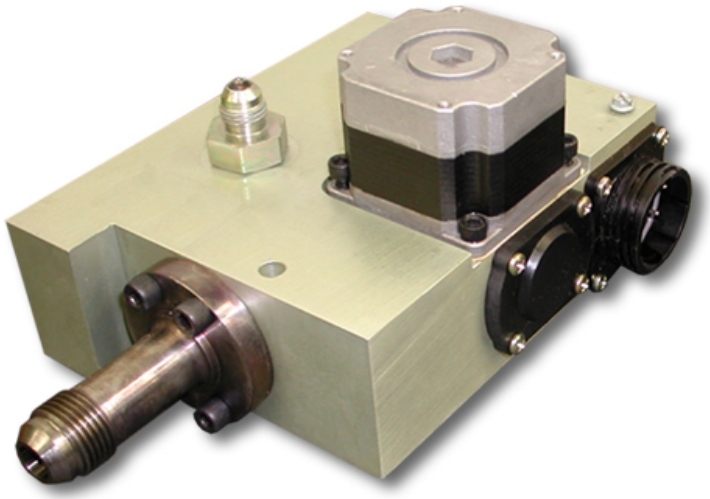
WOODWARD

Product Manual 26350
(Revision B)
Original Instructions



Swift™ Safety Shutoff and Gas 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 *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:

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Proper Use

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

Translated Publications

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

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

Contents

Illustrations and Tables

Warnings and Notices

Important Definitions

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

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

⚠WARNING

Start-up

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

⚠WARNING

Automotive Applications

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

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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

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

Follow these precautions when working with or near the control.

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

Regulatory Compliance

European Compliance for CE Mark:

ATEX – Potentially Explosive Atmospheres Directive: Declared to 94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres.
Zone 2, Category 3, Group II G, EEx nA II T3 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:

EMC Directive: Not applicable to this product. Electromagnetically passive devices are excluded from the scope of the 2004/108/EC Directive.

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

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

North American Compliance:

UL: UL Listed for Class I, Division 2, Groups A, B, C, & D, T3C at 70 °C Ambient. For use in Canada and the United States.
UL File E300556

This product is certified as a component for use in other equipment. The final combination, including grounding, is subject to acceptance by the authority having jurisdiction or local inspection. This equipment is suitable for use in Zone 2, Category 3 or Class I, Division 2, Groups A, B, C, D or non-hazardous locations only.

Special Conditions for Safe Use:
Valves are intended only for connection to an NEC/CEC Class 2 or limited voltage/limited current power source.

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

Do not plug the drain connection; it must be routed to a suitable location.

Field Wiring must be suitable for at least 90 °C and a minimum of 10 °C above ambient.

Connect ground terminal to earth ground.

The Swift™ valve must be mounted inside an enclosure that will reduce the risk of mechanical danger; the valve meets low risk impact requirements per EN60079-0.

The control system supplied by the customer must meet Machinery Directive safety shutoff valve requirements if the product is used as a safety valve in EU installations.

⚠WARNING

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

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

⚠AVERTISSEMENT

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

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

Chapter 1.
General Information

Introduction

This manual describes the Woodward Swift™ Safety Shutoff and Gas Metering Valves (Swift SSV GMV) for micro/mini-turbines, small industrial turbines, and high-pressure fuel cell applications. This manual provides installation instructions, product description, troubleshooting, and specifications. This manual does not contain instructions for the operation of the complete prime mover system. For prime mover or plant operating instructions, contact the plant-equipment manufacturer.

How to Use This Manual

To install a Swift valve into a new or existing system:

- Unbox and inspect the hardware.
- Mount the hardware following the procedures and recommendations in Chapter 2.
- Wire the hardware—see Chapter 3.
- Stroke valve and verify functionality.
- Troubleshooting guidelines are provided in Chapter 5.
- Specifications are provided in Chapter 6.

Applications

The Woodward Swift SSV GMV valves operate on micro/mini-turbines, and small industrial turbines ranging from 30 to 2000 kW, as well as high-pressure fuel cells (> 97 kPa/14 psig) up to 3000 kW. The Swift product line has several valve sizes with maximum fuel flows of 10 to 123 g/s (81 to 976 lb/hr) of standard natural gas, depending on the system pressures (see Table 1-1). The valves are designed for installation in the prime mover enclosure and can accommodate gas temperatures up to 121 °C (250 °F).

Swift Safety Shutoff and Metering Valve Size Identification

Valve Size(s): The valve size is designated by the first number in the product description (e.g., “Swift 20” is a size 20 valve).
Divide the valve size number by 1000 to get the actual size (nominal area, ACd, in square inches) of the valve:

- **7** represents 0.007 in² (4.52 mm²)
- **12** represents 0.012 in² (7.74 mm²)
- **20** represents 0.020 in² (12.90 mm²)
- **36** represents 0.036 in² (23.23 mm²)
- **60** represents 0.060 in² (38.71 mm²)

Swift Valve

The Swift valve is a sonic flow-metering valve. The valve has a converging/ diverging nozzle and a moving needle to adjust the valve flow area. An open loop step motor through a rack and pinion drive positions the needle. A return spring is included to remove the effects of gear backlash and to minimize closed-valve leakage. A mechanical stop allows the valve to re-zero the valve position during start-up. After the re-zero, the driver counts the step motor steps and monitors the step motor position.

The flow rate table below provides a breakdown of the flow rates at various pressure conditions.

