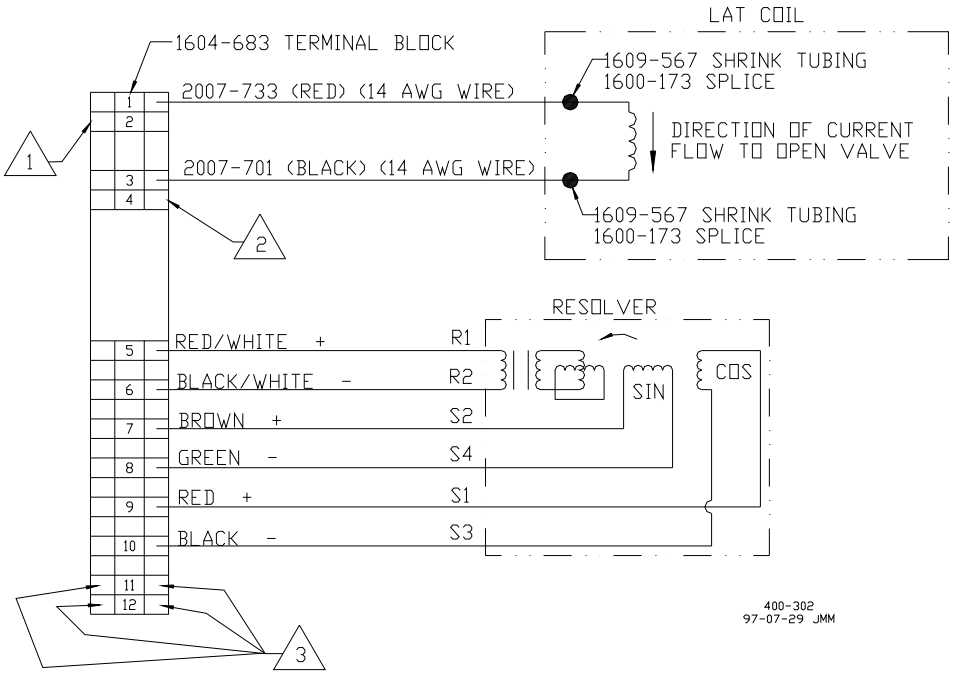


Figure 2-2. LQ3 Valve Outline Drawing



NOTES:

1. Position 1/2 are connected together with an internal jumper.
2. Position 3/4 are connected together with an internal jumper.
3. Position 11/12 must be used for customer ground connection and also used as extra termination ends.

