WOODWARD

Product Manual 35066
(Revision A, 7/2017)
Original Instructions

LQ6T
Oil Metering Valve

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 *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:

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The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

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 *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, 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 Out-of-date translations are marked with ⚠.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— A bold, black line alongside the text identifies changes in this publication since the last revision.

Manual 35066

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Important Definitions

This is the safety alert symbol 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.

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:

EMC Directive Declared to Directive 2004/108/EC COUNCIL DIRECTIVE of 15 Dec 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC)

ATEX Directive: Directive 2014/34/EU on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres
Zone 1, Category 2, Group II G, Ex d IIB T3 Gb
TUV 13 ATEX 7404 X
Zone 2, Category 3, Group II G, Ex nA IIC T3 Gc
TUV 13 ATEX 7409 X

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

ATEX Directive: Exempt from the non-electrical portion of the ATEX Directive 2014/34/EU due to no potential ignition sources per EN 13463-1:2009 when installed in a Zone 1, Category 2 environment.

Machinery Directive: Compliant as partly completed machinery with Directive 2006/42/EC of the European Parliament and the Council of 17 May 2006 on machinery.

Pressure Equipment Directive: Compliant as “SEP” per Article 4.3 to Pressure Equipment Directive 2014/68/EU on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment.

IECEx: Certified for use in explosive atmospheres per Certificate:
IECEx TUR 11.0014X
Ex d IIB T3 Gb or Ex nA IIC T3 Gc

North American Compliance:

CSA: CSA Certified for Class I, Div. 1, Groups C & D T3, or Class I, Div. 2, Groups A, B, C, & D T3 at 93°C ambient. For use in Canada and the United States.
Certificate 1214202.

Special Conditions for Safe Use:

Refer to the specifications section for the ambient operating temperature range.

The valve wiring must be in accordance with North American Class I, Division 1 or 2 or European Zone 1, Category 2 or Zone 2, Category 3 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Field wiring for the valve power input must be suitable for at least 103 °C.

A conduit seal must be installed within 457 mm (18 inches) of the conduit entry when the valve is used in Class I, Division 1 hazardous locations. For installation in Zone 1, Category 2: only previously certified Ex d IIB Gb cable glands or conduit sealing devices may be used with this product.

For installation in Zone 1, Category 2: only previously certified Ex d IIB Gb cable glands or conduit sealing devices may be used with this product.

Connect the ground terminal of the valve to earth ground for proper safety and EMC performance.

The RS-232/-485 interface must not be used in hazardous locations unless the area is known to be non-hazardous.

Compliance with the Machinery Directive 2006/42/EC noise measurement and mitigation requirements is the responsibility of the manufacturer of the machinery into which this product is incorporated.

⚠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 applications.

⚠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 situez bien dans une zone non-explosive.

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2 ou Zone 2.

⚠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.

⚠WARNING

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.

⚠WARNING

Do not lift or handle the valve by any conduit. In order to prevent injury, use a lifting strap when handling the LQ6 valves. Using a strap suitable for lifting 43 kg (95 lb) is recommended. See Figure 2-2 for an example of how to use a sling to lift the valves.

⚠WARNING

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the LQ6 Valve.

NOTICE

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.

Chapter 1.
General Information

Introduction

The LQ6T valve is an electrically actuated valve with an on-board, electronic position controller.

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.

Connections to the LQ6T Valve

The LQ6T valve requires the following electrical connections. Additional details are provided in Chapter 2, Installation.

Earth Ground	Provided through ground lug on housing
Power Input	18–32 Vdc measured at the LQ6 valve
Analog Input	4–20 mA position command signal
CAN Network	DeviceNet™ * position, status, and limited configuration
Analog Output	4–20 mA output proportional to valve position
Shutdown Input	Relay or dry contact inputs for valve shutdown/reset
Status Output	Solid stead relay output for shutdown states

*—DeviceNet is a trademark of ODVA (Open DeviceNet Vendor Association, Inc.)

The LQ6T valve has one RS-232 service port for program upgrades by qualified service personnel.

Table 1-1. System Position Bandwidth

Unit	rad/sec	approx. Hz
LQ6T	60	9.5

LQ6T Oil Metering Valve

The LQ6T valve is an electrically actuated oil-metering valve with an on-board, electronic position controller. The valve is designed to accept a demand signal, and then accurately position the oil-metering element, exposing the port effective area proportional to flow. The metering element is designed to promote self-cleaning by a shear-type action created by the rotary plate and shoe. Position feedback is achieved using a resolver. The resolver is directly coupled to the oil-metering element, thus eliminating the need for couplings or gear trains and their associated inaccuracies.

Oil metering control is achieved by a combination of accurately scheduling the metering valve port area and regulating the differential pressure across the metering port. Regulation is achieved through an integral, single stage, throttling differential pressure regulator.

This design will operate in conjunction with any type of “pressure source” oil system (centrifugal type pump or bypassing system on a positive displacement pump that controls inlet pressure to this valve). Flow metering is implemented with the use of an electrically actuated rotary plate and shoe with electrical dual-position feedback. The valve is designed to automatically purge trapped air or vapor within the internal passages. No provision for manual bleeding of the valves in required. The valve is self-cleaning, with a shear action metering section.

Turbine manufacturer's requirements for oil flow can vary considerably depending on oil pressures, oil types, oil and ambient temperatures, turbine size, etc. Information on predicting oil flow through the LQ6T 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 sections. This oil flow information may be critical to the proper operation of your gas turbine and may be required information for the electronic control system to operate the turbine properly.

The LQ6T has two resolvers; the dual resolvers provide redundant feedback should a resolver fail.

The LQ6T will be commanded to a minimum flow position in the event of a detected failure within the valve or driver assemblies. Loss of electrical power results in the valve moving towards the minimum flow or full closed position, or holding at the last commanded position.

Operation of the LQ6T Valve

The LQ6T meters oil 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 torque motor (LAT). The resolver, mounted directly on the shaft of the valve, provides valve position feedback.

To accurately meter oil flow, the valve maintains a constant pressure drop across the oil metering port in the metering sleeve/shaft. The valve regulates the intermediate pressure to (P2) to maintain this constant pressure differential by positioning the throttling regulator piston.

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

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

Under operating conditions, oil at the system pressure (P1) flows to the metering sleeve/shaft and to one side of the regulator piston. Metered oil at the intermediate pressure (P2) is directed to the regulator metering ports and through a damping orifice (P2d) to the other side of the regulator piston. The regulator metering ports' effective area is such that the metered flow is throttled from the intermediate pressure (P2) to the outlet pressure (PN).

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 P2d acting on the piston's effective area and the force from the delta P spring. When the balance of forces has been established, the difference between the spring force acting on the piston is equal to the difference between the pressures (P1–P2d) acting on equal effective areas, and the pressure drop across the regulator metering ports is the difference between P2 and PN.

By varying the force of the ΔP spring, the pressure difference (typically 345 kPa/3.45 bar/50 psid) can be adjusted to suit the requirements of a particular application.

As long as the inlet pressure (P1) is sufficiently high (typically greater than 1034 kPa/10.34 bar/150 psid), the intermediate pressure (P2) is maintained and the metered flow is unaffected by the valve downstream pressure (PN).

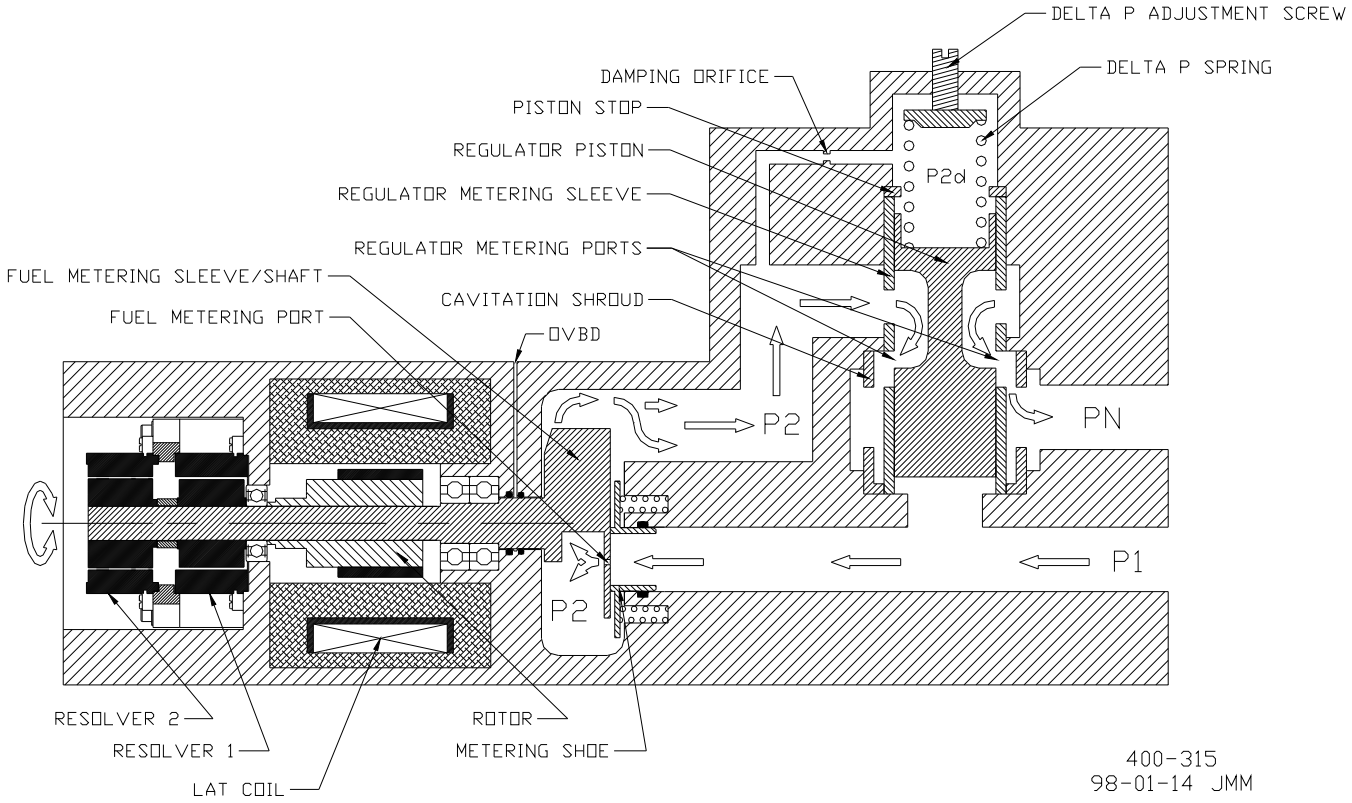


Figure 1-1. LQ6T Valve Schematic

Chapter 2.
Installation

Terminal Blocks

Terminal blocks are used on all LQ valves. 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:

- Insert the screwdriver 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.
- Withdrawal the screwdriver and the conductor is automatically clamped.

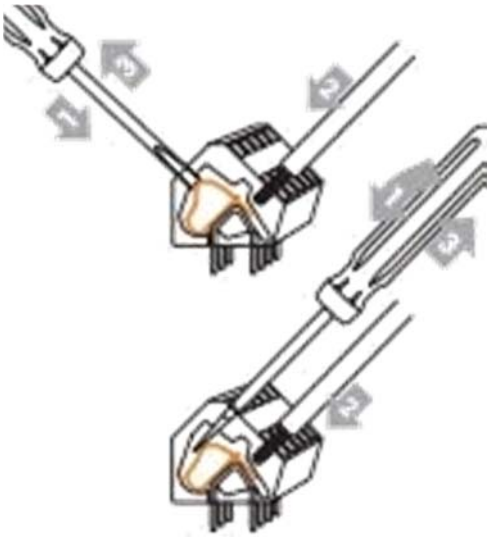


Figure 2-1. WAGO 736 Series Terminal Block

LQ6 Valve Unpacking

Be careful when unpacking the LQ6 valve. Check the assembly for signs of damage, such as bent or dented covers, scratches, and loose or broken parts. Notify the shipper and Woodward if damage is found.

⚠WARNING

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.

⚠WARNING

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the LQ6 Valve.

WARNING

Do not lift or handle the valve by any conduit. In order to prevent injury, use a lifting strap when handling the LQ6 valves. Using a strap suitable for lifting 31 kg (68 lb) is recommended. See Figure 2-2 for an example of how to use a sling to lift the valves.

Figure 2-2. Using a Sling to Lift the Valve

WARNING

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

Conduit seals must be installed within 457 mm (18 in) of the conduit entry when the LQ6 is used in Class I, Division 1 hazardous locations.

WARNING

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

WARNING

For Zone 1 / Division 1 products: Proper torque is very important to ensure that the unit is sealed properly. Damage to sealing surfaces may result in moisture ingress, fire, or explosion. Clean the surface with rubbing alcohol if necessary. Inspect the conduit and joint surfaces to ensure that they are not damaged or contaminated.

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 2-5 and 2-6).

NOTICE

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.

LQ6T Valve Mounting

The LQ6T valve is designed to operate within a temperature range of –28 to +93 °C (–18 to +200 °F) with a normal liquid oil temperature range of +15 to +65 °C (+59 to +149 °F).

The valve should be mounted as close to the turbine as practical in order to minimize the volume of oil 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 6: Detailed Specifications. Consideration must be given to the strength of the mounting plate in order to support the 31 kg (68 lb) mass of the LQ6T.

See Figure 2-3 for dimensions of the LQ6T mounting hole pattern. The valve should be securely attached to a clean, flat, rigid surface that will not exceed the vibration limits specified in Chapter 6, Detailed Specifications.

Connect inlet, outlet, and overboard lines to the valve. The inlet port receives pressurized oil from the pump. The outlet line should be attached to the oil line(s) going to the turbine. The overboard (OBVD) drain port depicted in Figure 2-3 is a vent between dual redundant shaft seals. It must be connected by means of rigid steel piping to an oil collection system so as not to be exposed to danger of obstruction, physical damage, or backpressure in excess of 69 kPa (0.69 bar/10 psig).

⚠WARNING

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

The overboard drain piping must be sufficiently sloped to eliminate the possibility of stagnant water which could freeze and plug the drain, resulting in a hazardous condition with the potential to cause personal injury and/or damage to the valve.

IMPORTANT

Leakage exceeding 20 cm^3/min from the overboard drain line indicates a worn or damaged shaft seal in the LQ6 valve and should be investigated immediately. Special tooling is required to replace the shaft seal. Contact Woodward for service.

Table 2-1. LQ6T Connections

Inlet	1.312-12 UN Straight Thread Port (-16)
Outlet	1.312-12 UN Straight Thread Port (-16)
OBVD (Overboard Vent Drain Port)	0.438-20 UNF Straight Thread Port (-04)

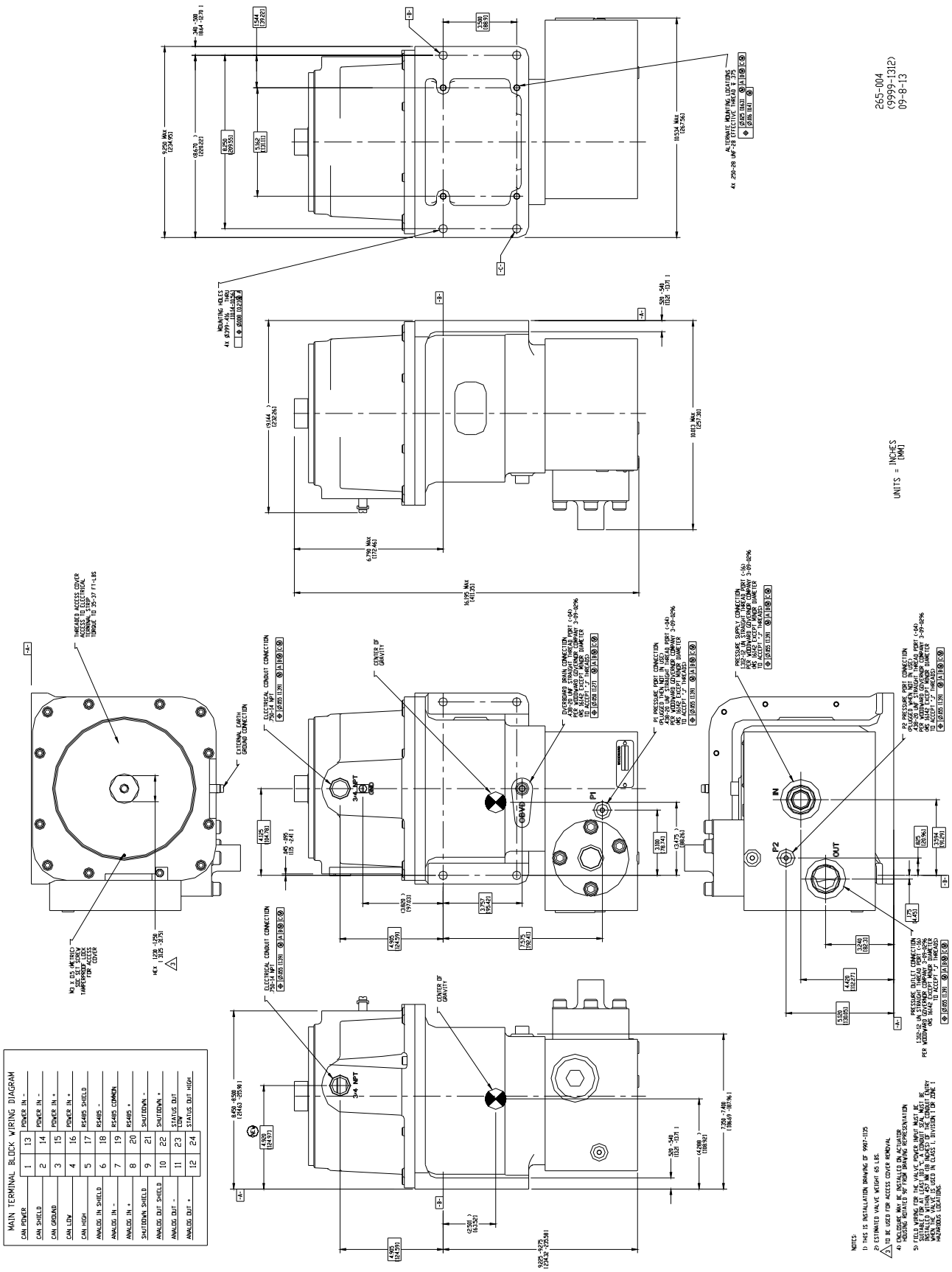


Figure 2-3. LQ6T Outline Drawing

Electrical Connections

⚠WARNING

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

⚠WARNING

The engine, turbine, or other type of prime mover should be equipped with an overspeed, misfire, detonation detection shutdown device(s), that operate totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the system fail.

⚠WARNING

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

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 2-5 and 2-6).

The LQ6 valve is connected to the engine control system by the main terminal block connector. A conduit seal must be installed within 457 mm (18 inches) of the conduit entry when the valve is used in Class I, Division 1 hazardous locations.

Damage to sealing surfaces may result in moisture ingress, fire, or explosion. Clean the surface with rubbing alcohol if necessary. Inspect the LQ6 joint surfaces to ensure that they are not damaged or contaminated.

The LQ6 valve has two ¾" NPT conduit entries in order to facilitate separation of power and control signal wiring into separate conduits. If an entry is not used for wiring, it must be plugged when the valve is installed. For valves installed in hazardous locations, unused conduit entries must be plugged with certified stopping plugs. Plugs must be sized for a 3/4" – 14 NPT conduit entry and meet the ambient temperature range of the product.

Class I, Division 1 and Zone 1 hazardous areas require plugs with specific certifications. In North America, the plug must be certified or listed for use in a Class I, Division 1, Groups C, and D area. For European installations, an Ex d stopping plug certified for Zone 1, Category 2, Group II G, Ex d IIB must be used. Follow all manufacturer's installation instructions to ensure that the plug is installed properly and meets the hazardous area requirements. The Redapt Ltd. part number PD-U-3-0-30-00 or similar plug may be used in North American installations, and the Redapt Ltd. part number PA-D-3-0-30-00 or similar may be used in European installations.

For valves installed in Class I, Division 2 or Zone 2 areas, the stopping plug must meet installation requirements based on the authority having jurisdiction. For European Zone 2 units, the plug must provide a minimum ingress protection value of IP66 and may only be removed with the aid of a tool. Ensure that any plugs or glands are properly torqued during installation.

Use of a cable gland or stopping plug that does not meet the hazardous area certification requirements, or thread form, or thread size will invalidate the suitability of the valve for hazardous locations.

Terminals are spring-loaded type, accepting wire size from 0.08 to 3.0 mm² (28 to 12 AWG). Recommended wire sizes are 3.0 mm² (12 AWG) for Power In (+) and (–) and 1.0 mm² (16 AWG) for other signals. Refer to Figures 2-5 and 2-6, and to the description below, for LQ6 wiring requirements.

Shielded Wiring

All shielded cable must be twisted conductor pairs. Do not attempt to tin (solder) the braided shield. All signal lines should be shielded to prevent picking up stray signals from adjacent equipment. Connect the shields to the correct pins on the driver connector or wiring as specified in the wiring diagram. Do not connect shields to the actuator ground. Wire exposed beyond the shield should be as short as possible, not exceeding 50 mm (2 inches). The other end of the shields must be left open and insulated from any other conductor. DO NOT run shielded signal wires along with other wires carrying large currents. Where shielded cable is required, cut the cable to the desired length, and prepare the cable as instructed below:

- Strip the outer insulation from BOTH ENDS, exposing the braided or spiral wrapped shield. DO NOT CUT THE SHIELD.
- Using a sharp, pointed tool, carefully spread the strands of the shield.
- Pull the inner conductor(s) out of the shield. If the shield is the braided type, twist it to prevent fraying.
- Remove 6 mm (1/4 inch) of insulation from the inner conductors. The shield must be considered as a separate circuit when wiring the system. The shield must be carried through connectors without interruption.
- A conduit seal must be installed within 457 mm (18 inches) of the conduit entry when the valve is used in Class I, Division 1 hazardous locations.

Installations with severe electromagnetic interference (EMI) may require additional shielding precautions. Contact Woodward for more information.