Inlet Pressure / Discharge Pressure (@ gas temp = 250 °F/121 °C)

	25/20 psia	**85/68 psia**	**200/160 psia**	**300/240 psia**	**170/136 kPa**	**600/480 kPa**	**1400/1120 kPa**	**2000/1600 kPa**
Swift-7	9 lb/hr	33 lb/hr	77 lb/hr	116 lb/hr	1.2 g/s	4.2 g/s	10 g/s	14 g/s
Swift-12	15 lb/hr	50 lb/hr	116 lb/hr	175 lb/hr	1.8 g/s	6.3 g/s	14.8 g/s	21.1 g/s
Swift-20	25 lb/hr	90 lb/hr	210 lb/hr	315 lb/hr	3.5 g/s	11.5 g/s	26.9 g/s	38.4 g/s
Swift-36	50 lb/hr	160 lb/hr	380 lb/hr	575 lb/hr	6.2 g/s	21.0 g/s	48.9 g/s	69.8 g/s
Swift 60	81 lb/hr	277 lb/hr	651 lb/hr	977 lb/hr	10.2 g/s	34.9 g/s	82.0 g/s	123.1 g/s

Table 1-1. Flow Rates

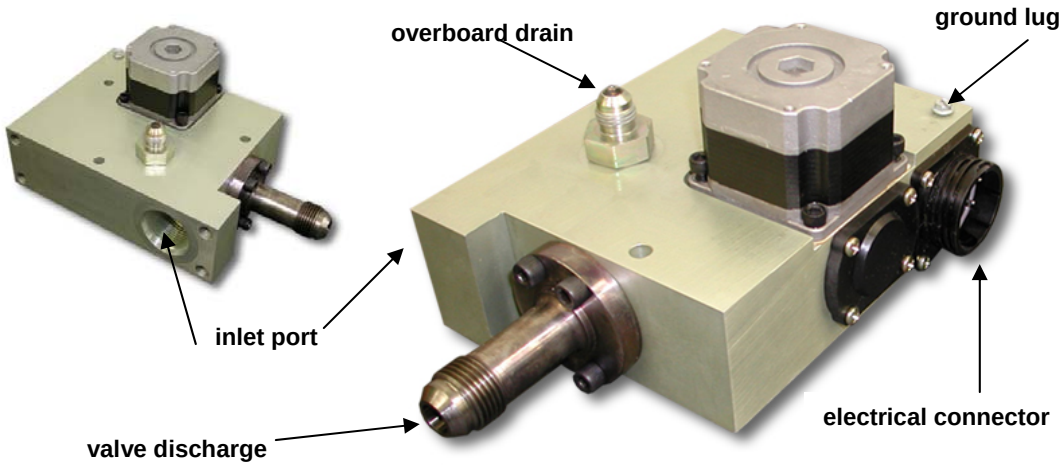


Figure 1-1. Swift Single Safety Shutoff and Gas Metering Valve

Mechanical Interface

Mounting

The Swift valve is base-mounted using either ¼" or M5 bolts through three 0.280" (7.11 mm) mounting holes (see Figure 2-1).

See Chapter 2 (Installation) for details on mounting and installation.

Electrical Connections

Swift Valve
The interface for the Swift is a circular 24-pin sealed connector (Figure 3-2). All I/O points on this connector are wired to the driver. Refer to Chapter 3 for details on Swift valve wiring.

Swift Valve Input/Output (I/O)

The following Input/Output (I/O) is available in the Swift Valve:

- driver stepper motor inputs (2), see Figure 3-1

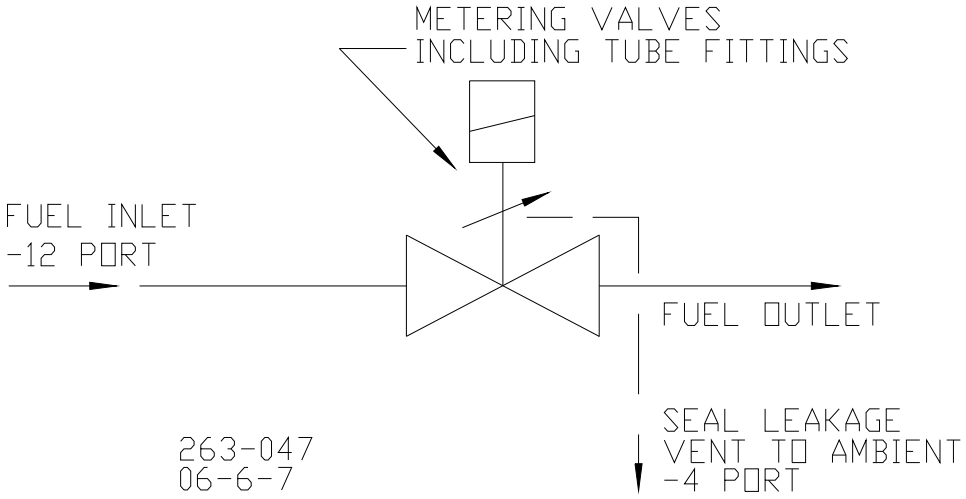


Figure 1-2. Swift Valve Schematic

Chapter 2.
Hardware Installation

Introduction

This chapter provides instructions on how to mount and connect the Swift™ SSV GMV into a system. Hardware dimensions are provided for mounting the Swift in a specific application.

⚠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.

⚠CAUTION

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the Swift Gas Metering System.

Unpacking

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

Mounting Location

The Swift SSV GMV is designed to operate within an ambient temperature range of –29 to +70 °C (–20 to +158 °F). The Swift SSV GMV valve is designed for installation on the prime mover.

The Swift valves have been tested to a water and dust ingress protection level of IP54 per EN 60529.

Mounting

Application Guidelines

The full functionality and reliability of the valve can be assured by following the environmental guidelines for applying the Swift valves.

Mounting Hardware

The Swift valve is base mounted using either ¼” or M5 bolts through three 0.281” mounting holes (see Figure 2-1). The valve weighs approximately 4 kg (8 lb).

The bracket and attaching hardware must be designed to hold the weight and to withstand the vibration associated with prime mover mounting. Additionally, the bracket must be designed to provide a heat sink (heat transfer) from the valve to the prime mover block as described in the following section.

Fluid Connections

The overboard drain port must be connected to vent the small leakage flow to a safe location. Use only aluminum or steel pipe or tubing. Back pressure on the vent port must not exceed 172 kPa (25 psig) at any time. If leakage from the vent port is excessive, contact Woodward for assistance.

The outlet fitting should have a straight section of pipe no shorter than 10 cm (4”). Placing a bend in the pipe within 10 cm (4”) of the valve outlet port may slightly reduce the critical pressure ratio of the valve.

Orientation

The valve should be mounted with the motor housings oriented upward or horizontal (see Figure 2-1 outline drawings).

⚠WARNING

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

⚠CAUTION

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.