Figure 2-3. LQ3 Valve Wiring

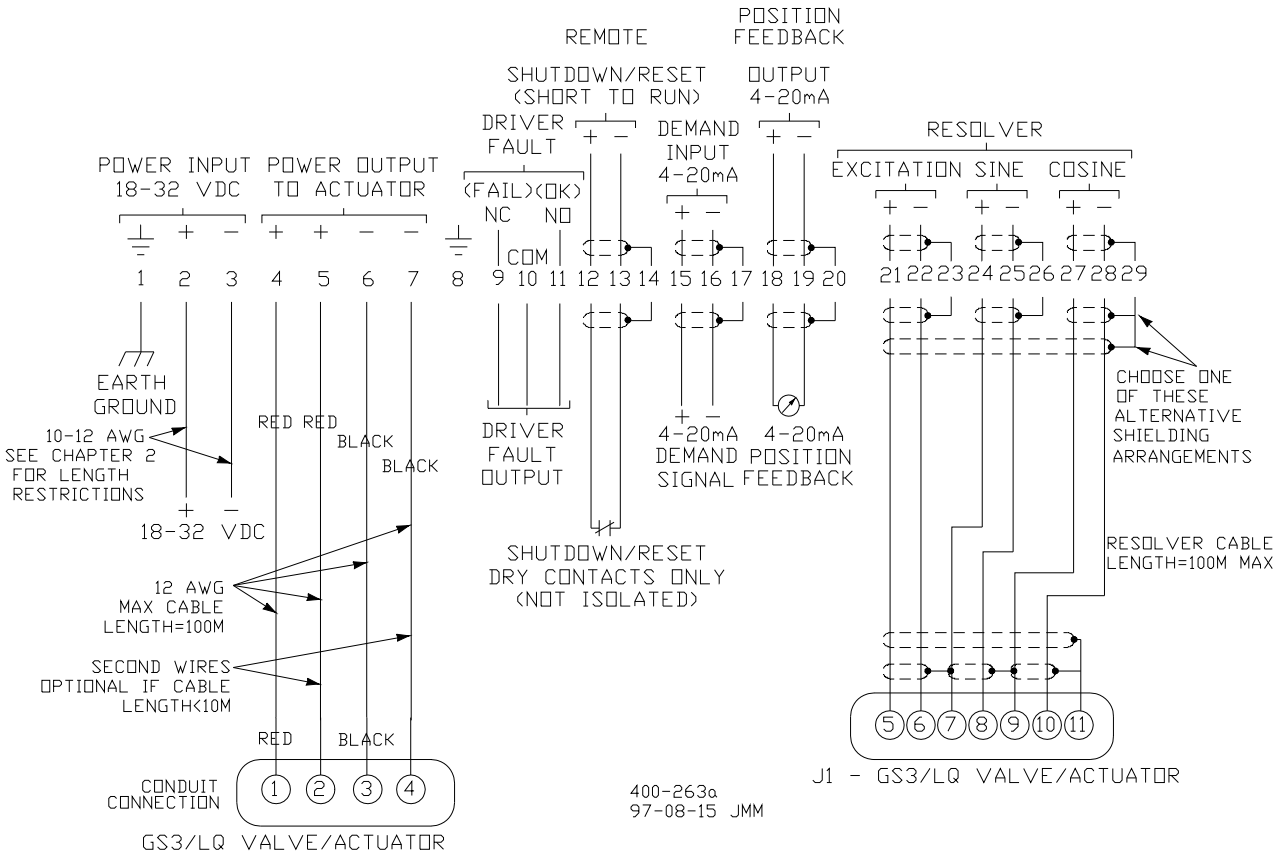


Figure 2-4. Control Wiring Diagram for LQ3 to Analog Driver

Chapter 3.
Detailed Specification

LQ3 Valve Specifications

Environmental Specifications	
Operating Temperature	–28 to +103 °C (–18 to +217 °F)
Storage Temperature	–40 to +103 °C (–40 to +217 °F)
Vibration	US MIL-STD-810C, Procedure 1, Table 514.2-ii, Figure 514.2-2, Curve J 20-2000 Hz (5g) Tested to a random vibration profile per MS202F, Method 214A Test Condition D
Shock	US MIL-STD-810C, Method 516.2, Procedure 1, 20 g, 11 ms, sawtooth wave form
Valve Weight	13 kg (29 lbs)
Air Born Noise	Ear protection must be worn while Valve is operating

Electrical Characteristics	
Dielectric Withstand	500 Vac to PE ground for 1 minute
Coil— Coil Resistance	0.525–0.900 Ω
Coil Inductance	20 mH at 60 Hz
Insulation Resistance	>50 MΩ after dielectric test
Actuator Voltage	18–32 Vdc
Actuator Current	3 A steady state, 8 A max. Expected transient current may be up to 20 A with a maximum of 20% duty cycle
Feedback Device— Type	Frameless resolver
Excitation	4 Vac at 5000 Hz, resistance 28–34 Ω at 20 °C
Return	4 Vac at 5000 Hz, for sine and cosine, each 131–159 Ω at 20 °C
Steady State Performance Characteristics	
Range of Maximum Metered Flows	1134 to 1814 kg/h (2500 to 4000 lb/h) depending on port size
Minimum Metered Flow	36 kg/h (80 lb/h)
Fuel Supply Pressure Range— Normal Operation	1034 to 8274 kPa (10.34 to 82.74 bar/150 to 1200 psig)
Proof Pressure	12 MPa (124 bar/1800 psig)
Burst Pressure	41 MPa (414 bar/6000 psig)
Max Metering Valve Leakage	36 kg/h (80 lb/h)
Max Bypass Pressure	690 kPa (6.90 bar/100 psig)