Failure to provide shielding can produce future conditions that are difficult to diagnose. Proper shielding at the time of installation is required to ensure satisfactory operation of the LQ6 valves.

13	14	15	16	17	18	19	20	21	22	23	24
Power In -	Power In -	Power In +	Power In +	485 Shield	485 Lo	485 Com	485 Hi	Shut-down -	Shut-down +	Status Out Lo	Status Out Hi
1	2	3	4	5	6	7	8	9	10	11	12
Can Pwr	Can Shield	Can Gnd	Can Lo	Can Hi	4-20 In Shield	4-20 In -	4-20 In +	Shut-down Shield	4-20 Out Shield	4-20 Out -	4-20 Out +

Shading indicates terminal not used on analog version of LQ6

Figure 2-5. LQ6 Terminal Block Wiring Diagram

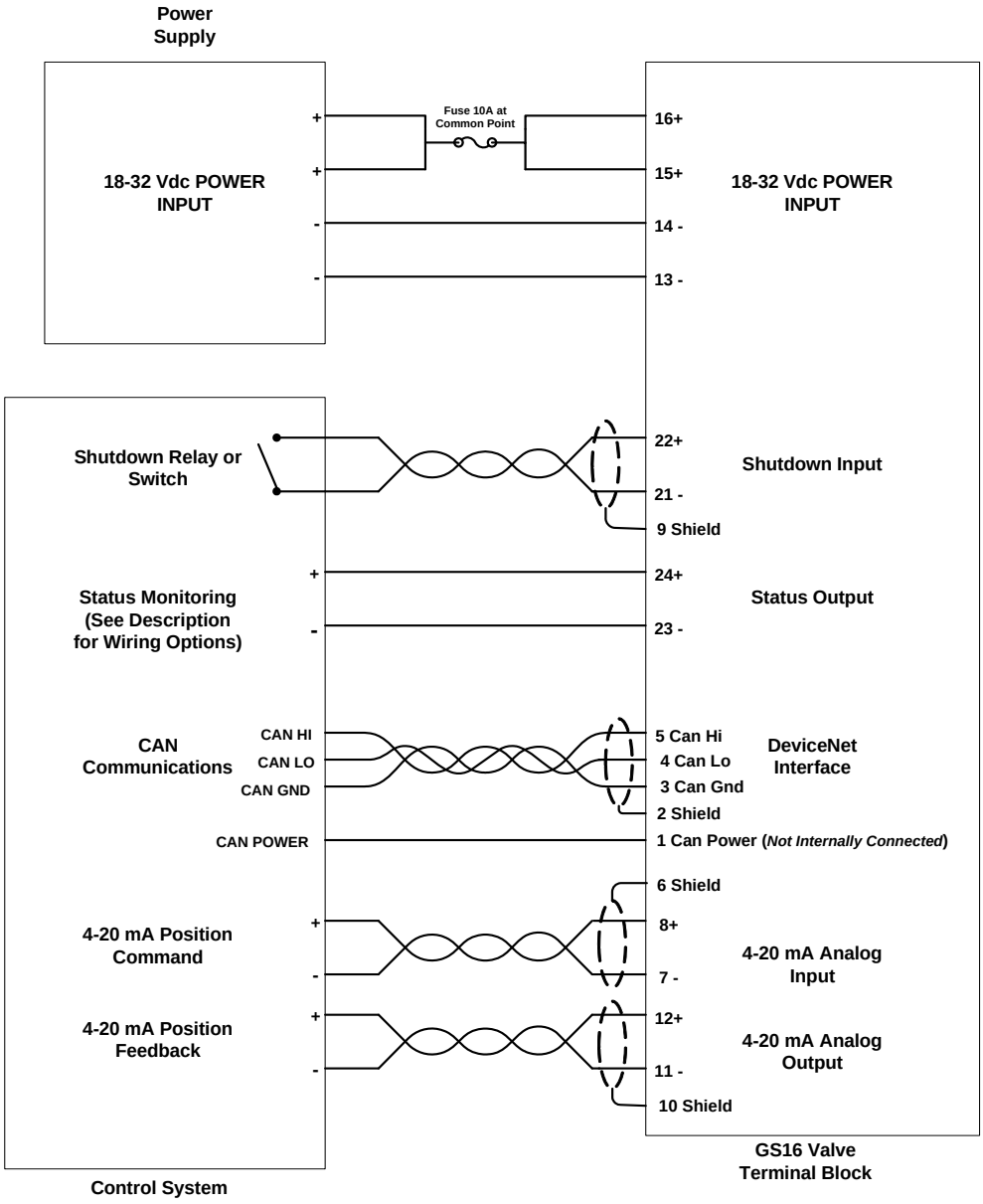


Figure 2-6. LQ6T Plant Wiring Diagram

Supply Voltage

Terminal 15 and/or 16 = Supply voltage (+)
Terminal 13 and/or 14 = Supply voltage (–)

The supply voltage during normal operation must be 18 to 32 V, measured at the LQ6 valve connectors. Input current is typically less than 2.0 A, but momentary current peaks can reach 7 A. The recommended power supply cable size is 3.0 mm² (12 AWG). Two terminals each are supplied for both Power In (+) and Power In (–). This allows for connecting two parallel power supply cables, each of 3.0 mm² (12 AWG) to reduce line loss in the power supply wiring. ***Power supply line losses can adversely affect dynamic performance of the LQ6 under conditions of minimum supply voltage, high temperature, and long line lengths. Each LQ6 valve should have dedicated power supply lines to the power source. The power should not be daisy-chained between valves.*** The power supply wiring must be fused outside of the valve. A slow-blow type, 10 A fuse is recommended. If parallel supply lines are used, each supply line must be fused, with one 10 A fuse in a common point.

Refer to the tables below to determine the appropriate wire size and number for the supply power lines based on the distance from the LQ6 driver to the power supply. The following line voltage drops are calculated at 27 °C ambient temperature.

Table 2-2. Wire Gauge and Voltage Drop Specifications

Wire Gauge (AWG)	Voltage Drop per Meter at 7 A Round-Trip (V)	Voltage Drop per Foot at 7 A Round-Trip (V)
14 AWG (2 mm²)	0.150	0.046
12 AWG (3 mm²)	0.094	0.028

Example Calculation (AWG): 12 AWG wires will drop 0.028 V/ft at 7 A. Using 50 feet of wire between the LQ6 driver and the power supply would result in a voltage drop of 50 X 0.028 = 1.4 V. Thus the power supply must always provide between 19.4 and 32 Vdc as specified on the input power.

Example Calculation (Metric): 3 mm² wires will drop 0.094 V/m at 7 A. Using 15 m of wire between the LQ6 driver and the power supply would result in a voltage drop of 15 X 0.094 = 1.4 V. Thus the power supply must always provide between 19.4 and 32 Vdc as specified on the input power.

Table 2-3. Cable Length Specifications

Maximum Cable Length		Terminal Pins 13, 15	Terminal Pins 14, 16	American Wire Gauge (AWG)	Metric Wire (mm²)
Meter	Feet				
12	40	X		14	2
24	79	X	X	14	2
19	62	X		12	3
39	128	X	X	12	3

The power supply wiring must be fused outside of the valve. A slow-blow type, 10 A fuse is recommended. If parallel supply lines are used, each supply line must be fused, with one 10 A fuse in a common point.

The controller can produce transients on the power supply lines that may interfere with certain regulated power supplies. If this is the case, the interference may be reduced or eliminated by connecting a 100 V, 1000 µF or larger electrolytic capacitor across the power supply lines. Correct polarity must be observed when connecting the electrolytic capacitor.

If batteries are not used, Woodward recommends the following power supply:

- Woodward P/N 1784-3032 (Phoenix Contact QUINT-PS-100-240AC/24DC/20, Phoenix Contact P/N 2938620) with 1000 µF 100 V electrolytic capacitor (Woodward P/N 1662-111) installed.
- Place the 1000 µF, 100 V capacitor across the + and – dc output terminals on the power supply.

NOTICE **To prevent damage to the power supply, be sure to observe correct polarity.**

- This power supply accepts 85–264 Vac (45–65 Hz) or 90–350 Vdc. Output voltage is rated at 22.5 to 28.5 Vdc.

4–20 mA Input

Terminal 8 = 4–20 mA Input (+)
Terminal 7 = 4–20 mA Input (–)
Terminal 6 = Shield

The LQ6 Analog Version is controlled via the 4–20 mA Input. Input scaling from the factory is such that 4 mA input current corresponds to the minimum-scaled (%) valve position and 20 mA input current corresponds to maximum-scaled (%) valve position. Valve position (not flow) vs. input current is linear between these extremes. Input current less than 2 mA or greater than 22 mA will cause a shutdown condition where the valve will be driven to the 0% position and the 4–20 mA Output will be set to 0 mA.

⚠WARNING

The input scaling (mA input to % valve position) of the LQ6 is factory configured per customer specific oil flow range requirements. Modifying the input scaling will increase or decrease the available flow range of the LQ6, which may result in adverse turbine operation including possible personal injury, loss of life, and/or property damage.

Recommended cable is 1.0 mm² (16 AWG) twisted, shielded pair. The input impedance of the 4–20 mA Input is approximately 200 Ω resistive. The input circuit will withstand a differential voltage up to 24 V and common mode voltage, with respect to Power Supply (–), up to ±500 V without damage at 25 °C. Presence of common mode voltage at the input terminals will cause a slight error in valve position. Performance to specifications is attainable only with common mode voltage less than ±40 Vdc.

DeviceNet / CANopen Digital Interface

Terminal 5 = CAN Hi
Terminal 4 = CAN Lo
Terminal 3 = CAN GND
Terminal 2 = CAN Shield
Terminal 1 = CAN Pwr (not connected internally)

The LQ6 Digital Version is controlled via either DeviceNet or CANopen. It can also be configured to accept DeviceNet / CANopen and 4–20 mA position demand signals, and upon failure of either demand signal, switch to the healthy input demand signal. Terminal 1 is not connected internally and is provided as an optional placeholder for the CAN power wire. This product has been self-tested by Woodward and found to comply with ODVA Protocol Conformance Test Version 16.

⚠WARNING

The input scaling (mA input to % valve position) of the LQ6 is factory configured per customer specific oil flow range requirements. Modifying the input scaling or controlling the valve position via DeviceNet / CANopen will increase or decrease the available flow range of the LQ6, which may result in adverse turbine operation including possible personal injury, loss of life, and/or property damage.

For CANopen based CAN Networks:

- At 500 kbps, there should be no more than 15 active valves.
- At 250 kbps, there should be no more than seven active valves.
- At 125 kbps, there should be no more than three active valves.

Table 2-4. CANopen Cable Limitation for LQ6

Baud Rate	Distance (meters)	Distance (feet)
125 kbps	500 m	1640 ft
250 kbps	250 m	820 ft
500 kbps	100 m	328 ft

4–20 mA Output

Terminal 12 = 4–20 mA Output (+)
Terminal 11 = 4–20 mA Output (–)
Terminal 10 = Shield

The 4–20 mA Output provides the analog output indication of the LQ6 valve position. Output scaling is such that 4 mA output corresponds to the minimum factory scaled (%) valve position and 20 mA output corresponds to the maximum factory scaled (%) valve position. Output between these extremes is a linear function of valve position. A shutdown condition (resulting from certain errors or from an open Shutdown Input) is indicated on the 4–20 mA Output by 0 mA output current.

Recommended cable is 1.0 mm² (16 AWG) twisted, shielded pair. The output will drive a load resistance up to 500 Ω. The output circuit is electrically isolated from all other LQ6 driver circuitry and will withstand common mode voltage up to ±500 Vdc with respect to Power Supply (–) without damage at 25 °C.

Shutdown Input

Terminal 22 = Shutdown Input (+)
Terminal 21 = Shutdown Input (–)
Terminal 9 = Shield

The Shutdown Input provides a means to shut down and reset the LQ6 driver through a relay or other dry contact. For normal operation, the shutdown inputs must be closed, (+) and (–) shorted together. When the Shutdown Input is opened, the driver is held in shutdown state, the valve is driven to the 0% position, the 4–20 mA Output is set to 0 mA, and the Status Output is put into shutdown. Upon closing the Shutdown Input, the driver resets and will resume control of the valve position according to the input command.

Recommended cable is 1.0 mm² (16 AWG) twisted, shielded pair. Nominal current through the wiring and external contact is 10 mA.

Status Output

Terminal 24 = Status Output (+)
Terminal 23 = Status Output (–)

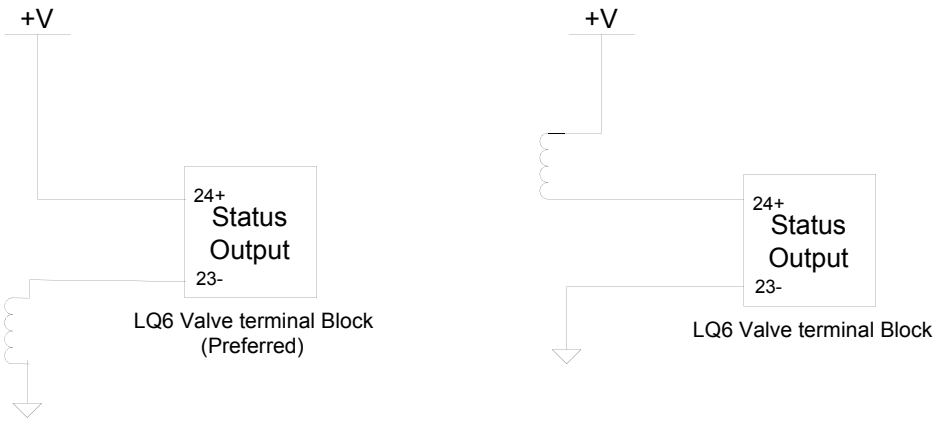


Figure 2-7. Terminals 24 and 23 LQ6 Valve Terminal Block Examples

The two methods for wiring the Status Output are shown above. The Status Output indicates if the LQ6 is shut down or running. There are two ways for the LQ6 to be shut down—if the Shutdown/Reset input is in shutdown, or if a diagnostic has been triggered. If the LQ6 is in a shutdown situation, the status output is open (no current).

Maximum Switch Current: 500 mA
Maximum Output Voltage at 500 mA: 1 V
Maximum Output Voltage (Open): 32 V
Default at Power Up: Open Contact
Error Condition: High Impedance
Normal Operating Condition: Low Impedance
Common Mode Range: 40 V
Implementation Types: Relay or Solid State Relay
Load Configuration Types: High Side or Low Side (see diagram above)

⚠WARNING

The engine, turbine, or other type of prime mover should be equipped with an overspeed, misfire, detonation detection shutdown device(s), that operate totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the system fail.

Service Port

The service port (Figure 2-7) provides an RS-232 connection for troubleshooting and program upgrades. Connection to the service port should be made only when the area is known to be non-hazardous. When replacing the cover, torque the cover to 47 N·m (35 lb-ft). A 9-pin straight RS-232 serial cable is required when using this service port. To configure the RS-232 Service Port for RS-232 communication, Jumper (JPR3) is set to RS-232 position, and Jumper (JPR5) is set to RS232EN.

Recommend disabling the RS-232 Service Port when the valve is in normal service. To disable the RS-232 Service Port, Jumper (JPR3) is set to RS-485 position, and Jumper (JPR5) is set to RS232DIS.

⚠WARNING

Proper torque is very important to ensure that the unit is sealed properly.

Figure 2-8. Service Port

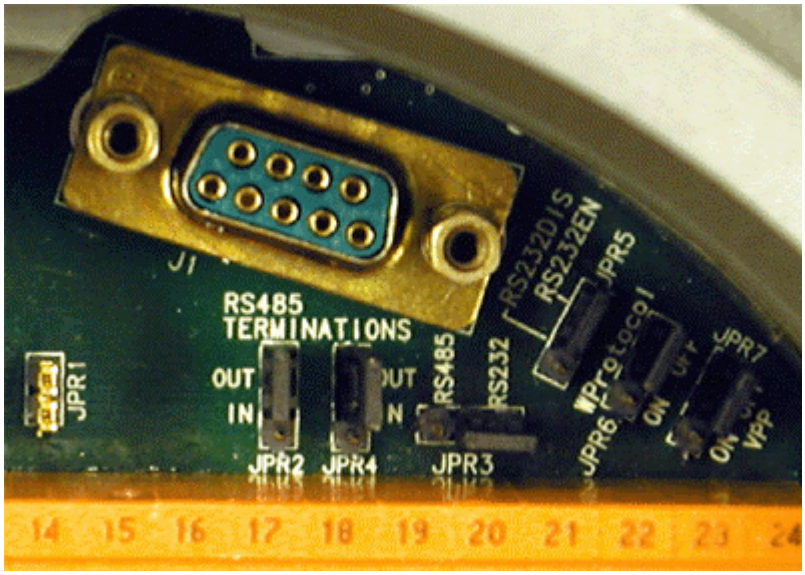


Figure 2-9. Service Port (close-up)

Chapter 3.
Description of Operation

Description

LQ6 Operating Modes

The valve can be in four operational modes.

- Running
- Shutdown
- Shutdown position
- Shutdown system

Running:
In this mode, the valve operates normally and is in position control. The Status Output terminals will be closed, and the 4–20 mA output will follow actual position of the valve.

Shutdown:
In this mode, the valve is still in position control, but there has been a situation that forced the valve into shutdown. The position will be set to zero %. The 4–20 mA output will be set to zero mA, and the status output will be in shutdown (terminals open).

There are different situations that will force the valve into shutdown. See troubleshooting for more details. If the LQ6 Valve is a Digital version, also see the next section on Redundancy for situations that will force the valve into shutdown.

Shutdown Position:
If the valve is in shutdown position mode, the valve will not control position any more. The driver will try to close the valve in current control mode. The 4–20 mA output will be set to zero mA, and the status output will be in shutdown.

Shutdown System:
If the valve is in shutdown system mode, the driver will try to close the valve with a PWM signal. This is the last attempt to close the valve. The 4–20 mA output will be set to zero mA, and the status output will be in shut down.

See troubleshooting for more details on the different situations that will put the valve into the different modes.

Redundancy

This valve has the following redundancy features.

- DeviceNet position control with Analog backup
- CANopen position control with Analog backup
- Two Position Feedback devices

Position Control:
The following table shows the operating states for the LQ6 Digital Version. Configuration for Backup Used and Analog Primary are done over the Digital Interface (DeviceNet / CANopen). See Chapter 6 for a description of Shutdown Input, Tracking Error, DigitalCom Error, and Analog Error. The Digital and Analog states indicate if the valve is controlled via the Digital Interface or the Analog Input.

Table 3-1. LQ6 Digital Version Operating States

LQ6 Valve State	Shutdown Input	Backup Used	Tracking Error	DigitalCom Error	Analog Error	Analog Primary
DeviceNet / CANopen	False	False	Don't Care	False	Don't Care	Don't Care
Shutdown	False	False	Don't Care	True	Don't Care	Don't Care
DeviceNet / CANopen	False	True	Don't Care	False	True	Don't Care
Analog	False	True	Don't Care	True	False	Don't Care
DeviceNet / CANopen	False	True	False	False	False	False
Analog	False	True	False	False	False	True
DeviceNet / CANopen	False	True	True	False	False	Don't Care
Shutdown	False	True	Don't Care	True	True	Don't Care
Shutdown	True	Don't Care	Don't Care	Don't Care	Don't Care	Don't Care

Position Feedback:
The valve can be configured to use the Average, the Higher, or the Lower of the two resolvers by setting the Difference Error Mode accordingly. The following table shows when the valve will use the Average, the Higher, or the Lower of the two resolvers for different configurations and valve states.

Table 3-2. LQ6 Different Configurations and Valve States

	Difference Error Mode		
LQ6 Valve State	Use Average	Use Higher	Use Lower
No Difference Errors	Average	Average	Average
Difference Error 1	Average	Higher	Lower
Difference Error 2	Average	Higher	Lower

CANopen Communications

The LQ6 valve supports CAN communications in the CIA CANopen Protocol format complying with DS301 version 4.02. Further detailed information regarding CANopen can be obtained at www.can-cia.org. Information about CAN is available at **www.semiconductors.bosch.de**. Specific information regarding LQ6 behavior is detailed below.

All LQ6 CANopen messages use the CAN 2.0 11-bit Standard Data Frame Format. All data in CANopen is formatted as "Little Endian" also known as "Intel Format".

Baud Rate
The baud rate is configurable in the service tool for 125, 250, 500 kbps. The default is 500 kbps.

The LQ6 will allow a change in the CAN baud rate if:

The proper CANopen Parameters value is changed, i.e. "BaudRate";

–AND–

The LQ6 is then power cycled;

–OR–

The LQ6 is set to a different "Input Type" and then returned to the "CANopen with Analog Backup" selection. (This action Closes/Opens the CAN device, thus providing the opportunity to change the CAN device's baud rate.)

The LQ6 valve will operate on a CAN Network that has the following "valves-per-baud rate-setting" restrictions:

- At 500 kbps, there shall be no more than 15 valves operating simultaneously
- At 250 kbps, there shall be no more than 7 valves operating simultaneously
- At 125 kbps, there shall be no more than 3 valves operating simultaneously

Table 3-3. CANopen Cable Limitation for LQ6

Baud Rate	Distance (meters)	Distance (feet)
125 kbps	500 m	1640 ft
250 kbps	250 m	820 ft
500 kbps	100 m	328 ft

Recommend the CANbus Load should not exceed 90% in order to achieve the best performance.

CAN parameters that need to be configured in Service Tool:

Node ID
The Node is Configurable in the Service Tool.
1..31 if TxPDO 5 and 6 are enabled.
1..255 if TxPDO 5 and 6 are disabled.
The Default values of one and zero should not be used.

CAN Timeout
Description: Timeout or Maximum Sync rate time in ms
Range/Type: 0 – 1000, unsigned 16 bit
Default Value: 40

Enable PDO5 and PDO6
Description: Enable/Disable Transmission of TxPDO5 and TxPDO6
Range/Type: 0=disabled, 1=enabled
Default Value: 0 (= disabled)

Heartbeat
The Heartbeat message is not supported.

CANopen State
The LQ6 valve starts in boot-up mode, sends the required Boot Message, and then goes to the pre-operational state. An operational command needs to be received on the CAN bus to enter the Operational mode.

