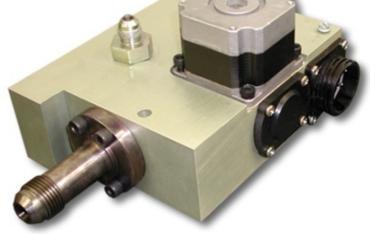
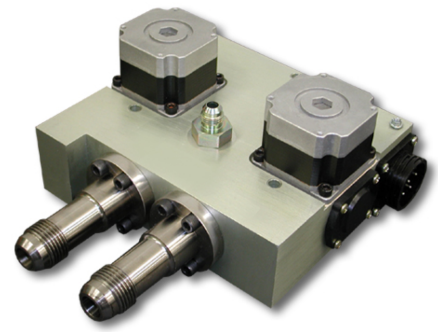
WOODWARD

Product Manual 26363
(Revision C)
Original Instructions





Swift™ Gas Metering System

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:** **www.woodward.com/publications** **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 *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.**

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

Contents

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 Marking:

EMC Directive: Declared to 89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility.

ATEX – Potentially Explosive Atmospheres Directive: Declared to 94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres.
LCIE 03 ATEX 6077X
Zone 2, Category 3, Group II G, EEx nA II T3

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

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

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

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

North American Compliance:
These listings are limited only to those units bearing the UL or CSA identification.

CSA: CSA Certified for Class I, Division 2, Groups A, B, C, & D, T3Cat 70 °C Ambient for use in Canada and the United States
Certificate 1309541

UL (valves only): 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 is subject to acceptance by the authority having jurisdiction or local inspection.

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.

Special Conditions For Safe Use:

- Field Wiring must be suitable for at least 90 °C.
- Connect ground terminal to earth ground.
- Ambient Temperature Ratings: –29 to +70 °C (Valve and Driver)

⚠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 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	**Do not use any test points on the power supply or control boards unless the area is known to be non-hazardous..**

⚠AVERTISSEMENT	**Ne pas utiliser les bornes d'essai du block d'alimentation ou des cartes de commande à moins de se trouver dans un emplacement non dangereux.**

Chapter 1.
General Information

Introduction

This manual describes the Woodward Swift™ Gas Metering System 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 actuator 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.
- Optionally configure the driver using the Service Tool (see Chapter 7)—this is required if DeviceNet is used.
- Stroke valves and verify functionality.
- Troubleshooting guidelines are provided in Chapter 9.
- Specifications are provided in Chapter 10.

Applications

The Woodward Swift gas metering system operates 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 system has four valve sizes with maximum fuel flows of 6 to 88 g/s (50 to 695 lb/hr) of standard natural gas, depending on the system pressures (see Table 1-1). The system is designed for installation in the prime mover enclosure and can accommodate gas temperatures up to 121 °C (250 °F).

Description

The system is available in two primary configurations. The "Swift" configuration provides either single- or dual-metering valves in a single housing. This configuration can be integrated into a new or existing gas metering system to provide low-cost, accurate, reliable control. The Swift Model 200 system, sizes 65, 36, and 20, have been designed to provide system mass flow accuracy of 2% of point at 100% of rated flow across the entire temperature range. The Swift Model 200 system, size 11, has been designed to provide system mass flow accuracy of 6.2% of point between 50 and 100% of rated flow, across the entire temperature range.

The Swift gas metering system components include one or two metering valves and one valve driver (see Figure 1-1). For fuel systems requiring two independently modulated fuel flows, the primary valve can be integrated with a secondary metering valve. The primary valve can accommodate this integration without duplicating either electrical or mechanical connections.

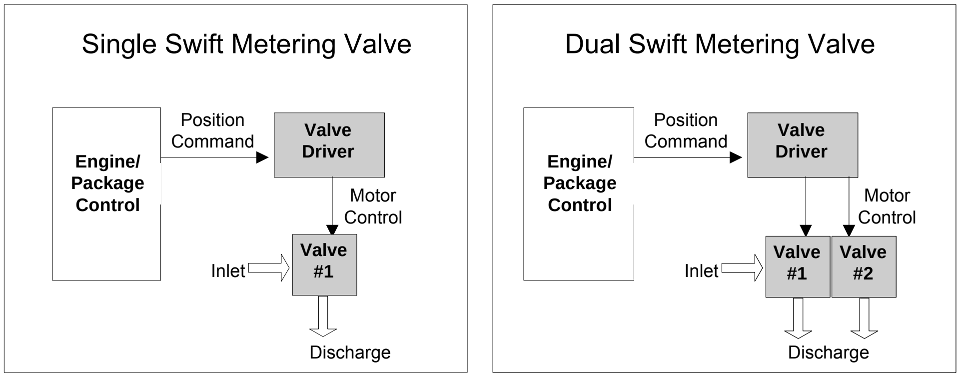
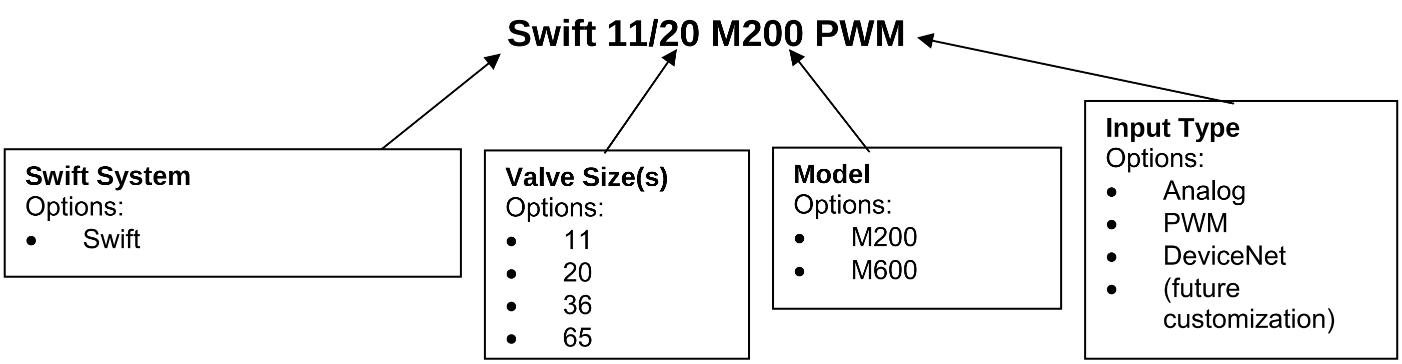


Figure 1-1. Swift Metering System Options

Swift System Identification



There are four parts to identify a Swift valve: the **system** (Swift), the **valve size** (11, 20, 36, 65), the **model** (M200, M600), and the **input type** (analog, PWM, DeviceNet). These are explained on the next page.

Swift System

- **Swift**—provides either single- or dual-metering valves in a single housing

Valve Size(s)

Divide the valve size number by 1000 to get the actual size (nominal area, Acd, in square inches) of the valve:

- **11** represents 0.011 in² (7.10 mm²)
- **20** represents 0.020 in² (12.90 mm²)
- **36** represents 0.036 in² (23.23 mm²)
- **65** represents 0.065 in² (41.94 mm²)

In addition, a Swift valve can have one or two metering valves. Swift systems with two metering valves are shown with both valve sizes, for example Swift 11/20 (one metering valve is 0.011 in² and the second is 0.020 in²).

Model

- **M2xx**—valves are characterized to provide a better than 2% mass flow accuracy at flows of 100%
- **M200**—Swift system with characterized flow

- **M6xx**—valves are not characterized (lower overall cost than M2xx); provides a 7% mass flow accuracy at flows of 100%
- **M600**—uncharacterized Swift system

Input Type

- **Analog** (4–20 mA)
- **PWM**
- **DeviceNet** (CAN/DeviceNet)

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-11	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-65	90 lb/hr	295 lb/hr	695 lb/hr	N/A	11.2 g/s	38.2 g/s	88.9 g/s	N/A

Table 1-1. Flow Rates

Swift Driver

The driver is effectively a positioner that will accept a desired position signal from another device in the system, such as a speed control, and drive the valve to that position. The position controller software is executed on dual Texas Instruments 16-bit DSPs, operating at 40 MHz, onboard the Swift Driver. The driver can be commanded to a position via 4–20 mA, PWM, or CAN/DeviceNet interfaces. The driver monitors all available signals, internal and external, and annunciates any detected shutdown conditions through the discrete output. A discrete input is available to remotely shut down the actuator and to reset shutdown conditions.

Features of the driver include dual (2) model-based position control loops, on-line diagnostics, CAN communications, and service port communications (described in detail in Chapter 5). A Windows-based Service Tool software program is available for monitoring, troubleshooting, and parameter adjustments. The Service Tool software is loaded on a PC and communicates serially to the driver via RS-232. Refer to Chapter 7 (Service Tool) for installation instructions.

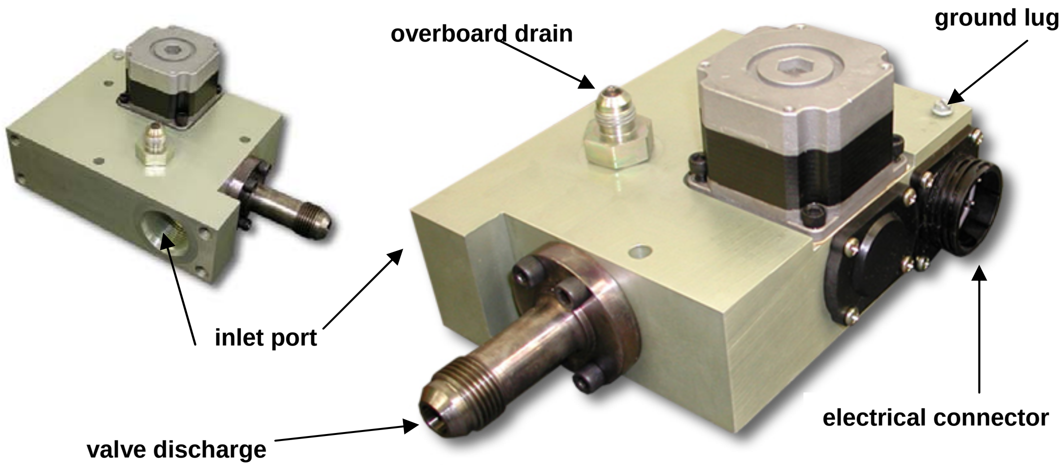


Figure 1-2. Swift Single Valve

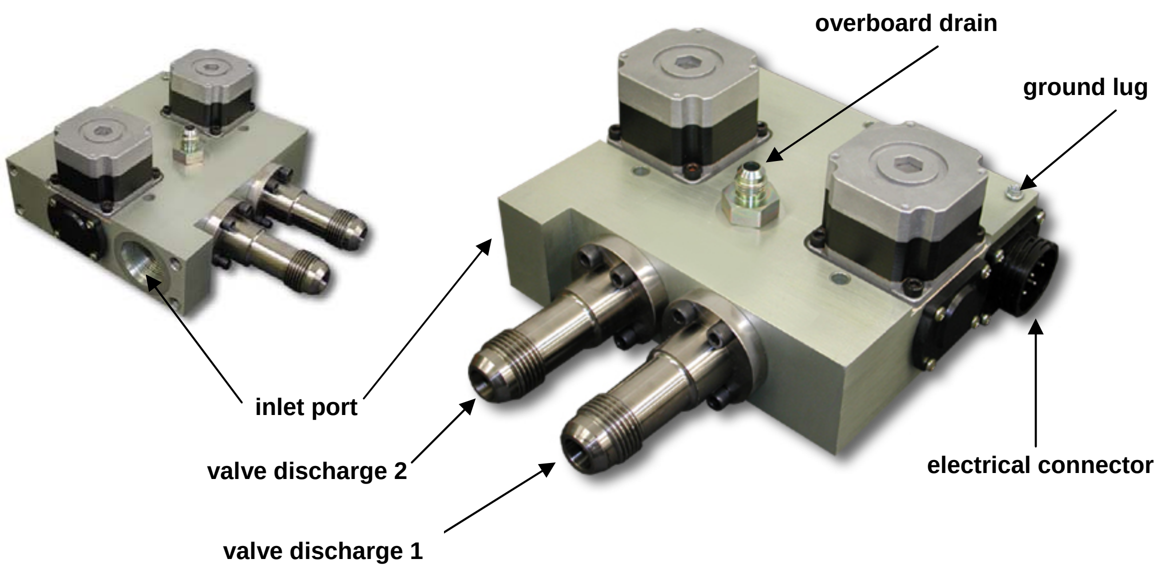


Figure 1-3. Swift Dual Valve

Mechanical Interface

Mounting

The Swift Driver is mounted using ¼” or M6 bolts through four oval mounting holes, and can be mounted in any orientation. 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 3 (Installation) for details on mounting and installation.

Electrical Connections

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

Swift Driver
The interface for the Swift Driver is a 48-pin PCB-mounted sealed automotive style receptacle, which protrudes through the driver enclosure. Wiring harness mating is accomplished using two separate plugs, one 30-pin (J1) and an 18-pin (J2). Refer to Chapter 3 for details on Swift Driver wiring.

Swift Valve Inputs/Outputs (I/O)

The following Inputs/Outputs (I/O) are available in the Swift Valve:

- driver stepper motor inputs (2)

Driver Stepper Motor Inputs
Each driver channel has stepper motor inputs for connection to the Swift Driver.

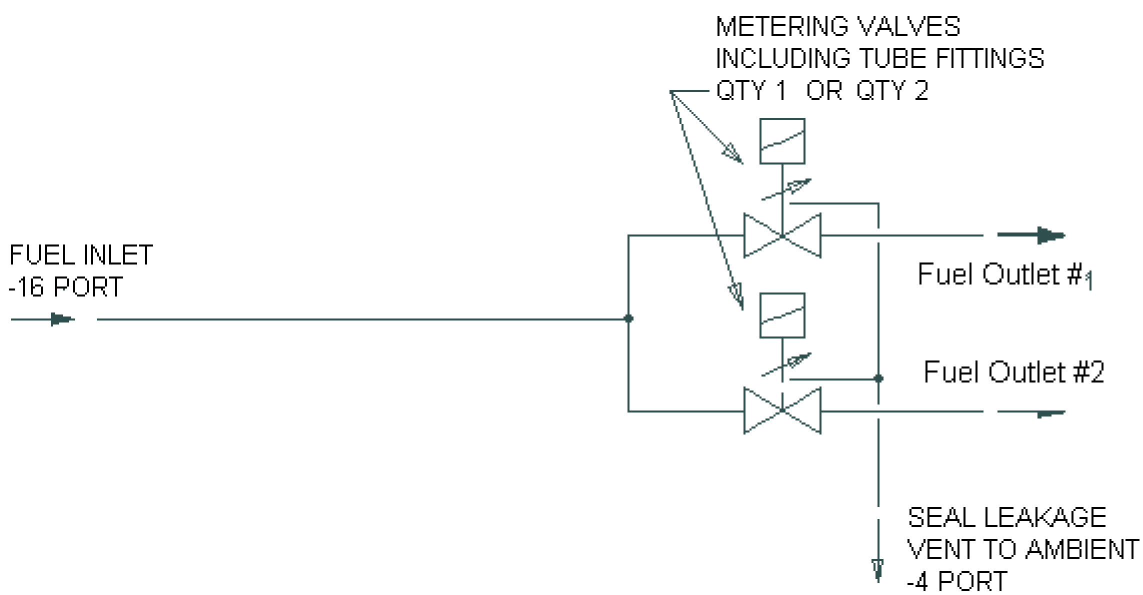


Figure 1-4. Swift Valve Schematic

Driver Inputs/ Outputs (I/O)

The following Inputs/Outputs (I/O) are available in the Swift Driver:

- power input
- 2 analog inputs; one per valve channel (optional)
- 2 PWM inputs; one per valve channel (optional)
- 1 discrete input
- 1 discrete output
- 1 RS-232 communications port
- 1 CAN (Controller Area Network)/DeviceNet port

Power Input
The input power has an operational range of 21.5—28 Vdc, nominal 24 Vdc. Input power out-of-range diagnostics are provided.

Analog Input for Position Demand
The analog inputs are nominally 4–20 mA (25 mA range). Range and failure diagnostics are provided based on software configuration and settings.

PWM Input for Position Demand
The PWM input accepts a 500 to 2000 Hz input signal of 5 to 26 volts peak-to-peak voltage (referenced to unit battery ground), and each channel is independently jumper-configurable to accept push-pull or open-collector PWM signals. The PWM input duty cycle minimum and maximum fields are adjustable to match the controller sending the demand. Range and failure diagnostics are provided based on software configuration and settings.

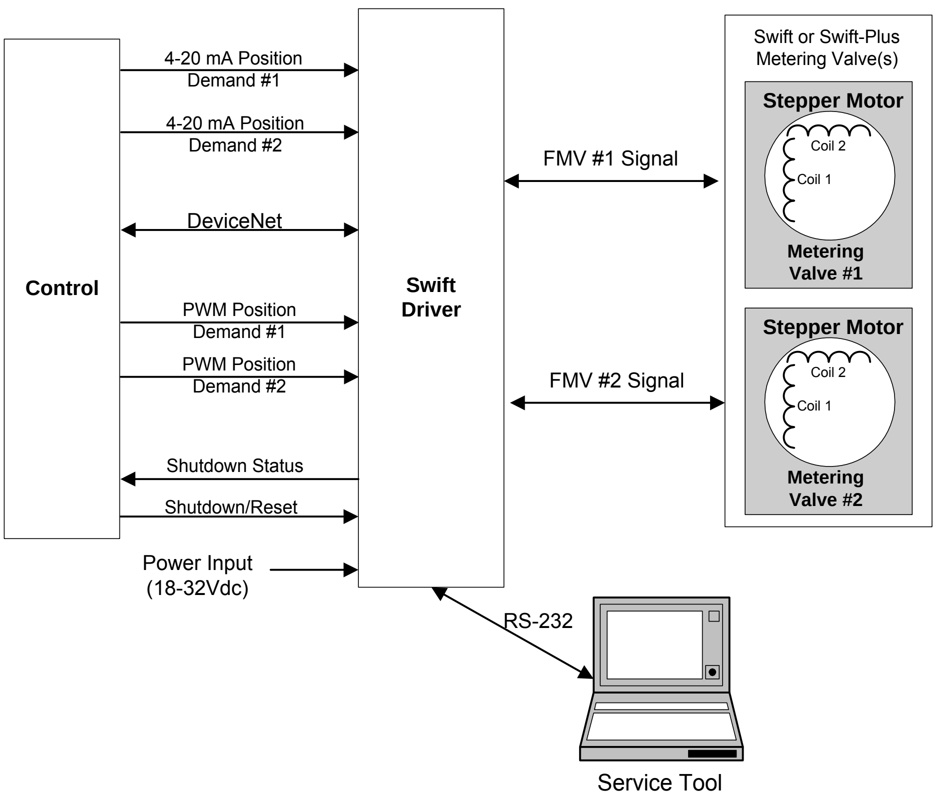


Figure 1-5. Driver Overview

Shutdown/Reset Discrete Input
When the shutdown contact is opened, the driver goes into a shutdown mode and the valves are commanded to and held at minimum position. When the shutdown contact is closed, the driver returns to 'run' mode and it resets all driver faults.

⚠WARNING **The Shutdown/Reset input must be closed to operate the unit. When open, the unit is forced into a shutdown state.**

Discrete Output for Driver Status Indication

The discrete output contact is normally on/closed (customer-supplied power applied to load such as a trip-string relay) under normal driver operation, and turns off/opens to indicate any detected shutdown condition within the driver. Both alarm and shutdown indications are latching, which means a reset command is required to clear the fault. The Service Tool program can be used to interrogate the cause of the alarm or shutdown. The CAN communications can also be used to determine alarm and shutdown causes.

The Swift Gas Metering System will continue to operate with an alarm condition (for example, failure of the primary demand signal). However, the unit will cease to operate on a shutdown condition (for example, failure of position demand input signal).

RS-232 Communications Port

An RS-232 communications service port is provided in the J1 harness plug for connection to a PC service tool. This connection is a typical three-wire RS-232 communication (Tx = J1-A1, Rx = J1-A2, Gnd = J1-A3), which is limited to 15 m (50 feet). The port supports OPC protocol and has fixed communications settings of 38.42 K baud rate, 8 data bits, no parity, and 1 stop bit. Refer to Chapter 7 for details on the Service Tool.

CAN Communications Port

The driver has CAN communications, version 2.0B, with 29-bit identifiers. The CAN port supports independent positioning (position demand from CAN) and shutdown of each driver channel. It also supports driver diagnostic monitoring and position demand feedback. Reading of CAN parameters is available regardless of the configured Demand Source. The address and data rate parameters are set using the Service Tool. The data rate may be chosen from 125 kbps, 250 kbps, and 500 kbps.

Chapter 2.
Hardware Installation

Introduction

This chapter provides instructions on how to mount and connect the Swift™ Gas Metering System into a system. Hardware dimensions are provided for mounting the Swift package to 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**

NOTICE	**Jumpers should not be moved or changed unless power has been switched off.**

Unpacking

Be careful when unpacking the actuator. 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.

IMPORTANT	**The driver and valve(s) are shipped as a matched set and must remain together.**

Mounting Location

The Swift Gas Metering System actuator is designed to operate within a temperature range of –29 to +70 °C (–20 to +158°F). Mount the driver close enough to the power source to meet the wire-length requirements (see wiring instructions in Chapter 3).

The Swift Gas Metering System is designed for installation on the prime mover. The installer must consider the heat conductivity of the installation bracket, and the operating temperature of the ultimate heat sink to which the bracket will be attached. Generally the heat transfer abilities of aluminum and low-carbon steel are better than those of high-carbon steel or stainless steel.

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

Mounting

Application Guidelines

Here are environmental guidelines for applying the Swift Gas Metering System. By adhering to the limitations and recommendations set forth in these sections, the full functionality and reliability of the actuator can be assured.

Mounting Hardware

Four oval 7x9 mm through-holes are provided on the driver for mounting with 0.250 inch or 6 mm screws.

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

The Swift System components weigh approximately:

Driver	2 kg (4 lb)
Single Swift Valve	4 kg (8 lb)
Dual Swift Valve	5 kg (10 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.