Fuel Pressure Differentials	
Nominal Regulated Metering Valve ΔP	276 kPa (2.76 bar/40 psid)
Chip Shearing Force Capability	133 N (30 lb force) minimum at the metering port edge
Flow Metering Accuracy	Greater of ±5% of nominal point or ±0.5% of maximum rated flow
Valve Position Stability	Oscillations <±0.05% of full stroke
Metered Flow Dynamic Response	Bandwidth = 40 rad/s, damping factor = 1 dP Bandwidth = 30 to 50 rad/s, damping factor = 0.4 to 0.8
Max Slew Time	0.100 s
Hysteresis	Less than 0.5% of full stroke
Position Loop Bandwidth	35 rad/s with a damping factor of 1
Liquid Fuel Types and Test Fluids	
Operating Fuel Types	The valve is compatible with most types of diesels, kerosenes, gasolines, heavy and light distillates including naphtha, gas turbine fuels and fuel oils, and other liquid fuels such as biodiesel that are compatible with fluorocarbon (FKM) type elastomers and conform to international standards for utility, marine, and aviation gas turbine service. Ultra low sulfur diesels are also acceptable with proper lubricity additives. Other fuels such as ethanol or methanol may be acceptable with internal seal compound substitutions. Contact Woodward for these and other special fuel applications.
Fluid Inlet Temperature Range	–28 to +103 °C (–18 to +217 °F)
Fuel Specific Gravity Range	0.650 to 0.900
Fuel Viscosity Range	0.50 to 12.0 Centistokes
Inlet Fuel Filtration Levels	Liquid fuel must be filtered to limit particulate size to 20 µm or smaller. Water and sediment must be limited to 0.1% by volume. Total particulate concentration must be limited to 2.64 mg per liter of fuel.

Chapter 4.
Maintenance

The valve assembly is designed to avoid the accumulation of air and fuel vapor in service, and does not require any action by the user to purge air or vapor from the assembly following installation or use on the turbine system.

The valve is also designed such that during normal operation or storage, fuel or condensed water vapor does not accumulate within any part of the assembly in such a way as to cause damage or deterioration.

When removed from the turbine system, it is possible to drain all fuel, condensed water vapor, or other contaminants from the assembly without further disassembly.

There are no field-replaceable parts on the LQ3.

Chapter 5.
Troubleshooting

⚠WARNING

The valve(s) may not fail shut in every situation. If the driver is unable to shut the valve in a fault situation, the valve will stay open. For safe turbine operation in fault situations, the valve must be used in conjunction with an additional high-speed shutoff valve. Also, the driver fault relay should be tied into the turbine protection system.

⚠WARNING

Before attempting any troubleshooting action, verify that the prime mover is shut down and that fuel pressure is not present to valves that may open due to actuator motion.

Valve Problems

This troubleshooting section does not give the certain cause of any problem. Nor does it cover all possible problems or all possible causes of any problem. This section will not enable a technician to locate a faulty component in the valve.

If trouble occurs, use Figure 5-1, the Troubleshooting Flowchart, as a guide to locate and repair the problem. Follow the flow chart down from the title block to the next block. Rectangular boxes contain suggestions on where to look for a problem. Diamond-shaped boxes ask you questions based on the information you have gathered. The answer to that question will guide you to the next step in the troubleshooting procedure. By following the flowchart, you should be able to identify and correct most problems that may occur with the valve. If after following these troubleshooting procedures you are unable to find the cause of a problem and repair it, contact Woodward for assistance.

If the results of these procedures indicate that the valve may be faulty, replace the suspected unit with a valve known to be good to verify that the cause of the problem is in the valve.