Once in operational mode, the LQ6 will remain in normal functioning if it receives a SYNC message (COB-ID=0x80) and a FAST REQUEST message
(COB-ID=0x20x) within “CAN Timeout” ms. “CAN Timeout” is configurable in the Service Tool.

Another way of stating this is: if EITHER a Sync or a Fast message is NOT seen within the timeout, the DigitalComErr bit/alarm is set.

The alarm/bit may be cleared with a "RESET DIAGNOSTICS" command from the MicroNet™/NMT controller via the proper FAST REQUEST message command bit, in combination with a subsequent SYNC message.

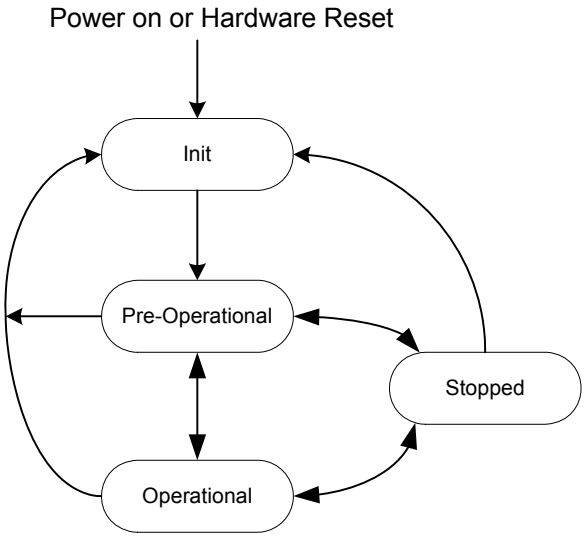


Figure 3-1. CANopen State Chart

The "DigitalCom Slow-Data Not Received" bit will be initially SET when CANopen digital communications begins. It is CLEARED when at least one "Slow Request #1" (RxPDO2) AND at least one "Slow Request #2" (RxPDO3) have been received. It will stay cleared unless digital communications is lost. Diagnostic Word 2, Bit 4 in PDO 6: DigitalNotAllSlowDataReceived.

Table 3-4. Transmit PDO Table

Name	TxPDO	COB_ID	Type	Rate
Actual Position and Status from Valve	1	384 (0x180) +NodeId	SYNC	Sync/Timeout ms
Input Voltage and Temperature	2	640 (0x280) +NodeId	ASYNC	Rx PDO 2 rate
Efficiency and Analog Position In	3	896 (0x380) +NodeId	ASYNC	Rx PDO 2 rate
Actual current and Filtered current	4	1152 (0x480) +NodeId	ASYNC	Rx PDO 2 rate
Actual Position 1 and Actual Position 2	5	480 (0x1E0) +NodeId	ASYNC	Rx PDO 2 rate
Error Status Bits	6	736 (0x2E0) +NodeId	ASYNC	Rx PDO 2 rate

Table 3-5. Receive PDO Table

Name	RxPDO	COB_ID	Timeout
Fast Request: Demand and Bit Command	1	512 (0x200) +NodeId	Sync Rate
Slow Request #1 and Tracking	2	768 (0x300) +NodeId	N/A
Slow Request #2: and Dual Max Diff	3	1024 (0x400) +NodeId	N/A

Receive (Rx) PDO Definitions

Receive PDO 1 – Fast Request with Demand and Command Bits
This and a sync message needs to be received within the timeout milliseconds.

Message type: “SYNC” (requires SYNC message)
COB Id: 512+Node Id (0x200+NodeId)
Data length: 3 bytes

Data:
Byte 1-2: Position Demand
Data length: 2 bytes, byte 1 is LSB, byte 2 MSB
Resolution: 16 bits
Units: %
Scaling: 2,500 = 0% to 62,500 = 100%

WARNING

The input scaling (mA input to % valve position) of the LQ6 is factory configured per customer specific oil flow range requirements. Modifying the input scaling or controlling the valve position via DeviceNet / CANopen will increase or decrease the available flow range of the LQ6, which may result in adverse turbine operation including possible personal injury, loss of life, and/or property damage.

Byte 3: Command Bits
Data length: 1 byte

Bit 0: **Shutdown**. If this bit is "1", the LQ6 will shutdown and set the Shutdown bit.
Bit 1: **Reset diagnostics bits**. On a "0" to "1" transition (Edge triggered), the LQ6 will reset from a shutdown or alarm condition and reset all the diagnostic bits.
Bit 2: **Resolver check enabled**. The LQ6 will do a resolver check. The Demand Must be <= 0 on DeviceNet.
Bit 3: **AnalogPrimaryDemand**. If set, the analog input is the primary demand. If analog and DeviceNet inputs are OK, the analog is used. If the bit = “0" the DeviceNet input is used.
Bit 4: **UseAnalogBackup**. Set this to “0” so the analog input will be ignored and no reading or diagnostics will be triggered.

Bit 5 to Bit 7 are reserved, must always be "0".

Bytes 4-8 are unused

Receive PDO 2 – Slow Request #1 with Tracking Command

Message type: “ASYNC”
COB Id: 768+Node Id (0x300+NodeId)
Data length: 8 bytes

Data:
Byte 1-4: TrackingMaxDiff
Data length: 4 bytes, Float
Units: % (0..1 = 0%..100%)
Range: 0 to 100%
Default: 1%.

Byte 5-6: TrackingTime
Data length: 2 bytes, unsigned 16
Units: millisecond
Range: 50-5,000

Byte 7-8: DualResolverDiffErrMode
Data length: 2 bytes, unsigned 16
Units: ENUM
Range: 0-2

0 = UseMaxResolver
1 = UseMinResolver
2 = UseAverage

Receive PDO 3 – Slow Request #2 with Dual Resolver Max Diff 1 & 2

Message type: "ASYNC"
COB Id: 1024+Node Id (0x400+NodeId)
Data length: 8 bytes

Data:
Byte 1-4: DualResolverMaxDiff1
Data length: 4 bytes, Float
Units: % (0..1 = 0%..100%)
Range: 0 to 100%

Byte 5-8: DualResolverMaxDiff2
Data Length: 4 bytes, Float
Units: % (0..1 = 0%..100%)
Range: 0 to 100%

Transmit (Tx) PDO Definitions

Transmit PDO 1 – Actual Position and Status from Valve

Message type: Transmitted in Response to Receipt of Receive PDO 1
COB Id: 384+Node Id (0x180+NodeId)
Data length: 3 bytes

Data:
Byte 1-2: Position Feedback
Data length: 2 bytes, byte 1 is LSB, byte 2 MSB
Resolution: 16 bits
Units: %
Scaling: 2,500 = 0% to 62,500 = 100%

Byte 3: Status Bits
Data length: 1 byte
Bit 0: **Alarm**. This is a copy of the alarm bit.
Bit 1: **Shutdown System**. This is a copy of the shutdown system bit.
Bit 2: **Shutdown Position**. This is a copy of the shutdown position bit.
Bit 3: **Shutdown**. If this bit is "1" the LQ6 is shutdown. This bit will follow the status output. If all shutdown conditions are not true and the start-up position is not true this bit will be set to zero.
Bit 4: **ManualResolverTestInprogress**. This bit will be "1" if the manual resolver test is in progress. If the resolver test is not performed (Demand is not <= 0.0) this bit will not go to "1".
Bit 5-7 are sent as 0.

Transmit PDO 2 – Input Voltage and Electronics Temperature

Message type: Transmitted in Response to Receipt of Receive PDO 2
COB Id: 640+Node Id (0x280+NodeId)
Data length: 8 bytes

Data:
Byte 1-4: Input Voltage
Data length: 4 bytes, Float
Units: Volt

Byte 5-8: Electronics Temperature
Data length: 4 bytes, Float
Units: Kelvin

Transmit PDO 3 – Efficiency and Analog Position In

Message type: Transmitted 2 ms after Transmit PDO 2
COB Id: 896+Node Id (0x380+NodeId)
Data length: 8 bytes

Data:
Byte 1-4: Efficiency
Data length: 4 bytes, Float
Units: None

Byte 5-8: Analog Input
Data length: 4 bytes, Float
Units: % (0..1 = 0%..100%)

Transmit PDO 4 – Actual current and Actual Current Filtered

Message type: Transmitted 2 ms after Transmit PDO 3
COB Id: 1152+Node Id (0x480+NodeId)
Data length: 8 bytes

Data:
Byte 1-4: Current Feedback
Data length: 4 bytes, Float
Units: Amp

Byte 5-8: Current Feedback Filtered
Data length: 4 bytes, Float
Units: Amp

Transmit PDO 5 – Actual Position 1 and Actual Position 2

Message type: Transmitted 2 ms after Transmit PDO 4
COB Id: 480+Node Id (0x1E0+NodeId)
Data length: 8 bytes

Data:
Byte 1-4: Actual Position 1
Data length: 4 bytes, Float
Units: % (0..1 = 0%..100%)

Byte 5-8: Actual Position 2
Data length: 4 bytes, Float
Units: % (0..1 = 0%..100%)

Transmit PDO 6 – Error Status Bits

Message type: Transmitted 2 ms after Transmit PDO 5
COB Id: 736+Node Id (0x2E0+NodeId)
Data length: 8 bytes

Data:

Byte 1-2: Diagnostic Word 1 (Error will result in valve shutdown)

Data length: 2 bytes

Bit 0: MainEepromWriteFail.
Bit 1: MainEepromReadFail.
Bit 2: ParameterErr.
Bit 3: ParameterVersionErr.
Bit 4: Adc5VoltErr.
Bit 5: AdcRefErr.
Bit 6: Plus15VoltErr.
Bit 7: Min15VoltErr.
Bit 8: AdcErr.
Bit 9: SpiAdcErr.
Bit 10: FactoryCalibrationErr.
Bit 11 to 15: Reserved.

Byte 3-4: Diagnostic Word 2 (The Alarm(ALM) and Shutdown (SD) setting can vary depending on the valve configuration purchased)

Data length: 2 bytes

Bit0: StartupPositionSensorErr.
Bit1: PositionSensorErr.
Bit2: PositionErr.
Bit3: CurrentControlErr.
Bit4: DigitalNotAllSlowDataReceived.
Bit5: AnalogInputHighErr.
Bit6: AnalogInputLowErr.
Bit7: PowerupReset.
Bit8: WatchdogReset.
Bit9: ShutdownInputActive.
Bit10: DigitalComErr.
Bit11: Reserved.
Bit12: DigitalAnalogTrackingErr.
Bit13: InputVoltageLowErr.
Bit14: InputVoltageHighErr.
Bit15: PositionSensor2Err.

Byte 5-6: Diagnostic Word 3

Data length: 2 bytes

Bit 0: DualResolverDiff1Err. (ALM)
Bit 1: StartupPositionSensor2Err (ALM)
Bit 2: DualResolverDiff2Err (SD)
Bit 3 to 15: Reserved (SD)

On the CAN bus the Diagnostic words will appear in the following order:
(Diagnostic word 1)
b7, b6, b5, b4, b3, b2, b1, b0, b15, b14, b13, b12, b11, b10, b9, b8
(Diagnostic word 2)
b7, b6, b5, b4, b3, b2, b1, b0, b15, b14, b13, b12, b11, b10, b9, b8
(Diagnostic word 3)
b7, b6, b5, b4, b3, b2, b1, b0, b15, b14, b13, b12, b11, b10, b9, b8
Everything else 0x00

Shutdown(SD) and Alarm (ALM) Glossary

Actual Position 1 (Output) – Feedback of the resolver 1 position.

Actual Position 2 (Output) – Feedback of the resolver 2 position.

AdcErr (Output – Internal Driver/Electronics Error) – Failure of the Analog to Digital Converter.

AdcRefErr (Output – Internal Driver/Electronics Error) – This bit will be a “1” if a reference error was detected in the Analog to Digital Converter.

Adc5VoltErr (Output – Internal Driver/Electronics Error) – This is an Analog to Digital Converter (on the driver) voltage error.

Alarm (Output) – This is a general alarm bit. If any parameters are out of range, this bit will send a “1”.

Analog Input (Output) – This is readback of the analog signal input to the valve.

AnalogInputHighErr (Output) - If the analog input is mis-connected or driven With more than the normal current, an analog high error will shut down the valve (>22 mA).
AnalogInputLowErr (Output) - If the analog input is not connected, an analog input low error (< 2 mA) will shut down the valve.

AnalogPrimaryDemand (Input) – If set to “1” by the control system, the analog input is the primary demand. If analog and CANopen inputs are OK the analog is used. If the bit = “0" the CANopen input is used.

CurrentControlErr (Output – Internal Driver/Electronics Error) – This bit will become a “1” if a fault is detected with the current feedback driver.

Current Feedback (Output) – This is the feedback of the current being consumed by the driver.

Current Feedback Filtered (Output) – This is a filtered feedback of the current being consumed by the driver. The filter being used is: Value(n+1) = (Value(n) - Value(n-1)) * Coeff + Value(n-1)
CoEff = 0.002

DigitalAnalogTrackingErr (Output) – This bit will be a “1” if the difference between the digital demand and the analog demand is greater than the “TRACKMAXDIFF” input.

DigitalComErr (Output) – This is a breakdown of the digital network. This error is caused by one of the following conditions:

- Incorrect or zero length message
- Duplicate MAC ID
- Bus Off
- No messages received

DigitalNotAllSlowDataReceived (Output – Internal Driver/Electronics Error)- This error occurs if not all of the digital information/messages were received from the control system.

DualResolverDiffErrMode (Input) – This will define which resolver should be used as feedback in a dual resolver system. You can either use the higher reading, lower, or average the 2 resolvers.

DualResolverMaxDiff1 (Input) – This is the first threshold level of the maximum difference accepted between resolver 1 and resolver 2.

DualResolverMaxDiff2 (Input) - This is the second threshold level of the maximum difference accepted between resolver 1 and resolver 2.

DualResolverDiff1Err (Output) – This bit will go to a “1” if the difference between resolver 1 and resolver 2 is greater than the value of “DualResolverMaxDiff1”.

DualResolverDiff2Err (Output) – This bit will go to a “1” if the difference between resolver 1 and resolver 2 is greater than the value of “DualResolverMaxDiff2”.

Electronics Temperature (Output) – This is feedback of the temperature of the on board driver.

Efficiency (Output) – This is a multiplier to the position demand to correct the position to a calibrated flow point.

FactoryCalibrationErr (Output – Internal Driver/Electronics Error) – Error in reading the factory calibration file.

Input Voltage (Output) – This is feedback of the input voltage being supplied to the onboard driver.

InputVoltageLowErr (Output) – This bit will be a “1” if the input voltage to the driver goes below 17 V.

InputVoltageHighErr (Output) – This bit will be a “1” if the input voltage to the driver goes above 33 V.

MainEepromWriteFail (Output – Internal Driver/Electronics Error) – Failure of the EEPROM on the driver.

MainEepromReadFail (Output – Internal Driver/Electronics Error) – Failure of the EEPROM on the driver.
Min15VoltErr (Output – Internal Driver/Electronics Error) – This bit will become a “1” if the on-board driver -15 supply has an error.

ManualResolverTestInprogress (Output) – This bit will be "1" if the “Resolver Check Enabled” is set to “1” and the check is in progress.

ParameterErr (Output – Internal Driver/Electronics Error) – During a read or write cycle, the parameter values are checked. If either set is incorrect, the values from the correct set are copied into the incorrect set. If both sets are incorrect this bit is set to “1”.

ParameterVersionErr (Output – Internal Driver/Electronics Error) – During operation, if the block number in the parameter set does not match the block number used when retrieving the parameter, a version mismatch is detected and the ParameterVersionErr is set to “1”.

Plus15VoltErr (Output – Internal Driver/Electronics Error) – This bit will become a “1” if the on-board driver +15 supply has an error.

Position Demand (Input) – The position input being demanded from the control system.

Position Feedback (Output) – This is the actual position of the valve being sent to the control system.

PositionSensorErr (Output) – The valve is continuously checking if the signals for resolver 1 are correct. If the resolver signals are missing or incorrect, a Position Sensor Error 1 is set and the valve will continue running on resolver 2.

PositionErr (Output) – During run time, the valve will check if the position feedback and the demanded position are the same. If not, a position error will be flagged, and the valve will be shut down.

PositionSensor2Err (Output) – The valve is continuously checking if the signals for resolver 2 are correct. If the resolver signals are missing or incorrect, a Position Sensor Error 2 is set and the valve will continue running on resolver 1.

PowerupReset (Output) – After power up, the valve will go into shutdown until the valve is reset by the shutdown-reset input.

Reset diagnostics bits (Input) – On a "0" to "1" transition (Edge triggered) from the control system, the LQ6 will reset from a shutdown or alarm condition and reset all the diagnostic bits.

Resolver check enabled (Input) – During normal running conditions, the valve is continuously checking to see if the signals of the resolvers are correct. You can manually run a resolver check when the valve is in shutdown and at 0% by making this bit a “1”.

SpiAdcErr (Output – Internal Driver/Electronics Error) – Failure of the “SPI” Analog to Digital Converter.

Shutdown (Output) – If this bit is "1" the LQ6 is shutdown. This bit will follow the status output. If all shutdown conditions are not true and the start-up position is not true this bit will be set to zero.

ShutdownInputActive (Output) – If the shutdown input is active (open), the valve will be in shutdown.

Shutdown Position (Output) – If the valve is in shutdown position mode, the valve will not control position. The driver will try to close the valve in current control mode. The 4–20 mA output will be set to zero mA, and the status output will be in shutdown. This shutdown will typically occur with positional errors.

Shutdown System (Output) – If the valve is in shutdown system mode, the driver will try to close the valve with a PWM signal. This is the last attempt to close the valve. The 4–20 mA output will be set to zero mA, and the status output will be in shut down. This shutdown will typically occur with internal errors.

StartupPositionSensorErr (Output) – Failure of resolver 1 on start-up.

StartupPositionSensor2Err (Output) - Failure of resolver 2 on start-up.

Shutdown (Input) - If this bit is "1" from the control system, the LQ6 will shut down and set the Shutdown bit.

TrackingMaxDiff (Input) – This is the maximum difference allowed between the analog command and digital command, if digital demand is used with analog backup.

TrackingTime (Input) – This is the amount of time that must elapse after the limits of the “TrackingMaxDiff” have been exceeded for the driver to shutdown the valve.

UseAnalogBackup (Input) – If set to “1” by the control system the valve will switch to the analog signal in the event of the CANopen network failing. If set to “0” the analog input will be ignored and no reading or diagnostics will be triggered.

WatchdogReset (Output – Internal Driver/Electronics Error) – The driver will check to see if the processes that are running in the software are still running. If not, a watchdog reset will be given and the system will restart.

Chapter 4.
Service Tool

Introduction

Pressing the Export button during or after the trending process allows to export the data collected during the trending process to a file of Comma Separated Values (*.csv). This file can be opened in a spreadsheet or math analysis software package for post-processing of the data and further analysis.

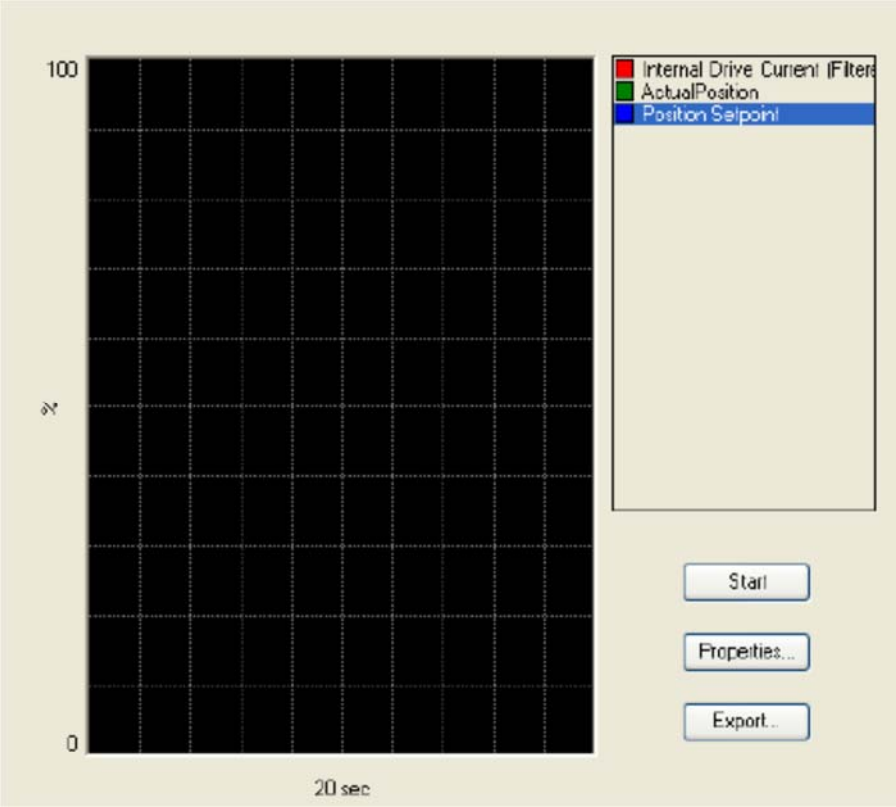


Figure 4-1. Trend Chart

Creating a Custom Trend Chart

Point the cursor to a control parameter to be monitored and right clicking. The new ‘Add to trend’ button will pop up (Figure 4-2).