Heat Sink

The driver should be mounted on a flat metal surface with at least 654 mm² (1 in²) in contact with the driver housing. The Swift valve should be mounted on a metal surface with at least 6450 mm² (10 in²) in contact with the valve housing. The mounting surface should be thermally conductive with other metallic hardware to allow heat generated inside the driver and valves to be dissipated.

Orientation

The driver will function in any mounting orientation. The Swift valve should be mounted with the motor housings oriented upward (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.**

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

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

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).**

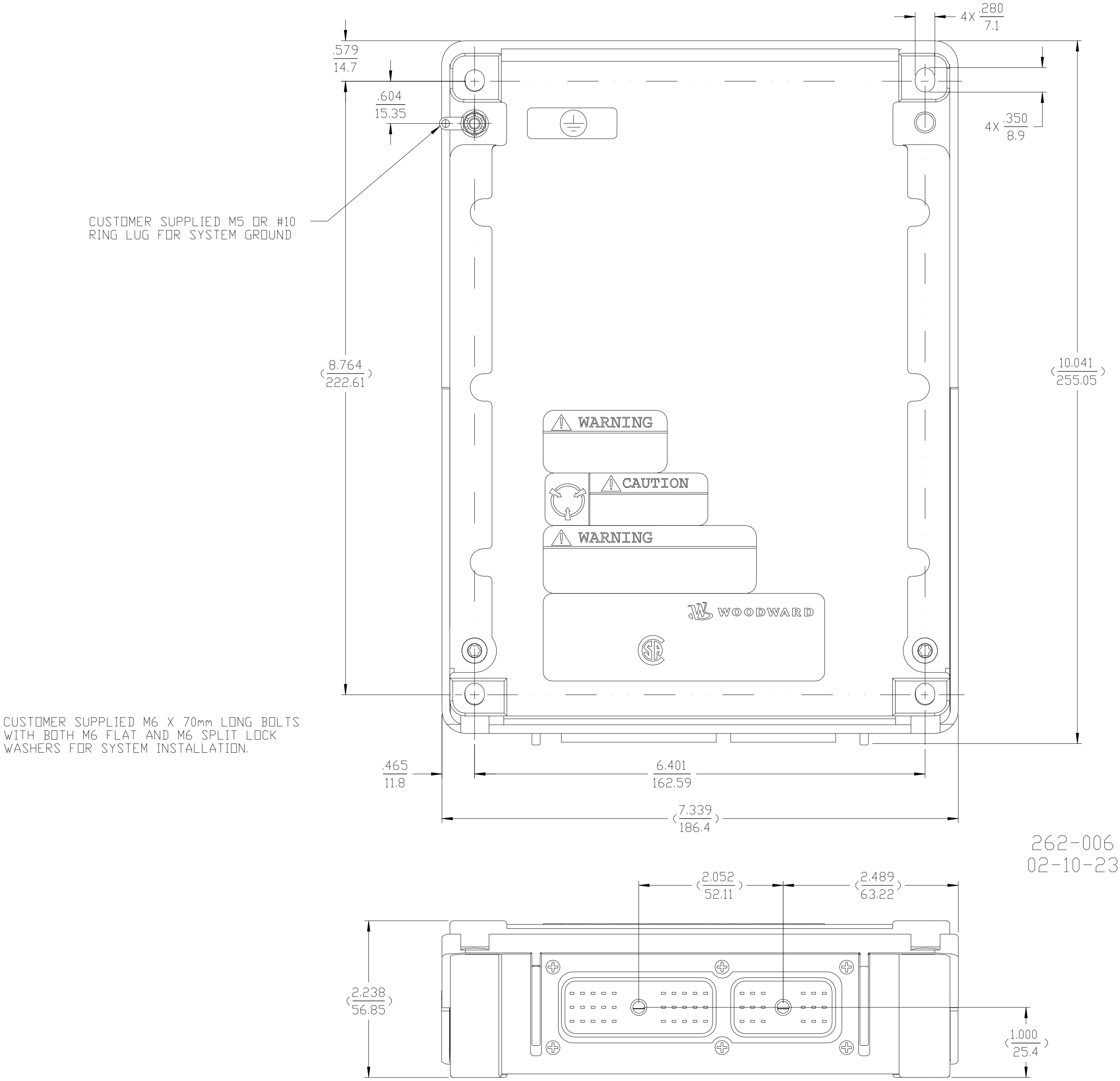


Figure 2-1a. Swift Driver Outline Drawing

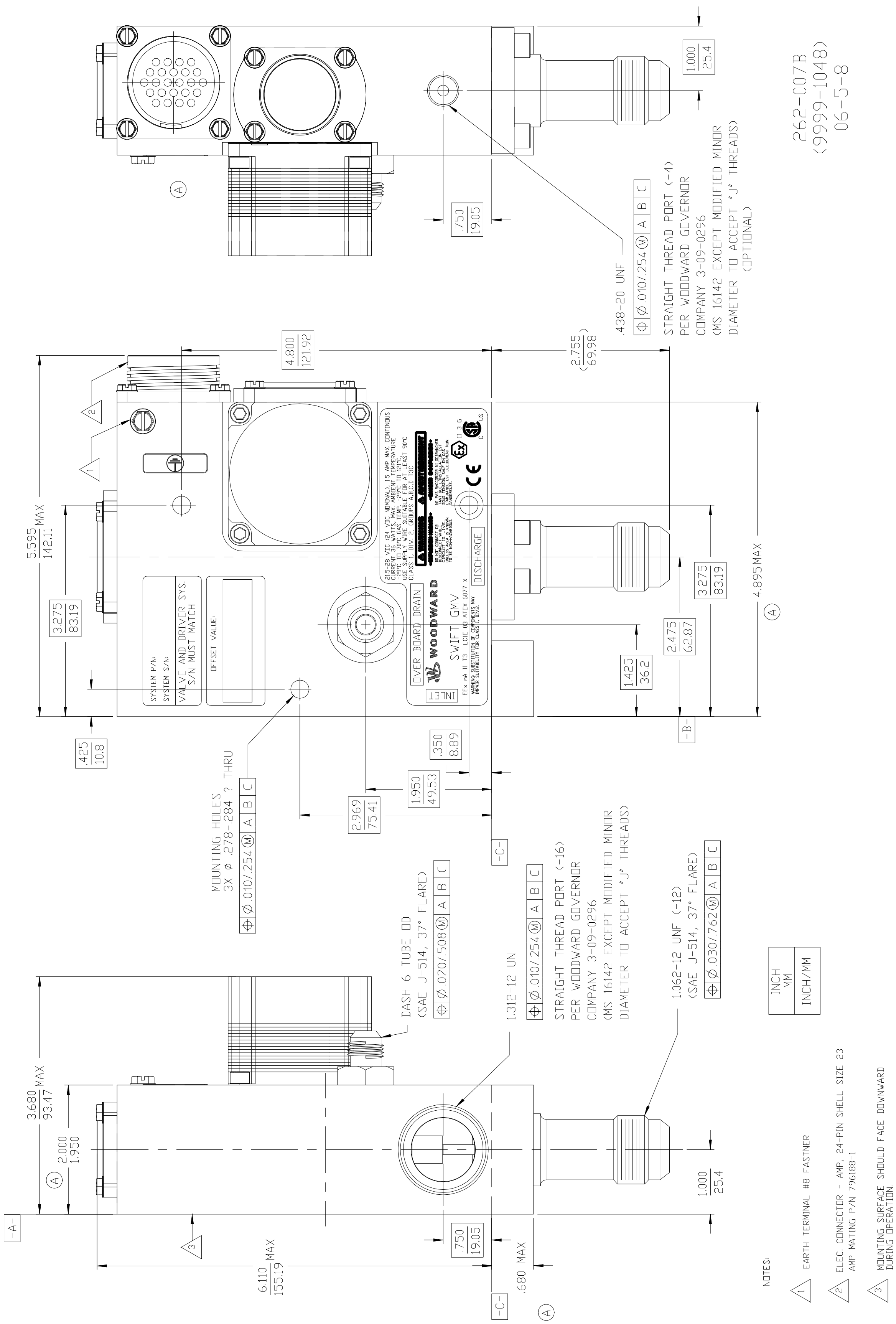


Figure 2-1b. Swift xx Outline Drawing

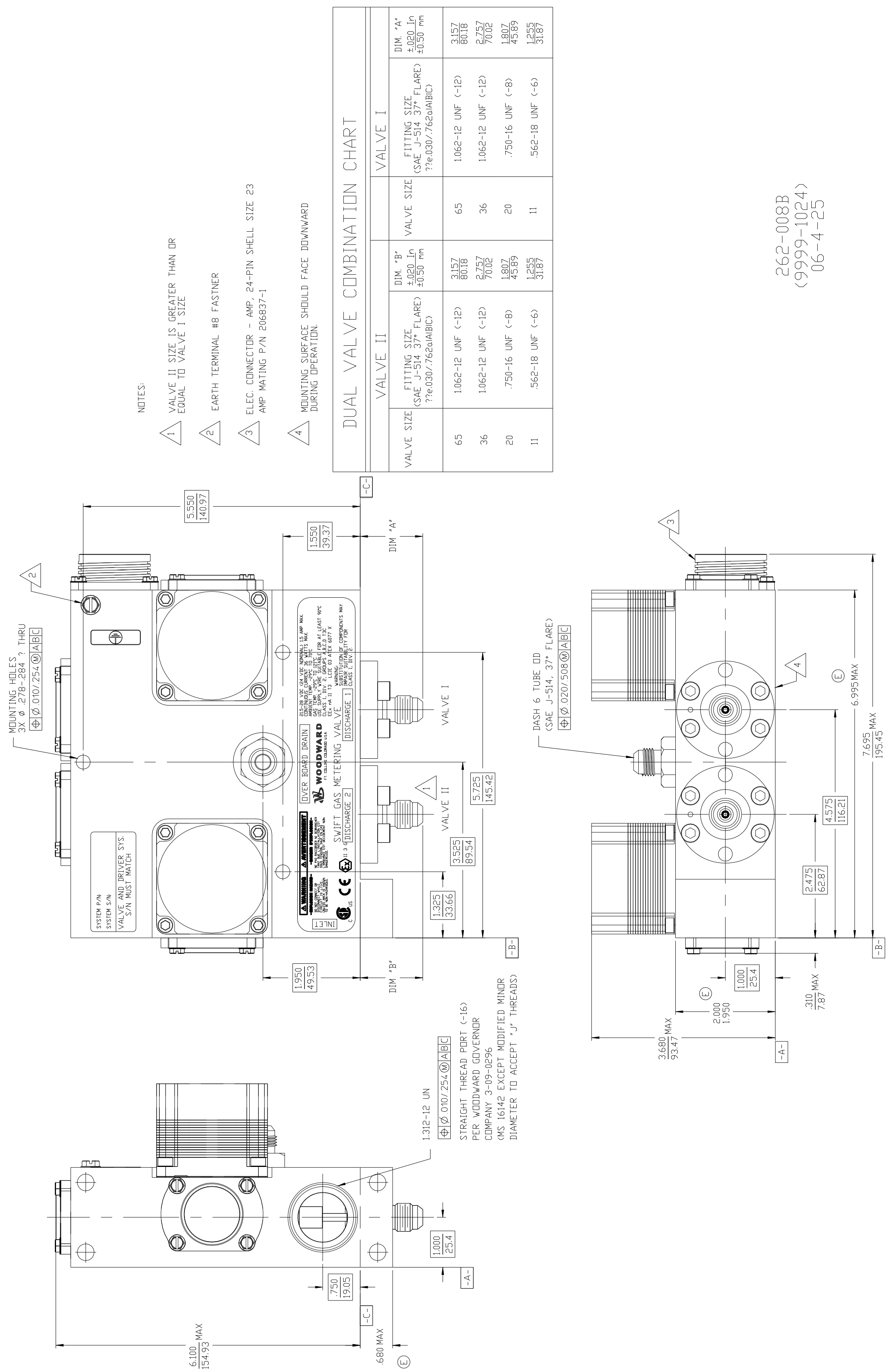


Figure 2-1c. Swift xx/xx System Outline Drawing

Chapter 3.
Wiring

Introduction

This chapter provides instructions on how to connect the Swift™ driver and valve(s) into a system. Ratings and jumper configurations are given to allow wiring and configuration of the Swift package to a specific application.

Electrical ratings, wiring requirements, and options are provided to allow full installation the Swift actuator 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 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.

NOTICE

Jumpers should not be moved or changed unless power has been switched off.

Electrical Connections

Refer to the wiring assembly overviews, control wiring diagrams, and the representative I/O interfaces schematic in this chapter. Also, review the Specifications section in Chapter 10 of the manual for the hardware I/O specifications.

All connectors used on wire harnesses for connection to the Swift valve and Swift driver must have backshells sealed against water ingress.

Grounding and Ground Connections

Each device 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.

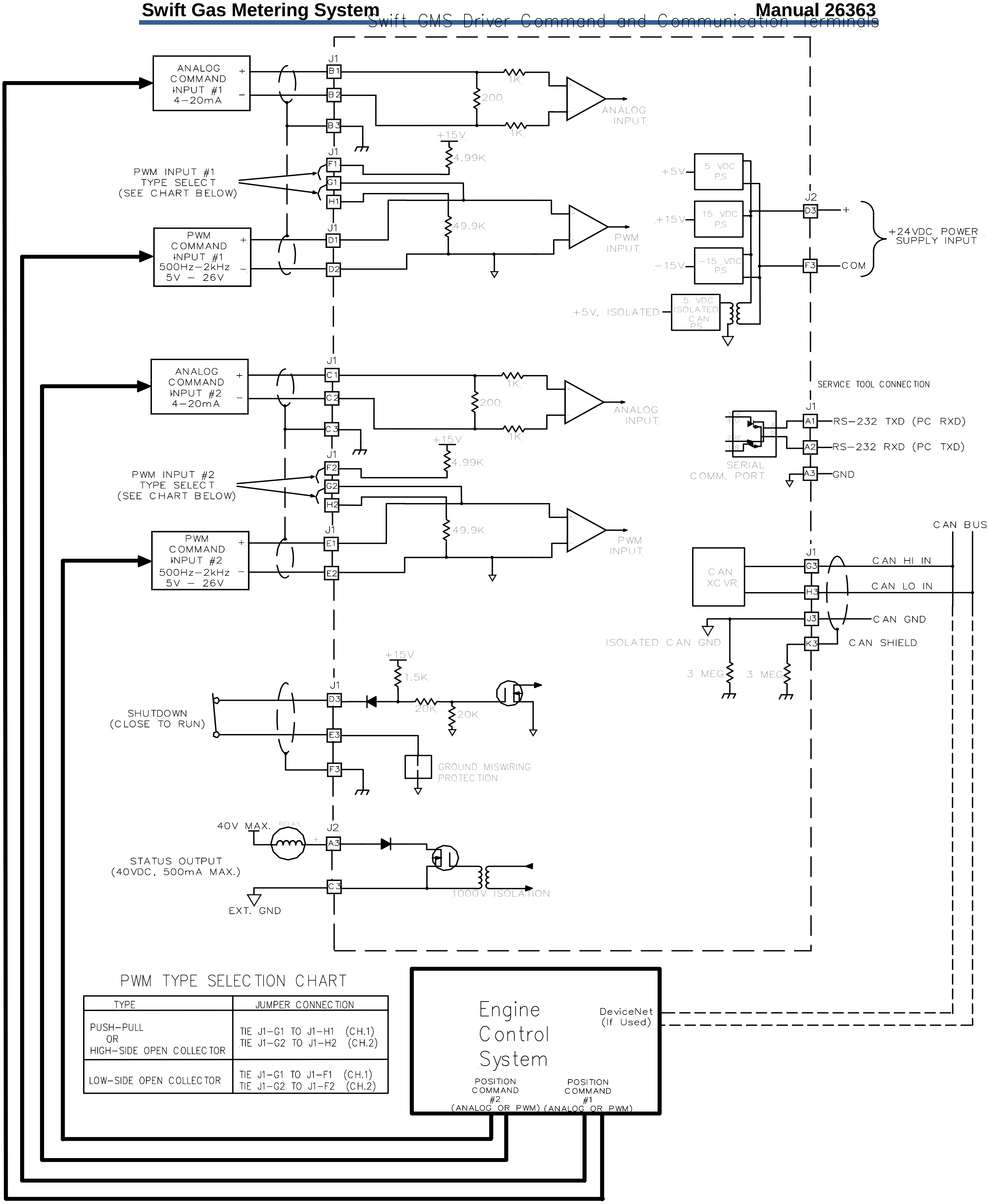
Shielded Wiring

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 Swift control system.



PWM TYPE SELECTION CHART

TYPE	JUMPER CONNECTION
PUSH–PULL OR HIGH–SIDE OPEN COLLECTOR	TIE J1–G1 TO J1–H1 (CH.1) TIE J1–G2 TO J1–H2 (CH.2)
LOW–SIDE OPEN COLLECTOR	TIE J1–G1 TO J1–F1 (CH.1) TIE J1–G2 TO J1–F2 (CH.2)

Figure 3-1a. Control Wiring Diagram

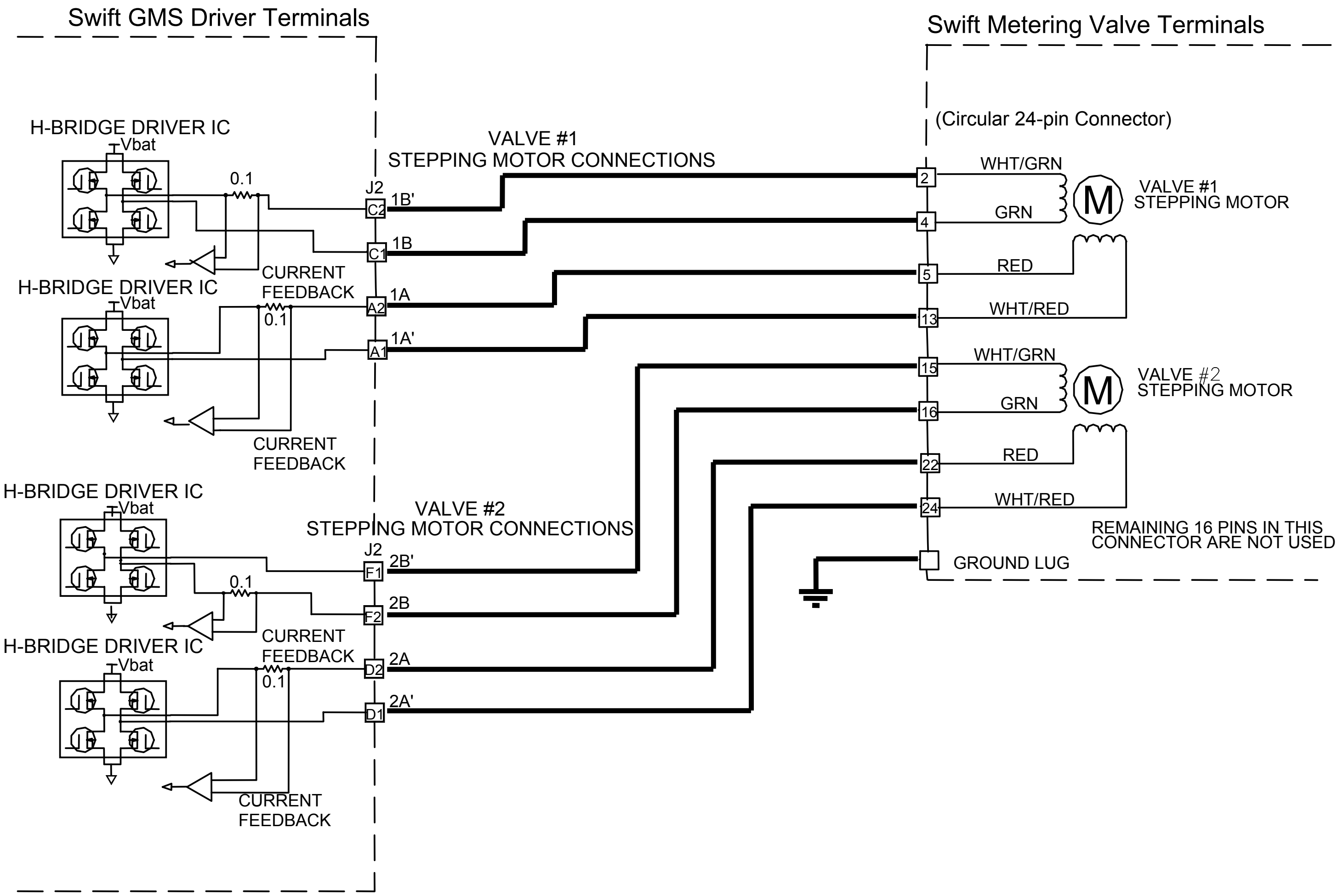


Figure 3-1b. Control Wiring Diagram

Swift Valve Inputs/Outputs

The interface for the Swift is a circular 24-pin sealed connector. All I/O points on this connector are wired to the Swift 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.**

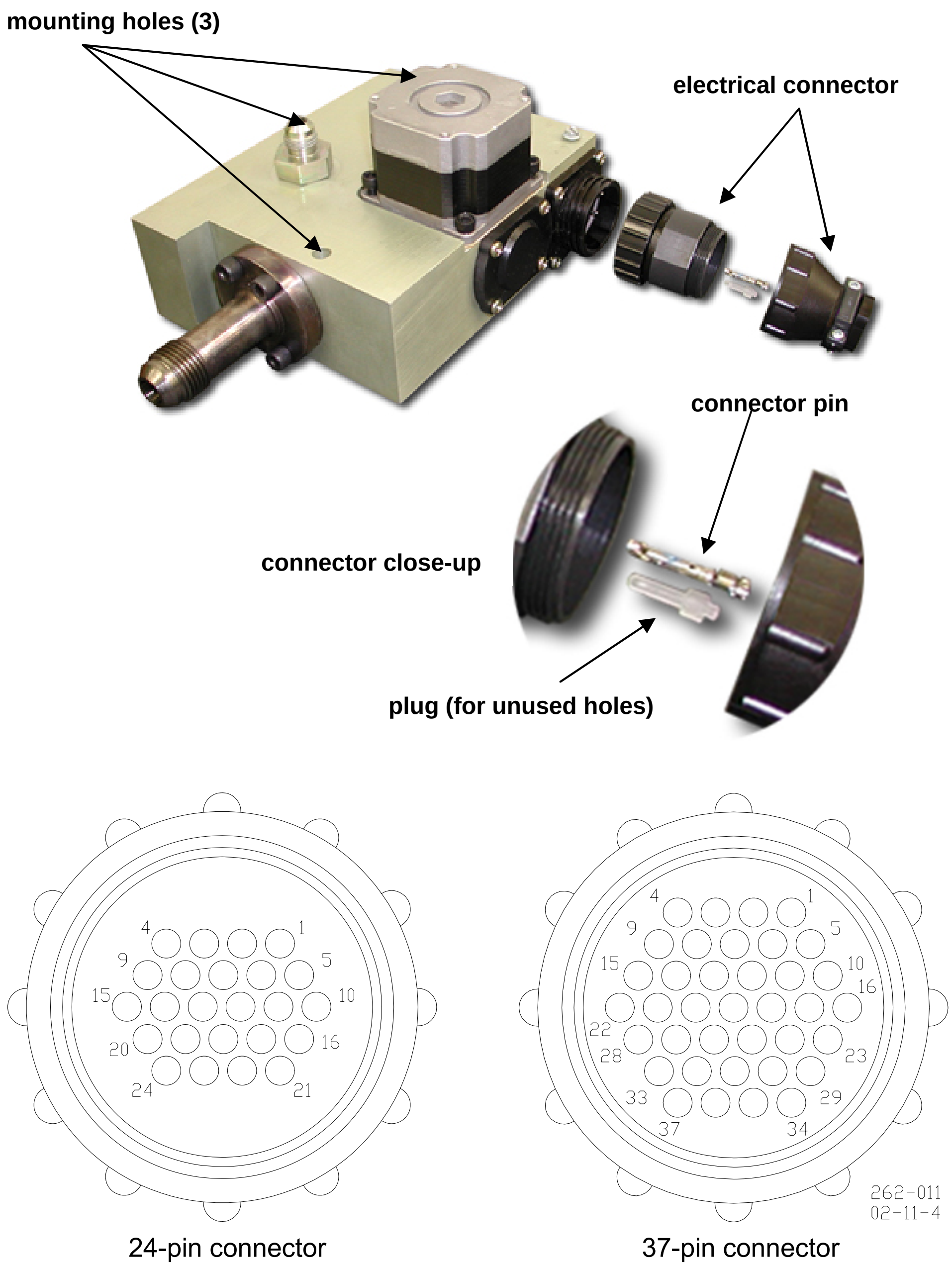


Figure 3-2. Swift Valve Wiring Assembly Overview

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

- 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).