Calibration

The valve requires no field calibration. Valve-to-valve flow differences are calibrated out at the factory by means of the offset number. This offset number ensures correct phasing of the stepper motor to the driver when the valve is on the closed stop. If the offset number is not used there could be a positioning error of up to 1.6% of stroke (one full electrical phase). This position error translates into a small flow error (as a % of full scale) at small strokes but can produce up to a 3% error at large strokes. It is recommended that the customer use the offset valve to avoid this additional error.

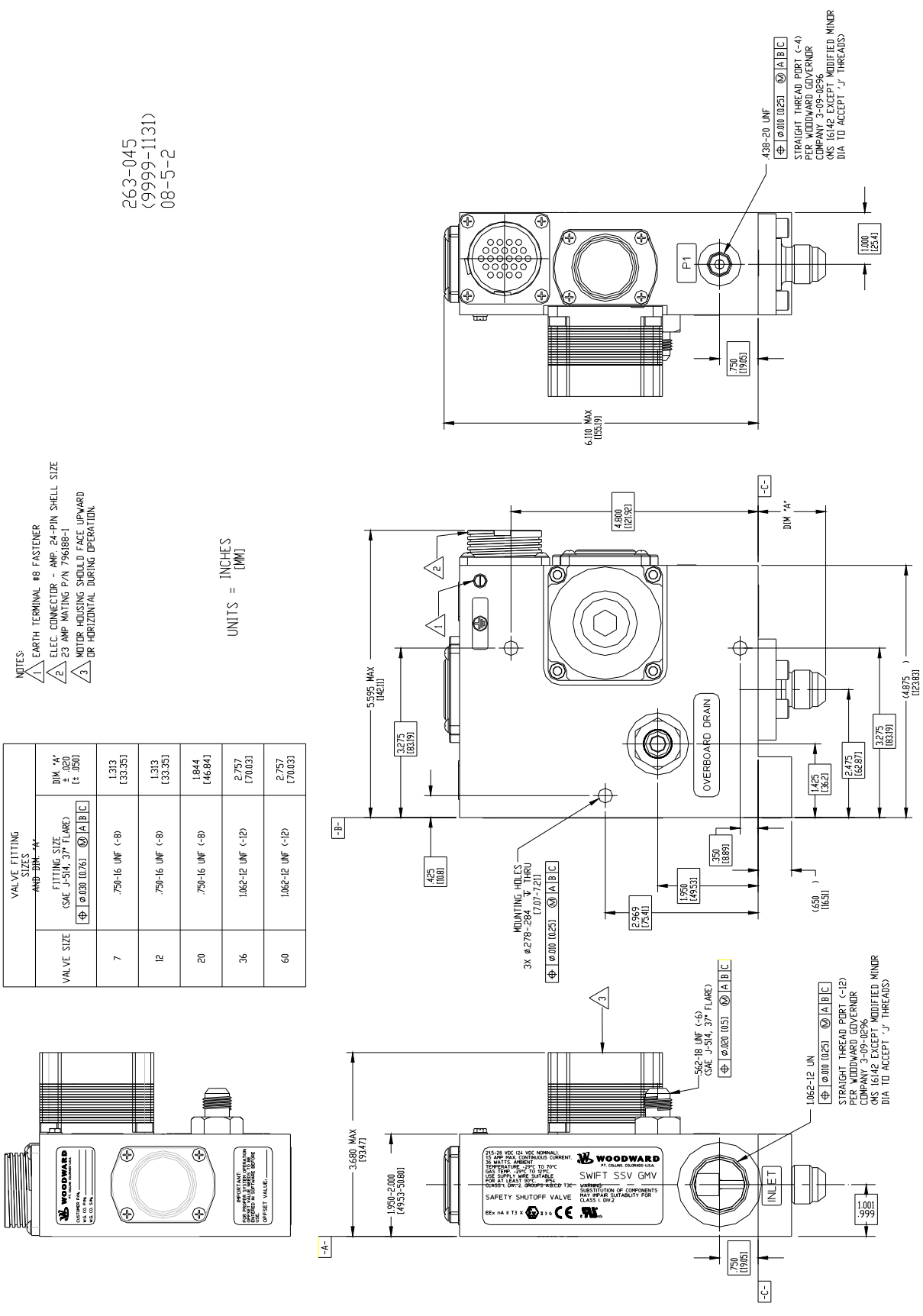


Figure 2-1. Swift Outline Drawing

Chapter 3.
Wiring

Introduction

This chapter provides instructions on how to connect the Swift™ valve(s) into a system. Electrical ratings, wiring requirements, and options are provided to allow installation of the valve into a new or existing application.

⚠WARNING

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

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

⚠AVERTISSEMENT

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

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

⚠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 (Figure 3-1).

Electrical Connections

Refer to the wiring assembly overviews, control wiring diagrams, and the representative I/O interfaces schematic in this chapter.

All connectors used on wire harnesses for connection to the valves must have backshells sealed against water ingress with a minimum rating of IP54 per EN 60529.

Grounding and Ground Connections

Each valve is equipped with a ground lug or grounding screw. Wires for the fixed mounted power terminals should be stripped 5–6 mm (0.2 inch). The wires must be terminated with insulated spade or ring lugs.

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. See Woodward application note 50532, *EMI Control for Electronic Governing Systems*, for more information. 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.

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

Failure to provide shielding can produce future conditions which are difficult to diagnose. Proper shielding at the time of installation is required to assure satisfactory operation of the valve.

Swift Valve Inputs/Outputs

The interface for the Swift valve is a circular 24-pin sealed connector. All I/O points on this connector are wired to the driver (see Figure 3-1 for details). Wire size of 0.8 to 1.0 mm² (16 or 18 AWG) is recommended.

The following wiring assembly is provided as a detailed overview. All wiring accessories (connectors, pins, ring lugs, etc) are provided by the customer and shown here for ease of assembly.