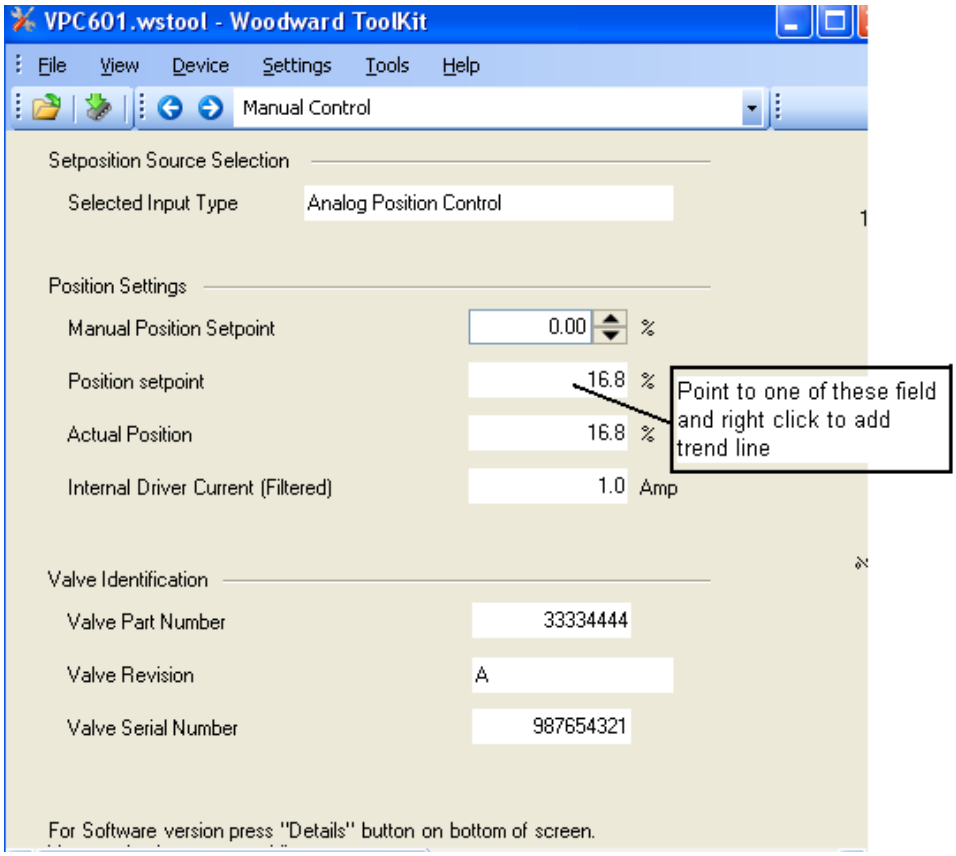


Figure 4-2. Creating a Custom Trend Chart

Selecting the “Add to trend” button a new trending window will open showing a trending chart for the selected control variable. Pressing the Start button starts the trending process for the selected variables. Pressing the Stop button freezes the currently displayed values. Pressing the Start button again erases the last traces and restarts the trending process.

The trend chart can be modified by pressing the properties button. From this window trend screen properties such as trending time span, sample rate and variable scaling can be modified (Figure 4-3).

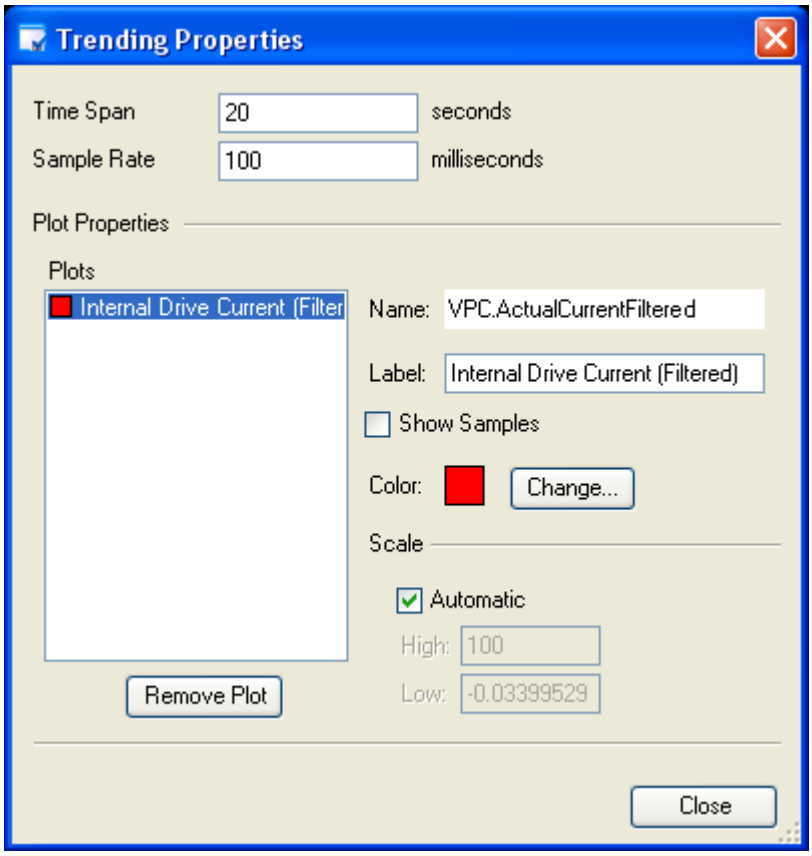


Figure 4-3. Trending Properties

Exporting and Saving Trend Values

Custom trend values can be exported and saved to a file of Comma Separated Values (*.csv file) or Web Page (*.htm) file by pressing the export button. This file can be opened in a spreadsheet or math analysis software package for post-processing of the data and further analysis.

Process Fault & Status Overview

The Process Fault & Status Overview screen gives an overview of the entire range of process fault and status flags and their individual status. A red LED indicates the process is at fault. In the case of a Power Reset or Analog input error, the LQ6 will be in a shutdown mode. If the LED indicator is green, the process fault or status flag indicates no error detected and the LQ6 is ready for operation (Figure 4-4). The process fault and status flags are grouped according to their function.

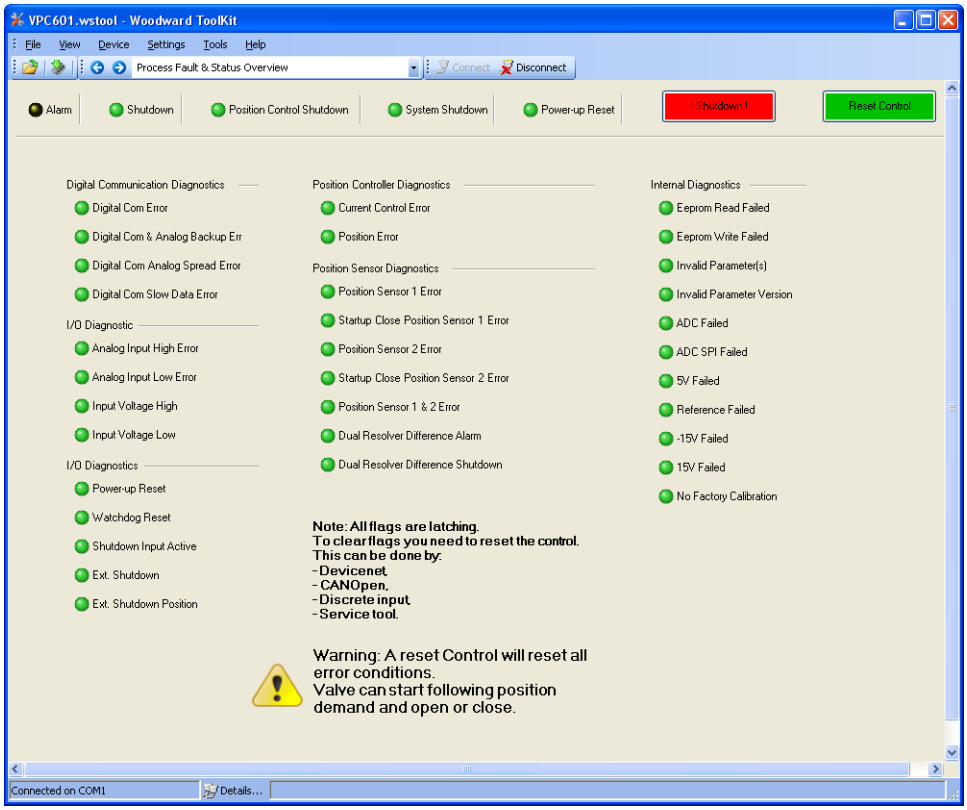


Figure 4-4. Process Fault & Status Overview

Process Fault & Status Configuration Overview

This screen gives an overview of the configuration of the process fault and status flags. Two LED indicators depict the configuration of each individual process fault or status flag.

The flags appear on the Process Fault & Status Configuration Overview is in the same order as on the previous Process Fault & Status Overview screen (Figure 4-5).

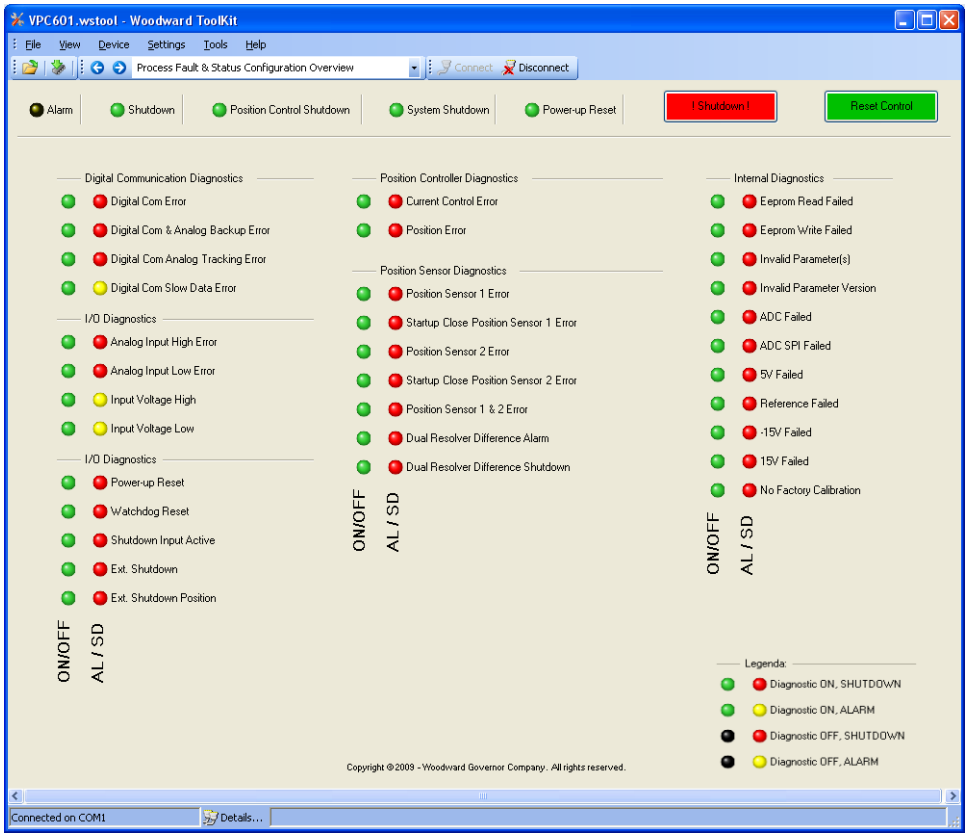


Figure 4-5. Process Fault & Status Configuration Overview

An illuminated green LED indicator on the left indicates that the flag is enabled. If not illuminated, the flag is disabled. A yellow LED indicator on the right indicates that the process fault or status flag is configured as an alarm. This means that if there is a process fault, the driver will not shut down because of the occurrence. If red, the process fault and status flag is configured as a shutdown. A fault under this configuration will force the LQ6 to shutdown (Figure 4-6).

Figure 4-6. Diagnostic Configuration LED

WARNING

Modification to these settings could affect the operation and plant diagnostic enunciation.

Disabling diagnostic flags or changing their function from Shutdown to Alarm could result in dangerous condition.

Recommend an appropriate review of the settings prior to making any settings modifications.

Configuration of the user-configurable flags is done with the VPC Service Tool settings editor. Some of these flags are changed depending on the configuration of the valve. For a dual resolver valve, the resolver 1 and 2 errors will be set to alarm—if one of the resolvers fails, the unit will automatically switch to use the other resolver. The resolver 1 and 2 fault flag will be set to a shutdown—if two resolvers fail, the unit will shut down the valve.

The same rule is also applied to the digital communication. In the case of using Analog input as backup, the analog input high and low errors are alarms and not shutdowns.

Setpoint Source Selection & Control Operations Summary

The LQ6 can be operated using different sources for the setpoint signal. The Setpoint Source Selection page provides an overview of which setpoint source is currently selected and the current setpoint settings for the selected source. Figure 4-7 shows the Analog input as the selected source for the LQ6.

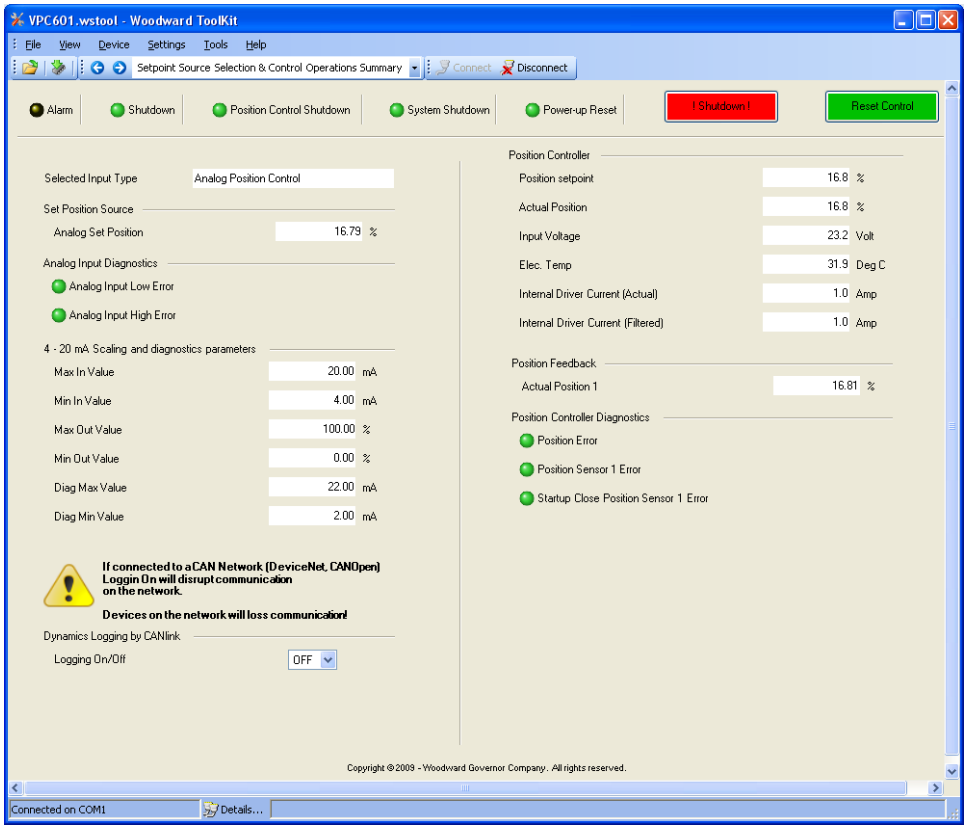


Figure 4-7. Setpoint Source Selection Screen

Setpoint sources available on the LQ6 are shown in Table 4-1.

Table 4-1. Setpoint Sources

Setpoint Source	Setpoint Signal Type
Analog Position Control	4–20 mA
Manual Position Control	Internally generated setpoint, user-configurable from the Manual Control page
CANopen Position Control	CANopen base protocol using CAN Port. Optional use Analog back up.
DeviceNet Position Control	DeviceNet based protocol. Using CAN port. Optional use Analog back up.
Function Generator Position Control	Built-in function generator mode.

WARNING

The input scaling (mA input to % valve position) of the LQ6 is factory configured per customer specific oil flow range requirements. Modifying the input scaling or controlling the valve via Manual Position Control, CANopen Position Control, DeviceNet Position Control or Function Generator Position Control modes will increase or decrease the available flow range of the LQ6, which may result in adverse turbine operation including possible personal injury, loss of life, and/or property damage.

Selected Input Type
This indicator shows the currently selected active setpoint source.

Set Position Source
The indicator shows the actual set position in percent of position (%) resulting from the currently active analog configuration.

Analog Input Diagnostics
Two LEDs are provided in front of the Analog Input Low Error and Analog Input High Error. An illuminated red LED on the Analog Input Low Error indicates the Analog input signal is too low or it is not presented. An illuminated red LED on the Analog Input High Error indicates the Analog input signal is too high or has not been correctly calibrated.

4–20 mA Scaling and Diagnostics Parameters
This section displays the scaling of the 4–20 mA input signal and the scale valve position. The 4–20 mA setting can be configured using the Edit Settings File.

WARNING

The input scaling (mA input to % valve position) of the LQ6 is factory configured per customer specific oil flow range requirements. Modifying the input scaling will increase or decrease the available flow range of the LQ6, which may result in adverse turbine operation including possible personal injury, loss of life, and/or property damage.

Position Controller
This section shows the position setpoint to the controller and the actual valve position (in %), the controller's internal input voltage (volts), driver internal electronic temperature (°C), and Driver drive current (amps).

Position Feedback
Position feedback is the actual position of the valve. The position feedback is displayed as percent of electrical revolution of the resolver (% Elec Rev).

Position Controller Diagnostic
This section displays the status of the position controller. There are three possible position errors were identified Position Error, Position Sensor 1 Error, and Startup Close Position Sensor 1 Error. An illuminated red LED on the indicator indicates the position controller encounters an error.

Manual Position Control Setpoint Source

The LQ6 can be configured for Manual Control operation mode when the Manual Position Control is set on the Selected Input Type Figure 4-8. In this mode, the user can stroke the valve by changing the position on the Manual Control page.

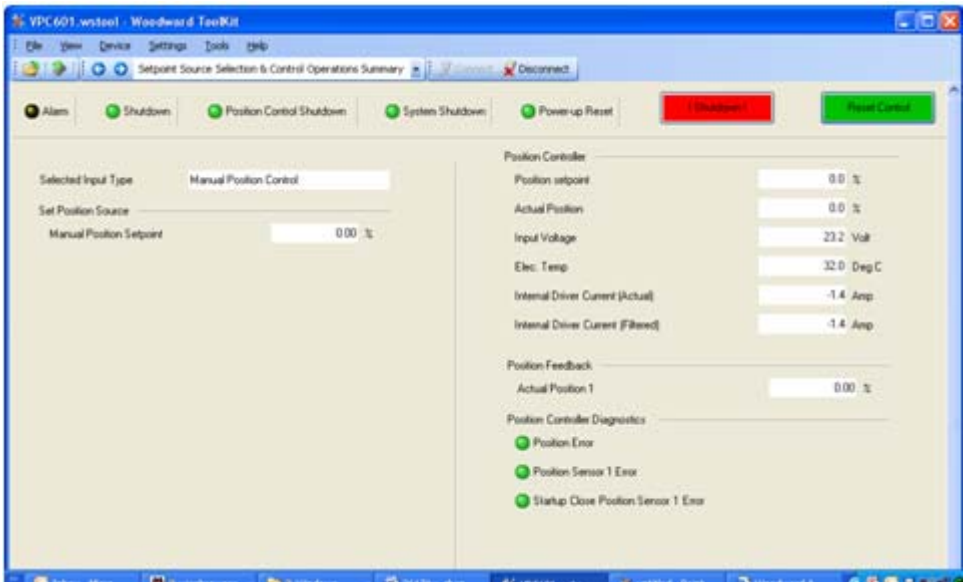


Figure 4-8. Manual Position Control

Selected Input Type
This indicator shows the currently selected active setpoint source.

Set Position Source
The indicator shows the actual set position in percent of position (%) resulting from the currently active of the manual position set point.

Position Controller
This section shows the position setpoint to the controller and the actual valve position (in %), the controller's internal input voltage (volts), driver internal electronic temperature (°C), and Driver drive current (amps).

Position Feedback
Position feedback is the actual position of the valve. The position feedback is displayed as percent of electrical revolution of the resolver (% Elec Rev).

Position Controller Diagnostic
This section displays the status of the position controller. There are three possible position error were identified Position Error, Position Sensor 1 Error, and Startup Close Position Sensor 1 Error. An illuminated red LED on the indicator indicates the position controller encounters an error.

CANopen/DeviceNet Position Control Setpoint Source

CANopen Position Control in the Selected Input Type settings indicates the LQ6 is configured for CANopen operation. The CANopen Position Control screen displays the Selected Input Type, Set Position Source, CAN Open Diagnostics, Analog Set Position, CAN Open Parameters, Position Controller, Position Feedback and Position Controller Diagnostics (Figure 4-9).

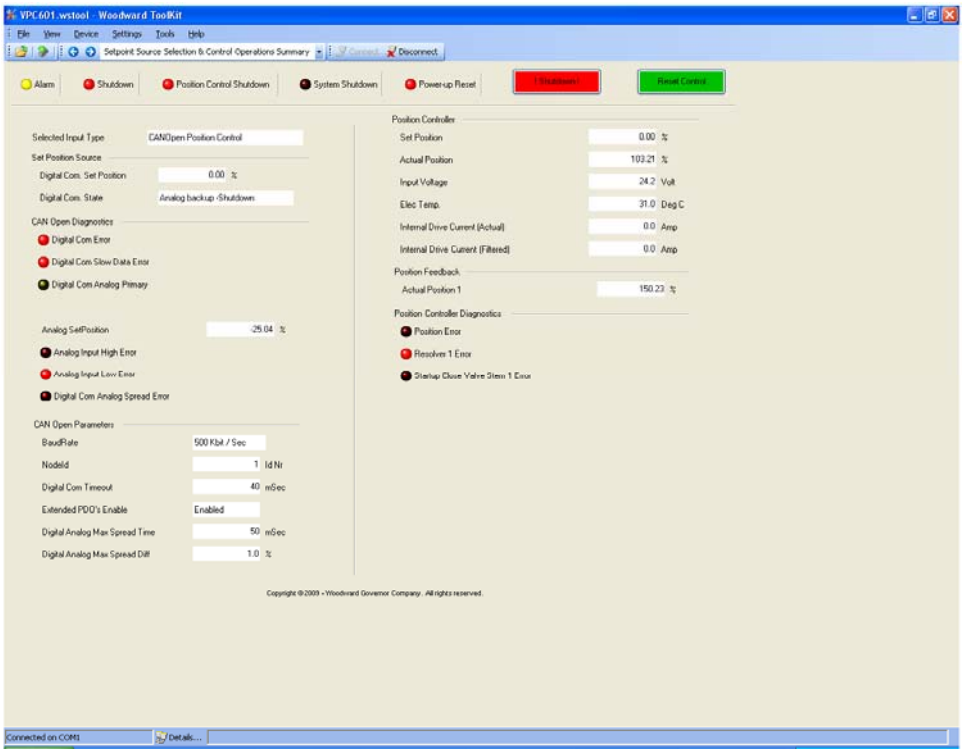


Figure 4-9. CANopen Position Control

Selected Input Type

This indicator shows the currently selected active setpoint source.