Valve Stepper Motor Connections

Each driver channel has step motor inputs for connection to the Swift driver.

Swift Driver

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 in).

⚠WARNING

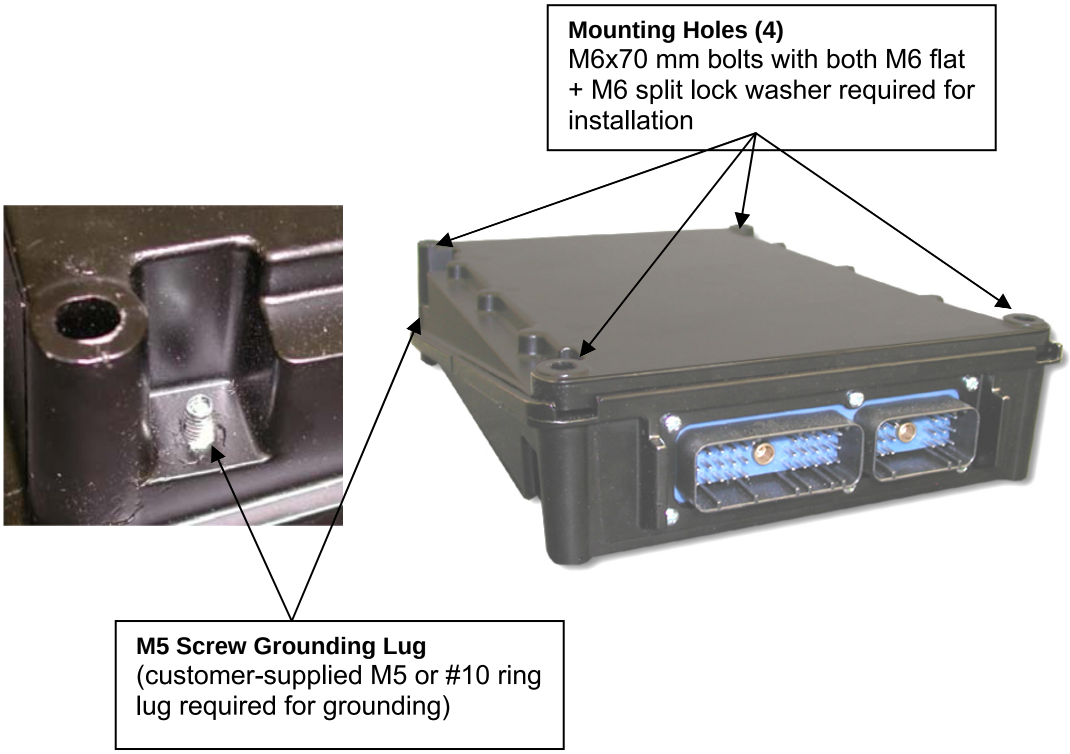
If the recommended cable distances between power source and valves are exceeded, missed steps may result. The total length from power supply to driver plus driver to valve distance should not exceed 7.6 m (25 ft).

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

The interface for the Swift Driver is vai two PCB-mounted, sealed automotive-style receptacles, which protrude through the driver enclosure (see Figure 3-4). Wiring harness mating is accomplished using two separate plugs, one 30-pin (J1) and the other 18-pin (J2).

IMPORTANT

All wiring accessories and connections to the driver are provided by the customer.



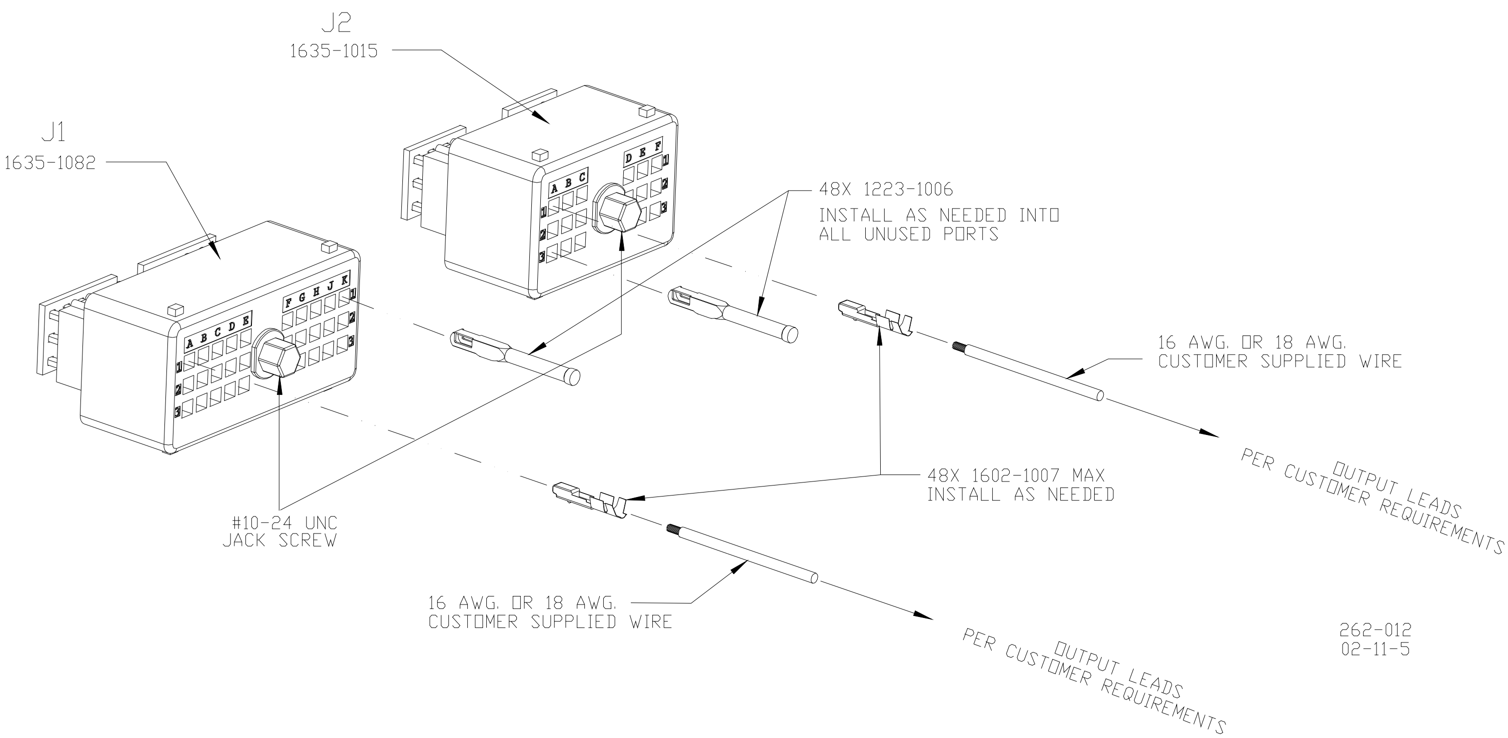


Figure 3-3. Driver Wiring Assembly Overview

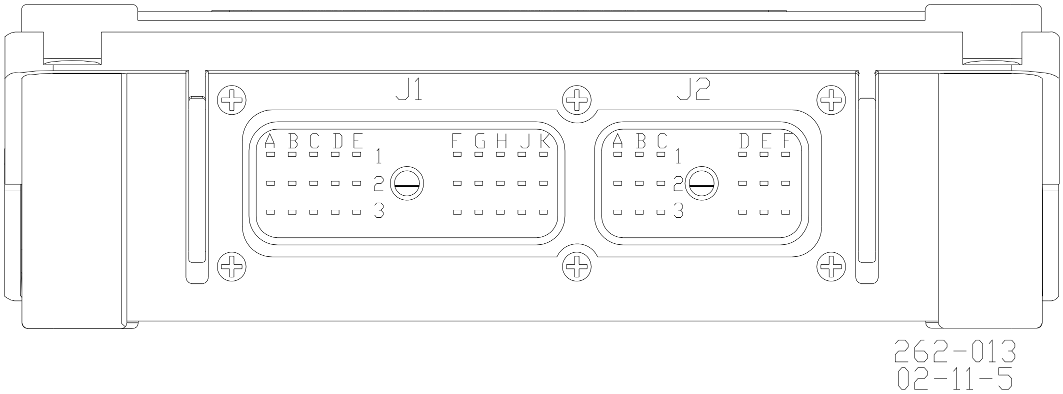
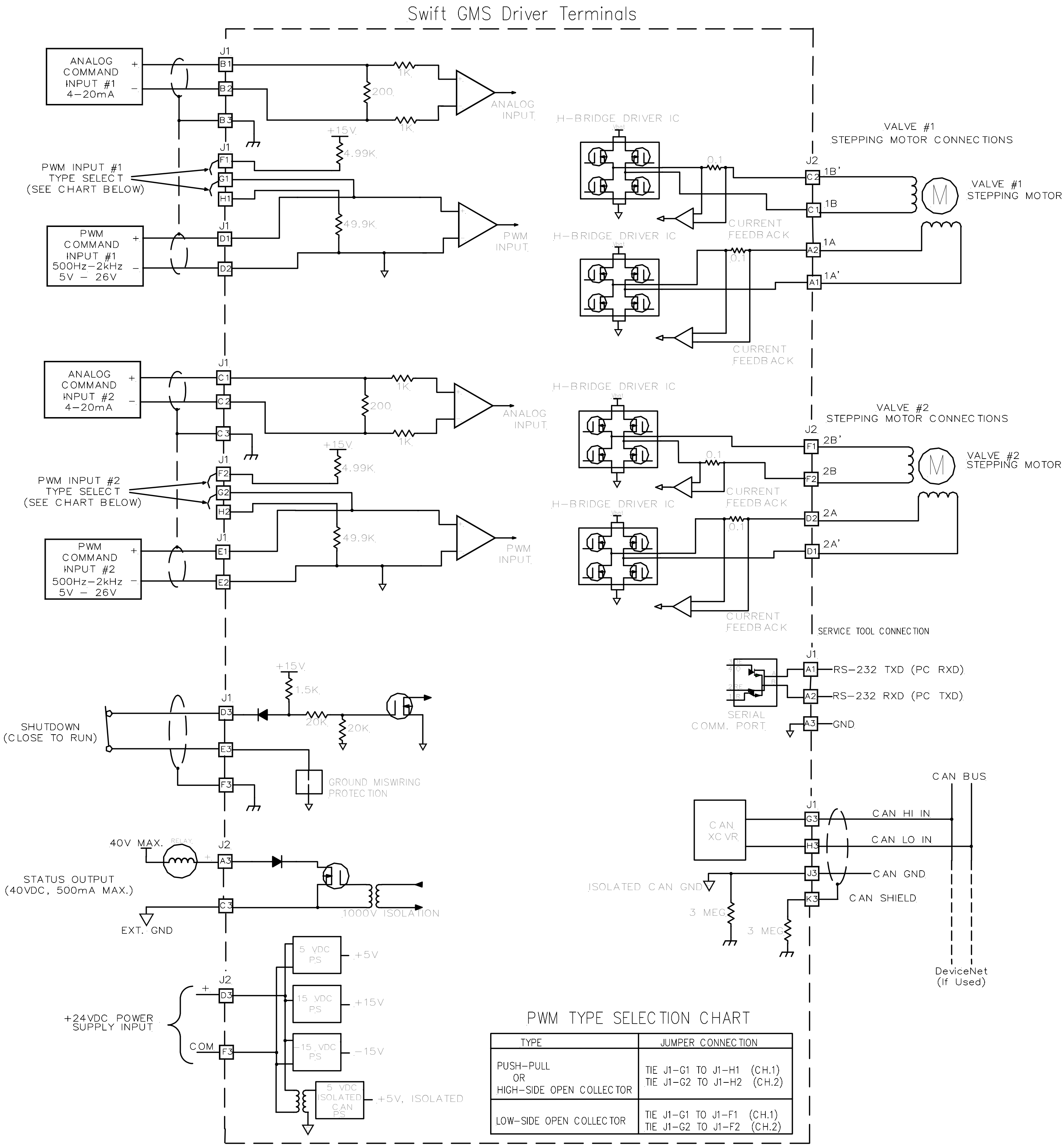


Figure 3-4. Driver Connector Pin Locations
(viewed looking at the driver housing)

Connector Components for Figure 3-3

	Woodward P/N	Cinch P/N
Connector Kit	6995-1013	
J1 30-pin Connector	1635-1082	581 01 30 0295
J2 18-pin Connector	1635-1015	581 01 18 023S
Socket Connector	1602-1007	425 00 00 873/872
Seal Plug (for empty sockets)	1223-1006	581 00 00 011
Recommended Tools		
Connector Fabrication Hand Tools Kit	6995-1009	
• contains the following tools:		
Terminal Crimp Tool	8996-2000	599 11 11 616
Terminal Removal Tool	8996-2001	581 01 18 920
Secondary Lock Removal Tool	1012-2345	599 11 11 628

- Insert seal plugs in all empty connector wire ports.
- Customer wiring to be 0.8 or 1.0 mm² (16 or 18 AWG).



TYPE	JUMPER CONNECTION
PUSH–PULL OR HIGH–SIDE OPEN COLLECTOR	TIE J1–G1 TO J1–H1 (CH.1) TIE J1–G2 TO J1–H2 (CH.2)
LOW–SIDE OPEN COLLECTOR	TIE J1–G1 TO J1–F1 (CH.1) TIE J1–G2 TO J1–F2 (CH.2)

Figure 3-5. Representative I/O Schematic

Jumpers

The only jumpers necessary are those to select the type of PWM used (push-pull or open collector). If PWM is not used, jumpers are not required. The jumper function must be wired external to the driver as part of the harness wiring. For details on jumpers for PWM type selection, refer to the PWM Type Selection Chart in Figure 3-1a.

Internal Switches and Test Points

Figure 3-6 and Table 3-1 identify the test points and Demand Source switch selection internal to the driver. If the driver is opened, the four M5 screws must be re-torqued to 5.1 N·m (45 lb-in), while observing appropriate electrostatic discharge precautions (see page iii). All voltages are referenced to Common (digital ground DGND – TP5 or TP19) with the exception of the CANbus voltage (TP24) which is referenced to CANbus Common (TP23).

⚠WARNING

Do not use any test points on the power supply or control boards unless the area is known to be non-hazardous.

⚠AVERTISSEMENT

Ne pas utiliser les bornes d'essai du block d'alimentation ou des cartes de commande à moins de se trouver dans un emplacement non dangereux.

Test Point	Function	Tolerance
TP1	–15 V	±2.79 V
TP2	+15 V	±2.34 V
TP3	Analog Input #1 Command Signal (0–25 mA = 0–5 V)	
TP4	VppON (internal function)	N/A
TP5	Common (DGND)	N/A
TP6	Analog Input #2 Command Signal (0–25 mA = 0–5 V)	
TP7	Valve 2 Coil A Feedback (–5 to +5 A = 0 to 5 V)	
TP8	Valve 1 Coil A Feedback (–5 to +5 A = 0 to 5 V)	
TP9	PWM Input #1 Command Signal	
TP10	PWM Input #2 Command Signal	
TP11	Valve 2 Coil B Feedback (–5 to +5 A = 0 to 5 V)	
TP12	Test Signal Output (internal use only)	
TP13	MP_MC (internal use only)	N/A
TP14	+5 V	±0.33 V
TP15	ClkOut (internal use only)	N/A
TP16	+5 V Ref	±0.33 V
TP17	+3.3 V	±0.22 V
TP18	Valve 1 Coil B Feedback (–5 to +5 A = 0 to 5 V)	
TP19	Common (DGND)	N/A
TP20	+1.8 V	±0.11 V
TP21	+15 V	±2.34 V
TP22	–15 V	±2.79 V
TP23	Common for +5 V CANbus (C GND)	N/A
TP24	+5 V C (CANbus)	±0.33 V

Table 3-1. Driver Test Points and Switches

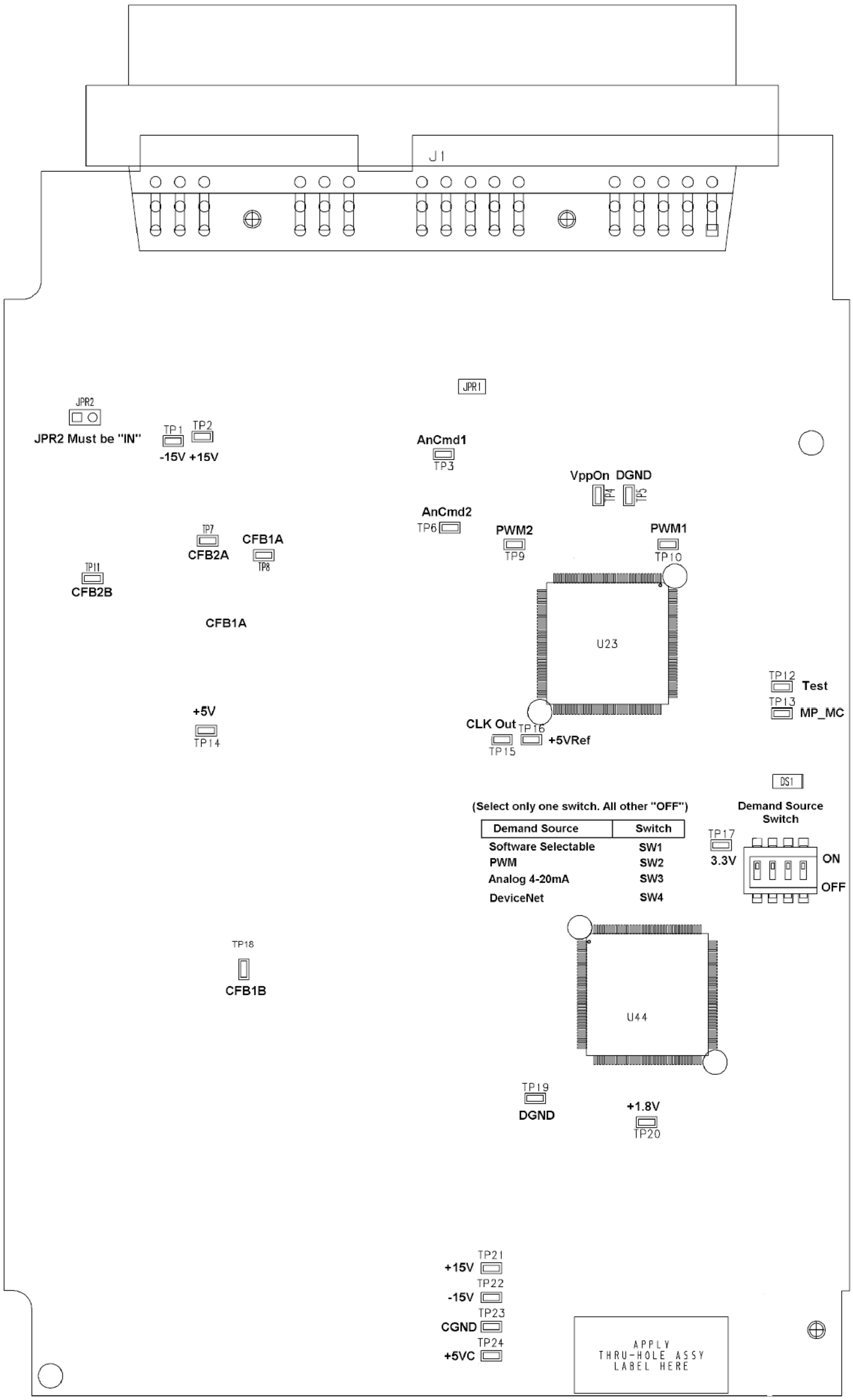


Figure 3-6. Internal Driver Test Points and Switches

Jumper Selection of Demand Source

Four internal switches are utilized to select the appropriate demand source. Upon a driver power up, the switch locations (or optional jumpers) will determine the selected demand source. If the selection is 'Software', then the Service Tool can be used to permanently modify the demand source between Analog, PWM, and DeviceNet. If the selection is not 'Software', changes can be made to the demand source, but the demand source will revert back to the jumper selected mode on the next driver power-up cycle.