IMPORTANT **All wiring accessories and connections to the valve are provided by the customer.**

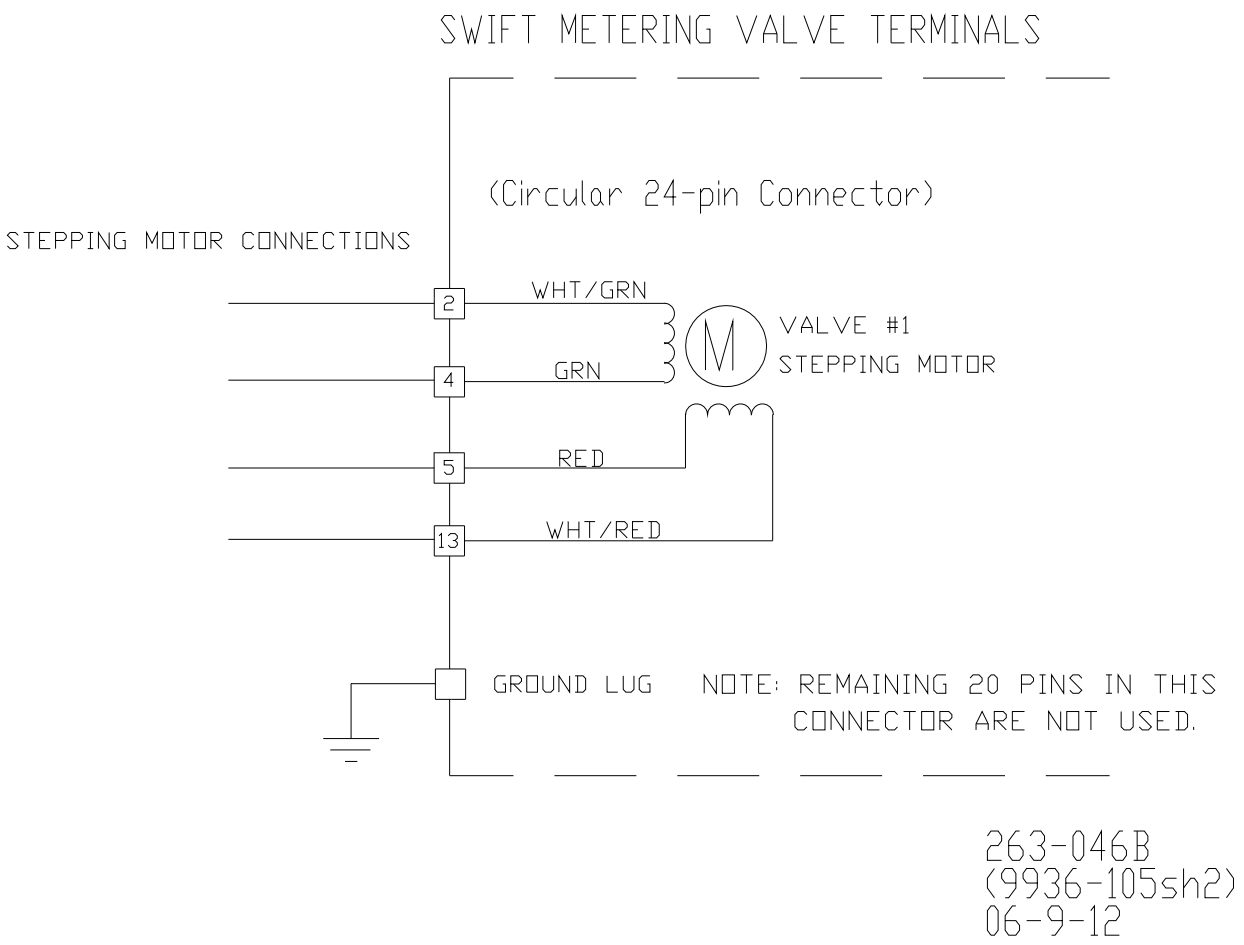
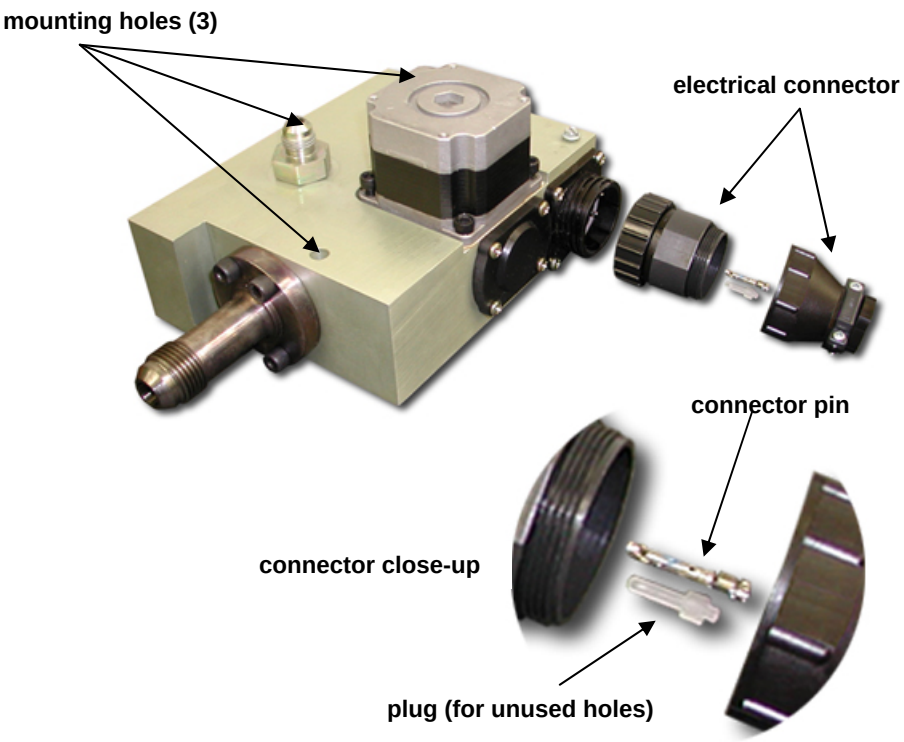
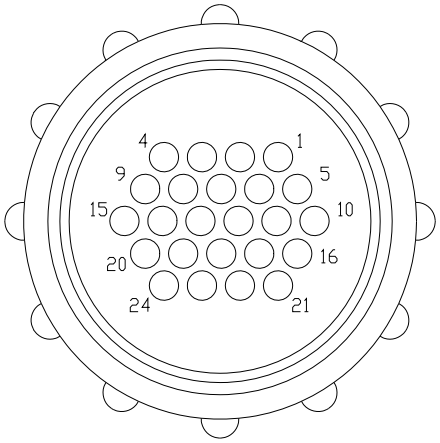


Figure 3-1. Valve Wiring Diagram





24-pin connector

- Insert seal plugs in all empty connector wire ports.
- Customer wiring to be 0.8 or 1.0 mm² (16 or 18 AWG).
- Max. cable diameter to be 17.86 mm (0.703 inch).