To verify electrical connections within the valve, disconnect the electrical cables at the driver and measure resistances between driver connector terminals. Note that the following resistances are approximate and do not include tolerances. This test is to check for open or short circuits, and to test the wiring from the driver to the valve.

Use resistances called out on Figure 5-1.

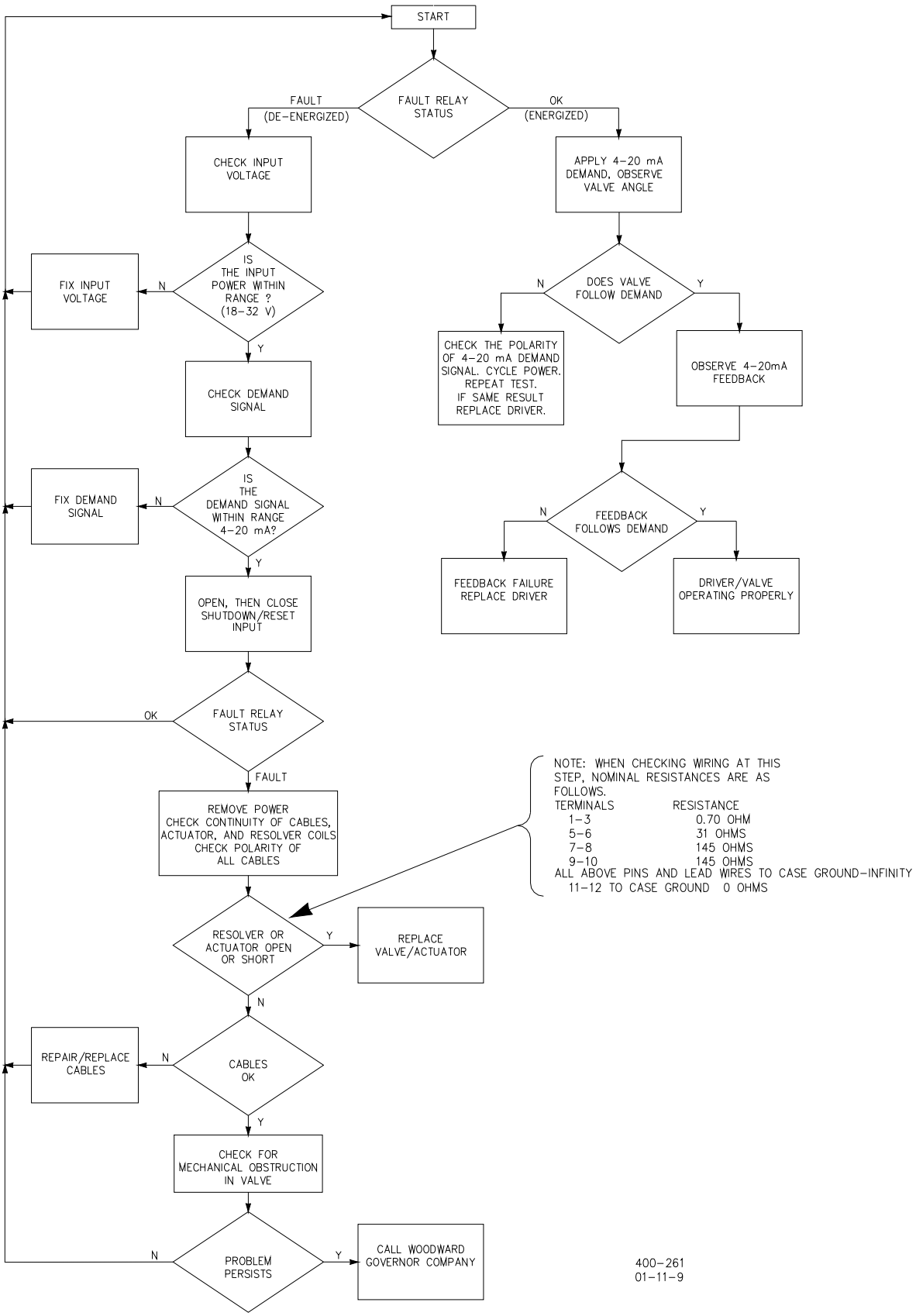


Figure 5-1. Troubleshooting Flowchart

Chapter 6.
Service Options

Product Service Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM and Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.
- A **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