Demand Source	Switch/Jumper Selection
Software	Switch 1
PWM	Switch 2
Analog 4–20 mA	Switch 3
DeviceNet	Switch 4

Table 3-2. Driver Demand Source Jumper Selection

Swift Driver Inputs/Outputs

IMPORTANT **The driver and valve(s) are shipped as a matched set and must remain together.**

Driver Input Power

The following table summarizes the driver power input requirements. The input voltage operational range is 21.5–28 Vdc, 24 Vdc nominal. The power input provides protection against reverse voltage connection. Refer to Table 3-3 for maximum cable lengths and wire sizes.

Input Power Fusing

⚠WARNING **The input power must be fused. Failure to fuse the Swift could, under exceptional circumstances, lead to personal injury, damage to the control valve, and/or explosion.**

Recommended fuse rating–Driver: 5 A Slow Blow Fuse

All fuses should have a voltage rating of at least 100 V and an I^2t rating greater than 2 $Amps^2$ seconds. A typical fast acting fuse will meet these ratings, although the use of a slower fuse could be beneficial to minimize nuisance trips upon power-up due to inrush current. The power supply inrush current of the Swift driver peaks at 35 A for a duration of 100 µs, settling within 700 µs.

Input Power Wire Length Considerations

Input power wire lengths should be as short as possible. Maximum wire lengths are shown in Table 3-3.

⚠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).**

Device 1	Device 2	Max cable Length	Cable Type
Driver	Power supply	See Note 1	0.8/1.0 mm² 16/18 AWG
Driver	Engine/package control	8 m/25 ft	0.8/1.0 mm² 16/18 AWG
Driver	HMI service tool	15 m/50 ft	0.8/1.0 mm² 16/18 AWG
Driver	Valve	See Note 1	0.8/1.0 mm² 16/18 AWG
Engine/package control		30 m/100 ft	0.8/1.0 mm² 16/18 AWG

Table 3-3. Max Wire Length

Note 1—The total length from power supply to driver plus driver-to-valve distance should not exceed 8 m/25 ft.

NOTICE

Unless otherwise specified, to ensure EMC compliance, field wiring must not exceed the maximum cable length requirements in Table 3-3.

Position Command Input

There are three possible position command signals. See the table below for an overview of the signals and corresponding input signal-to-valve position. All adjustments are done via the Service Tool software (see chapter 7). All circuits are protected against short circuit to battery negative. These short circuits will not cause damage to the control.

Input Signal	Nominal Range	Adjustment Range	Valve Output for Input Range
PWM: 5 to 26 V 500 Hz to 2 kHz	10% to 90% Duty Cycle	5% to 95% Duty Cycle	0% to 100% Valve Position
Analog: 4 to 20 mA	4 to 20 mA	0.0 to 25 mA	0% to 100% Valve Position
DeviceNet Command	0 to 100 %	n/a	0% to 100% Valve Position

Table 3-4. Positioning Command Input

The position command is selected either by the Service Tool's configured demand source or by the internal jumper/switch selection. The internal jumper/switch selection has priority; every power cycle of the driver will re-select this demand selection. Refer to the Jumper Selection of Demand Source section earlier in this chapter.

Analog Position Command Signal

The analog input will accept a 0–25 mA input signal with a nominally configured operational range of 4–20 mA. The position command input will be capable of providing a common mode input voltage range (power source ground referenced) of 0–32 volts for all analog type inputs.

PWM Position Command Signal

The PWM input will accept a push-pull or open-collector 500 to 2000 Hz PWM input signal of 5 to 26 volts peak voltage (referenced to unit ground). The position command input will be capable of providing a common mode input voltage range (unit ground referenced) of 0 to 4 volts for all PWM type inputs.

Connector-side jumpers are required to select the desired push-pull or open-collector PWM circuitry (see Figure 3-5 for details).

Shutdown/Reset Discrete Input

This discrete input is closed to 'run' and opened for a shutdown mode. When the discrete input is opened, both valves are commanded to the closed position. All communications (CAN/DeviceNet and RS-232) remain active while in this mode. When the discrete input is closed, a reset command is issued to clear all latched alarms or shutdowns that no longer exist. When the input is closed and all shutdown conditions are cleared, the driver will position the valve outputs to the demanded settings.

IMPORTANT **The Shutdown/Reset discrete input must be closed to run the driver and open the valves.**

Discrete Output

A discrete output is provided to serve as a status indicator. If the driver fails or shuts down, the discrete output will open. The circuit can drive up to 500 mA and can handle a maximum voltage of 40 V.

Communications

Service Port

An RS-232 service port is provided through the 48-pin interface connector. Functions available through this port include monitoring and configuration of the driver and actuator. Detailed driver status information is also available.

IMPORTANT **A separately purchased Service Port adaptor cable is available from Woodward (5450-1010) to facilitate the Service-Port-to-Service-Tool connection. This adaptor provides a female DB9 connection.**

Any RS-232 wiring must meet the requirements in the EIA RS-232 Standard document. The RS-232 standard states that the maximum length of the RS-232 cable between the driver and the PC must be 15 m (50 ft) with a total capacitance less than 2500 pF. The RS-232 data rate is fixed at 38.4 kbps. The communication port is non-isolated and susceptible to both EMI noise and ground loops related to PC connections and typical industrial environments.

IMPORTANT **The service port is not isolated and is not intended to function while the prime mover is in normal operation. The service port is provided for configuration and setup only.**

CAN Communications

The CAN wiring must meet the requirements in the ISO 11898 specification. The data rate is software configurable between 125 Kbits/s, 250 Kbits/s, and 500 Kbits/s. Maximum cable length specifications based on the data rate can be found in Chapter 10 (Specifications).

The device address (Mac ID) is set in software using the Service Tool. A driver power cycle (power-down and -up) is required for data rate and device address changes to take affect.

Chapter 4.
Setup, Calibration, and Configuration

General Description

Setup, calibration, and configuration adjustments are all provided through software. To use these functions, the Service Tool must be installed. Refer to Chapter 7 (Service Tool) for instructions on installation and operation of the Service Tool.

Setup

Setup and configuration must be performed when the prime mover is shut down.

Calibration

The Swift™ driver requires no field calibration. The analog signals are factory calibrated. Valve-to-valve flow differences are calibrated out at the factory using the efficiency tables.

Configuration

Configuration adjustments are provided to optionally fine-tune an application. Configuration is not required on most OEM-supplied units. Configuration is performed using the Service Tool (see Chapter 7). Over 20 adjustable configuration parameters are available. Appendix A provides a Program Summary worksheet which gives an overview of the Service Tool configuration settings available as well as a form to document individual application settings.

Chapter 5. Description of Operation

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 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.

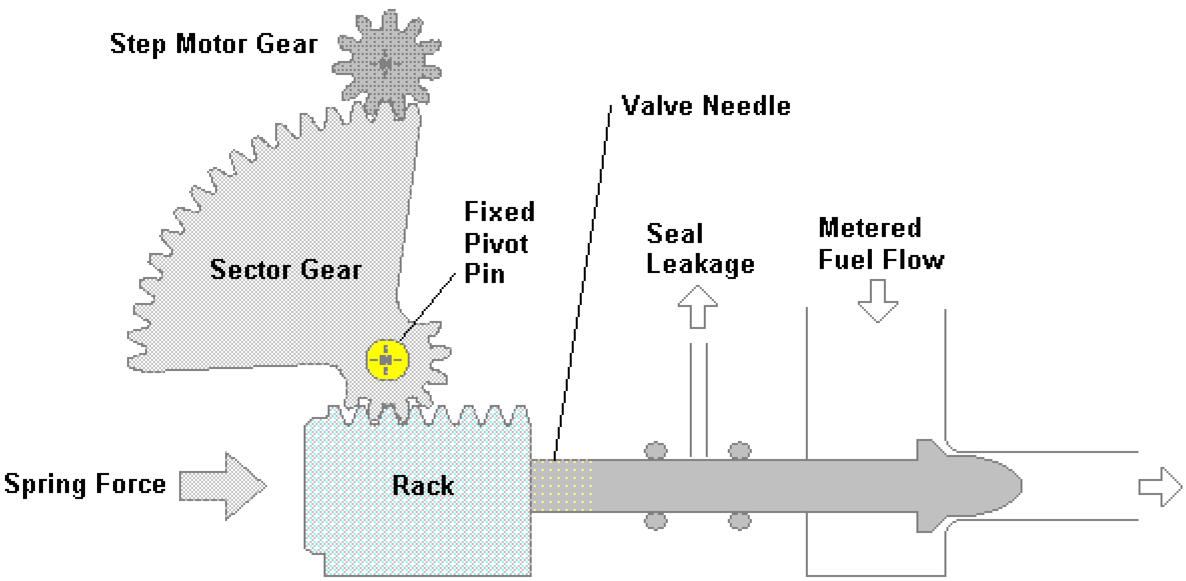


Figure 5-1. Valve Schematic

Accuracy

Overall system flow control accuracy for valve sizes 65, 36, and 20 is 2% of point at 100% prime mover load. Overall system flow control accuracy for valve size 11 is 6% of point at 100% prime mover load. An additional 1% is added if a 4–20 mA demand signal is used.

Repeatability

Repeatability is less than ±5% valve-to-valve variation from the nominal ACd curve. For individual valves, repeatability is less than 1% of point. The light-off condition occurs at ~20% of total flow through the primary fuel valve; the secondary fuel valve is closed at light-off (if applicable).

Metering Valve Characterization

Valve nominal effective area (ACd) vs. % valve position for the particular Swift metering valve model size (family characterization data) will be stored in the engine/package control. The nominal effective area family curves for each valve size is provided in Chapter 10 (Specifications). Individual valve characterization data is stored in the Swift driver, accounting for valve-to-valve differences in flow. Therefore, the valve and driver are linked at the point of calibration testing. The driver/valve system contains a common identifying serial number to field verify that the Swift driver and Swift valve are a matched set.

The position command sent to the Swift driver by the engine/package control is in percent of valve travel. The Swift driver will modify the percent valve position command received from the engine/package control, using the calibration data in the efficiency curve, to account for the variation from the nominal ACd vs. % valve position for the particular matched set valve.

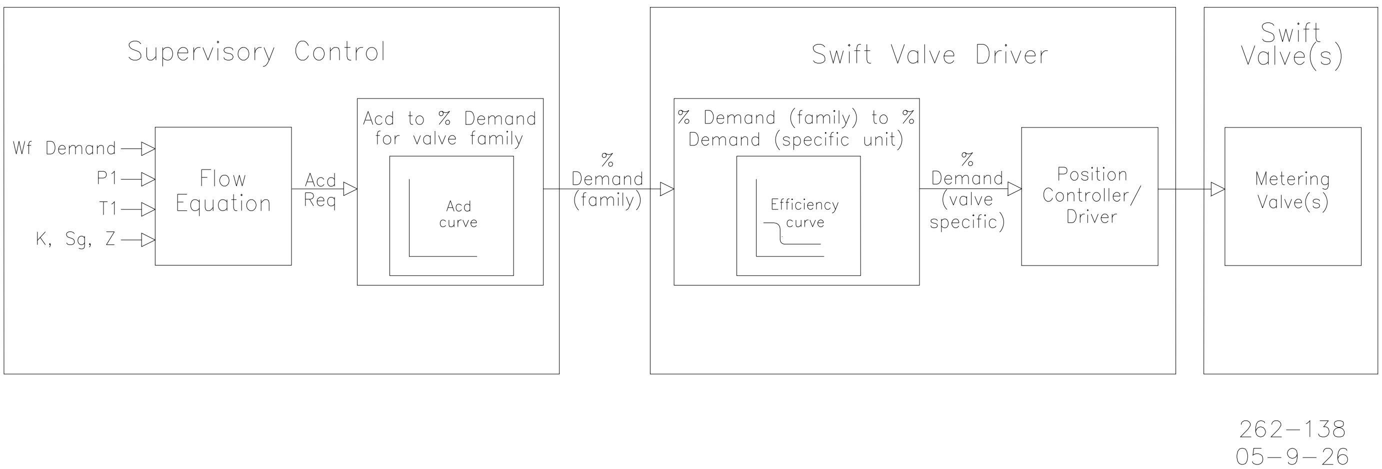


Figure 5-2. Flow Demand Overview

Fuel Properties

The fuel properties such as specific gravity or heating value will be compensated for in the engine/package control. The Swift driver does not use the fuel property data.

Re-zero Valve Position

The Swift driver performs a re-zero of the Swift metering valve(s) upon driver power-up initialization. In addition, clearing of certain shutdown conditions will cause a re-zero function to re-establish position control.

Swift Driver

Position Control

The Swift Gas Metering System provides open-loop position control based on an internal position calculation and the desired position demand signal. Software model-based position and current controllers are utilized to position the output. A discrete output is also available to provide a status indication of the driver itself.

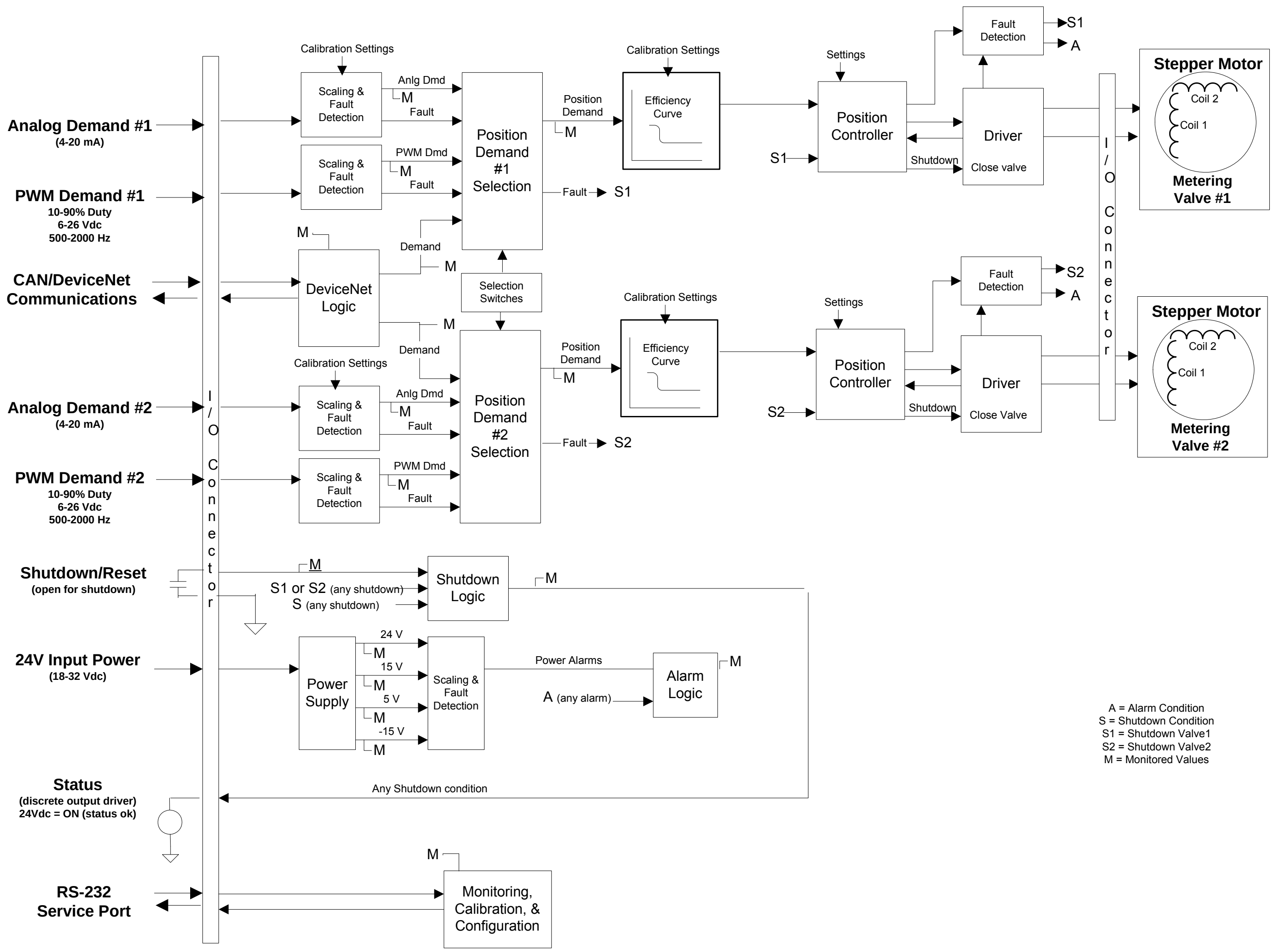


Figure 5-3. Driver Functional Overview

Position Demand

The position demand can be provided by any one of three configurable signal sources: analog, PWM, or CAN. The position demand input signals are internally scalable to match the demand of the signal's source. Failure of any configured position demand signal will issue a shutdown and command the valve to the closed position. Software adjustments are available for min and max position demands.

Driver Output

If the current to the valve is out of range, the driver is put into the shutdown state and the valve is commanded to a closed position. Upon power-up, the unit will stay disabled until the problem is rectified and a position command signal has been received in the proper range.

Communications

The driver has two communications ports; one CAN port and one RS-232 service port. The CAN port provides operation and monitoring capability. The service port provides the capability to perform factory calibration and test, customer/site configuration, tunable parameter and performance tuning, and overall driver monitoring. The PC-based service tool allows the Swift Gas Metering System software to be updated by Woodward factory or field service technicians.

CAN Communications

The CAN port supports positioning (position demand from CAN) of the Swift metering valve. It also supports Swift Gas Metering System monitoring of all shutdown and alarm conditions as well as some system variables.

The initial CAN implementation is generic and adaptable to various customer applications. The data rate is configurable from 125, 250, and 500 kbps. Communication failure diagnostics are provided and annunciated.

The following are examples of parameters that would be available on CAN.

- Analog parameters including:
  Demanded Position for both valves
- Discrete parameters including:
  Diagnostic Status indications—all individual alarms and shutdowns

Service Port (RS-232) Communications

The Service Port uses RS-232 communications and supports Woodward's ServLink protocol for monitoring and tuning of software variables. The Service Port is used for calibration, troubleshooting, and alarm/shutdown monitoring. Additional functions available through this port include troubleshooting, configuration, and monitoring of the driver and valves. It also supports configuration upload (send) and download (receive) as well as the capability to install a new application program in flash. If CAN is not used, the Service Tool is the only means of identifying/determining specific alarm and shutdown causes.

Service Tool

The Service Tool software resides on a PC (personal computer) and communicates to the driver through the RS-232 Service Port.

Configuration

The Service Tool provides the capability to adjust or monitor all driver-configurable parameters. Examples of configurable parameters include: Demand Source, Demand Scaling, Failure Settings, and DeviceNet Baud Rate and Address (Mac ID).

Monitoring

The Service Tool provides the capability to monitor control values at any time. Viewing and monitoring these parameters is available at any time and is not limited to a shutdown state.

Monitoring is available for, but not limited to, the following parameters:

- Alarms and Shutdowns (individual)
- Demanded Position (2)
- Actual Motor Current Monitor (4)
- Analog Input Monitor (2)
- PWM Input Monitor (2)
- CAN Demanded Position
- Discrete Input Monitor
- Electronics Temperature
- Input Power Monitoring (24 V)
- Internal Power Monitoring (15 V, –15 V, 5 V, 1.8 V)

Chapter 6.
Driver Diagnostics

General Information

There are several diagnostics available in the Swift™ driver, including power-up self-test diagnostics and on-line diagnostics of alarm and shutdown conditions. Driver conditions are monitored and a shutdown of either valve is annunciated through the discrete output. The communications ports also provide complete fault diagnostic indications, identifying the cause of the fault.

An alarm is an indication to the user that there is a condition which may require specific action on the user's part. A shutdown causes the Swift driver to take action by forcing the valve to close or power off, depending on how the shutdown is configured.

Power-up Diagnostics

The Swift Gas Metering System provides power-up self-test diagnostics. After successfully completing the power-up diagnostics, the driver verifies all coil connections by driving current to each coil individually. Lastly, the driver performs a re-zero function. Upon successful completion of the power-up self-tests, coil checks, and re-zero, the driver provides position control functionality and activates the Status discrete output.

On-line Diagnostics

Once the power-up tests are completed, the unit starts controlling and provides on-line indication of alarms and shutdowns. The Discrete Output turns off to indicate a shutdown or alarm condition. Individual Shutdown and Alarm conditions can be monitored through the CAN or RS-232 communications links.

Shutdowns Detection and Annunciation

A shutdown condition forces the valve to a closed position regardless of the demanded position. All shutdown conditions are latching and require a “reset” command. Upon reset (when the shutdown condition no longer exists), the driver returns to a non-shutdown state following the Position Demand input command.

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

Shutdown—Valve Closed

When shut down, the Swift Driver forces the valve to its closed position. The valve remains 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 Swift Driver attempts to close the valve, and then the output current is removed. It remains in this position until the shutdown condition is cleared by a reset command. When the condition is restored, the driver performs a re-zero to re-establish the position of the valve's minimum stop.

Alarms Detection and Annunciation

An alarm condition is a warning that the driver has determined that something is not operating properly. The driver takes no additional action other than annunciating the alarm condition. The alarm condition is latching and requires a reset to return to a non-alarmed state.

Alarm and Shutdown Reset

A reset command can be issued from the Alarms or Shutdown tab sheets on the Service Tool, from DeviceNet, or by opening and re-closing the Shutdown/Reset discrete input.

Individual Fault Conditions

Here is a detailed description of the Swift driver diagnostics. By default, all identified fault conditions listed are factory configured to shut down the Valve/Driver.