Figure 3-2. Swift Valve Wiring Assembly Overview

Connector Components for Figure 3-2

	Woodward P/N	AMP P/N
24-pin connector		
Connector Plug	1223-1013	796188-1
Connector Clamp	1298-1008	206138-1
Socket Connector	1681-5000	66101-2
Seal Plug (for empty sockets)	3051-1003	796075-1
Recommended Tools		
Connector Fabrication Hand Tools Kit	6995-1010	
• contains the following tools:		
AMP Crimper	8996-2003	58495-1
AMP Insertion Tool	8996-2004	200893-2
AMP Extraction Tool	8996-2005	305183

Control System Wiring

The following wiring assembly is provided as a detailed overview. All wiring accessories (connectors, pins, ring lugs, etc) are provided by the customer and shown here for ease of assembly. Wire size of 0.8 to 1.0 mm² (16 or 18 AWG) is recommended. To ensure proper connector sealing, the wire insulation diameter must be within 1.96 to 2.64 mm (0.077 to 0.104 inch).

⚠WARNING

If the recommended cable distances between power source and valves are exceeded, missed steps may result. The total length from power supply to driver plus driver to valve distance should not exceed 7.6 m (25 ft).

To ensure proper connector sealing, the wire insulation diameter must meet sealing diameter specifications.

Swift Valve Inputs/Outputs

Input Power Wire Length Considerations

⚠WARNING

If the recommended cable distances between power source and valves are exceeded, missed steps may result. The total length from power supply to driver plus driver to valve distance should not exceed 7.6 m (25 ft).

Input power wire lengths should be as short as possible. The maximum wire length from the driver to the valve, using 0.8/1.0 mm² (16 or 18 AWG) must be determined by the wire length from the driver to the engine control package and the driver to the power supply. The overall maximum length of wiring is 25 feet/ 7.6 meters.

NOTICE

Unless otherwise specified, to ensure EMC compliance of the final system, field wiring must not exceed the maximum overall cable length requirement of 7.6 m (25 ft).

Chapter 4.
Description of Operation

The Swift™ valve is a sonic flow-metering valve. The valve has a converging/diverging nozzle and a moving needle to adjust the valve flow area. An open-loop stepper motor through a rack-and-pinion drive positions the needle. A return spring is included to remove the effects of gear backlash and to minimize closed valve leakage. A mechanical stop is used to allow the driver to re-zero the valve position during start-up. After the re-zero, the driver counts the stepper motor steps to monitor the stepper motor position.

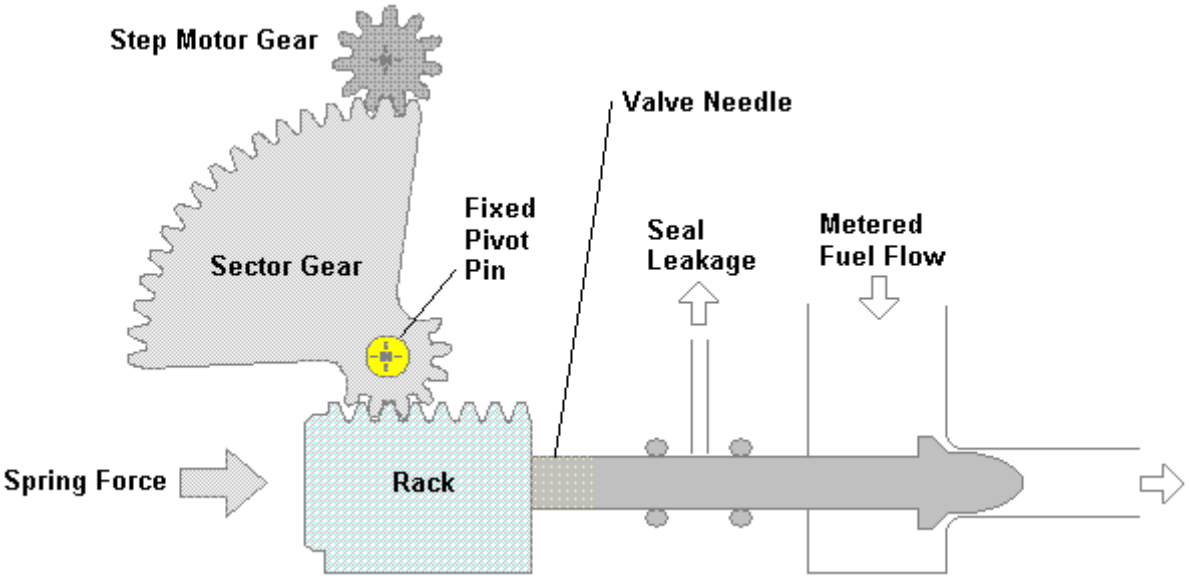


Figure 5-1. Valve Schematic

Accuracy

Flow accuracy for valves is ±7% of point at 100% stroke and ±2% of full scale at 6% stroke with a linear interpolation of accuracy between these points. Additional error can be introduced through driver positioning error.

Repeatability

For loads less than 50% the repeatability is less than 5% of point. For loads above 50%, the repeatability is less than 2% of point. The light-off condition should occur at ~20% of total flow through the fuel valve.

Metering Valve Characterization

The nominal effective area family curves for each valve size is provided in Chapter 6 (Specifications).

Shutdowns

The control system supplied by the customer must meet Machinery Directive safety shutoff valve requirements if the product is used as a safety valve in EU installations.

A shutdown condition must force the valve to a closed position regardless of the demanded position. All shutdown conditions must be latching and require a “reset” command.

There are two different shutdown actions possible: valve closed and powered down.

Shutdown—Valve Closed

When shutting down, the driver must force the valve to its closed position. The valve must remain in this position until the shutdown condition is cleared by a reset command.