You can locate your nearest Woodward distributor, AISF, RER, or RTR on our website at:

www.woodward.com/directory

Woodward Factory Servicing Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:

- return authorization number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact us via telephone, email us, or use our website: **www.woodward.com**.

How to Contact Woodward

For assistance, call one of the following Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (0) 21 52 14 51
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Turbine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

You can also locate your nearest Woodward distributor or service facility on our website at:

www.woodward.com/directory

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

Your Name	
Site Location	
Phone Number	
Fax Number	
Engine/Turbine Model Number	
Manufacturer	
Number of Cylinders (if applicable)	
Type of Fuel (gas, gaseous, steam, etc)	
Rating	
Application	
Control/Governor #1	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #2	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #3	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Revision History

Changes in Revision F—

- Updated fuel particulate concentration to 2.64 mg/L

Declarations

DECLARATION OF CONFORMITY

Manufacturer's Name:	WOODWARD GOVERNOR COMPANY (WGC) Industrial Controls Group
Manufacturer's Address:	1000 E. Drake Rd. Fort Collins, CO, USA, 80525
Model Name(s)/Number(s):	LQ3 Valves 9908-275, 9908-276 and similar Oil Metering Valve 9908-300 and similar
Conformance to Directive(s):	94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
Marking(s):	Category 2, Group II G, EEx d IIB T3
Applicable Standards:	EN 50014 (1997) + ammendments 1 and 2: Electrical apparatus for potentially explosive atmospheres - General Requirements EN 50018 (2000) + ammendment 1: Electrical apparatus for potentially explosive atmospheres - Flameproof enclosure 'd'
Third Party Certification:	LCIE 03 ATEX 6375 X
Conformity Assessment: **Notified Body** **For ATEX:**	ATEX Production Quality Assessment, ITS05ATEXQ4211 Intertek (0359) Intertek House, Cleeve Road Leatherhead, Surrey, KT22 7SB UK

We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

Signature

Dan Gear

Full Name

Engineering Manager

Position

WGC, Fort Collins, CO, USA

Place

1/6/06

Date

5-09-1183 Rev 10, 15-Jul-05 00122-04-CE-02-03

Declaration of Incorporation

Woodward Governor Company
1000 E. Drake Road
Fort Collins, Colorado 80525
United States of America

Products and Part Numbers:

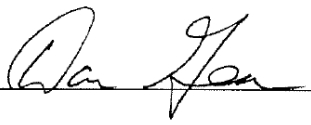
GS3 Valves 9908-250 and similar
LQ3 Valves 9908-275 and similar
LQ25T Valves 9907-504, 9908-200 and similar
LQ Bypass Valve 9908-201 and similar
Oil Metering Valve 9908-300 and similar

The undersigned hereby declares, on behalf of Woodward Governor Company of Loveland and Fort Collins, Colorado, that the above-referenced product is in conformity with the following EU Directives as they apply to a component:

98/37/EC (Machinery)

This product is intended to be put into service only upon incorporation into an apparatus/system that itself will meet the requirements of the above Directives and bears the CE mark.

MANUFACTURER



Signature

Dan Gear
Full Name

Engineering Manager
Position

WGC, Fort Collins, CO, USA
Place

1/10/06
Date

5-09-1182 (REV. 5) 00122-04-CE-02-04.doc

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26087F.

B26087:F

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Email and Website—www.woodward.com

**Woodward has company-owned plants, subsidiaries, and branches,
as well as authorized distributors and other authorized service and sales facilities throughout the world.**

Complete address / phone / fax / email information for all locations is available on our website.