External Shutdown Input
A shutdown was commanded by the opening of the Shutdown/Reset discrete input for longer than 4 ms. The discrete input must be closed to run.

Power Source Voltage Low
This is caused by an out-of-range input power source. The fault is enabled when the 24 V input voltage is below 17 V for more than 50 ms. Verify the input signal. If the input seems proper, monitor the input voltage using the Service Tool.

Power Source Voltage High
This is caused by an out of range input power source. The fault is enabled when the 24 V supply voltage reads higher than 33 Vdc for more than 50 ms. Verify the input signal. If the input seems proper, monitor the input voltage using the Service Tool.

Overtemperature (Valve #1 and #2)
This indicates high temperature as indicated by the H-bridge stepper motor driver chip. The error is annunciated as a thermal when the junction temperature in the driver chip reaches 145 °C. This fault can be an indication of a short in the coil wiring.

Coil A Fault (Valve #1 and #2)
This indicates incorrect 'A' coil wiring. This check is performed during the power-up tests.

Coil B Fault (Valve #1 and #2)
This indicates incorrect 'B' coil wiring. This check is performed during the power-up tests.

Coil Current Error (Valve #1 and #2)
This indication a current error in one or both of the coils. Total current measured is lower than the expected current to operate the unit, indicating a fault in the driver, wiring, or coils. Verify coil wiring—could be open, loose, or cross-connected.

Analog Input Low fault (Valve #1 and #2)
This indicates the analog input signal is below the failure setting. The error is enabled when the Analog Input signal is configured for use and is below the failure setting for longer than 50 ms. The analog demand is disabled until the signal is restored and reset. Verify the input signal. If the input seems proper, monitor the input in the Service Tool and check the failure settings (Lower Threshold Range Fault Setting).

Analog Input High fault (Valve #1 and #2)
This indicates the analog input signal is above the failure setting. The error is enabled when the Analog Input signal is configured for use and is above the failure setting for longer than 50 ms. The analog demand is disabled until the signal is restored and reset. Verify the input signal. If the input seems proper, monitor the input in the Service Tool and check the failure settings (Upper Threshold Range Fault Setting).

PWM Frequency Low Error (Valve #1 and #2)
This indicates a problem with the frequency of the PWM input signal—indicates input frequency is below the failure setting. The error is enabled when the PWM Input signal is configured for use and is below the failure setting for longer than 50 ms. The PWM demand is disabled until the signal is restored and reset. Verify the input signal. If the input seems proper, monitor the input in the Service Tool and check the failure settings (Lower Threshold Frequency Fault Setting).

PWM Frequency High Error (Valve #1 and #2)
This indicates a problem with the frequency of the PWM input signal—indicates input frequency is out of range (low/high). The error is enabled when the PWM Input signal is configured for use and is above the failure setting for longer than 50 ms. The PWM demand is disabled until the signal is restored and reset. Verify the input signal. If the input seems proper, monitor the input in the Service Tool and check the failure settings (Upper Threshold Frequency Fault Setting).

PWM Duty Cycle Low Error (Valve #1 and #2)
This indicates a problem with the duty cycle of the PWM input signal—indicates input duty cycle is below the failure setting. The error is enabled when the PWM Input signal is configured for use and is below the failure setting for longer than 50 ms. The PWM demand is disabled until the signal is restored and reset. Verify the input signal. If the input seems proper, monitor the input in the Service Tool and check the failure settings (Lower Threshold Duty Cycle Fault Setting).

PWM Duty Cycle High Error (Valve #1 and #2)
This indicates a problem with the duty cycle of the PWM input signal—indicates input duty cycle is above the failure setting. The error is enabled when the PWM Input signal is configured for use and is above the failure setting for longer than 50 ms. The PWM demand is disabled until the signal is restored and reset. Verify the input signal. If the input seems proper, monitor the input in the Service Tool and check the failure settings (Upper Threshold Duty Cycle Fault Setting).

PWM Signal Failure (Valve #1 and #2)
This is caused by failure of the input signal or hardware, which is continuously checked. Set if there are no pulses on the PWM input. The error indicates no input signal is detected for longer than 50 ms and the input signal is configured. The error is disabled when the signal is restored. The PWM demand is disabled until the signal is restored and reset. Refer to the PWM Duty Cycle and Frequency Error descriptions above for troubleshooting and possible adjustments.

DeviceNet Fault
This is caused by loss of communications on the CAN port which is checked continuously. The alarm is enabled only when CAN is configured for use. The DeviceNet demand is disabled until the signal is restored and reset. Verify the input signal connections, device address, data rate, termination resistors, etc. Verify the DeviceNet settings in the driver using the Service Tool (Baud Rate and MAC Address); a power cycle is required for configuration changes to take effect.

DeviceNet Shutdown Command (Valve #1 and #2)
A Shutdown was commanded through the DeviceNet communication link. This command is available to shutdown both valves at once or each valve individually. The DeviceNet demand is disabled until a reset command is issued.

Internal Fault Conditions

Here is a detailed description of the Swift driver internal fault diagnostics. For any of the Internal Fault Conditions, cycle power on the driver and issue a reset command. If the fault condition remains, the driver must be returned for repair.

ADC (A/D Converter) Error
This is caused by faulty hardware or software. The A/D converter is not getting interrupts and is not providing updated conversions for more than 50 ms.

SPI ADC (A/D Converter) Error
This is caused by a failure of the analog to digital converter. The A/D converter is not communicating or did not complete all of its conversions for more than 5 ms.

Internal Watchdog Timeout
Internal run-time software watchdog timeout error of 1 second. If a watchdog timeout error is detected the driver will shut down and attempt to restart.

Sensed +1.8 V Out of Range
This is caused by faulty hardware. The 1.8-volt supply voltage is incorrect. An internal 1.8V supply voltage must be correct in order for the electronics on the PCB to function properly. The CPU monitors this voltage and generates a diagnostic if it is not in tolerance. The error is enabled when the 1.8 V reads less than 1.69 Vdc or higher than 1.91 Vdc for more than 50 ms.

Sensed +5 V Out of Range
This is caused by faulty hardware. The 5-volt supply voltage is incorrect. An internal +5 V supply voltage must be correct in order for the analog electronics on the PCB to function properly. The CPU monitors this voltage and generates a diagnostic if it is not in tolerance. If the voltage is outside the operational range of the processor the CPU will go into a reset state. While the CPU is in the reset state the Swift Gas Metering System will not function. The error is enabled when the 5 V reads less than 4.66 Vdc or higher than 5.33 Vdc for more than 50 ms.

Sensed +5 V Reference Out of Range
This is caused by faulty hardware. The 5-volt reference supply voltage is incorrect. An internal +5 V supply voltage must be correct in order for the electronics on the PCB to function properly. The CPU monitors this voltage and generates a diagnostic if it is not in tolerance. The error is enabled when the 5 V REF reads less than 4.67 Vdc or higher than 5.33 Vdc for more than 50 ms.

Sensed –15 V Out of Range
This is caused by faulty hardware. The –15 volt supply voltage is incorrect. An internal –15 V supply voltage must be correct in order for the analog electronics on the PCB to function properly. The CPU monitors this voltage and generates a diagnostic if it is not in tolerance. The alarm is enabled when the –15 V reads less than –12.21 Vdc or higher than –17.79 Vdc for more than 50 ms.

Sensed +15 V Out of Range
This is caused by faulty hardware. The 15-volt supply voltage is incorrect. An internal +15 V supply voltage must be correct in order for the analog electronics on the PCB to function properly. The CPU monitors this voltage and generates a diagnostic if it is not in tolerance. The alarm is enabled when the 15 V reads less than 12.66 Vdc or higher than 17.34 Vdc for more than 50 ms.

EEPROM Write Fail
This error is set if writes to the main EEPROM fail. When writing to the EEPROM, every byte is checked to ensure it is entered into the EEPROM correctly. If the value read from the EEPROM is different from the value written to the EEPROM, a new write is executed and a retry counter will be incremented. After five retries, the EEPROM Error is set and the driver will shut down.

EEPROM Read Fail
This error is set if reads from the EEPROM fail. The EEPROM will always be read twice during operation. If the two values do not match, a retry will be executed and a retry counter will be incremented. After five retries, the EEPROM Error will be set and the driver will shut down.

Parameter Error
There is an error detected in the parameter set. Two redundant sets of parameters are stored in non-volatile memory. During a read or write cycle, the parameter values are checked. If either set is incorrect (as indicated by their CRC16 value) the values from the correct set are copied into the incorrect set. If both sets are incorrect the EEPROM Error is set and the Swift driver will shut down.

Parameter Version Error
The CRC checksum stored with the parameters does not match the checksum of the parameters currently residing in non-volatile memory.

If this error occurs after a program download, this is an indication that the EE structure has changed and the EEPROM must be initialized before the unit will operate.

Auxiliary CPU Error
The Aux CPU did not initialize, it has not been loaded with its program correctly or is not running within the allocated time.

Chapter 7.
Service Tool

Description

The Service Tool software is used to configure, monitor, and troubleshoot the Swift™ driver. The screens displayed by the Service Tool are auto-generating based on the Configured Demand Source. This chapter describes installation and use of the Service Tool. It identifies the parameters available in the Swift product that can be viewed using the Service Tool. It also provides information on configuring the Swift driver to the customer-specific field application.

The Service Tool software resides on a PC (personal computer) and communicates to the Swift driver through the driver's RS-232 service port.

⚠WARNING	**An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.**

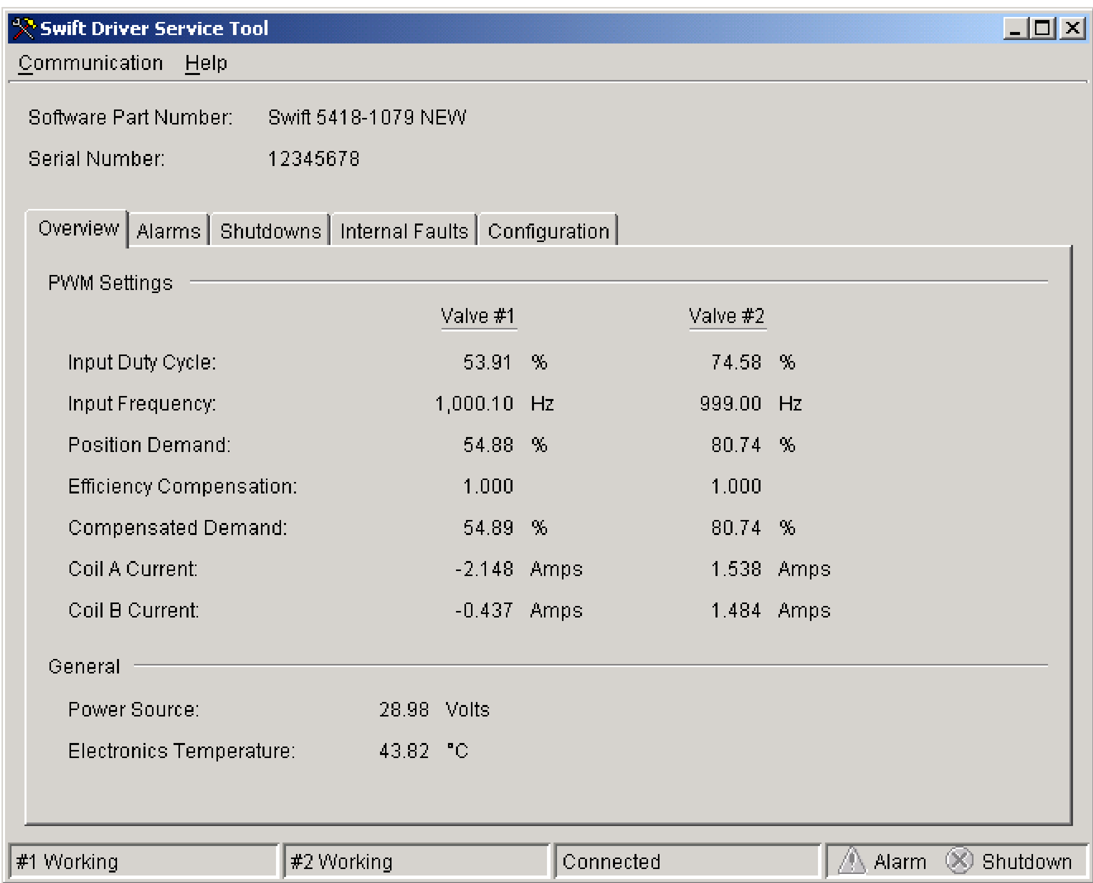


Figure 7-1. Example Service Tool Screen

Getting Started

Installation Procedure

Download the Swift Driver Service Tool software from the Woodward website (**www.woodward.com/software**). The setup program will guide you through the installation.

What to Do Next

After the software is installed, connect a serial communications cable between the RS-232 connections on the Swift control and an unused serial port on your computer. Run the Service Tool program and select the appropriate comm port. Once connected to the driver, the status bar will display 'connected' and the Service Tool screen will populate with monitor parameters.

Service Tool Help

More help on using Service Tool is available and included with the installation of the Service Tool product. Service Tool Help can be accessed from the Service Tool 'Contents' drop-down window selection under the Help menu located on the Main Window.

Software Version Identification

The Service Tool software version can found by selecting 'About' under the Help menu. The Swift software version is identified as the 'Software Part Number' on the Service Tool screen. The Service Tool and Swift driver must be connected to view this information. Refer to this version information in any correspondence with Woodward.

Driver Configuration

The Configuration parameters are found on the right-most tab sheet of the Service Tool. This tab sheet is used to verify the configuration settings for the Swift driver. To change the settings, press the Edit Configuration button (see Figure 7-2). This will open the Configuration Editor window (Figure 7-3).

Configuring the Unit

Unit configuration is summarized as follows:

1. Open the Configuration Editor Dialog.
2. Edit the configuration.
3. Load the configuration to the Swift Driver.

IMPORTANT	**As changes are made to Configuration parameters, they are not used by the driver until a save command is issued. Selecting the 'Cancel' button closes the Configuration Editor and does not make any changes to the driver.**

⚠WARNING	**Changes made to the DeviceNet Configuration parameters require a power cycle after they are saved before they will take effect.**

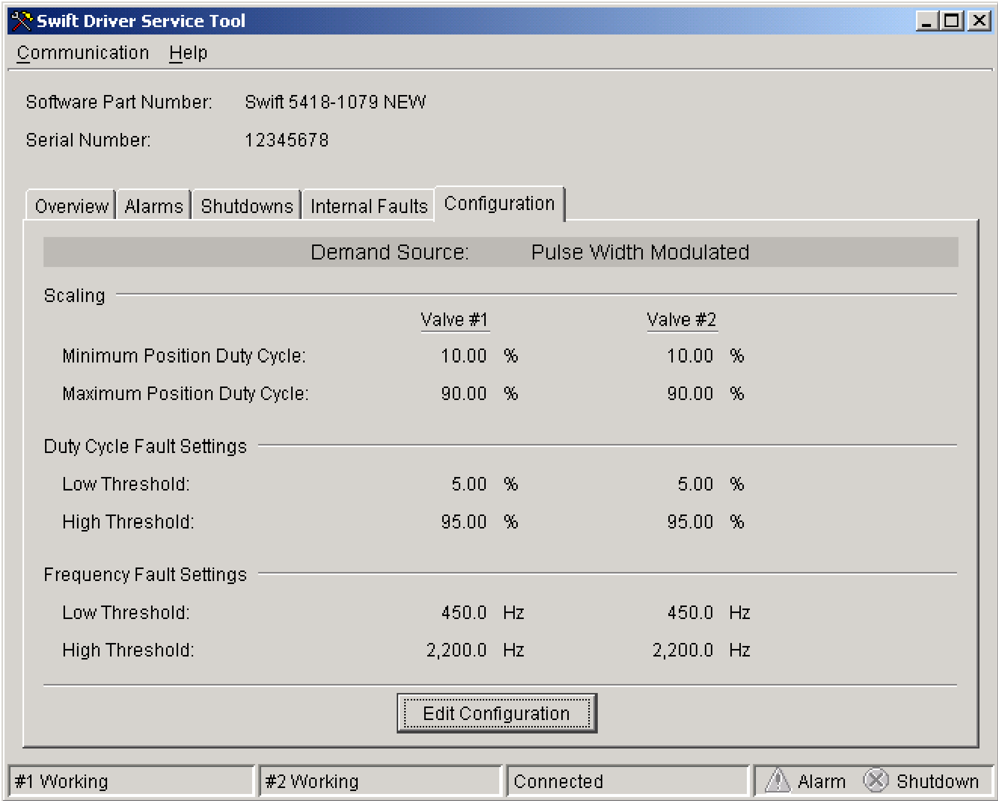


Figure 7-2. Configuration Tab Sheet

Configure Mode Parameters

Overview

Changing the Demand Source will modify the parameter settings available as well as the displayed indications within the Service Tool.

A description of each configuration parameter and its adjustment range is also available in the contents of the Service Tool Help.

Demand Source

The Demand Source can be set to one of the following:
Analog—The Swift driver position demand is received on the Analog Demand Input.
PWM—The Swift driver position demand is received on the PWM Demand Input.
DeviceNet—The Swift driver position demand is received on the DeviceNet bus.
The demand source applies to both driver channels; both are set by the same setting.

⚠WARNING

The internal Demand Source selection switches have priority over the Service Tool Demand Source selection. When the internal switches are set to 'Software' (Switch 1), then Service Tool Demand Source selection will be active.

If the internal Demand Source selection switches are not set to 'Software' (Switch 1), the driver will revert back to the internally selected Demand Source when power is cycled on the driver (see Table 3-2). The Demand Source can be changed and saved using the Service Tool, but changes will be lost when power is cycled. If the Demand Source is 'Software', then all Service Tool changes will be permanently saved.

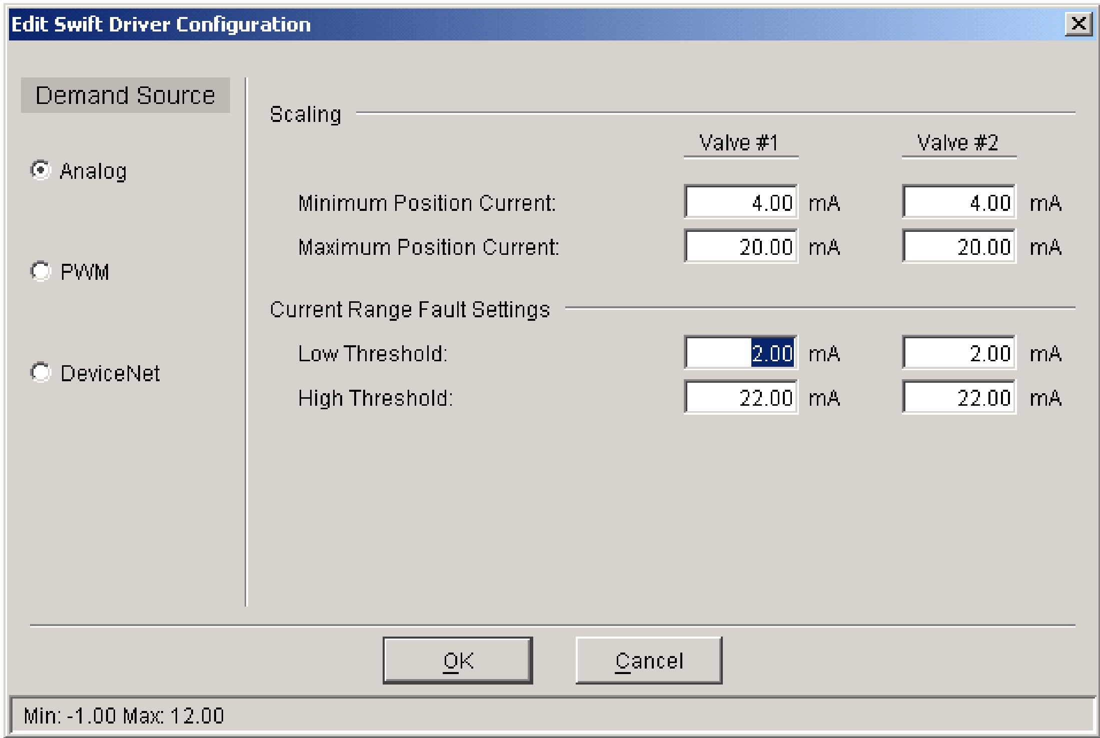


Figure 7-3a. Configuration Editor—Analog Settings

Analog Settings

Minimum Position Current
Sets the Input mA corresponding to 0% valve position.
Allowed values: 0.0—11.99 mA

Maximum Position Current
Sets the Input mA corresponding to 100% valve position.
Allowed values: 12—25 mA

Lower Range Threshold
Sets the Input value, in milliamps, below which corresponds to an input failure.
Allowed values: –1.0 to 12.0 mA

Upper Range Threshold
Sets the Input value, in milliamps, above which corresponds to an input failure.
Allowed values: 12—25 mA

PWM Settings

Minimum Position Duty Cycle
Sets the PWM Duty cycle corresponding to 0% valve position.
Allowed values: 5—49.99%

Maximum Position Duty Cycle
Sets the PWM Duty cycle corresponding to 100% valve position.
Allowed values: 50—95%

Duty Cycle Lower Range Threshold
Sets the Input value, in percent duty, below which corresponds to an input failure.
Allowed values: –5 to 50%

Duty Cycle Upper Range Threshold
Sets the Input value, in percent duty, above which corresponds to an input failure.
Allowed values: 50—99%

Frequency Lower Range Threshold
Sets the Input value, in hertz, below which corresponds to an input failure.
Allowed values: 300—2200 Hz

Frequency Upper Range Threshold
Sets the Input value, in hertz, above which corresponds to an input failure.
Allowed values: 300—2200 Hz