Shutdown—Powered Down

Certain shutdown conditions can result in loss of control of valve position. When these shutdown conditions occur, the driver must attempt to close the valve, and then remove the output current.. The valve will close and remains in this position until the shutdown condition is cleared by a reset command. When the condition is restored, the driver should perform a re-zero to re-establish the position of the valve's minimum stop.

Chapter 5. Troubleshooting

Introduction

⚠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.

Improper engine operation may often be the result of factors other than the Swift™ SSV GMV operation. This chapter gives tips about engine problems that can resemble valve problems. Make sure that the engine is operating correctly before making any changes to the valve. The following troubleshooting guide is an aid in isolating trouble to the valve, wiring, or elsewhere. Troubleshooting beyond this level is recommended ONLY when a complete facility for control testing is available.

Attempting to correct engine or load problems with untimely valve adjustment can make problems worse. If possible, isolate the valve from the engine to determine whether the problem is with the valve or with the engine or the load on the engine. Swift valve faults are usually caused by problems in the installation or control system.

Carefully review all the wiring connections and the power supply before making any adjustments to the valve. Fuel supply and injector conditions can also present problems that resemble valve problems. Although no maintenance is required, the valve may be cleaned using the procedure outlined below under “Cleaning the Valves.”

Troubleshooting Procedure

This chapter is a general guide for isolating system problems. The guide assumes that the system wiring, soldering connections, switch and relay contacts, and input and output connections are correct and in good working order. Make the checks in the order indicated. Various system checks assume that the prior checks have been properly done.

General System Troubleshooting Guide

The following is a general troubleshooting guide for areas to check which may present potential difficulties. By making the checks appropriate to your engine/turbine before contacting Woodward for technical assistance, your system problems can be more quickly and accurately assessed.

Valves

- Is the wiring correct?
- Is the direction of the stroke correct?
- Does the valve move through its proper stroke smoothly?
- Does the valve travel its full stroke?
- Can mid-stroke be obtained and held?
- Does the valve fully seat (close)?
- Does the valve fully open?

Mechanical Troubleshooting Guide

- Verify driver to valve electrical continuity:
  1. Remove the valve wire harness connector from the driver.
  2. Measure the resistance through the wire harness of each stepper motor phase. The resistance should be approx. 0.7 Ω.
- Verify that the valve moves:
  1. Before attempting to view the valve needle to ensure the needle is not jammed, be certain that the fuel has been shut off upstream of the valve.
  2. Remove the outlet tube from the valve outlet fitting. Do ***not*** loosen the four screws on the flange of the outlet fitting. View the valve needle tip by looking inside the outlet fitting into the valve nozzle. Power up the driver and vary the demand from 0–100%. Verify that the valve moves approximately 8.1 mm (0.32 inch).
  3. Reattach the gas outlet pipe to the valve.

If the valve moves in the wrong direction, verify the following:

- Check that the valves are wired correctly (refer to Chapter 3). If one of the valve coils is wired backwards, the motor direction will be reversed.

If the valve movement is jerky and unpredictable, verify the following:

- Check that the valves are wired correctly (refer to Chapter 3). The valve coils may be cross-wired.
- Look for loose connections.

Performance Troubleshooting Guide

Cleaning the Valves

If the flow rate of the valves appears to be lower than when the valve was initially installed, it is possible that material has condensed out of the gas and deposited on the valve walls.

1. Before attempting to clean the valve needle and nozzle, be certain that the fuel has been shut off upstream of the valve.
2. Remove the gas inlet supply pipe.
3. Attach shop air supply pressure to the valve inlet.
4. Remove the outlet tube from the valve outlet fitting. Do not loosen the four screws on the flange of the outlet fitting. View the valve needle tip by looking inside the outlet fitting into the valve nozzle. Power up the driver and demand 100% valve flow. Verify that the valve moves approx. 8.1 mm (0.32 inches). Pressure-wash the tip of the needle by directing a high-pressure water & solvent stream into the nozzle. Direct shop air pressure through the valve to remove the water and solvent.
5. Reattach the gas inlet and outlet pipes to the valve.

Chapter 6.
Swift™ Safety Shutoff and Gas Metering Valve Specifications

Environmental Specifications

Parameter	Value
Ambient Temperature	–29 to +70 °C / –20 to +158 °F
Gas Temperature	–29 to +121 °C / –20 to +250 °F
Storage Temperature	-40 to +80 ˚C / -40 to +175 ˚F
Vibration	Long term environment 2 g per US MIL-STD-810C, curve B
Inlet Pressure (operating)	345–1380 kPa / 50–200 psia
Proof Pressure (non-operating)	3100 kPa / 450 psia
Ingress Protection	IP54 per IEC 60529
Chemical Resistance	The Swift™ SSV GMV valves use materials proven capable of withstanding normal engine environment chemicals per SAE J1455, such as diesel fuel, engine oil, and antifreeze.

Mechanical Specifications

Parameter	Value
Slew Rate	150 ms (10–90%) 150 ms (90–10%)
Valve Effective Area Accuracy	±7% of point at 100% stroke, ±2% of full scale at 6% stroke
Shutoff Capability	Per UL429—Safety Shutoff Valve
OBVD Fitting—37° flare	–6 SAE J514
Inlet Port	–12 SAE J514
Discharge Fitting—37° flare	–8 SAE J514 for valve size 7,12 & 20 –12 SAE J514 for valve size 36
Envelope	127 x 178 x 102 mm / 5 x 7 x 4 inches
Weight	4 kg / 8 lb
Electrical Connector	Amp P/N 206838-3, 24-pin connector Mating connector: Amp P/N 796188-1 24-pin connector Amp P/N 206138-1 connector cable kit Mating Connector pins: Amp P/N 66101-2 (qty 4) Mating Connector plugs (for unused pins): Amp P/N 796075-1 (qty 20) Refer to Chapter 3 for Woodward part numbers.