Set Position Source

The indicator shows the actual Digital Com. set position in percent of position (%) and the state of Digital Com. Analog backup configuration. The analog backup is used and the setting limit can be configured by using the Edit Settings File tool.

CAN Open Diagnostics

Three possible errors on this group. Digital Com Error, Digital Com Slow Data Error and Digital Com Analog Primary, are provided. An illuminated red LED any of the identified errors indicates the controller may has experienced the error.

Analog Setpoint

The indicator shows the actual Analog Set Position in percent of position (%) with three possible error flag. These error flags are Analog Input High Error, Analog Input Low Error, and Digital Com Analog Spread Error. An illuminated red LED any of the identified errors indicates the controller may has experienced the error.

CAN Open Parameters

This section displays the setting status of the CAN protocol and can be configured using the Edit Settings file tool. Refer to CANOpen communication section for proper setting.

Position Controller

This section shows the position setpoint to the controller and the actual valve position (in %), the controller's internal input voltage (volts), driver internal electronic temperature (°C), and Driver drive current (amps).

Position Feedback

Position feedback is the actual position of the valve. The position feedback is displayed as percent of electrical revolution of the resolver (% Elec Rev).

Position Controller Diagnostic

This section displays the status of the position controller. There are three possible position error were identified Position Error, Resolver Error, and Startup Close Valve Stem 1 Error. An illuminated red LED on the indicator indicates the position controller encounters an error.

Function Generator Position Control Setpoint Source

The LQ6 can be configured to operate in Function Generator Position Control Mode. The Function Generator Position Control screen displays the Selected Input Type, Set Position Source, Function Generator Settings, Position Controller, Position Feedback, and Position Controller Diagnostics (Figure 4-10).

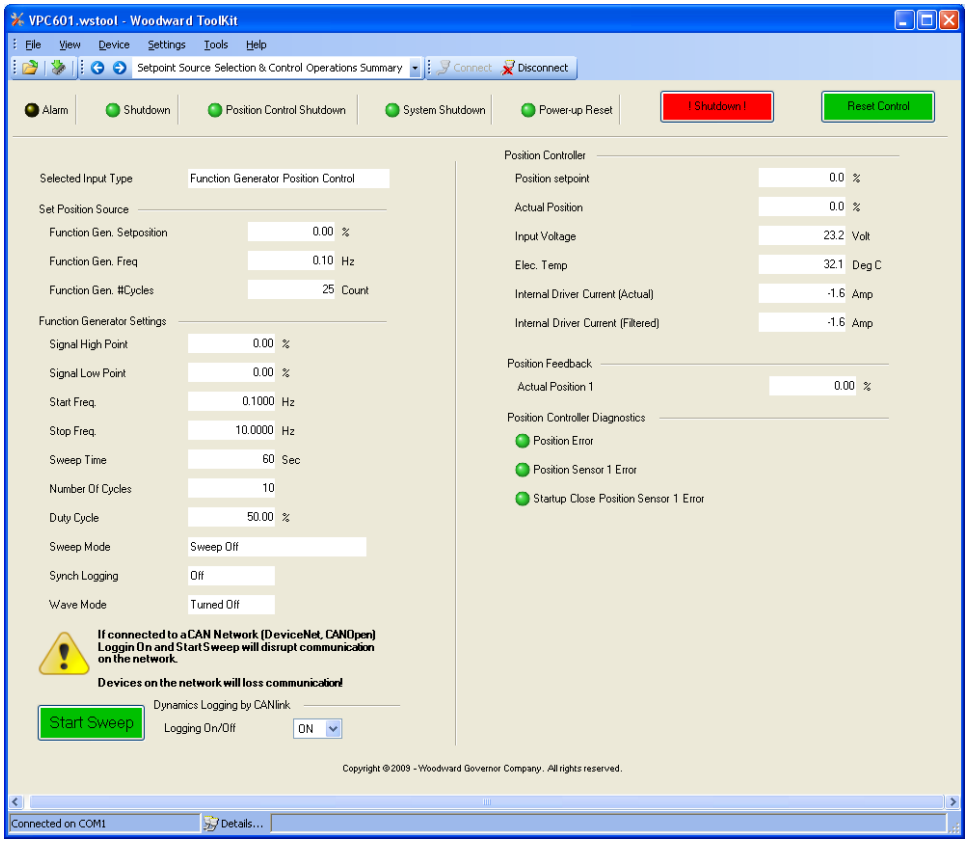


Figure 4-10. Function Generator Position Control

Selected Input Type

This indicator shows the currently selected active setpoint source.

Set Position Source

The indicator show the actual Function Gen. Set Position in percent of position (%), Function Gen. Frequency (Hz), and Function Gen. #Cycles (count).

Function Generator Settings
The indicators show the function generator setting parameters. These parameters can be reconfigured by using the Edit Settings File tool.

Position Controller
This section shows the position setpoint to the controller and the actual valve position (in %), the controller's internal input voltage (volts), driver internal electronic temperature (°C), and Driver drive current (amps).

Position Feedback
Position feedback is the actual position of the valve. The position feedback is displayed as percent of electrical revolution of the resolver (% Elec Rev).

Position Controller Diagnostic
This section displays the status of the position controller. There are three possible position error were identified Position Error, Resolver Error, and Startup Close Valve Stem 1 Error. An illuminated red LED on the indicator indicates the position controller encounters an error.

Actuator Calibration

The LQ6 product is manufacture configured to a single or dual resolver depends on the application. The VPC actuator calibration page of the VPC Service Tool provides an overview of the actuator position. The single resolver actuator display is shown in Figure 4-11. The tool automatically display the resolver configuration in Single or Dual resolver. The resolver is pre-configured from the factory.

Single Resolver Actuator

The single resolver actuator screen shows the Position Scaling and Diagnostic Settings, Raw Position Sensor Data, and Position Sensor Mode (Figure 4-11).

Position Sensor 1 Scaling and Diagnostic Settings
This indicator displays the LQ6 resolver factory calibrated value in digital count. The resolver min and max count represent the LQ6 actuator position 0–100% scale.

Raw Position Sensor Data
This section shows the raw data in Position 1 and Position 2 in counts. Three digital graphic meters are provided to display the set position and actual position.

Position Sensor Mode
The indicator shows the LQ6 is in either a Single Resolver Mode or Dual Resolver Mode.

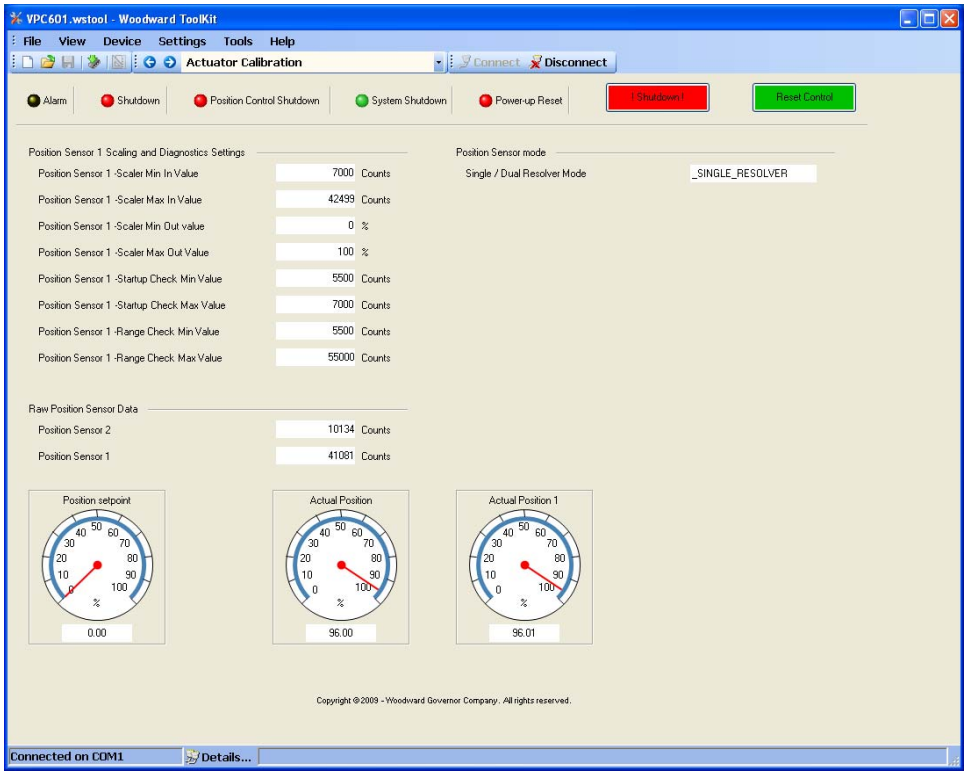


Figure 4-11. Single Resolver Screen

Dual Resolver Actuator

The Dual resolver actuator screen shows the Position Scaling and Diagnostic Settings, Raw Position Sensor Data, Position Sensor Mode, Position Sensor 2 and Diagnostic settings, and Dual Resolver Difference Error Checking
(Figure 4-12).

Position Sensor 1 Scaling and Diagnostic Settings

This indicator displays the LQ6 resolver factory calibrated value in digital count. The resolver min and max count represent the LQ6 actuator position 0–100% scale.

Raw Position Sensor Data

This section shows Position Sensor 1 and 2 resolver raw data. Unlike the single resolver mode, the digital graphic meters are expanded to four and they are position setpoint, actual position, actual position1, and actual position 2.

Position Sensor Mode

The indicator shows the LQ6 is set for Dual Resolver Mode.

Position Sensor 2 Scaling and Diagnostic Settings

This indicator displays the LQ6 resolver 2 factory-calibrated value and position sensor check value.

Dual Resolver Difference Error Checking

This indicator displays the mode used when error is detected and the differences between resolver error 1 and 2.

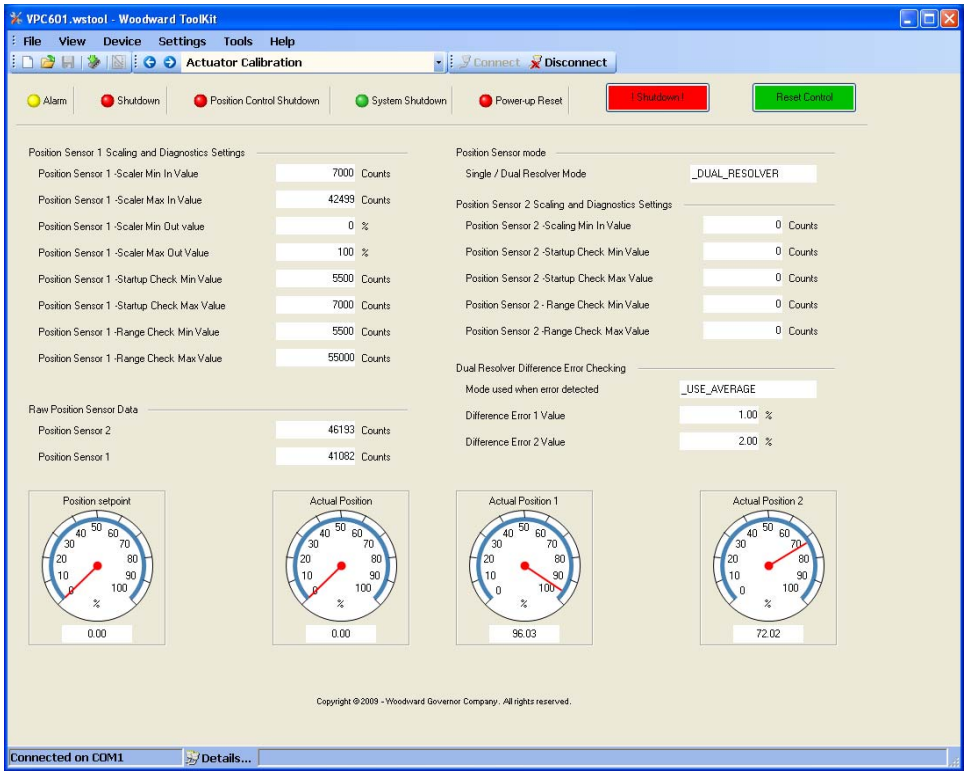


Figure 4-12. Dual Resolver Actuator

Output Configuration

The Output Configuration page displays the analog output configuration of the LQ6 (Figure 4-13). The output page provides two output modes: the Discrete Output state and the Analog Output Settings. These outputs can be configured for shutdown, internal shutdown or not shutdown. The analog output scaling is configurable through the VPC Edit Settings tool (See Settings Editor Tool Section)

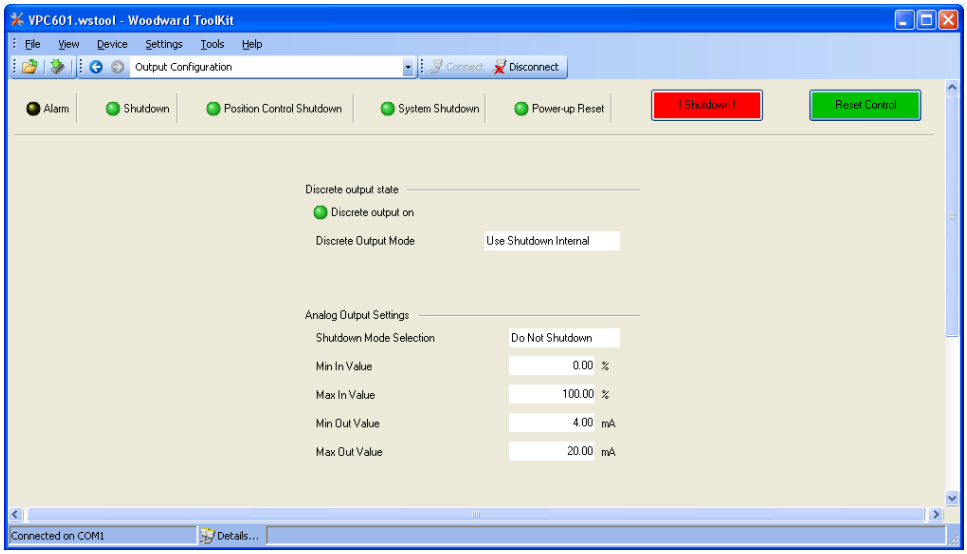


Figure 4-13. Output Configuration

Settings Editor Tool

The VPC Service Tool is designed within the Woodward Toolkit that allows the user to configure the LQ6 *.wset file to fit the preferred application. In the Toolkit settings utilities it provides many options for the user to create, edit and save *.wset file Figure 4-14.

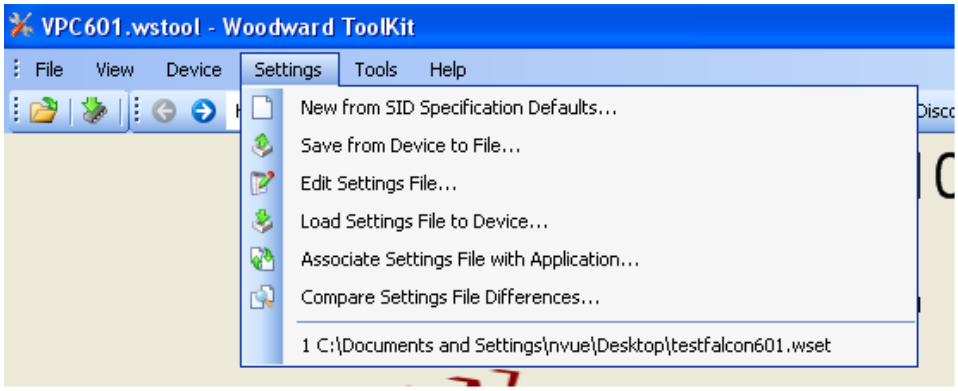


Figure 4-14. Woodward ToolKit Settings Menu

New from SID Specification Defaults (Creating new *.wset File)
This options allow user to create a *.wset file from the main application software SID file. To create the new *.WSET file, select the “New From SID Specification Defaults” and the tool will prompt to another window as shown on Figure 4-15. Select the appropriate VPC Service tool firmware version and click on “OK” to continue.

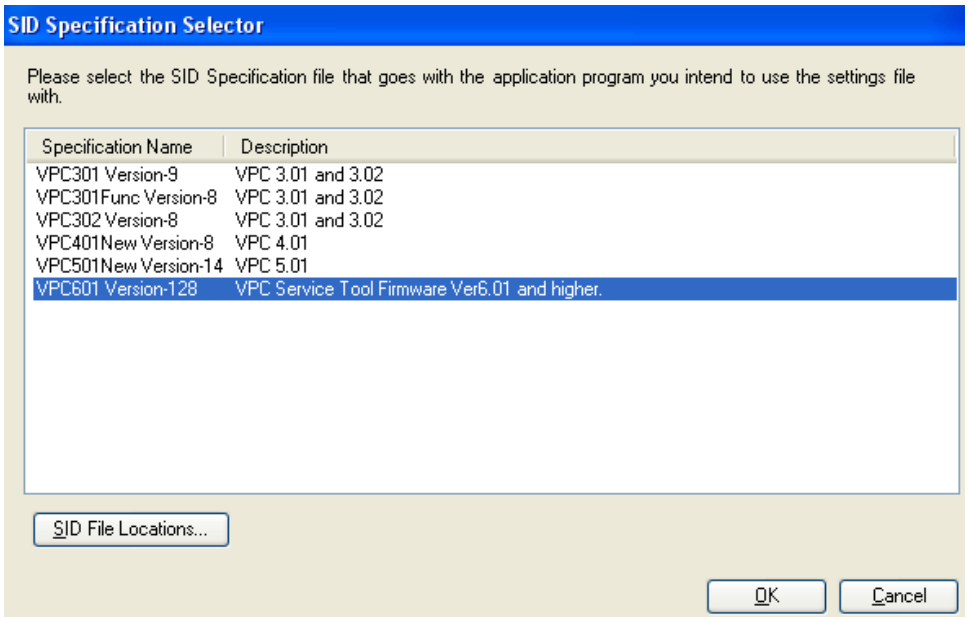


Figure 4-15. SID File Selector

Another window will prompt for a Valve Settings or User Settings Figure 4-16. Recommend using “User Settings” for field modification. Select OK to continue.

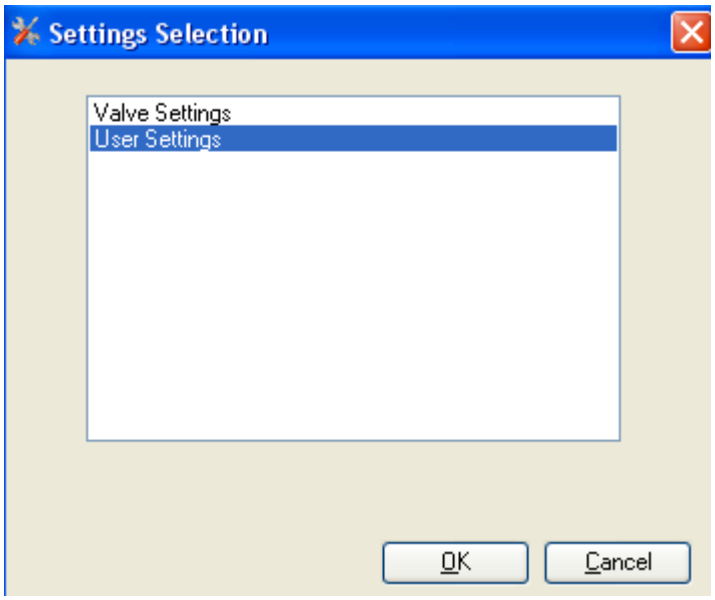


Figure 4-16. SID File Selector

The Settings Editor window will pop up for tool *.WSET file configuration. The available configurable options of the *.WSET are Input Type Selection, Input Modifications, Position Error/Resolvers, Output Selections and Alarm Shutdown Selections Figure 4-17.

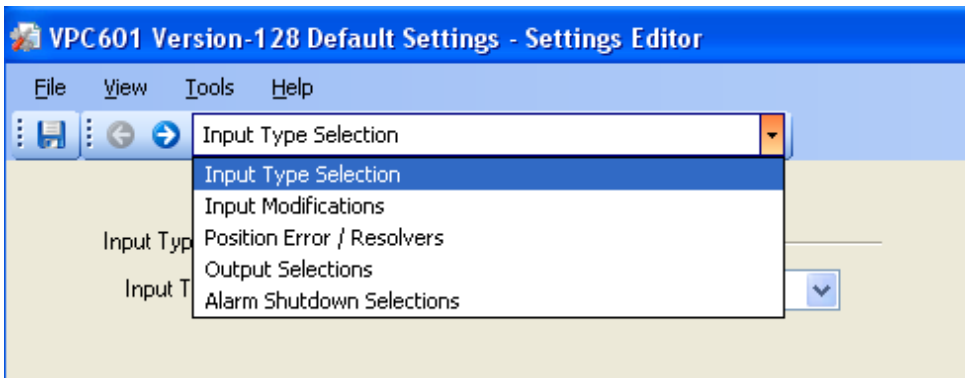


Figure 4-17. Available Configurable Options

Input Type Selection

On a typical LQ6 product, the valve is factory configured to Analog Position Control as default input type. This input type can be configured to meet the use's need. The Input Type Selection includes Analog Position Control, Manual Position Control, CANopen Position Control, DeviceNet Position Control, and Function Generator Position Control Figure 4-18.

⚠WARNING

The input scaling (mA input to % valve position) of the LQ6 is factory configured per customer specific oil flow range requirements. Modifying the input scaling or controlling the valve via Manual Position Control, CANopen Position Control, DeviceNet Position Control or Function Generator Position Control modes will increase or decrease the available flow range of the LQ6, which may result in adverse turbine operation including possible personal injury, loss of life, and/or property damage.