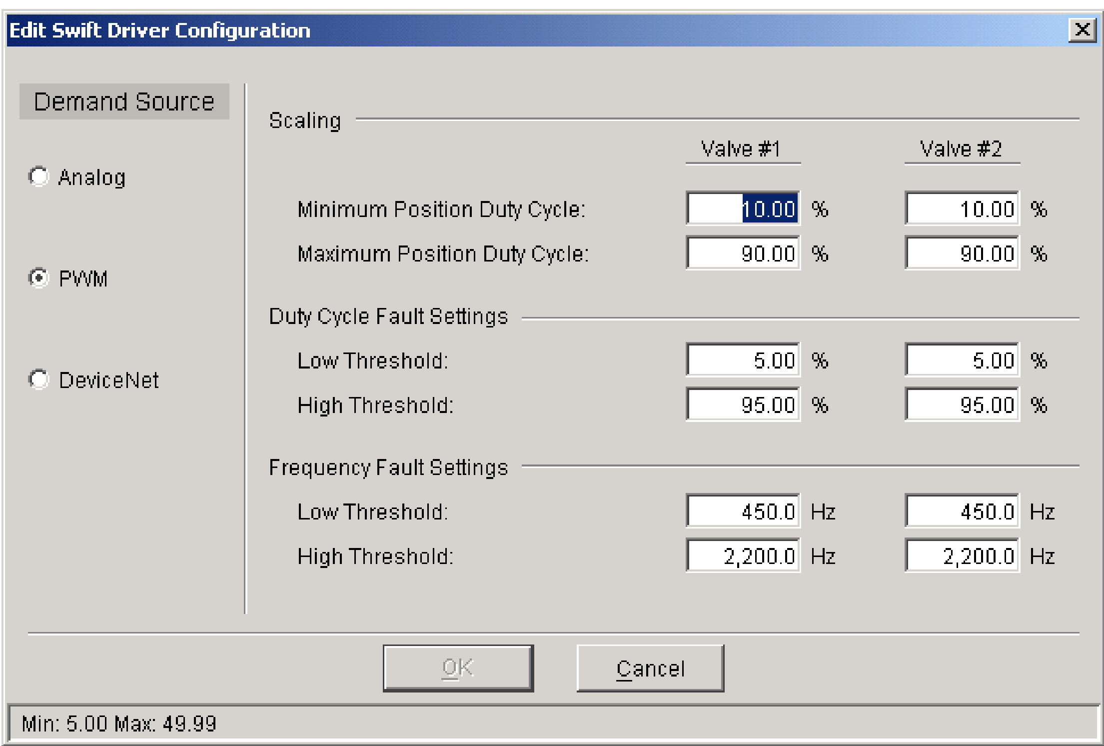


Figure 7-3b. Configuration Editor—PWM Settings

DeviceNet Settings

Baud Rate
Sets the DeviceNet communications baud rate.
Allowed values: 125, 250, or 500 kbps

MAC Address
Sets the DeviceNet MAC ID or node number for this Driver.
Allowed values: 0 - 63

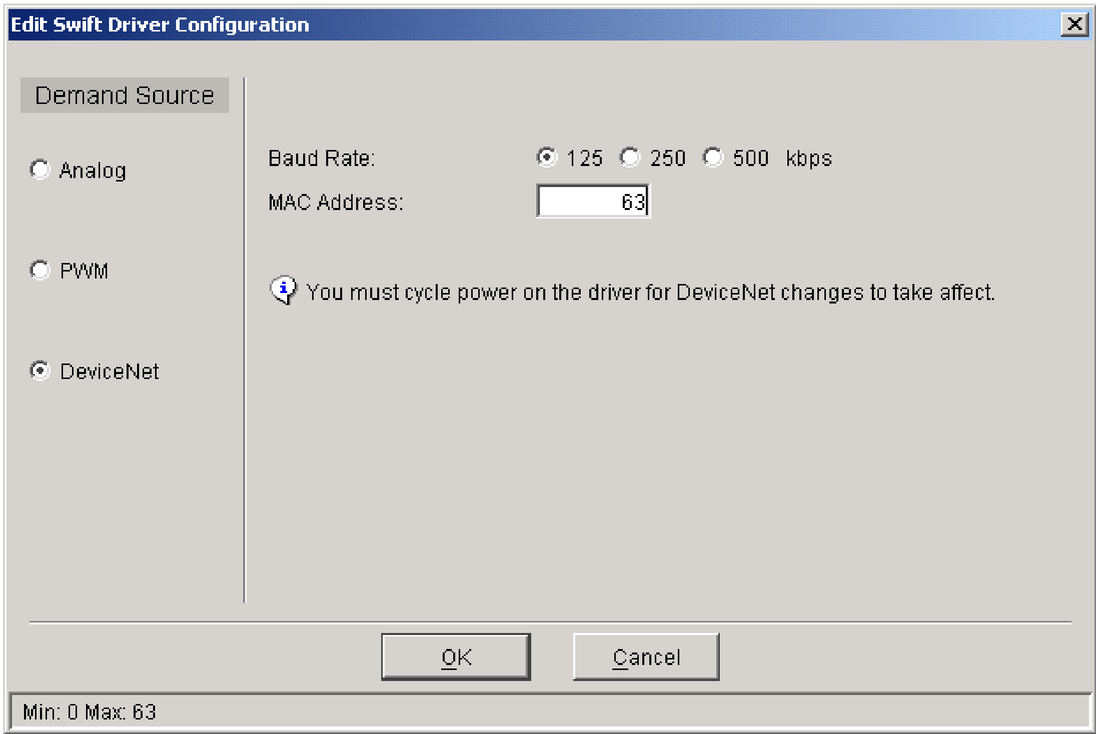


Figure 7-3c. Configuration Editor—DeviceNet Settings

Using DeviceNet to monitor the Driver

In order to use DeviceNet to monitor the driver without monitoring the command position, the DeviceNet settings must be configured. This is accomplished by selecting DeviceNet as the Demand Source in the Configuration Editor. This allows setting and saving of the Baud Rate and Mac Address parameters. Once these are saved to the desired values, re-select and save the desired Demand Source. A power cycle is required for the new DeviceNet setting to take effect.

If the default DeviceNet settings of 125 kbps baud rate and a device address of 63 are acceptable, then the driver can be monitored without any changes to the configuration settings.

Loading the Configuration (Save)

Select the OK button on the Configuration Editor to exit the configuration mode and save changes in the driver. Selecting Cancel will exit this mode without saving any changes.

Monitoring the Driver

The Service Tool has five different tab sheets to monitor driver parameters. The content on these screens is auto-generated based on the configured Demand Source. The tab sheet screens include:

- **Overview** (see Figures 7-4, 7-6, 7-8)
- **Alarms** (see Figure 7-10)
- **Shutdowns** (see Figures 7-5, 7-7, 7-9)
- **Internal Faults** (see Figure 7-11)
- **Configuration** (see Figures 7-3a, 7-3b, 7-3c)

Status Bar Indications

At the bottom of the Swift Driver Service Tool window is a status bar. The status bar has several sections. From left to right the sections show valve(s) operating mode, communication status, and alarm & shutdown status.

Valve(s) Operating Mode

This section of the status bar shows the current operating mode of the valve(s):

- **Working**—The driver is controlling the valve.
- **Closed**—The valve has been closed because of a fault.
- **Powered-down**—The valve driver (output to the valve) has been powered down because of a fault.

Communication Status

This section of the status bar shows the status of communication between the service tool and the Swift Driver. For more information, see Establishing Communication.

- **Connected**—The Service Tool is connected to and communicating with the driver.
- **Not Connected**—The Service Tool is not connected to the driver.
- **Connecting**—The Service Tool is attempting to connect to the driver. This message is displayed when Connect is selected from the Communications menu or when attempting to re-establish communication to the driver. If the connection is lost it will continuously attempt to re-connect.

Alarm Status

One or more alarms on the Alarms screen is/are active.

Shutdown Status

One or more shutdowns on the Shutdowns screen is/are active. This also reflects the state of the hardware Shutdown Status discrete output.

Overview Parameters Screen

To monitor the Swift Driver overview parameters, go to the Overview page on the main window.

Position Demand

Displayed value of the driver channel's actual position demand in percent lift.

Efficiency Compensation

Displayed value of the driver channel's efficiency adjustment. Nominally a value of '1', this is the output of a curve set during factory calibration, which compensates for valve-to-valve flow differences.

Compensation Demand

Displayed value of the driver channel's position demand multiplied by the efficiency adjustment, compensating for valve-to-valve flow differences.

Coil A, B Current
Displayed value, in amps, of the measured value of the channel's coil current.

Power Source
Displayed indication of the input voltage of the driver (uncalibrated).

Electronics Temperature
Displayed indication of the electronics temperature of the driver (uncalibrated).

Input Current (displayed if Analog demand is configured)
Displayed value of the driver channel's analog input.

Input Duty Cycle (displayed if PWM demand is configured)
Displayed value of the PWM input duty cycle.

Input Frequency (displayed if PWM demand is configured)
Displayed value of the driver channel's PWM input frequency.