Electrical Specifications—Input Power

Parameter	Value
Input Range	21.5—28 V
Input Power (steady state)	Approximately 24 W
Input Power (transient)	Same as steady state
Wire Distance Limits	Total distance from power supply to driver plus driver to valve must not exceed 7.6 m (25 ft).
Wire Gauge	0.8 mm² (18 AWG), minimum

Driver Output to Valve Stepper Motor

Parameter	Value
Frequency	20 kHz
Duty Cycle Range	0.05—0.95
Motor Resistance Range	0.6—0.8 at 25 °C
Motor Inductance	0.0022 H
Current Limits	2.25 A steady state, 3 A transient
Wire Distance Limits	Total distance from power supply to driver plus driver to valve must not exceed 7.6 m (25 ft)
Wire Gauge	0.8 mm² (18 AWG)
Resolution	10.5 bits, min

Electrical Specifications—Stepper motor

Parameter	Value
Phase Resistance	0.61 Ω ±10% (at 20 °C)
Frame Size	NEMA 23
Winding Type	2 phase bipolar connected windings

Metering Valve Dynamics

Bandwidth

The frequency where the magnitude of the gain plot has dropped 6 dB must be 4.77 Hz (30 rad/s) minimum, with an orifice 762 mm (30 inches) downstream of the valve and with stepped input from 5–15% travel.

Slew Time

The slew times listed in the table are met over the specified range of supply voltage, pressure, and temperature.

Valve	Max Opening Time (ms)	Max Closing Time (ms)
Swift valve (time between 10% and 90% of a full travel step)	150	150

Stability

With a constant position demand, the valve will not oscillate more than 0.2% of full scale (0.9° step motor mechanical rotation or 45° step motor electrical rotation).

Swift Family Effective Area Curves

% Demand	Swift 7 S600 ACd (in²)	Swift 12 S600 ACd (in²)	Swift 20 S600 ACd (in²)	Swift 36 S600 ACd (in²)	Swift 60 S600 ACd (in²)
0	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.000000	0.000000	0.000124	0.000287	0.000000
4	0.000039	0.000132	0.000129	0.000337	0.000000
6	0.000089	0.000132	0.000149	0.000407	0.000065
8	0.000127	0.000132	0.000184	0.000498	0.000269
10	0.000160	0.000151	0.000236	0.000612	0.000489
12	0.000192	0.000171	0.000304	0.000750	0.000733
14	0.000228	0.000194	0.000390	0.000912	0.001004
16	0.000272	0.000222	0.000496	0.001101	0.001308
18	0.000326	0.000255	0.000620	0.001318	0.001649
20	0.000391	0.000296	0.000765	0.001562	0.002032
22	0.000470	0.000344	0.000931	0.001837	0.002460
24	0.000563	0.000403	0.001119	0.002141	0.002937
26	0.000669	0.000472	0.001328	0.002477	0.003467
28	0.000790	0.000552	0.001560	0.002845	0.004052
30	0.000923	0.000646	0.001815	0.003246	0.004695
32	0.001070	0.000753	0.002094	0.003681	0.005399
34	0.001228	0.000874	0.002396	0.004150	0.006166
36	0.001397	0.001011	0.002722	0.004653	0.006998
38	0.001576	0.001163	0.003072	0.005193	0.007896
40	0.001762	0.001332	0.003447	0.005769	0.008862
42	0.001956	0.001518	0.003846	0.006381	0.009897
44	0.002156	0.001722	0.004270	0.007030	0.011000
46	0.002360	0.001943	0.004718	0.007716	0.012173
48	0.002568	0.002183	0.005191	0.008440	0.013416
50	0.002779	0.002441	0.005688	0.009203	0.014729
52	0.002991	0.002718	0.006210	0.010003	0.016110
54	0.003205	0.003014	0.006755	0.010841	0.017559
56	0.003420	0.003328	0.007325	0.011718	0.019076
58	0.003635	0.003662	0.007918	0.012633	0.020658
60	0.003851	0.004014	0.008534	0.013586	0.022304
62	0.004067	0.004385	0.009172	0.014578	0.024012
64	0.004283	0.004774	0.009833	0.015608	0.025779
66	0.004501	0.005181	0.010516	0.016676	0.027604
68	0.004719	0.005606	0.011220	0.017782	0.029482
70	0.004940	0.006048	0.011944	0.018925	0.031411
72	0.005162	0.006506	0.012688	0.020106	0.033388
74	0.005388	0.006981	0.013452	0.021323	0.035409
76	0.005617	0.007471	0.014233	0.022576	0.037468
78	0.005851	0.007976	0.015032	0.023866	0.039563
80	0.006089	0.008495	0.015848	0.025190	0.041689
82	0.006332	0.009026	0.016679	0.026549	0.043839
84	0.006580	0.009570	0.017525	0.027943	0.046010
86	0.006834	0.010124	0.018384	0.029369	0.048196
88	0.007092	0.010689	0.019256	0.030828	0.050390
90	0.007355	0.011262	0.020138	0.032319	0.052586
92	0.007621	0.011843	0.021031	0.033841	0.054779
94	0.007888	0.012429	0.021933	0.035392	0.056960
96	0.008153	0.013021	0.022842	0.036972	0.059124
98	0.008415	0.013616	0.023757	0.038581	0.061263
100	0.008669	0.014213	0.024677	0.040216	0.063369

Chapter 7.
Service Options

Product Service Options

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

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

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

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

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

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

www.woodward.com/directory

Woodward Factory Servicing Options

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

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

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

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

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

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

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

Returning Equipment for Repair

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

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

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

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

How to Contact Woodward

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

Electrical Power Systems

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

Engine Systems

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

Turbine Systems

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

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

www.woodward.com/directory

Technical Assistance

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

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

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

Appendix.
Flow Equation Discussion

Nomenclature

Indirect Flow Measurement—A system consisting of a flow-characterized fuel metering valve, pressure and temperature transducers used as a modulating orifice flow meter for metering fuel.

ACd—Valve effective area. This is the apparent valve area as calculated through the flow equation with the valve discharge coefficient set to 1.

Wf—Fluid mass flow in lb/hr.

K—Ratio of specific heats. This is the ratio of the specific heat at constant pressure divided by the specific heat at constant volume for a gas (Cp/Cv).

Sg—Specific gravity. This is the ratio of the density of a gas at 60 °F divided by the density of air at the same temperature.

P1—Valve inlet pressure measured in psia for gas.

P2—Valve discharge pressure measured in psia for gas.

Pressure Ratio—The ratio of valve discharge to inlet pressure (P2/P1).