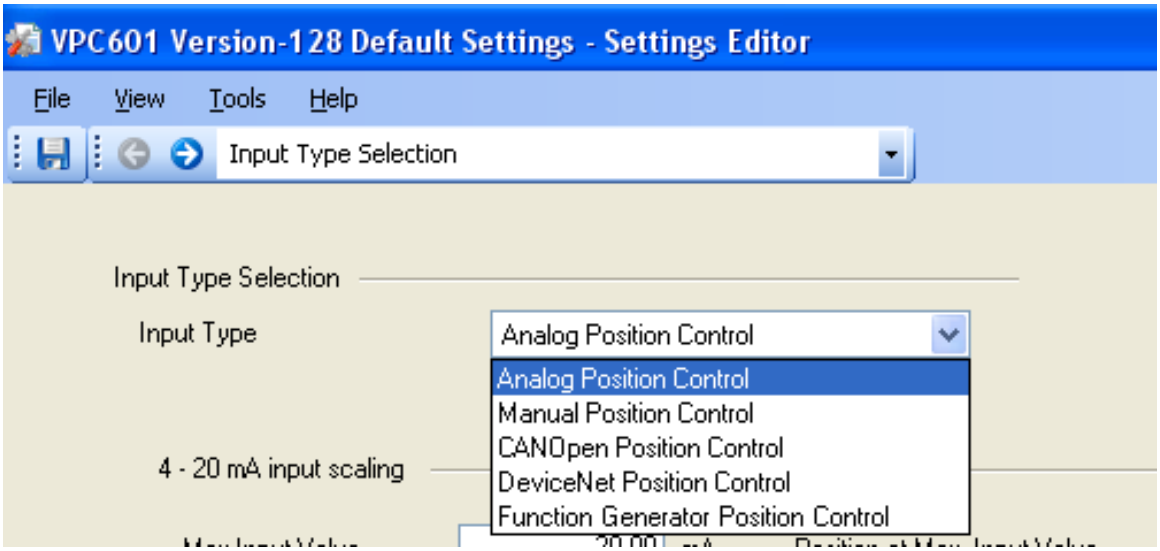


Figure 4-18. Input Type

Analog Position Control Setup

This section shows the Analog Input Position Control mode and the actual position value derived from the applied analog input signal. Signal ranges below or above the specified limits result in a fault Figure 4-19.

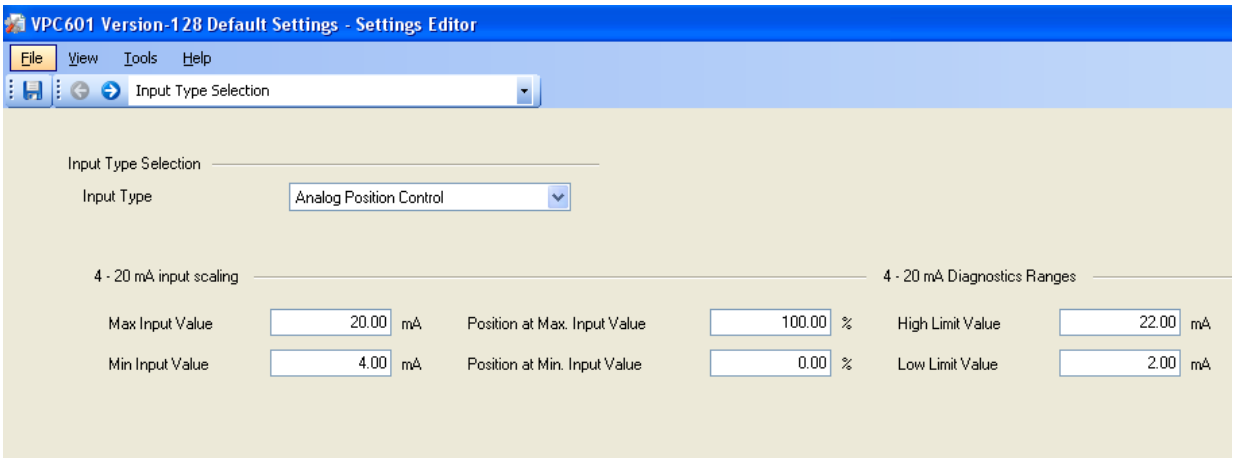


Figure 4-19. Analog Position Control

4–20 mA Analog Input Scaling

The 4–20 mA input-scaling group displays the calibration settings used to convert the analog input current level to the setpoint position in percent of position (%). The unit of the input current is milliamps (mA).

WARNING

The input scaling (mA input to % valve position) of the LQ6 is factory configured per customer specific oil flow range requirements. Modifying the input scaling will increase or decrease the available flow range of the LQ6, which may result in adverse turbine operation including possible personal injury, loss of life, and/or property damage.

4–20 mA Diagnostic Range

The diagnostic ranges for the 4–20 mA input configuration are displayed in this section. The unit of the limit settings is milliamps (mA). Low limit is the minimum input current input that the LQ6 considers as a valid input. Any the input signal drops below this limit, the software will trigger an error flag. A high limit is the maximum input current limitation on the high end.

Manual Position Control Setup

There is no parameter setting for this control page Figure 4-20. Control parameters are hardcode into the tool.

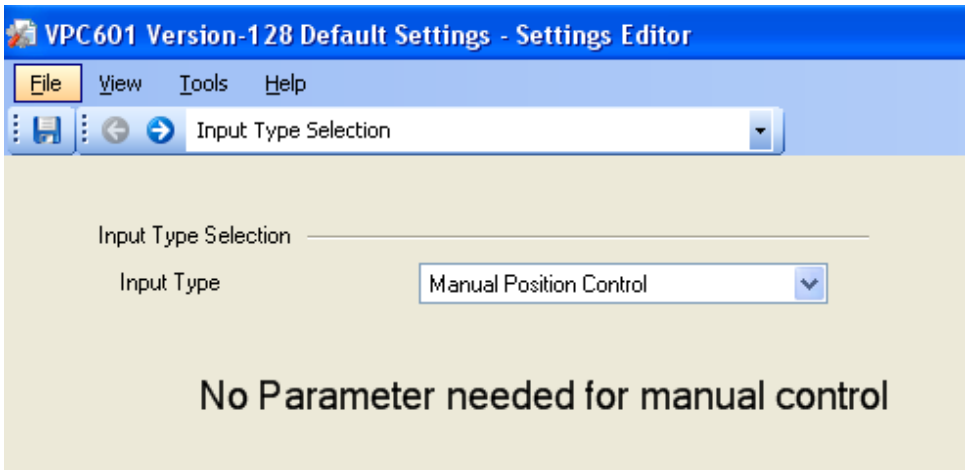


Figure 4-20. Manual Position Control

CANopen Position Control Setup

CANopen is a non-proprietary CAN-based command protocol (CAN = ‘Controller Area Network’). These protocol controllers are referred to as “NMT” controlled devices. CANopen, then, conforms to a traditional Master/Slave hierarchy.

The CANopen Input Configuration screen shows the configuration settings for the CANopen communication input of the LQ6. The CANopen protocol on the LQ6 is set to operate in single mode with an analog input as backup Figure 4-21).

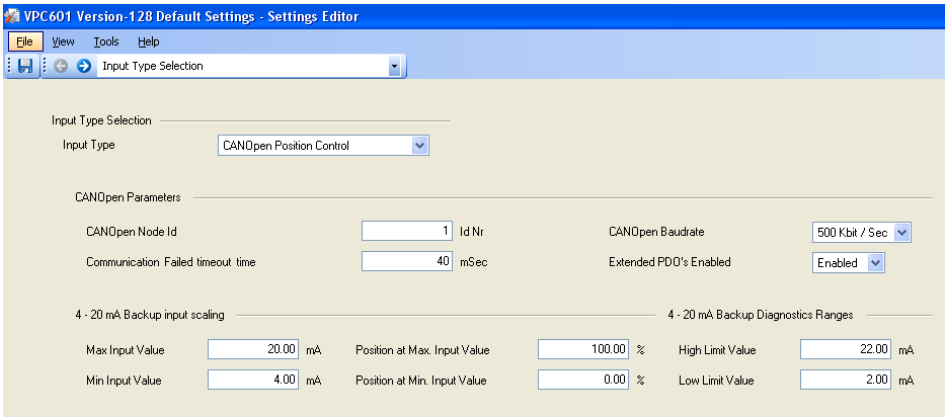


Figure 4-21. CANopen Position Control

CANopen Parameter Settings

This section shows the communication parameter settings of the CANopen communication input. The Baud Rate and port-specific Node IDs are shown as well as the Timeout parameter that determines the quality of the CAN communication link. The LQ6 normally uses a non-standard implementation of the CANopen protocol. The number of PDOs has been increased over the standard setting to allow more data transfer between NMT and the LQ6. This can be disabled in order to communicate with other customer's products that might require a true implementation of the CANopen protocol compliant to the standard.

The drop-down menu on the baud rate field allows changing the rate. The CANopen Communication section in this manual provides useful information regarding the CAN open Baud rate.

Analog Backup Parameter Settings on CANopen

This section shows the analog input scaling and diagnostic range. The Max and Min value of the input is converted to an equivalent valve position with a diagnostic fault ranges. The scaling and diagnostic value can be entered for the new setting configuration.

DeviceNet Position Control Setup

DeviceNet is a non-proprietary CAN-layer protocol. The DeviceNet Input Configuration screen shows the configuration settings for DeviceNet Digital Input of the LQ6. The DeviceNet protocol on the LQ6 is set to operate in single mode with an analog input as backup (Figure 4-22). In this setting, the analog input can be configured as backup.

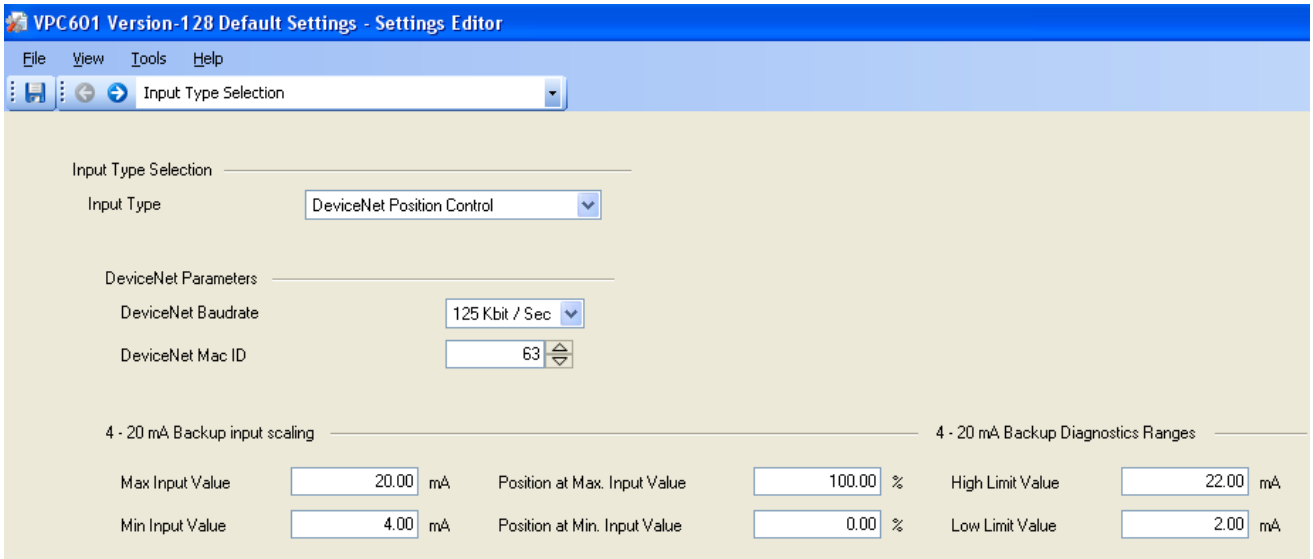


Figure 4-22. DeviceNet Position Control

DeviceNet Parameter Settings

This section shows the communication parameter settings of the DeviceNet Digital Input. The Baud Rate and port-specific Mac IDs are shown as well as the Timeout. The baud rate can be changed through the drop-down menu.

Analog Backup Parameter Settings of DeviceNet

This section shows the analog input scaling and diagnostic range. The Max and Min value of the input is converted to an equivalent valve position with a diagnostic fault ranges. The scaling and diagnostic value can be entered for the new setting configuration.

Function Generator Position Control Setup

The function generator is an internal Position Control function that use to simulate valve. The Function Generator Configuration screen shows the configuration settings in Figure 4-23.

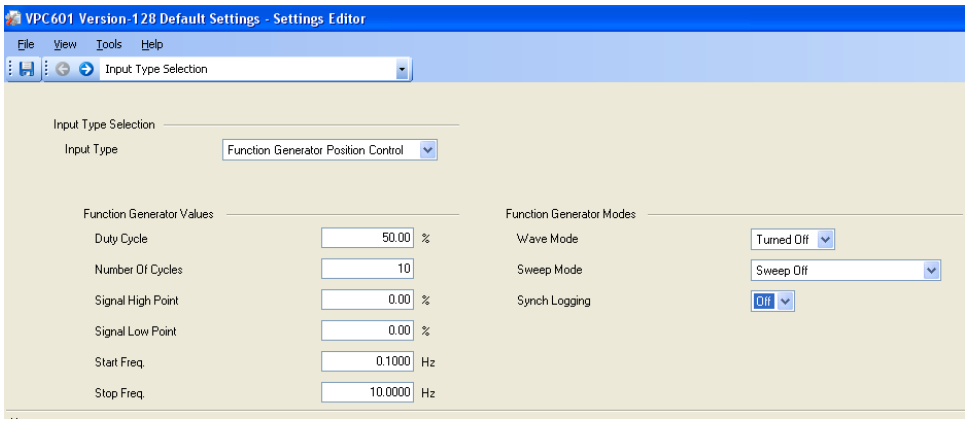


Figure 4-23. Function Generator Position Control

Function Generator Value

This section shows the duty cycle, number of cycle, Hi-Low point, Start-stop frequency, and sweep time of the generator value.

Function Generator Modes

The function generator mode defines the type, sweep of the frequency and it allows turning ON/Off of the Synchlogging.

Input Modification

This screen is used to configure or set to filter a noisy signal. The frequency range in the filter bandwidth can entered to the available space. This range is from 0.8 to 6 Hz with a filter of threshold 0.00% to 2.10% Figure 4-24.

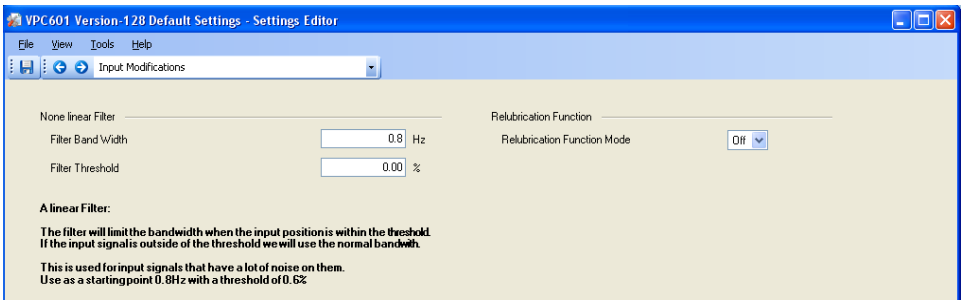


Figure 4-24. Input Modifications

Relubrication Function Mode

The Relubrication Function Mode is an advanced feature of the LQ6 that triggers a position pulse at periodic points in time to redistribute the lubrication in the actuator. This function is ON/OFF selectable by using the Settings Editor Tool Figure 4-25. An “OFF” option indicates that LQ6 will not use the function. A pop-up configurable parameter menu populates on the screen when the “ON” option is selected. Time Between Pulses, Impulse Half Duration, Position Step Size are the parameters that can be modified using the Settings Editor Tool.

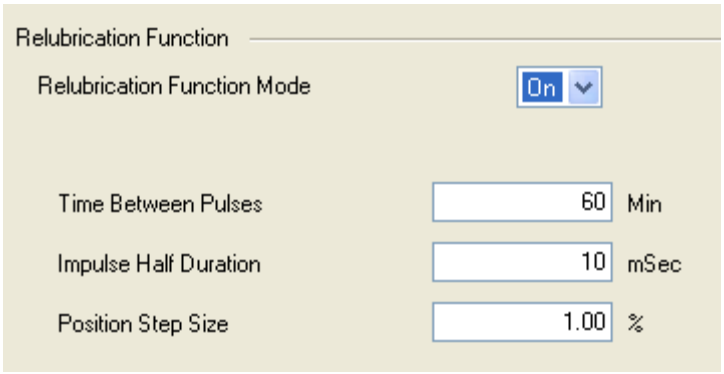


Figure 4-25. Relubrication Function

Position Error/Resolvers

The Position Error/Resolvers setting page is used to set the allowed position error of the feedback resolver. The position error function will compare the actual position and the set position Figure 4-26.

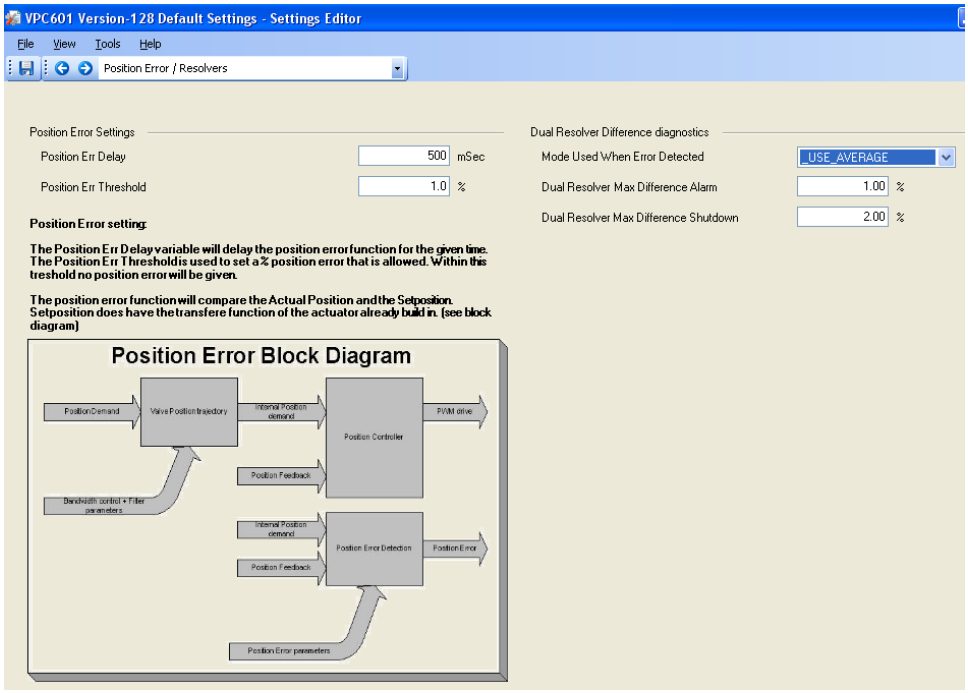


Figure 4-26. Position Error/Resolver Setting Screen

Position Error Settings
This section is the variable set to flag the resolver error mode. The Position Err Delay variable will delay the position error function for a given time. The PositionErr Threshold is used to set the allowed % of position error.

Dual Resolver Difference Diagnostics
This field is used for Dual resolver LQ6 and for Position Feedback Redundancy purpose. The mode of operation can be selected from the pull-down menu.

Available options are:
- _Use_Max_Resolver
- _Use_Min_Resolver
- _Use_Average

The redundancy issues a diagnostic event when the difference between the two resolvers exceeds a specified limit. The limit is specified in percent of position (%), i.e. for example if the difference between the two resolvers is bigger than 50% and the alarm limit is set to 50% an alarm will be issued. If the difference between the resolvers keeps increasing and exceeds the shutdown limit the redundancy manager will issue a shutdown command to LQ6.

Output Selections

This Output Selections setting page contains the Analog Output Scaling, 4–20 mA Output Shutdown Mode and Discrete Output Shutdown Mode Figure 4-27.

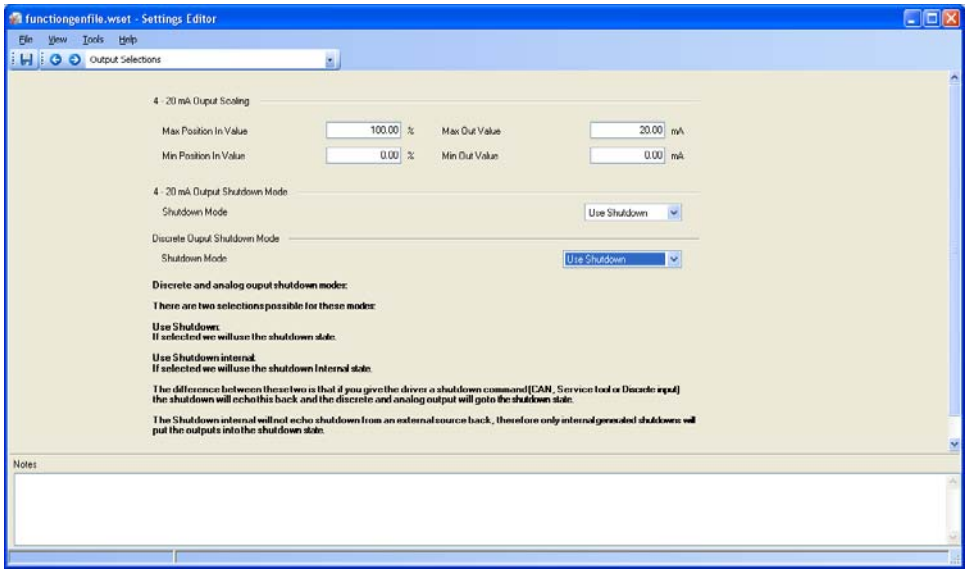


Figure 4-27. Output Selections Setting Screen

4–20 mA Output Scaling
The variable can be entered to the Analog scaling field via PC key board. The % of Max Position Value is corresponding to the Max out value (mA) of the Analog output.

4–20 mA Output Shutdown Mode
The 4–20 mA output can be configured to trigger a shutdown mode upon detection of a diagnostic event or command from other interface sources. Use the pull-down menu to set the appropriate selectable setting.
- Use Shutdown
- Do Not Shutdown

Discrete Output Shutdown Mode
The Discrete output can be configured to trigger a shutdown mode upon detection of a diagnostic event or shutdown command from other interface sources. Use the pull-down menu to set the appropriate selectable setting.