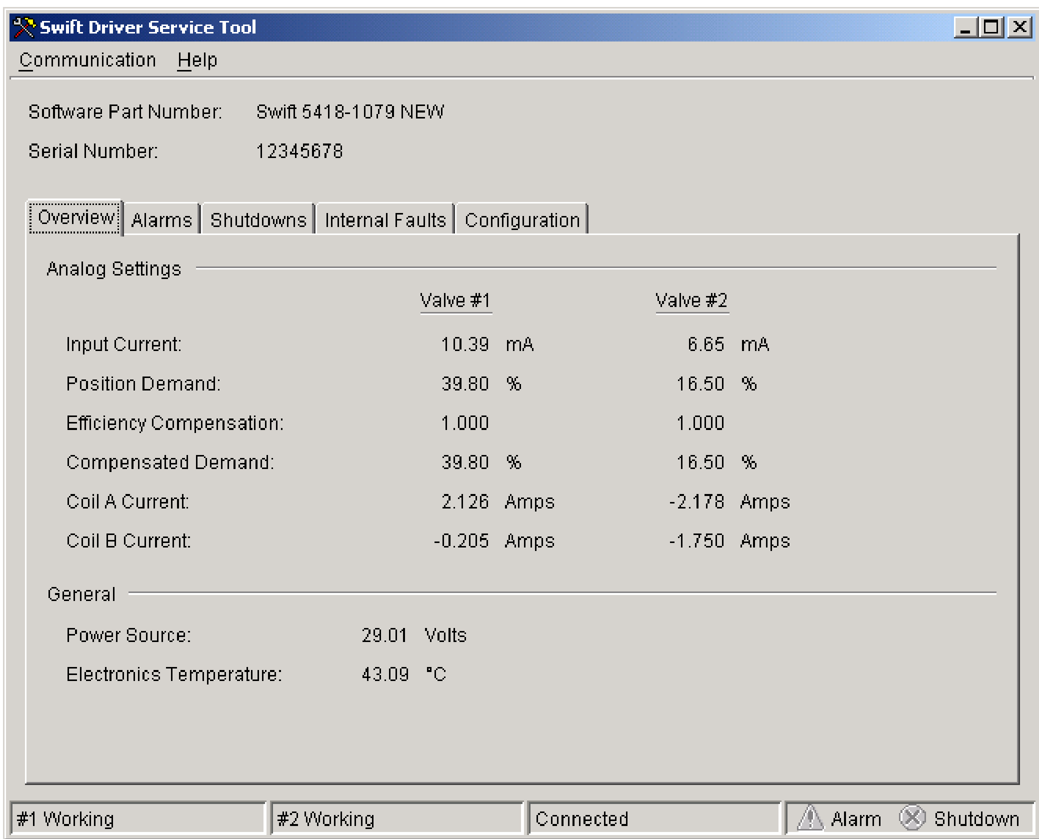


Figure 7-4. Analog Parameters

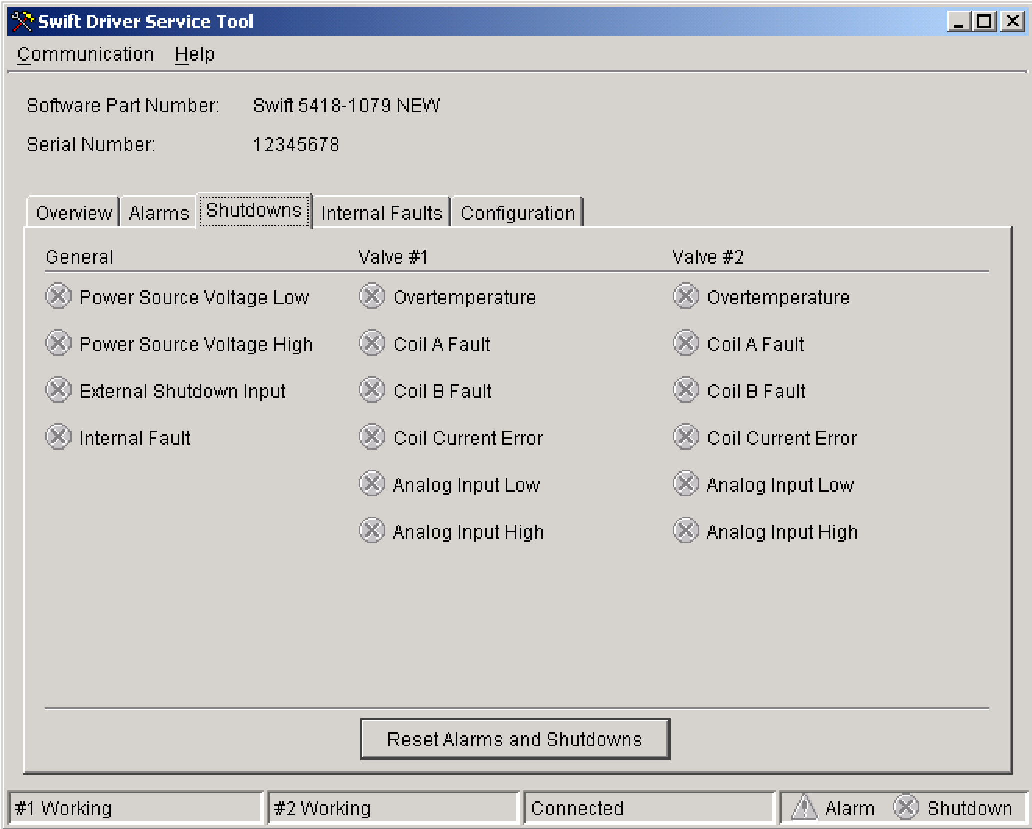


Figure 7-5. Analog Shutdowns

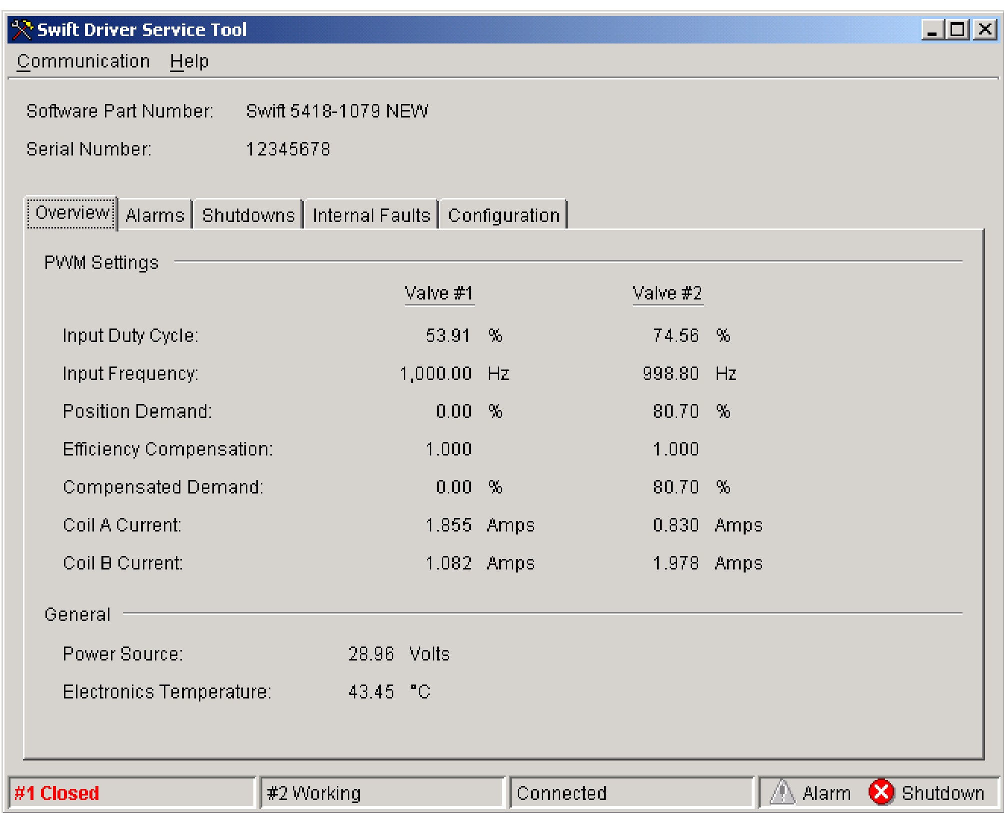


Figure 7-6. PWM Parameters

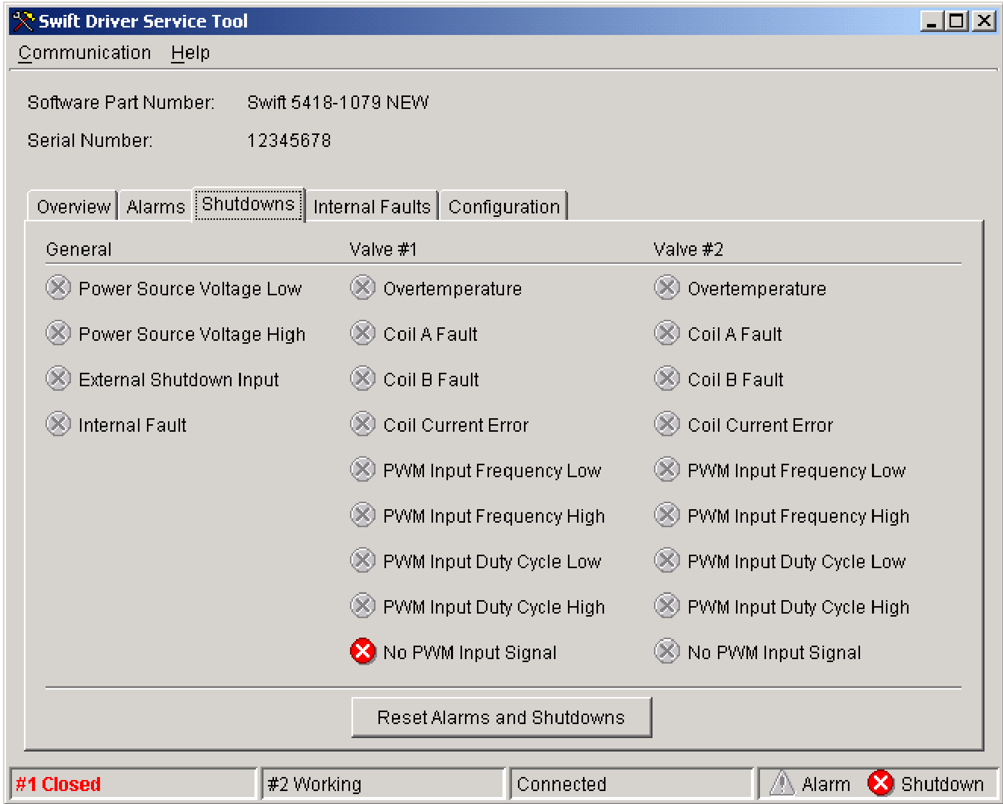


Figure 7-7. PWM Shutdowns

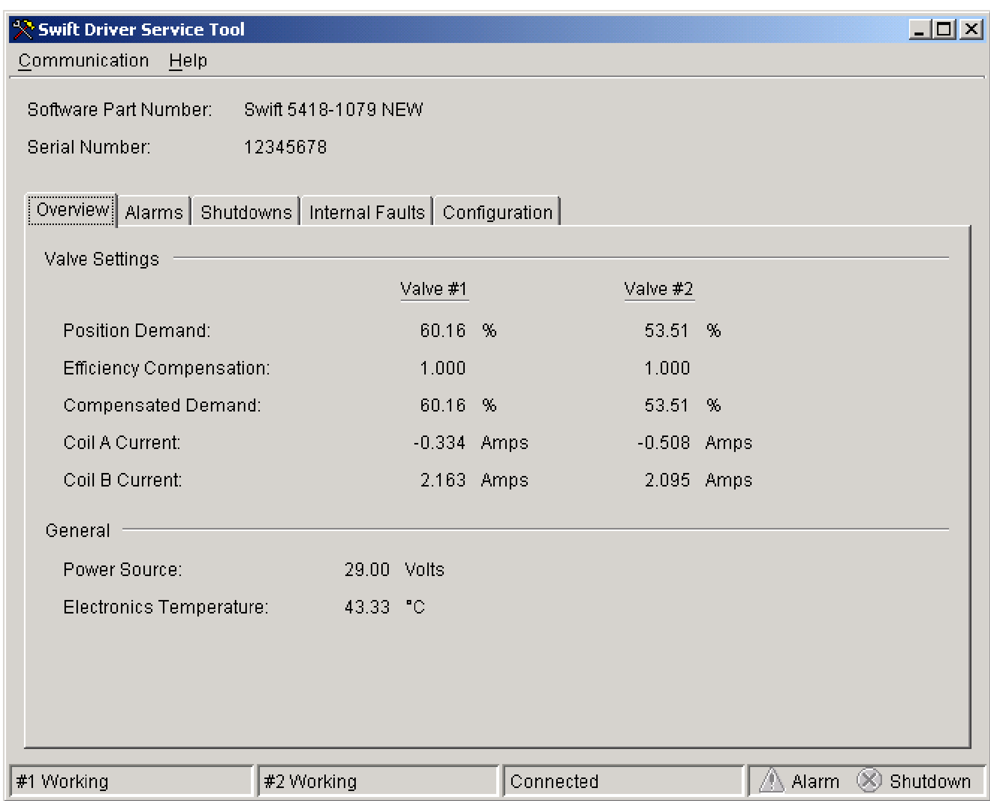


Figure 7-8. DeviceNet Parameters

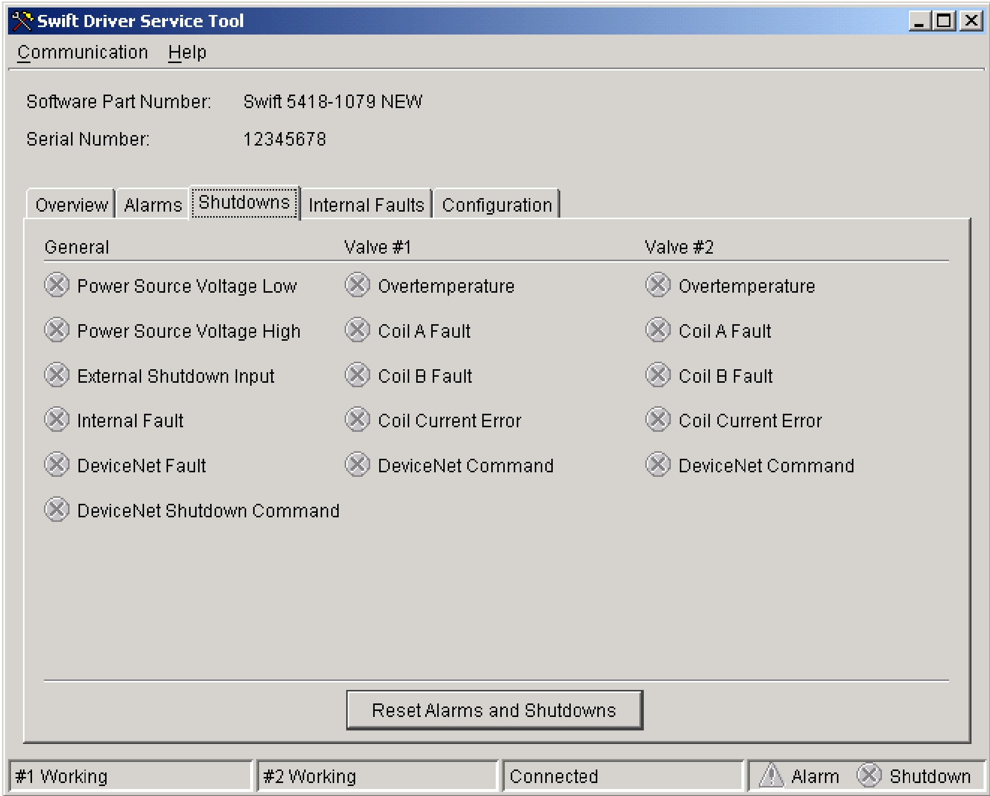


Figure 7-9. DeviceNet Shutdowns

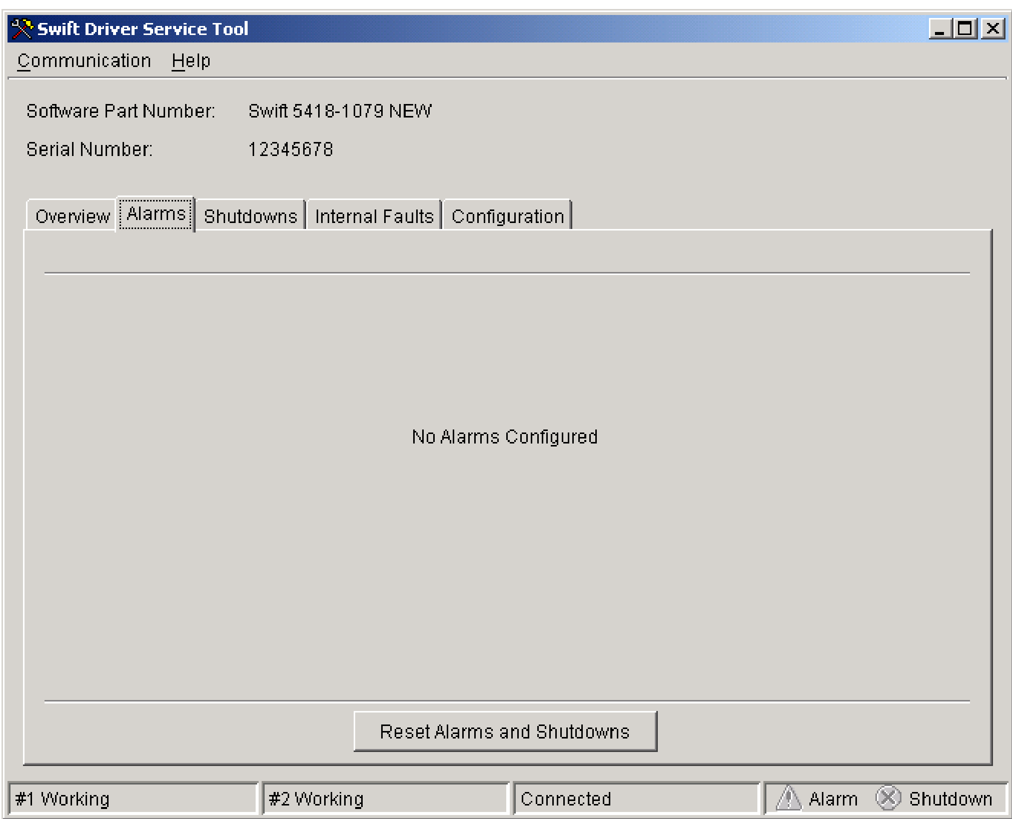


Figure 7-10. Alarms

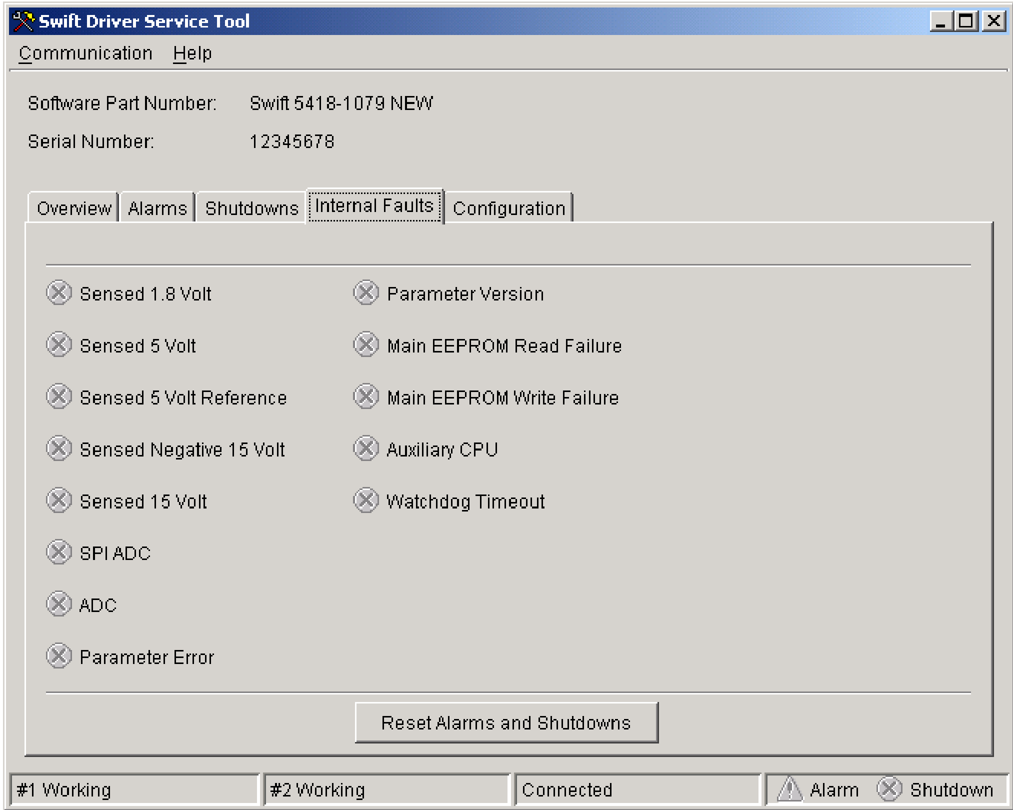


Figure 7-11. Internal Faults

Alarms, Shutdowns, and Internal Faults Screens

The Alarms, Shutdowns and Internal Faults screens are auto-generated based on the diagnostic fault mapping in the driver. All diagnostic faults are available on these three screens. A common Internal Fault indication is identified on the Shutdowns screen and the individual internal faults are available on the Internal Faults screen. For details on individual fault meanings, refer to the Diagnostics chapter in this manual.

Chapter 8. CAN/DeviceNet

Introduction

The Swift driver is capable of communicating and operating over DeviceNet communications. Monitoring over this communication link can be done at any time. However, to receive any commands, the driver must be configured with DeviceNet as the Demand Source. Monitored parameters include commanded valve position and diagnostic data for both valves. Control parameters include shutdown and reset commands as well as commanded valve position.

For proper operation, the user will need a cable connection with proper shielding, network termination, an external 24 Vdc supply for the DeviceNet™ network, and a program that has been written for their application.

The Swift driver communicates using a predefined Master/Slave connection set—it is not a UCMM (Unconnected Message Manager) capable device. The driver handles all Group 2 DeviceNet messages except I/O Cyclic messages, I/O Bit-Strobe messages, and fragmented messages. Changing the Baud Rate or MAC ID over DeviceNet is also not supported. The Swift driver does not have any indicators or configuration switches. All DeviceNet indication and configuration settings are provided through the Service Tool.

All products that communicate using DeviceNet are required to have a vendor ID. Vendor IDs are managed by the Open DeviceNet Vendor Association, Inc. (ODVA). Woodward's Vendor ID is '749', the Swift driver product code is '3', and the device type is '0'/Generic.

Interface Cables and Connectors

Most users will purchase finished cables, but the following information is provided for users that need to build custom cables.

The ODVA standard for DeviceNet defines two variations of the bus cable—Thick and Thin types. The thick cable is preferred and recommended for all uses. Most DeviceNet cable is not rated for temperatures above 80 °C so care should be taken during installation to avoid hot routing areas. Always use the appropriate CAN cable for DeviceNet wiring. Alternate cables will very likely inhibit reliable communication.

- **Thick**—recommended for high transmission speeds and long network distance in comparison to thin cable.
- **Thin**—should only be used at low baud rates and low requirements on network length. Thin cable should never be used on an engine in a vibration environment.

Impedance:	120 Ω ±10% at 1 MHz
Cable capacitance:	39 pf/m (12 pF/ft) at 1 kHz
Propagation delay	4.46 ns/m (1.36 ns/ft) (maximum)
Data Pair:	19 strands, 0.8 mm² (18 AWG), individually tinned, 10 twists/m (3 twists/ft)
Power Pair:	19 strands, 1.5 mm² (15 AWG), individually tinned, 10 twists/m (3 twists/ft)
Drain / Shield Wire:	19 strands tinned copper shielding braid or shielding braid and foil
Cable type:	twisted pair cable. 2x2 lines
Bend Radius:	20 x diameter during installation or 7 x diameter fixed position
Signal attenuation:	0.43 dB/100 m (0.13 dB/100 ft) @ 125 kHz (maximum) 0.82 dB/100 m (0.25 dB/100 ft) @ 500 kHz (maximum) 1.31 dB/100 m (0.40 dB/100 ft) @ 1000 kHz (maximum)

Table 8-1. Thick Cable Requirements

Network Wiring

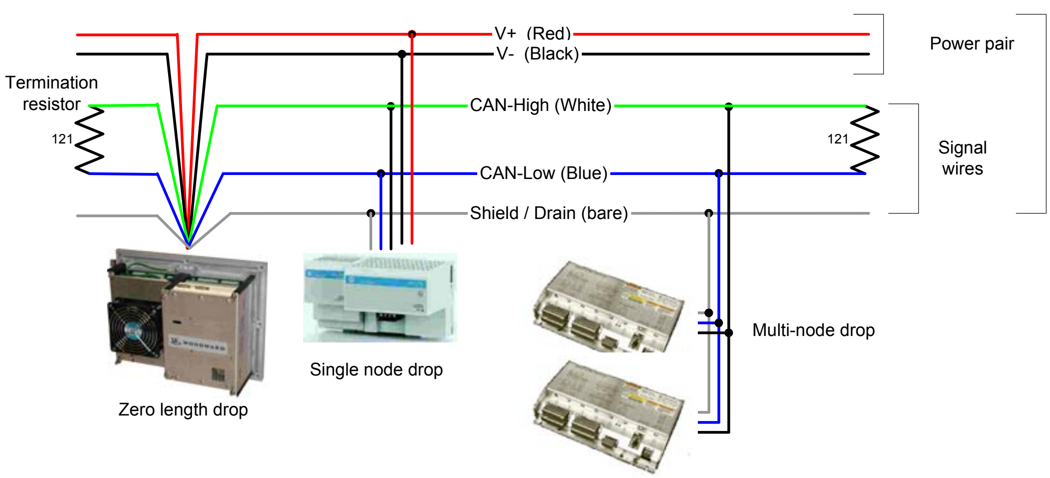
CAN networks are multi-drop networks arranged with two physical ends and up to 64 nodes connected between the ends. Many limitations work together to define the total end-to-end length of the network. This section will help define those.

Network Length

Length of the CAN cabling is variable depending on many factors. Cable type is one factor that significantly affects maximum length. Woodward recommends only the “thick” cable type, which is capable of the maximum length.

CAN allows for a single trunk with drops to each node (or multiple nodes). The number of drops is not limited nor is the number of nodes applied on a single drop. However, the length of wire in each drop is limited. The length of any single drop may be 0 to 6 meters, where a zero length drop means the node is attached directly to the trunk. The total length of all drops together (cumulative drop length) is limited by the application, cable type, and the baud rate in use.

The example below shows three methods of connecting a CAN device on the network. The example also includes a couple of devices that do not use the power pair in the CAN cable. Most devices require the power pair but some do not. Reference the device literature for details and requirements.



The table below gives the maximum trunk length and cumulative drop length for each supported baud rate. *Using less in one column does NOT allow usage of more in another column*. Each column is exclusive and represents an absolute maximum.

Baud Rate	Trunk Length (thick cable)	Cumulative Drop	Maximum Drop
125 K	500 m (1640 ft)	156 m (512 ft)	6 m (20 ft)
250 K	250 m (820 ft)	78 m (256ft)	6 m (20 ft)
500 K	100 m (328 ft)	39 m (128 ft)	6 m (20 ft)

Terminating Resistors
A termination resistor must always be present at each end of the network for the devices to communicate properly. CAN requires a terminating resistor to be installed at each end of the trunk – not at the end of a drop. The resistor requirements are:

- 121 Ω
- 1% Metal Film
- 1/4 W

The resistors must be installed between the CAN-Low and CAN-High pins of the DeviceNet connector.

IMPORTANT
Terminating resistors should not be installed at the end of a drop line. They should be installed only at the two ends of the trunk line.

Since termination resistors cannot be placed at the end of a drop line, the Swift control is not provided with built-in network termination resistors.

Shielding
Shielded cable is required to be used between the Swift control and any other devices. Unshielded cables and improperly shielded cables will very likely lead to communication problems and unreliable control operation.

The shield must always be ac coupled (connected through a capacitor or RC network) at one end and connected directly to earth on the opposite end for proper operation. The Swift control has been constructed so that the Shield/Drain connection is ac coupled to chassis ground. Devices connected to the opposite end of the cable must provide for connection directly to earth or the shield must be run to a properly grounded stud.

24-Volt Power Supply
The DeviceNet network is different from many others in that a 24 Vdc power supply is distributed with the network. The Swift system does not provide this supply and all customers using DeviceNet will have to provide a separate and isolated supply to ensure proper network operation.

The governing authority for DeviceNet (ODVA) has specific requirements for the 24 Vdc network supply. Select a supply that meets these requirements. Certified supplies can be found on the ODVA web site (http://www.odva.org).

Swift Driver DeviceNet Messages
There are six input and six output messages defined in the Swift Driver DeviceNet interface. These message bytes are defined in Chapter 10, Specifications.

IMPORTANT
The Swift driver electronic data sheet (.eds file) is available for download from the Woodward web site (www.woodward.com).

Chapter 9.
Troubleshooting

Introduction

Improper engine operation may often be the result of factors other than the Swift Gas Metering System operation. This chapter gives tips about engine problems that can resemble Swift system problems. Make sure that the engine is operating correctly before making any changes in the Swift system. The following troubleshooting guide is an aid in isolating trouble to the control box, actuator, 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 Swift system adjustment can make problems worse. If possible, isolate the Swift system from the engine to determine whether the problem is with the Swift system or with the engine or the load on the engine. Swift system faults are usually caused by problems in the installation.

Carefully review all the wiring connections and the power supply before making any adjustments to the Swift system. Fuel supply and injector conditions can also present problems that resemble Swift system problems.

NOTICE **The control can be damaged with the wrong voltage. When replacing a control, check the power supply, battery, etc., for the correct voltage.**

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

Swift Metering Valve

- Verify that the driver is powered per the driver troubleshooting guide below.
- Verify driver to valve electrical continuity:
  1. Remove the valve wire harness connector from the Swift 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.

IMPORTANT **The driver and valve must remain as a matched set. Failure to maintain the set will result in lowered accuracy and increased valve leakages.**

Electrical Troubleshooting Guide

Analog Input

If the Analog input is not functioning properly, verify the following:

- Check that the cable is shielded and the shield is properly grounded per the shields and grounding section in Chapter 3.
- Measure the input voltage. It should be in the range of 0–5 V.
- Verify that there are no or minimal ac components to the Analog Input signal. AC components can be caused by improper shielding.
- Check the wiring. If the inputs are reading 0 or the engineering units that correspond to 0 mA, look for loose connections and disconnected/ misconnected cables.
- If all of the inputs are reading high, check that the power is not connected across the input directly.
- Check the software configuration to ensure that the input is configured properly as the Demand Source. Verify the Analog In Min and Max scaling settings.
- Check the values seen by the Swift driver using the Service Tool. If the input is failed and the milliamp input is in the normal range, check the Service mode settings for Analog In Failure settings.

Discrete Input

If a discrete input is not functioning properly, verify the following:

- Measure the input voltage on the terminal block. It should be in the range of 18–28 Vdc.
- Check the wiring, looking for loose connections or misconnected cables.

Alarm or Shutdown Conditions

If the Swift driver has any alarm or shutdown conditions, refer to Chapter 6 for details on the exact cause of the condition. The Service Tool or CAN must be used to determine the cause of any shutdown or alarm condition.

Discrete Output

If the discrete output is not functioning properly, verify the following:

- Measure the output voltage on the terminal block. It should be in the range of 18–28 Vdc when the output is off/false. The voltage will be in this range only if all shutdowns are false. This can be verified through the Service Tool.
- Check the wiring, looking for loose connections or disconnected/ misconnected cables.

Serial (RS-232) Communications

If a serial port is not functioning properly, verify the following:

- Check the wiring, looking for loose connections or disconnected/ misconnected cables.
- Check the communication settings. They should be set to 38400 baud, 8 data bits, 1 stop bit, and no parity.

Service Tool

If a serial port is not functioning properly, review the installation information in Chapter 7. Verify the following:

- Check the wiring, looking for loose connections or disconnected/ misconnected cables. Refer to the Serial (RS-232) Communications troubleshooting above.
- Check that Service Tool is running. Verify that the Port setting is correct.
- Follow on-screen error messages. Re-install software as needed. The latest version of software is available for download from the Woodward web site (www.woodward.com).

Demand Source Selection

The Demand Source can be “forced” using the internal driver switches as follows: Switch 1 is ON for a software-selectable demand source, Switch 2 is ON for Analog Demand, Switch 3 is ON for PWM Demand, and Switch 4 is ON for DeviceNet Demand. Only one switch can be selected, the remaining switches must be OFF. After changing switch settings, power must be cycled on the driver before the changes will be accepted.

If the Demand Source changes do not get saved, verify the following:

- Check the internal Demand Source setting switches (Chapter 2). To make permanent changes to the Demand Source using the Service Tool, the internal switches must be in the ‘Software’ mode (switch 1).

CAN Communications

If a CAN port is not functioning properly, verify the following:

- Is the DeviceNet Communication bus supplied with an external 24 Vdc? The Swift driver does ***not*** supply the 24 Vdc needed for the DeviceNet Network.
- Is the proper 121 Ω termination resistance provided between CAN-Low and CAN-High at both physical ends of the trunk—not at the end of a drop?
- Check the wiring, looking for loose connections or disconnected/ misconnected cables. Check wiring of termination resistor, if required.
- Are all devices set to the same baud rate? Check the configured data rate (125, 250, 500 kbps) in both the Swift Service Tool and the speed control.
- Has the address been set? Is the address unique? Using the Service Tool, verify that the appropriate Device address (Mac ID) is set.
- If changes are made to Swift Driver DeviceNet settings, has power been cycled on the Swift Driver?
- If mis-wired, the CAN driver chip can fail. This could occur when the CAN Hi or Lo connections are inadvertently wired to 30 V or more. This failure requires a factory replacement of the CAN driver chip.
- Additional problems could include excessive common-mode voltage, low power supply voltage, excessive propagation delay which could be caused by faulty connectors, excessive cable length, or failure to follow system cabling or power rules.

IMPORTANT

If needed, the latest Swift driver DeviceNet electronic data sheet (.eds file) is available for download from the Woodward web site (www.woodward.com).

Performance Troubleshooting Guide

⚠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.