Critical Pressure Ratio—The pressure ratio that marks the transition between sonic and subsonic flow. It is defined by the ratio of specific heats for the gas and is defined as $\left(\frac{2}{1+K}\right)^{\left(\frac{K}{K-1}\right)}$

T1—Valve inlet temperature measured in deg R

Z—Gas compressibility factor. This is defined as $z=\frac{p}{R\cdot\rho\cdot T}$

Sonic Flow (Choked)—A gas flow condition such that the flow velocity through an orifice is Mach 1 at the vena contracta. At this point for a given inlet pressure, flow cannot be increased by reduction of the valve pressure ratio (see Gas Flow Equation—Equation 1).

Subsonic Flow (Unchoked)—A gas flow condition such that the flow velocity through an orifice is less than Mach 1 at the vena contracta. In this condition, reduction in pressure ratio causes an increase in flow rate (see Gas Flow Equation—Equation 2).

Gas Flow Equation

The recommended gas flow equation is a two-state equation based on the condition of the valve pressure ratio being greater than or less than the critical pressure ratio. The critical pressure ratio is defined in terms of the gases ratio of specific heats and is:

$$\left(\frac{2}{1+K}\right)^{\left(\frac{K}{K-1}\right)}$$

When P2/P1 is less than the critical pressure ratio, the flow is sonic. When flow across an orifice is sonic, changes in P2 do not have an effect on the flow rate. Thus, in Equation 1 the flow rate is only a function of the inlet pressure P1. When P2/P1 is greater than the critical pressure ratio, the flow is sub-sonic, and changes in P2 do have an effect on the flow rate. Therefore, in Equation 2 the flow rate is a function of both P1 and P2.

Equation 1—Sonic Flow (Choked)

$$WF = 3955.289 P1 \cdot ACd \cdot \sqrt{\frac{K \cdot SG}{(K-1) \cdot T1 \cdot Z} \cdot \left[\left[\left(\frac{2}{1+K}\right)^{\left(\frac{K}{K-1}\right)}\right]^{\left(\frac{2}{K}\right)} - \left[\left(\frac{2}{1+K}\right)^{\left(\frac{K}{K-1}\right)}\right]^{\left(\frac{1+K}{K}\right)}\right]}$$

$$\text{if} \quad \frac{P2}{P1} < \left(\frac{2}{1+K}\right)^{\left(\frac{K}{K-1}\right)}$$

Equation 2—Sub Sonic Flow (Unchoked)

$$WF = 3955.289 P1 \cdot ACd \cdot \sqrt{\frac{K \cdot SG}{(K-1) \cdot T1 \cdot Z} \cdot \left[\left(\frac{P2}{P1}\right)^{\left(\frac{2}{K}\right)} - \left(\frac{P2}{P1}\right)^{\left(\frac{1+K}{K}\right)}\right]}$$

$$\text{if} \quad \frac{P2}{P1} \geq \left(\frac{2}{1+K}\right)^{\left(\frac{K}{K-1}\right)}$$

High Recovery Valve Characteristics and Application

The Swift™ SSV GMV valves are high-recovery valves. Valves of this type appear to remain sonic at pressure ratios above the critical pressure ratio:

$$\frac{P2}{P1} = \left(\frac{2}{1+K}\right)^{\frac{K}{K-1}}$$

where K equals the metered fluid's ratio of specific heats. Because of pressure recovery downstream of the metering orifice, these valves appear to remain choked at pressure ratios up to 0.85. These valves can only be applied below a P2/P1 of 0.85. Only Equation 1 (below) can be applied.

Equation 1—Sonic Flow (Choked)

$$WF = 3955.289 P1 \cdot ACd \cdot \sqrt{\frac{K \cdot SG}{(K-1) \cdot T1 \cdot Z} \cdot \left[\left[\left(\frac{2}{1+K}\right)^{\left(\frac{K}{K-1}\right)}\right]^{\left(\frac{2}{K}\right)} - \left[\left(\frac{2}{1+K}\right)^{\left(\frac{K}{K-1}\right)}\right]^{\left(\frac{1+K}{K}\right)}\right]}$$

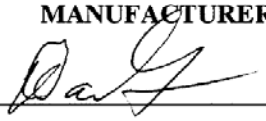
High recovery valves used in gas indirect flow measurement fuel control systems have several advantages over low recovery valves that operate in both sonic and sub sonic flow modes. Measurement of valve discharge pressure to determine flow is not necessary. This improves the system accuracy, as the accuracy of valve discharge pressure measurement is no longer an issue. Properly designed sonic flow valves do not typically have area variation as a function of valve inlet pressure. This eliminates the need for several tables at varying P1 pressures. It has been shown in testing that there can be an effective area dependency on pressure ratio (P2/P1). However, this effect can be mitigated by working with the valve geometry to stabilize the position of the vena contracta as a function of pressure ratio.

DECLARATION OF CONFORMITY

Manufacturer's Name:	WOODWARD GOVERNOR COMPANY (WGC) Industrial Controls Group
Manufacturer's Address:	1000 E. Drake Rd. Fort Collins, CO, USA, 80525
Model Name(s)/Number(s):	Swift Safety Shutoff and Metering Valves (SSV GMV) 9906-356 and similar
Conformance to Directive(s):	94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres 98/37/EC Council Directive of 22 June 1998 on the approximation of the laws of the Member States relating to machinery
Marking(s):	Category 3 Group II G, EEx nA II T3
Applicable Standards:	EN60079-15: 2003: Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection 'n' EN 12100 –1:2003: Safety of Machinery – Basic Concepts, General Principles For Design – Part 1: Basic Terminology, Methodology EN 12100-2:2003: Safety of Machinery – Basic Concepts, General Principles For Design – Part 2: Technical principles
Conformity Assessment:	ATEX Production Quality Assessment, ITS05ATEXQ4211
Notified Body For ATEX:	Intertek (0359) Intertek House, Cleeve Road Leatherhead, Surrey, KT22 7SB UK

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

MANUFACTURER



Signature

Dan Gear

Full Name

Engineering Manager

Position

WGC, Fort Collins, CO, USA

Place

3/27/06

Date

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26350B.

B26350:B

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Email and Website—www.woodward.com

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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.

2013/4/Colorado