Alarm Shutdown Selections

The Alarm Shutdown Selections page can be configured to generate an Alarm or Alarm/Shutdown Figure 4-28.

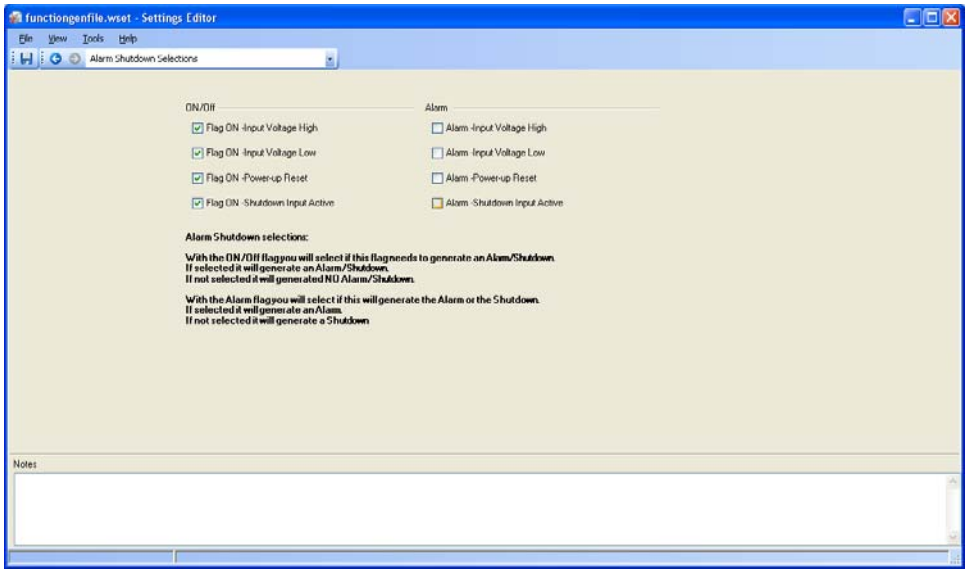


Figure 4-28. Alarm Shutdown Selection Screen

ON/OFF
With a " √ " mark on box of the ON/Off flag it will trigger an Alarm/Shutdown upon detection of a diagnostic event. If the box is not checked, it will generate NO Alarm/Shutdown upon detection of a diagnostic event.

Alarm
With a " √ " mark on box of the ON/Off flag it will trigger an Alarm upon detection of a diagnostic event. If the box is not checked, it will generate a Shutdown upon detection of a diagnostic event.

Upon completion of the configuration the *.wset file can be saved by using the file save from the main ToolKit menu Figure 4-29. The window will prompt for file save location.

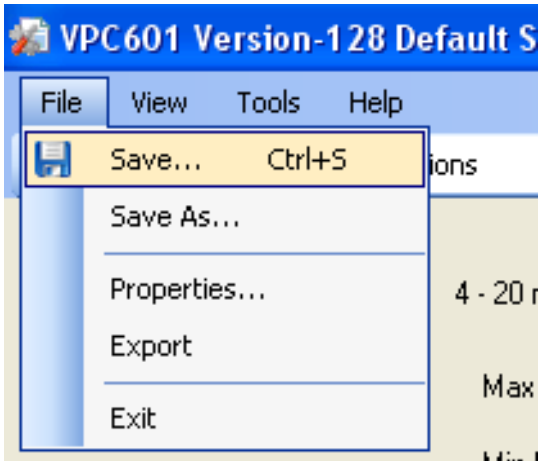


Figure 4-29. Save *.wset file

Save From Device to File

This option is to save the current setting from the LQ6 to a file on the PC. First, connect the VPC Service Tool to the LQ6 by pressing the Connect button or selecting 'Connect' from the main toolbar. LQ6 settings files can be created using the VPC Service Tool Settings Editor Wizard.

Procedure to create and save new LQ6 Settings File

1. Select "Settings" from the main VPC tool bar menu.
2. Select "Save from device to File" from the pull-down menu. A Settings File Selection window is prompted for a file name to be entered.
3. Press "Browse" to enter the new file name to be saved. Leave the type extension to be .wset.
4. Press "save" to continue. The save window is prompted for file location review.
5. If the file name and file location is the desired target then "next" button to continue.
6. A "Valve Settings/User Settings" option window will pop up. For a new save to file, it is recommended that "User Settings " is used. Select the "User Setting" and press "Next" to continue.
7. An option note window will pop up for entering any associated information with the file.
8. Select "Next" to continue. A "Device settings saved successfully" message will appear on the screen. Select "close" to get back to the VPC Service Tool menu.

Edit Settings File

This option allow for user to edit the pre-existing *.wset file. Connect the VPC Service Tool to LQ6 by pressing the connect button. Once the communication has been established, select the Settings from main menu bar and choose "Edit Settings File".

Procedure to Edit LQ6 Settings File

1. Select "Settings" from the main VPC tool bar menu.
2. Select "Edit Settings File " from the pull-down menu. A Settings File Selection window is prompted for a file name to be entered.
3. Press "Browse" to locate the file to be edited.
4. Press "Open" to continue. The tool will prompt the file in Setting Editor Window.
5. Modify the file to meet the need and save to location where can be loaded back to the LQ6.

⚠WARNING

The actions described may not be appropriate for all situations. The operator should verify that any actions taken while troubleshooting will not take equipment outside of specification, and will not damage property or result in dangerous situations. Consult with the local safety authority as necessary.

Load Settings File to Device

This option allows the user to down load the *.wset file to LQ6. Connect the VPC Service Tool to the LQ6 by pressing the connect button or selecting 'Connect' main tool bar. A new LQ6 settings file can be loaded into LQ6 driver by using the Settings Editor tool.

Procedure to load the *.wset file to LQ6

1. Select "Settings" on the main VPC Service Tool bar.
2. Select "Load Settings File to Device" from the pull-down menu. A "Browse" window will prompt to locate the file.
3. Locate and select the file to be loaded and click "Open " button to open the file.
4. A file name and location window is prompted for a review. After examination, if the file is the desired file, then press "Next" to continue the operation.
5. Upon completion of file loading, a "Device settings loaded successfully" message is displayed. Click "Close" to get back to the VPC Service Tool menu and the file is loaded.

Associate Settings File with Application

This tool allows the user to associate an *.wset file with specific main software application.

Compare Settings File Difference

This tool allows the user to two different *.wset files. The tool will return difference between the files in a report form.

The actions described may not be appropriate for all situations. The operator should verify that any actions taken while troubleshooting would not take equipment outside of specification, and will not damage property or result in dangerous situations. Consult with the local safety authority as necessary.

Chapter 5.
VPC Software Upgrade

This chapter addresses the options for upgrading the LQ6 Software to the latest released version using the VPC Service Tool.

Use the following procedure to upgrade the VPC to the latest version of software.

⚠WARNING

Woodward recommends performing the software upgrade when the LQ6 is operating OFFLINE. In the process of upgrading the software, the LQ6 will stop its operation and the valve will be in shutdown.

⚠WARNING

Check the system to ensure it is safe to upgrade before proceeding with the software upgrade.

⚠WARNING

Make sure to review the upgraded settings on the VPC Service Pages before resetting the LQ6.

1. Before you start, please note the part number, revision, and serial number of the product identification plate on the valve. You will need these numbers later during the software update process.

2. Make sure the VPC is shut down. Do this by cycling power, disconnecting control signals, using shutdown input, or using the control system to shut down the valve.

3. Connect to the driver using the Service Tool. Click on the “Connect” button (Figure 5-1). A window will appear on the bottom of the screen. This will give you the serial number and application ID. The application ID is the software part number.

4. Make sure the software part number is one of the following:
   5418-1580New (Ver. 3.01)
   5418-1580A (Ver. 3.02)
   5418-2238New (Ver. 3.01 Functional)
   5418-2691New (Ver. 4.01)
   5418-2727New (Ver. 5.01)

5. If the part number of the software is not one of these, do NOT update the software; contact Woodward. The service tool will not be able to update your software, and in the unlikely event it does try to update, the valve will be loaded with software where internal conversions may not complete accurately, making it impossible for the valve to operate any more.

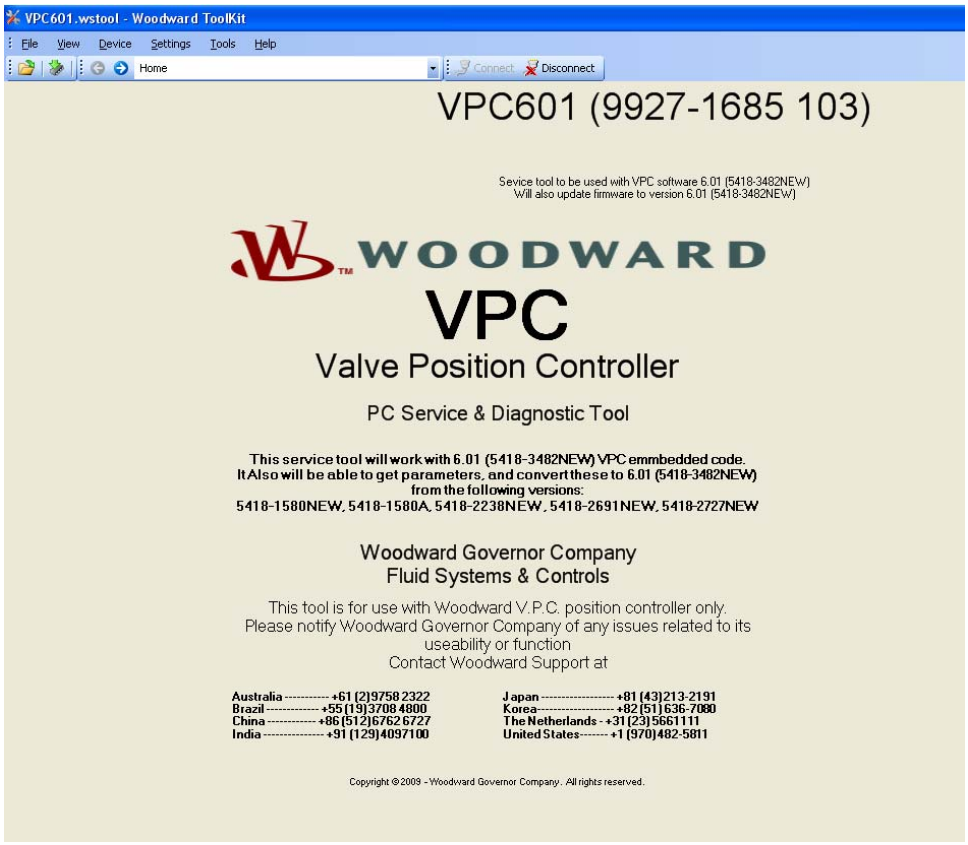


Figure 5-1. Serial Number & Application ID

6. Disconnect the Service Tool. Load the new application-using menu “File” “Load application”. A wizard screen will pop up (Figure 5-2). Follow the direction given. Press the Next button.

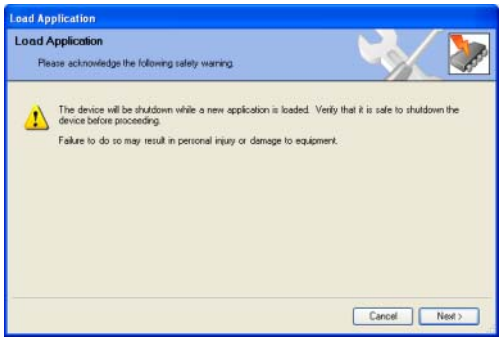


Figure 5-2. Wizard Screen

7. Select the file with the new application filename: VPC5418-3482 NEW.scp, and click the Next button (Figure 5-3).

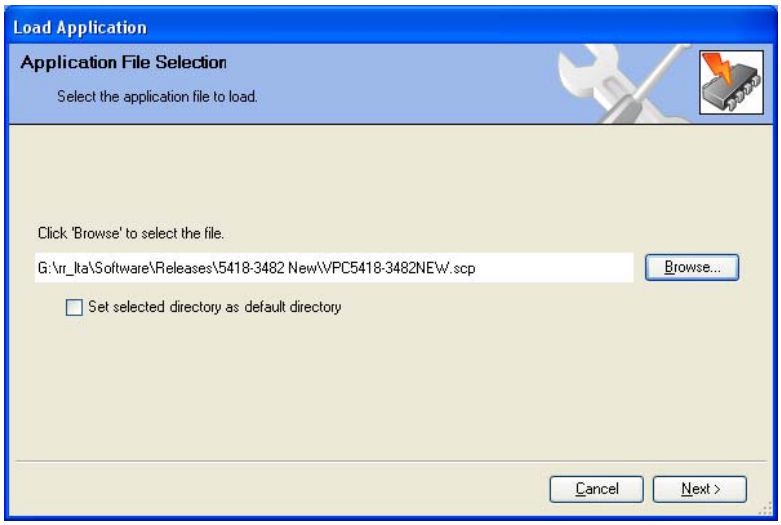


Figure 5-3. Application Filename

8. Make sure you select the “Restore the device’s current setting after loading the application” (Figure 5-4).

NOTICE **If you do not select this option, you will not be able to operate the valve after the software is loaded.**

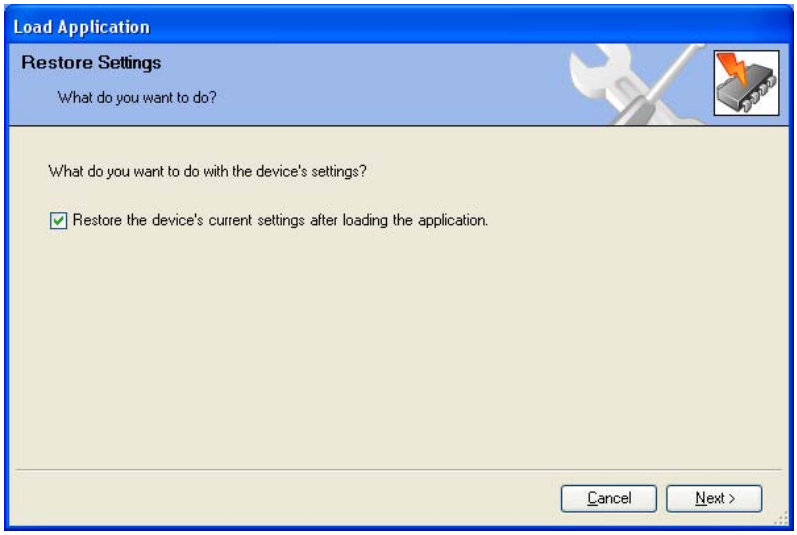


Figure 5-4. Load Application Screen

9. Connect using the communication port where the driver is connected, typically COM1. The baud rate must be “Baud_38400”. Click the Next button.

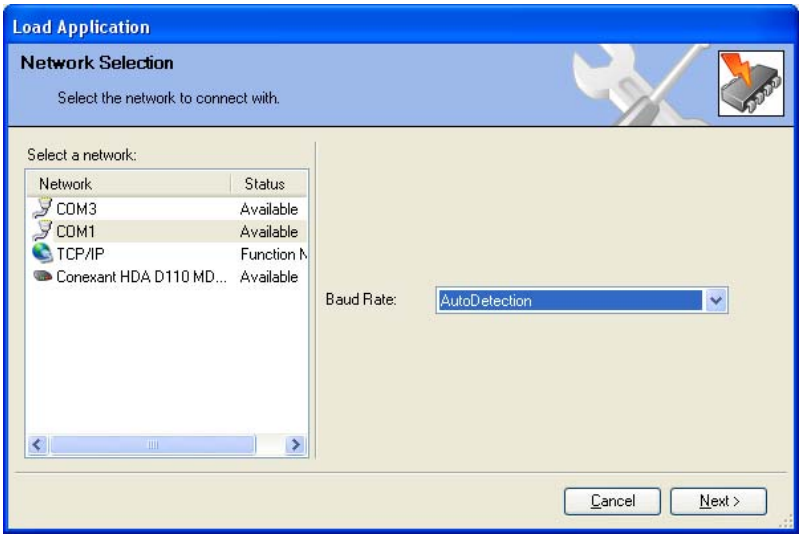


Figure 5-5 Communication Port

10. The following screen will pop up. This is OK, if you selected the correct SCP file “VPC5418-3482.scp“ you can click Next. Wait until the program is loaded. When the program is loaded, a screen will pop up asking for the serial and part numbers.

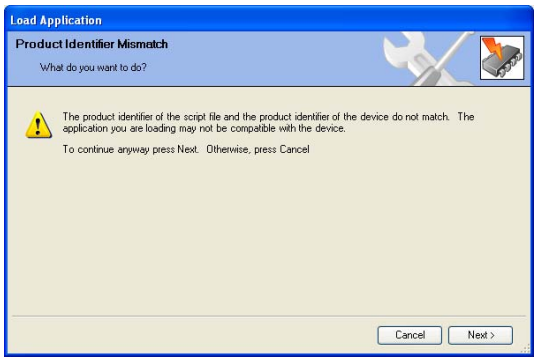


Figure 5-6. Product Identification Screen

11. If the display screen in Figure 5-7 pops up after the application is loaded, the conversion will not work properly. In this case, DO NOT select “NEXT” button to continue. Select the “CANCEL” button to terminate the upgrade process and contact Woodward immediately. Woodward may request the diagnostic log located under the Help Menu selection and the settings file saved before the application load.

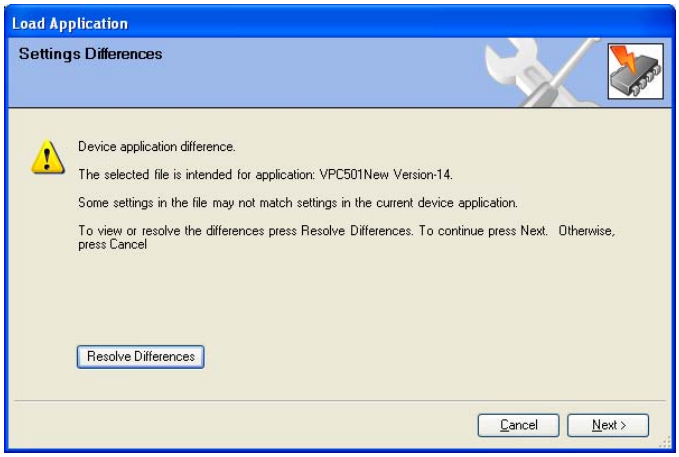


Figure 5-7. Setting Definitions Screen

12. Depending on the version of software you are converting from, the conversion library has populated the fields it can find. Please check the part number, serial numbers, and revision, and make sure that all these number are the same as the nameplate number on the valve.
13. ProductPartNumber is the part number without the dash, 1234-5678 will become 12345678.00000.
14. This works the same for the ProductSerialNumber if the serial number is 987654321, you will see the following number: 987654321.00000 (Figure 5-8).

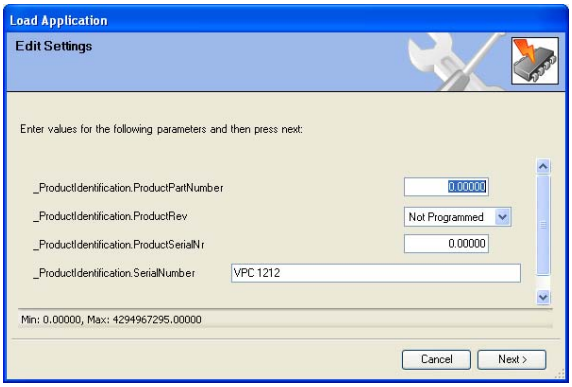


Figure 5-8. Serial Number Screen

15. Then repeat the serial number one more time and add the “VPC “ (and space) before the serial number. The screen must look something like this. You can now click the Next button, and the following screen will show (Figure 5-9).

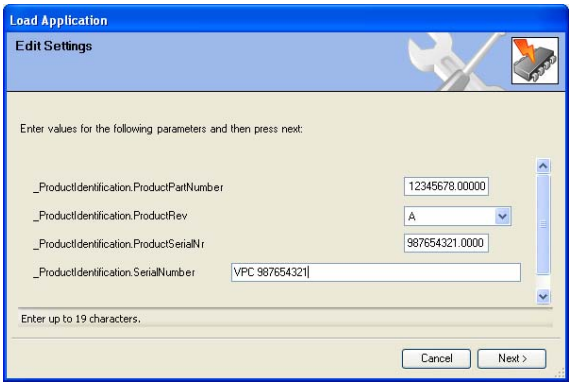


Figure 5-9. VPC Serial Number Screen

IMPORTANT **Some control systems will use the part number to determine if the correct valve is connected. See Figure 5-10.**

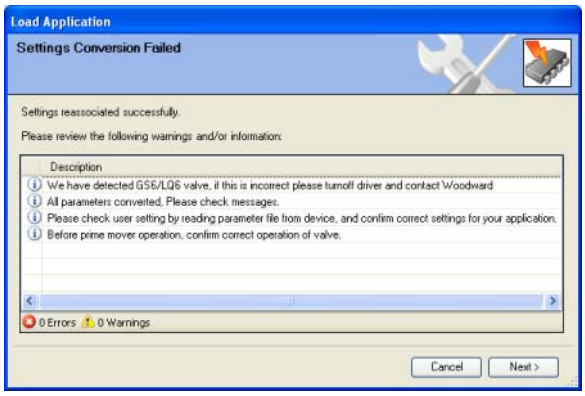


Figure 5-10. Settings Conversion Failed Screen

16. If this screen is shown, the conversion worked correctly. Please follow the instruction and click on the Next button (Figure 5-11).

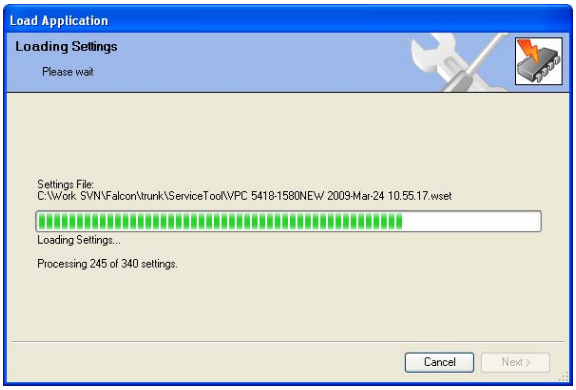


Figure 5-11. Loading Settings Screen

17. The converted setting will be loaded into the control. Wait until all settings are saved. The last screen will show the message “Application loaded successfully” (Figure 5-12). Click Close.