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 10. Swift System Specifications

Driver Specifications

Environmental Specifications

Parameter	Value
Operating Temperature	TO2— –20 to +70 °C
Storage Temperature	TS1— –40 to +125 °C, unpowered
Vibration	SV2— Sine: 4 G, 5 mm, 5–2000 Hz, 3 h min/axis, 90 min dwells RV1— Random: 0.04 G^2/Hz, 10–2000 Hz, 90 min/axis, 8.2 Grms at 10 Hz Long term environment 2 g per US MIL-STD-810C, curve B
Shock	MS1— 40 G 11 ms sawtooth
Sealing	IP54 per EN60529
Humidity	H2— 60 °C, 95% RH for five days at one cycle per day
Chemical Resistance	The Swift Gas Metering System uses materials proven capable of withstanding normal engine environment chemicals per SAE J1455, such as diesel fuel, engine oil, and antifreeze.
EMC	IEC6100-4-2, -3, -4, -5, -6

Mechanical Specifications

Parameter	Value
Envelope (driver)	241 x 163 x 58 mm / 9.5 x 6.4 x 2.3 inches
Weight (driver)	1.7 kg / 3.8 lb
Electrical Connector (driver)	Cinch P/N 581-01-48-001S, 48-pin connector Sealing Range for Wire Insulation Diameter: –Min 1.96 mm (0.077 in) –Max 2.64 mm (0.104 in) Mating connectors: Cinch P/N 581-01-30-027 30-pin connector Cinch P/N 581-01-18-023S 18-pin connector Mating Connector pins: Cinch P/N 425-00-00-873/872 Mating Connector plugs (for unused pins): Cinch P/N 581-00-00-011 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 single valve, 38.7 W dual valve
Input Power (transient)	Same as steady state
Out-of-Range Diagnostics (alarm)	< 17 V or > 33 V
Wire Distance Limits	Total distance from power supply to driver plus driver to valve must not exceed 8 m (25 ft).
Wire Gauge	0.8 mm² (18 AWG), minimum

Stepper Motor Output Driver

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 8 m (25ft).
Wire Gauge	0.8 mm² (18 AWG)
Resolution	10.5 bits, min

Analog Command Inputs

Parameter	Value
Input Type	0–25 mA, balanced differential input
Input Scaling	4 mA = 0% and 20 mA = 100% position (software adjustable)
Max Input Current (full scale)	25 mA ± 1%
Isolation	none
3 dB Circuit Bandwidth	100 Hz
Transient Protection	According to EMC norm
Common Mode Rejection	+40 V and –40 V at 60dB Min at dc
Input Common Mode Range	±32 V
Safe Input Common Mode Voltage	±200 V minimum
Input Impedance	200 Ω (±10%)
Anti-aliasing Filter	2 anti-aliasing poles at 1 ms (159 Hz)
Resolution	12 bits
Accuracy	±1% of full scale, @ 25 °C
Temperature Drift	<300 ppm/°C, maximum
I/O Latency	1 ms
Calibration Method	2-point linear software calibration
Out-of-Range Signal	< 2 mA or >22 mA (software adjustable)
Overcurrent Protection	Input protected against ±32 Vdc (160 mA) steady state

PWM Command Inputs

Parameter	Value
Input Magnitude	5–26 V p-p
Frequency Range	500–2000 Hz
Duty Cycle Scaling	10% = fully closed and 90% = fully open (software adjustable)
Isolation	none
Input Impedance Push-Pull Mode	44 kΩ
Input Impedance Open Collector Mode	4.9kΩ
Resolution	16 bits at 500 Hz, 14 bits at 2kHz
Accuracy	±1% of full scale (duty cycle), (RSS all errors including temperature)
Linearity	100 ppm full scale
Temperature Drift	300 ppm/°C
I/O Latency	1 ms
Calibration	2-point linear software calibration
Accuracy	±1% of full scale, @ 25 °C
Out-of-Range Frequency	< 450 Hz or >2200 Hz (software adjustable)
Out-of-Range Duty Cycle	< 5% or > 95% (software adjustable)

Discrete Input

Parameter	Value
Input Current	10 mA @ 0 Vdc
Input Type	Ground referenced discrete input
Delay Time for Shutdown	< 200 ms for system to recognize shutdown
Delay Time for Reset Detection	< 1 s for valves to move to minimum position
Max Voltage from + Connection	32 V (power input voltage)
Max External Contact Voltage at 10 mA	< 1 V
Isolation	None—Intended for use with external relay or other dry contact
Debounce/Delay Time	10 ms
Input Thresholds	< 4 Vdc = “ON” > 6 Vdc = “OFF”

Discrete Output

Parameter	Value
Output Type	Low-side output driver
Max Contact Voltage (open)	40 V
Max Current	0.5 A
Max Contact Voltage at 0.5 A (closed)	0.7 V
Max Delay Time for Opening Contact	< 2 ms
Default at Power-up	Open contact (No current)
Error Condition	Open contact (No current)
OK Condition	Closed contact
Driving Inductive Loads	Yes
Common Mode Range	40 V—must be able to float to 40 V as part of a trip string
Protection	Uses circuitry that will open the contact when output contacts are short-circuited. Self-resetting when fault is removed.

RS-232 Serial Communication Service Port

Parameter	Value
Isolation	None
Baud Rate	Fixed 38.4 Kbaud
Mechanical Interface	Accessible through 30-pin connector, J1. (Use Woodward kit number 5450-1-1010 to interface to these pins with a 9-pin sub-D connector)
Pinout	Tx = J1-A1, Rx = J1-A2, Gnd = J1-A3
Maximum Cable Length	15 m (50 ft)
Cable Type	Straight-through (no crossover)

Electronics Temperature Sensor

Parameter	Value
Accuracy	±1 °C at 25 °C ambient ±2 °C over full range (–40 to +125 °C)
I/O Latency	100ms

Current Feedback Sensing

Parameter	Value
Input	±5 A
Circuit Output	0–5 Vdc to analog-to-digital converter
Software Output	±5 A reading
Accuracy	±1.0% of full scale at 25 °C
Temperature Drift	<400 ppm/°C, maximum
I/O Latency	1ms

CAN Communication

Parameter	Value
CAN Protocol Spec	CAN 2.0B (Supporting 11 bits and 29 bits identifiers)
Can Voltage Level	5 V
Redundancy	Single wire CAN is not supported
Baud Rates Supported	125K, 250K, 500K. No auto detection (software configured)
Protocol Supported	DeviceNet
Number of Pins	Four (4) (Two signal, one shield, and ground)
Indication/Operation LEDs	None
Isolation	500 Vrms from CAN common to control common
Power	Capable of external power
Device ID Configuration	1–63 (software configured)
Max Latency	10 ms
Max Cable Length 125 Kbaud 250 Kbaud 500 Kbaud	 500 m (1640 ft) 250 m (820 ft) 100 m (328 ft)

Input Message Definition

Byte	Description	Type	Scaling / Description
0 1	Position Demand 1 (Low) Position Demand 1 (High)	UINT UINT	0 = 0% and 65535 = 100%
2 3	Position Demand 2 (Low) Position Demand 2 (High)	UINT UINT	0 = 0% and 65535 = 100%
4	Commands Bit 0: Reset driver shutdown Bit 1: Shutdown Both Drivers Bit 2: Shutdown 1 Bit 3: Shutdown 2 Bit 4-7: (spare)	WORD	
5	(intentionally blank to provide even # of bytes)		

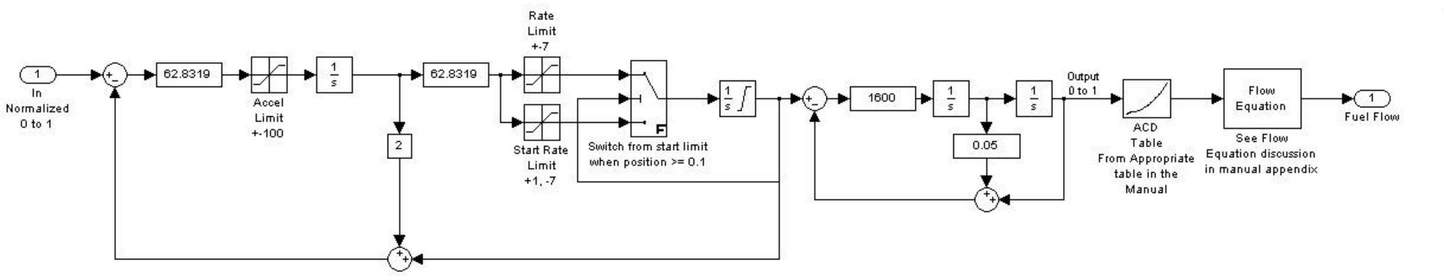
Output Message Definition

Byte	Description	Type	Scaling / Description
0	Position Demand 1	UINT	0 = 0% and 255 = 100%
1	Position Demand 2	UINT	0 = 0% and 255 = 100%
2&3	Driver Status word1 Bit 0: Driver Shutdown Bit 1: Driver Alarm Bit 2: Valve 1 Shutdown Bit 3: Valve 2 Shutdown Bit 4: Input Voltage High Bit 5: Input Voltage Low Bit 6: External Shutdown Input Bit 7: DeviceNet Shutdown Command Bit 8: DeviceNet Fault Bit 9: Driver Internal Fault Bit 10: Valve 1 Driver Overtemp Bit 11: Valve 1 Coil Fault Bit 12: Analog1 In High Bit 13: Analog1 In Low Bit 14: PWM1 In Freq High Bit 15: PWM1 In Freq Low	WORD	
4&5	Driver Status word2 Bit 0: PWM1 In Duty High Bit 1: PWM1 In Duty Low Bit 2: PWM1 In No Signal Bit 3: Vlv1 DeviceNet Shutdown Command Bit 4: Valve1 Demand Fault OR Bit 5: Valve 2 Driver Overtemp Bit 6: Valve 2 Coil Fault Bit 7: Analog2 In High Bit 8: Analog2 In Low Bit 9: PWM2 In Freq High Bit 10: PWM2 In Freq Low Bit 11: PWM2 In Duty High Bit 12: PWM2 In Duty Low Bit 13: PWM2 In No Signal Bit 14: Vlv2 DeviceNet Shutdown Command Bit 15: Valve2 Demand Fault OR	WORD	
6&7	Index / Data (for future use)	UINT	

Software Execution Rates

Software Routine	Nominal Software Execution Rate
Position and Current Control Algorithms	0.1 ms
Position Demand Algorithms	1 ms
Analog Input Logic	1 ms
PWM Input Logic	1 ms
CAN Demand Signal	1 ms
CAN/DeviceNet Transmissions	20 ms
Serial Port	background task
Shutdown Discrete Input	1 ms
Internal Switch/Jumper Inputs	only on power up
Discrete Output	1 ms
Diagnostics	20 ms

Transfer Function



Swift Metering Valve Specifications

Environmental Specifications

Same as the driver with the following exceptions.

Parameter	Value
Inlet Pressure (operating)—M200 versions	480–2070 kPa / 70–300 psia—Swift 11, 20, 36 480–1380 kPa / 70–200 psia—Swift 65
Inlet Pressure (operating)—M600 versions	345–2070 kPa / 50–300 psia—Swift 11, 20, 36 345–1380 kPa / 50–200 psia—Swift 65
Proof Pressure (non-operating)	3100 kPa / 450 psia
Gas Temperature	–29 to +121 °C / –20 to +250 °F
Ambient Temperature	–29 to +70 °C / –20 to +158 °F
Storage Temperature	-40 to +80 ˚C / -40 to +175 ˚F
Vibration	Long term environment 2 g per MIL-STD-810C, curve B
Sealing	IP54 per EN 60529.
EMC	IEC6100-4-2, -3, -4, -5, -6

Mechanical Specifications

Parameter	Value
Slew Rate	150 ms (10–90%) 150 ms (90–10%)
Metering Valve Effective Area Accuracy	Valve size 65, 36, 20: 2% of point at 100% flow—Swift M200 version Valve size 11: 6% of point at 100% flow—Swift M200 version Valve size 65, 36, 20, 11: 7% of full scale—Swift M600 version
System Mass Flow Accuracy—M200 (100% flow) 1	2.2% of point using pressure and temperature sensors equivalent to the Swift
Shutoff Capability	ANSI B16.104 Class IV (4) <0.1% of maximum flow at 50 psia / 345 kPa
OBD Fitting—37° flare	–6 SAE J514
Inlet Port	–16 SAE J514
Discharge Fitting—37° flare	–6 SAE J514 for valve size 11 –8 SAE J514 for valve size 20 –12 SAE J514 for valve size 36 –12 SAE J514 for valve size 65
Envelope	127 x 178 x 102 mm / 5 x 7 x 4 inches—Single 178 x 178 x 102 mm / 7 x 7 x 4 inches—Dual
Weight	4 kg / 8 lb—Single 5 kg / 10 lb—Dual
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 or 8) Mating Connector plugs (for unused pins): Amp P/N 796075-1 (qty 16 or 20) Refer to Chapter 3 for Woodward part numbers.

Note—An additional ±0.75% full scale error is added if a 4-20 mA demand signal is used. An additional ±0.15% and ±0.61% of full scale is added for PWM demand signal with 500 Hz and 2000 Hz excitation frequency respectively.

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 metering valve (time between 10% and 90% of a full travel step)	150	150

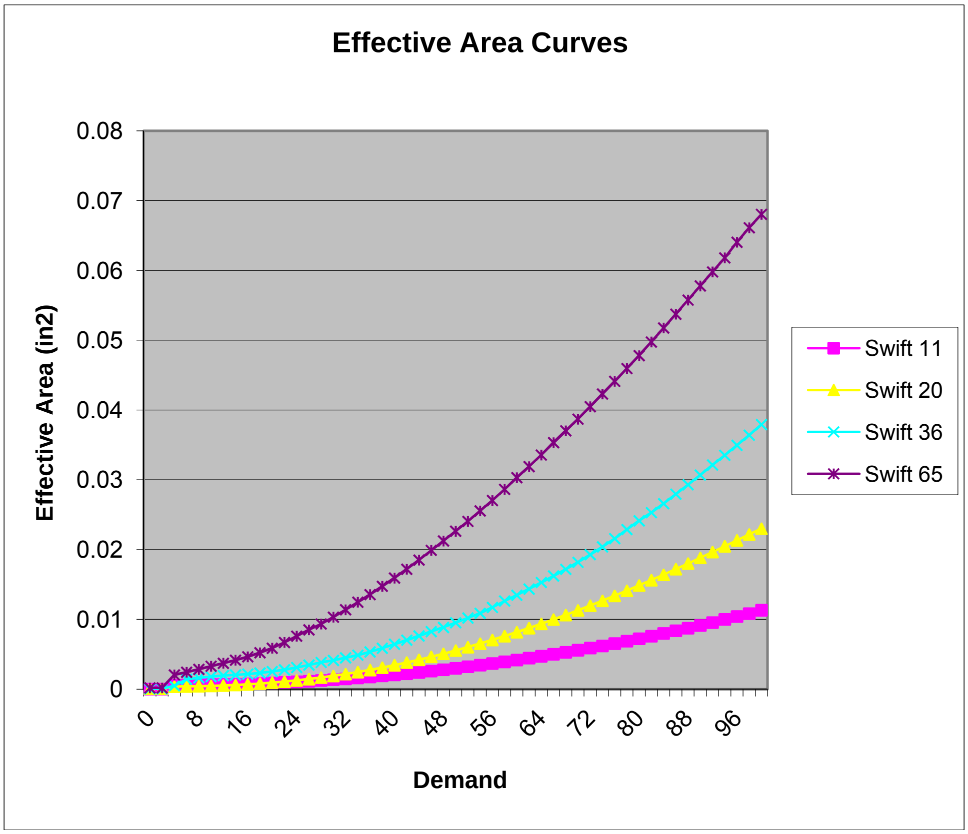
Stability

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 11 ACd (in²)	Swift 20 ACd (in²)	Swift 36 ACd (in²)	Swift 65 ACd (in²)
0.0	0.00002361	0.00006701	0.00005878	0.00018914
2.0	0.00002361	0.00006701	0.00005878	0.00018914
4.0	0.00054412	0.00037265	0.00050160	0.00205357
6.0	0.00060316	0.00039986	0.00141311	0.00243332
8.0	0.00064442	0.00043410	0.00162681	0.00284387
10.0	0.00067655	0.00047849	0.00180410	0.00330120
12.0	0.00070171	0.00053576	0.00195926	0.00372468
14.0	0.00073251	0.00060819	0.00204993	0.00416738
16.0	0.00076825	0.00069770	0.00217629	0.00465079
18.0	0.00082921	0.00080590	0.00233225	0.00523068
20.0	0.00090782	0.00093407	0.00252573	0.00587843
22.0	0.00098521	0.00108324	0.00277802	0.00670352
24.0	0.00106274	0.00125420	0.00311628	0.00760746
26.0	0.00114653	0.00144753	0.00346914	0.00851101
28.0	0.00125094	0.00166364	0.00384028	0.00934820
30.0	0.00136724	0.00190276	0.00413391	0.01032611
32.0	0.00148744	0.00216502	0.00449683	0.01139050
34.0	0.00162439	0.00245043	0.00488115	0.01247160
36.0	0.00176499	0.00275890	0.00534320	0.01355640
38.0	0.00192103	0.00309027	0.00587399	0.01475297
40.0	0.00206012	0.00344435	0.00644334	0.01592723
42.0	0.00222974	0.00382087	0.00703559	0.01719470
44.0	0.00241510	0.00421956	0.00764218	0.01850890
46.0	0.00261277	0.00464013	0.00825820	0.01990547
48.0	0.00279803	0.00508228	0.00885692	0.02124217
50.0	0.00299996	0.00554571	0.00952682	0.02264077
52.0	0.00323249	0.00603011	0.01019960	0.02405083
54.0	0.00345405	0.00653522	0.01088470	0.02555150
56.0	0.00368187	0.00706076	0.01172280	0.02703930
58.0	0.00392539	0.00760647	0.01264630	0.02863823
60.0	0.00418181	0.00817210	0.01347010	0.03032367
62.0	0.00445831	0.00875740	0.01434880	0.03190343
64.0	0.00472923	0.00936215	0.01530120	0.03355623
66.0	0.00501091	0.00998611	0.01623520	0.03533837

68.0	0.00529237	0.01062901	0.01718190	0.03703133
70.0	0.00559735	0.01129059	0.01818590	0.03869830
72.0	0.00590351	0.01197052	0.01928810	0.04049427
74.0	0.00620793	0.01266846	0.02039790	0.04230450
76.0	0.00653823	0.01338398	0.02158460	0.04412133
78.0	0.00688714	0.01411656	0.02288590	0.04595400
80.0	0.00723579	0.01486561	0.02413700	0.04779770
82.0	0.00759654	0.01563039	0.02531050	0.04975260
84.0	0.00800265	0.01641003	0.02659140	0.05176760
86.0	0.00837678	0.01720348	0.02795190	0.05373383
88.0	0.00874760	0.01800950	0.02930100	0.05576000
90.0	0.00914676	0.01882663	0.03069240	0.05778667
92.0	0.00955821	0.01965314	0.03212790	0.05979650
94.0	0.01000407	0.02048704	0.03352140	0.06180903
96.0	0.01041650	0.02132599	0.03495150	0.06404167
98.0	0.01083980	0.02216731	0.03639840	0.06612190
100.0	0.01132525	0.02300794	0.03792650	0.06804673



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
Driven by	Woodward Swift driver

Chapter 11.
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 A. Swift Driver Program Summary

APPLICATION ____

SERIAL NUMBER ____

For details on individual settings refer to Chapter 7.

Demand Source

Demand Source = ______________ (Analog, PWM, or DeviceNet)

Analog Input

Scaling		**Valve #1**	**Valve #2**	
Minimum Position Current (mA)	=	______________	______________	(0 to 11.99)
Maximum Position Current (mA)	=	______________	______________	(12 to 25)
Current Range Fault Setting				
Low Threshold (mA)	=	______________	______________	(-1 to 12)
High Threshold (mA)	=	______________	______________	(12 to 25)

PWM Input

Scaling				
Minimum Position Duty Cycle	=	______________	______________	(5 to 49.99)
Maximum Position Duty Cycle	=	______________	______________	(50 to 95)
Duty Cycle Fault Setting				
Low Threshold (% duty)	=	______________	______________	(-5 to 50)
High Threshold (% duty)	=	______________	______________	(50 to 99)
Frequency Fault Setting				
Low Threshold (Hz)	=	______________	______________	(300 to 2200)
High Threshold (Hz)	=	______________	______________	(300 to 2200)

DeviceNet Settings

Mac ID = ______________ (0-63)

Data Rate = ______________ (125, 250, or 500 kbps)

Appendix B. 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 $z = \frac{p}{R \cdot \rho \cdot T}$

MFSM—Mass Flow Sensor Module

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)

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

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

Equation 2—Sub Sonic Flow (Unchoked)

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

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

High Recovery Valve Characteristics and Application

The Swift metering valve is a high-recovery valve. 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/Number(s):	Swift Single and Dual Metering Valves; 9907-933, 9907-939, and similar Swift Single and Dual Metering Valves with SSM; 9907-934 and similar
Conformance to Directive(s):	94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
Marking(s):	Category 3 Group II G, EEx nA II T3
Applicable Standards:	EN50021, 1999: Electrical apparatus for potentially explosive atmospheres - Type of protection 'n'
Third Party Certification:	LCIE 03 ATEX 6077 X LCIE (0086) Siège Social : 33, Avenue du Général Leclerc F92260 Fontenay-aux-Roses, France
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]

Signature

Dan Gear

Full Name

Engineering Manager

Position

WGC, Fort Collins, CO, USA

Place

3/27/06

Date

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/Number(s):	Swift Driver/8239-119 and similar
Conformance to Directive(s):	89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility. 94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
Marking(s):	Category 3 Group II G, EEx nA II T3
Applicable Standards:	EN61000-6-4, 2001: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN61000-6-2, 2001: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments EN61000-3-2, 2000: EMC - Limits For Harmonic Current Emissions (Equipment Input Current < or = 16 A Per Phase) EN61000-3-3, 1995: EMC – Limitation of Voltage Fluctuations and Flicker in Low-Voltage Supply Systems for Equipment with Rated Current Up To and Including 16A. EN50021, 1999: Electrical apparatus for potentially explosive atmospheres - Type of protection 'n'
Third Party Certification:	LCIE 03 ATEX 6077 X LCIE (0086) Siège Social : 33, Avenue du Général Leclerc F92260 Fontenay-aux-Roses, France
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: [signature]

Dan Gear

Full Name

Engineering Manager

Position

WGC, Fort Collins, CO, USA

Place

3/27/06

Date

Declaration of Incorporation

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

Product: Swift Single and Dual Metering Valves with and without SSM
Part Number: 9907-948 and similar

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

98/37/EEC (Machinery)

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

Manufacturer

____
Signature

Douglas W. Salter
Full Name

Engineering Manager
Position

WGC, Fort Collins, CO, USA
Location

11/7/02
Date

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26363C.

PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

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.

2013/4/Colorado