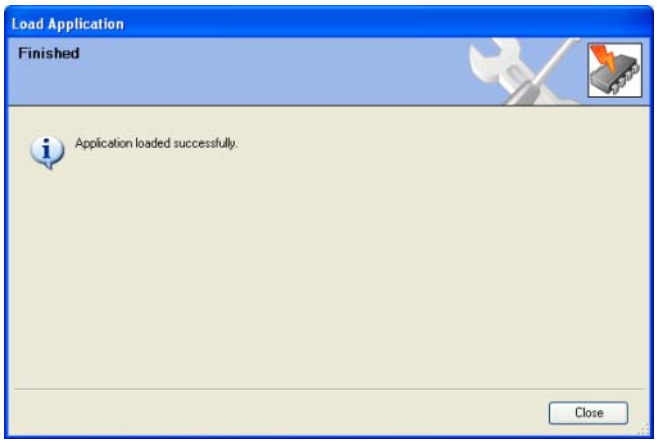


Figure 5-12. Final Screen

18. Cycle power on the valve, ensuring that the parameter error is cleared.

19. Connect to the valve by clicking the Connect button. You must see the new application ID and serial number you have supplied. Go to the “Manual Control” screen and you can see the part number, serial number, and revision.

Chapter 6.
Detailed Specifications

LQ6T Valve Specifications

Environmental Specifications

Ambient Temperature Range:	–28 to +93 °C (–18 to +200 °F)
Storage Temperature:	–40 to +68 °C (–40 to +154 °F)
Vibration:	US MIL-STD-810C, Procedure 1, Table 514.2-II, Figure 514.2-2, Curve AR (2g) from 5- 2000 HZ 10 min. per axis duration
Shock:	US MIL-STD-810C, Method 516.2, Procedure 1, 10 g, 11 ms duration, sawtooth wave form
Valve Weight:	31 kg (68 lb)
Air born Noise:	Ear protection must be worn while valve is operating
Ingress Protection:	IP66 per IEC 60529

Electrical Characteristics	
Input voltage range:	18–32 Vdc, 24 Vdc nominal
Normal input current range (steady-state, maximum):	0.2 to 2 A
Maximum continuous input current:	3 A
Maximum transient input current:	7 A

Steady State Performance Characteristics	
Range of Maximum Metered Flows*:	~177 L/min (~47 gal/min), MIL-PRF-23699 at 140 ± 10 °F
Range of Minimum Metered Flows*:	0.4 L/min (0.11 gal/min), MIL-PRF-23699 at 140 ± 10 °F

*See the Analog Input Scaling section below for additional information.

Oil Supply Pressure Range Normal Operation:	1724 to 3102 kPa (17.2 to 31.0 bar/250 to 450 psig)
Max Rated Pressure	96.5 bar (1400 psig)
Max Inlet (Proof Pressure):	145 bar (2100 psig)
Min Burst Pressure:	483 bar (7000 psig)
Max Internal Typical Oil Leakage:	0.2 L/min (0.05 gal/min), MIL-PRF-23699 at 140 ± 10 °F

Oil Pressure Differentials	
Nominal Regulated Metering Valve ΔP:	345 kPa (3.45 bar/50 psid)
ΔPressure Droop:	±6.9 kPa (±0.069 bar/±1.0 psid) w/ droop compensations in control
Total Differential Pressure:	P1 to PN 1034 to 9653 kPa (10.3 to 96.5 bar/150 to 1400 psid) For dynamic response, P1 to PN must be at least 1380 kPa (13.8 bar/200 psid).
Flow Metering Accuracy*:	Greater of ±0.15 L/min (0.04 gal/min) or ±5% of flow point (when compensated with the regulator map)

*See the Analog Input Scaling section below for additional information. Flow scaling/accuracy verification is performed at the 4 mA and 20 mA input points per customer specific scaling and flow accuracy requirements.

Analog Input Scaling

WARNING

The input scaling (mA input to % valve position) of the LQ6 is factory configured per customer specific oil flow range requirements. Modifying the input scaling will increase or decrease the available flow range of the LQ6, which may result in adverse turbine operation including possible personal injury, loss of life, and/or property damage.

The below listed flow rates are for MIL-PRF-23699 at 140 ± 10 °F.

Table 6-1. 4 to 20 mA Input Flow Scaling

Part Number	Flow Rate at 4 mA	Flow Rate at 20 mA
9908-029	0.40 L/min (0.11 gal/min) nominal with a range of 0.00 to 0.80 L/min (0.00 to 0.21 gal/min)	31.60 L/min (8.35 gal/min) nominal with a range of 29.9 to 33.43 L/min (7.90 to 8.83 gal/min)
9908-030	2.10 L/min (0.55 gal/min) nominal with a range of 1.05 to 4.10 L/min (0.28 to 1.08 gal/min)	60.0 L/min (15.85 gal/min) nominal with a range of 58 to 62 L/min (15.32 to 16.38 gal/min)
9908-031	6.50 L/min (1.72 gal/min) nominal with a range of 6.18 to 6.83 L/min (1.63 to 1.80 gal/min)	75.0 L/min (19.81 gal/min) nominal with a range of 71.25 to 78.75 L/min (18.82 to 20.80 gal/min)

See Figure 6-1, Figure 6-2, Table 6-2, and Table 6-3 to predict the nominal metered oil flow through the LQ6T as a function of Demand Input. Note: This curve represents 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.

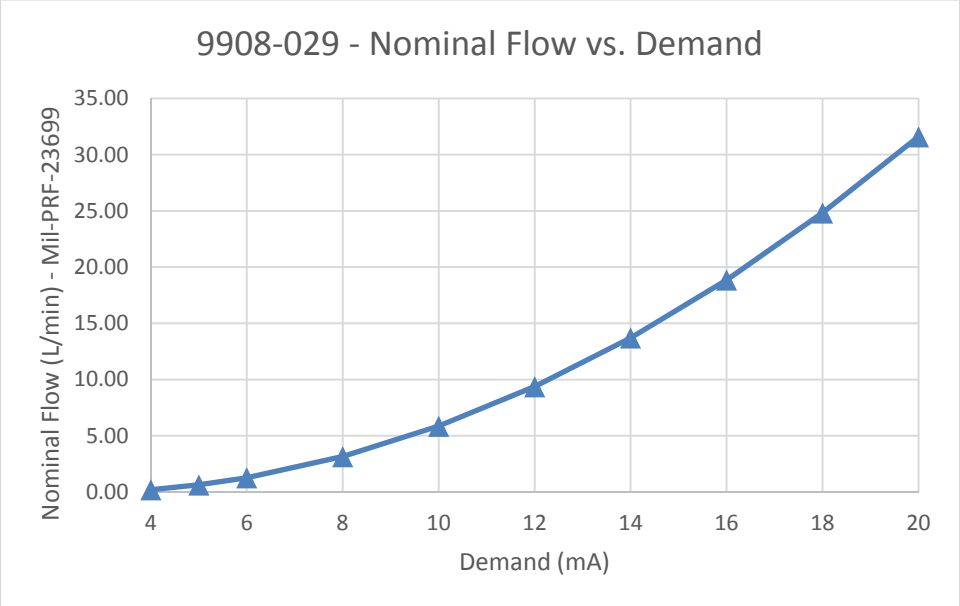


Figure 6-1. Oil Metering Flow vs. Demand for Part Number 9908-029

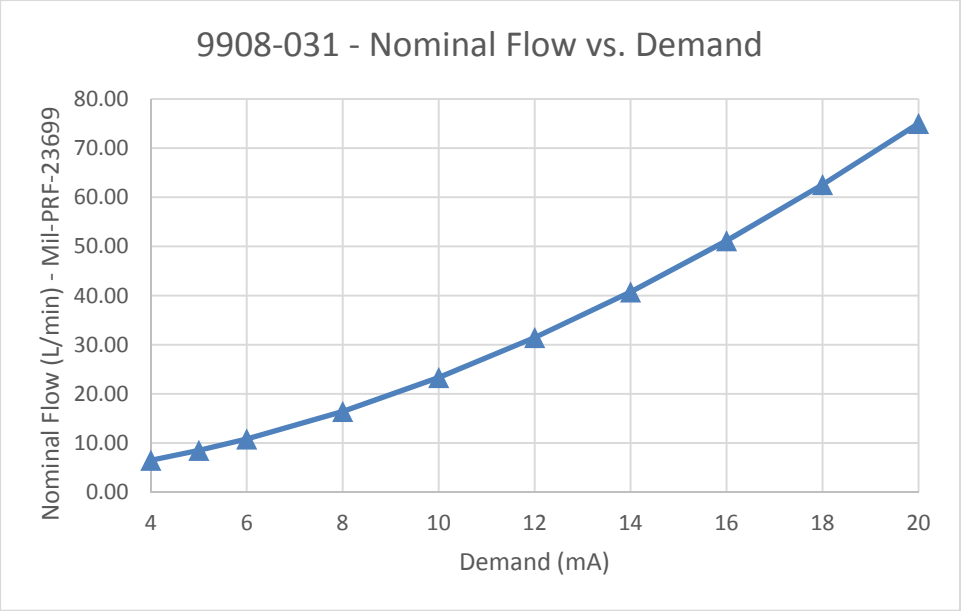


Figure 6-2. Oil Metering Flow vs. Demand for Part Number 9908-031

Table 6-2. Oil Metering Flow vs. Demand for Part Number 9908-029

Demand (mA)	Nominal Flow (L/min)
4	0.21
5	0.64
6	1.27
8	3.16
10	5.86
12	9.38
14	13.71
16	18.86
18	24.82
20	31.60

Table 6-3. Oil Metering Flow vs. Demand for Part Number 9908-031

Demand (mA)	Nominal Flow (L/min)
4	6.50
5	8.51
6	10.81
8	16.41
10	23.32
12	31.45
14	40.74
16	51.14
18	62.59
20	75.00

Metered Flow Dynamic Response:	60 rad/s bandwidth
Max Slew Time:	0.100 s (measured from 10 to 90% or 90 to 10%)

Operating Oil Types And Test Fluids	
Operating Oil Types:	The valve is compatible with most types of industrial and turbine hydraulic oils such as MIL-PRF-23699 that are compatible with fluorocarbon (FKM) type elastomers and conform to international standards for utility, marine, and aviation gas turbine service. Contact Woodward for other special oil applications.
Recommended Oil Inlet Temperature Range (for best performance):	+15 to 65 °C (59 to 149 °F)
Rated Fluid Inlet Temperature Range (per certifications):	-28 to 93 °C (-18 to 200 °F)
Typical Oil Specific Gravity:	0.945
Oil Viscosity Range:	13.5 to 70.0 Centistokes
Inlet Oil, Oil Filtration Level:	Nominal rating of 10 micron with Beta ratio of 200 recommended

Operating Life	
Mean Time Between	
Overhauls:	>50 000 operating hours
Cyclic Life:	>150 000 full stroke cycles
Total Design Life	
with Overhauls:	>150 000 operating hours
Storage Life:	>10 years, non-operating

Chapter 7.
Maintenance

LQ6T Valve Maintenance

The valve assembly is designed to avoid the accumulation of air and vapor in service (based on the use of oil with a specific gravity of 0.945), and does not require any action by the user to purge air or vapor from the assembly following installation or use on the engine system.

The valve is also designed such that during normal operation or storage, 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 engine system, it is possible to drain all oil, condensed water vapor, or other contaminants from the assembly without further disassembly.

There are no field-replaceable parts on the LQ6T.

Chapter 8.
Troubleshooting

WARNING

Before attempting any troubleshooting action, verify that the prime mover is shut down and that fuel pressure is not present to valves. Follow all installation notes and warnings when restarting the valve.

Find troubleshooting methods using the VPC Service Tool in the Help section of the service tool.

Possible Reason	Explanation	Action
Power up Reset (Shutdown)	After power up, the valve will go into shutdown until the valve is reset by the shutdown reset input.	Reset the valve after power up.
Shutdown Input Active (Shutdown)	If the shutdown input is active (open), the valve will be in shutdown.	Check wiring and/or control system.
Analog Low Error (Shutdown or switch to DeviceNet / CANopen)	If the analog input is not connected, an analog input low error (< 2 mA) will shut down the valve.	Check the wiring and the control system.
Analog High Error (Shutdown or switch to DeviceNet / CANopen)	If the analog input is mis-connected or driven with more than the normal current, an analog high error will shut down the valve (> 22 mA).	Check the wiring and the control system.
DigitalCom Error (Shutdown or switch to Analog)	This error is caused by one of the following conditions. • Incorrect or zero length message • Duplicate MAC ID • Bus Off • No messages received	Check the wiring and the control system.
Startup Position Error 1 (Run with other resolver)	During the start-up of the valve, the valve is closed to detect if resolver 1 is at the programmed position. If not, the valve will run using resolver 2 only.	Reset the valve, and the test will be performed again if the valve is Shutdown. Check if there is an obstruction in the valve. Check if the valve needs cleaning. Check pressure rating.
Startup Position Error 2 (Run with other resolver)	During the start-up of the valve, the valve is closed to detect if resolver 2 is at the programmed position. If not, the valve will run using Resolver 1 only. If both resolvers are not at the programmed position, the valve will shut down.	Reset the valve, and the test will be performed again if the valve is Shutdown. Check if there is an obstruction in the valve. Check if the valve needs cleaning. Check pressure rating.
Position Error (Shutdown Position)	During run time, the valve will check if the position feedback and the demanded position are the same. If not, a position error will be flagged, and the valve will be shut down.	Check if there is an obstruction in the valve. Check if the valve needs cleaning. Check pressure ratings.
Tracking Error	The difference between the DeviceNet / CANopen position demand and the Analog position demand is greater than the configured limit (1% default).	Check the control system analog output and the valve analog input.

Possible Reason	Explanation	Action
Position Sensor Error 1 (Run with other resolver)	The valve is continuously checking if the signals for resolver 1 are correct. If the resolver signals are missing or incorrect, a Position Sensor Error 1 is set and the valve will continue running on resolver 2.	Check wiring in the valve. Replace valve.
Position Sensor Error 2 (Run with other resolver)	The valve is continuously checking if the signals for resolver 2 are correct. If the resolver signals are missing or incorrect, a Position Sensor Error 2 is set and the valve will continue running on resolver 1. If both resolvers have errors, the valve will shut down.	Check wiring in the valve. Replace valve.
Resolver Difference Error 1	The difference between Resolver 1 and Resolver 2 is greater than the configured limit for Resolver Difference Error 1.	Check wiring in the valve. Replace valve.
Resolver Difference Error 2	The difference between Resolver 1 and Resolver 2 is greater than the configured limit for Resolver Difference Error 2.	Check wiring in the valve. Replace valve.
Internal Error	There are different internal errors that can be detected. • Supply voltage errors • AD converter errors • Software errors (Watchdog) • Factory calibration and parameter errors All of these errors will make the valve shut down in one of the three modes (Typical Shutdown System).	There is an internal error detected. Replace the valve.

⚠WARNING

The actions described may not be appropriate for all situations. The operator should verify that any actions taken while troubleshooting will not take equipment outside of specification, and will not damage property or result in dangerous situations. Consult with the local safety authority as necessary.

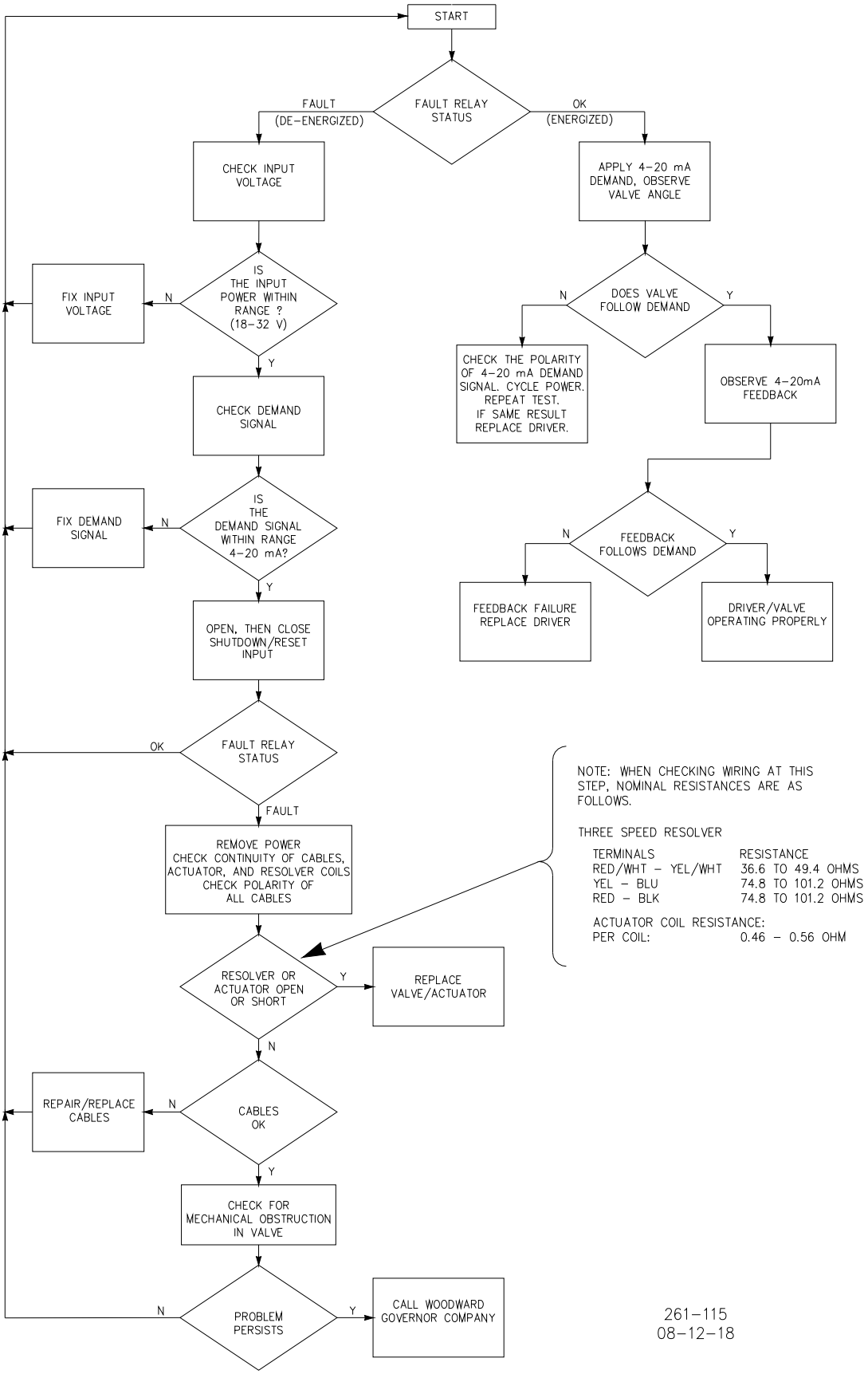


Figure 8-1. Troubleshooting Flowchart

Chapter 9.
Product Support and Service Options

Product Support 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 or 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 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.

A current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service 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**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at **www.woodward.com/directory**, which also contains the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (124) 4399500
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

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number _____

Prime Mover Information

Manufacturer _____

Turbine Model Number _____

Type of Fuel (gas, steam, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.) _____

Control/Governor Information

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 _____

Symptoms

Description _____

_____

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

Revision A—

- Added part number 9908-031 to Table 6-1
- Added Figure 6-2 with the flow schedule for 9908-031
- Added Table 6-3 with the flow schedule for 9908-031

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00160-04-EU-02-02
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	LQ6T and LQ6BP Valves
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (EMC)
Markings in addition to CE marking:	Category 2 Group II G, Ex d IIB T3 Category 3 Group II G, Ex nA IIC T3 IP66
Applicable Standards:	EN 60079-0:2012/A11:2013: Electrical apparatus for explosive gas atmospheres – Part 0: General Requirements EN 60079-1:2007: Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection 'd' EN 60079-15:2010: Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection 'n' EN 61000-6-4:2007/A1:2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN 61000-6-2:2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments
Third Party Certification:	ATEX Zone 1: TUV 13ATEX7404X, ATEX Zone 2: TUV 13ATEX7409X TUV Rheinland Industrie Service GmbH (0035) Am Grauen Stein, D51105 Cologne (Req. only for Zone 1)
Conformity Assessment:	ATEX Annex IV - Production Quality Assessment, 01 220 113542 TUV Rheinland Industrie Service GmbH (0035) Am Grauen Stein, D51105 Cologne

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

Signature

Goldino Alves
Full Name

Director of Engineering
Position

Woodward, Fort Collins, CO, USA
Place

2/20/17
Date

5-09-1183 Rev 28

DECLARATION OF INCORPORATION
Of Partly Completed Machinery
2006/42/EC

File name:	00160-04-EU-02-04
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Names:	LQ6T and LQ6BP Valves
This product complies, where applicable, with the following Essential Requirements of Annex I:	1.1, 1.2, 1.3, 1.5, 1.6, 1.7
Applicable Standards:	EN ISO 12100:2010

The relevant technical documentation is compiled in accordance with part B of Annex VII. Woodward shall transmit relevant information if required by a reasoned request by the national authorities. The method of transmittal shall be agreed upon by the applicable parties.

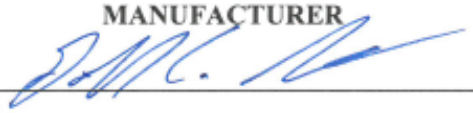
The person authorized to compile the technical documentation:

Name: Dominik Kania, Managing Director
Address: Woodward Poland Sp. z o.o., ul. Skarbowa 32, 32-005 Niepolomice, Poland

This product must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of this Directive, where appropriate.

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 Directive 2006/42/EC as partly completed machinery:

MANUFACTURER



Signature

Goldino Alves
Full Name

Director of Engineering
Position

Woodward Inc., Fort Collins, CO, USA
Place

2/20/17
Date

Document: 5-09-1182 (rev. 16) **PAGE** 1 of 1

Released

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 35066.

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1041 Woodward Way, Fort Collins CO 80524, USA
Phone +1 (970) 482-5811

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.