Product Manual 04153
(Revision P, 11/2016)
Original Instructions

SOGAV™ Solenoid Operated Gas Admission Valve Pre-Combustion Chamber (PCC) Valve

SOGAV 2.2

Installation and Operation Manual

General Precautions	**Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.** **Practice all plant and safety instructions and precautions.** **Failure to follow instructions can cause personal injury and/or property damage.**

Revisions	**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455* , *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 *26455* , *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 Out-of-date translations are marked with ⚠.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.

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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:
These listings are limited only to SOGAV 2.2 units bearing the CE Marking.

ATEX – Potentially Explosive Atmospheres Directive:	Declared to 94/9/EEC 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 explosive atmospheres. EEx m IIC T3, Category II 3 G
Low Voltage Directive:	Declared to 73/23/EEC COUNCIL DIRECTIVE of 10 February 1973 on the harmonization of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits.

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

Machinery Directive:	Compliance 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:	Exempt per Article 1-3.10
EMC Directive:	Compliant as a passive component to 89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility. Meets the surge requirements of EN 61000-6-2.

North American Compliance:
These listings are limited only to the SOGAV 2.2 units.

CSA:	CSA Certified for Class I, Division 2, Groups A, B, C, D, T4 at 105 °C Ambient for use in Canada and the United States Certificate 1514353

The SOGAV 2.2 solenoid is certified as a component for use with the SOGAV valve. The final combination is subject to acceptance by CSA International or local inspection authority.

Special Conditions for Safe Use

NOTICE — **The following Hazardous Locations and Potentially Explosive Atmospheres Requirements pertain only to SOGAV™ 2.2 solenoids with the appropriate markings.**

SOGAV 2.2 solenoids are suitable for use in Class I, Division 2, Groups A, B, C, and D environments, per CSA for Canada and US, or non-hazardous location only.

SOGAV 2.2 solenoids are suitable for use in European Zone 2, Groups IIC environments per the Declaration of Conformity.

The SOGAV 2.2 solenoid wiring must be in accordance with North American Class I, Division 2, or European Zone 2 wiring methods, and in accordance with the authority having jurisdiction.

Wiring for the SOGAV 2.2 solenoid must be suitable for at least 105 °C and at least 10 °C above the maximum ambient temperature.

Connect the ground terminals on the SOGAV solenoid to earth ground.

The SOGAV 2.2 solenoid is certified as a component for use in the SOGAV valve. The final combination is subject to acceptance by the local inspection authority.

⚠WARNING

Explosion Hazard—Do not connect or disconnect while circuit is live unless 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 raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

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

Chapter 1.
General Information

Introduction

The major intent of this manual is to provide the end user with the information necessary to properly install, operate, maintain, and troubleshoot the Woodward SOGAV™ 2.2 valve, the smallest of the Solenoid Operated Gas Admission Valve product family.

To a lesser extent, this manual is intended to assist the engine designer/ retrofitter in properly applying a SOGAV 2.2 valve. This manual is not intended to be a substitute for consultation with a Woodward application engineer.

The SOGAV 2.2 valve is designed for use as a pre-chamber fuel admission valve for four-cycle, turbocharged, natural-gas engine. It may also be applied as a main in-manifold (port) fuel admission valve, provided the application meets the valve specifications listed in this manual.

Principles of Operation

Magnetic

All valve actuation forces are generated magnetically through a circular solenoid device. Magnetic flux generated in the solenoid attracts a low carbon steel plate (the metering plate). The solenoid produces very high forces over short travels. The valve mechanism travels 0.25 mm from full closed to full open for the SOGAV 2.2 valve. The short travel along with the high forces result in fast and consistent opening and closing response.

Valve

The valve is similar to an air (or gas) compressor valve. It is a face-type poppet with a concentric groove. The moving metering plate is spring loaded (and pressure loaded) against the stationary housing, and is pulled off the stationary housing by the solenoid actuator. When the plate is separated, gas flows from the groove in the moving plate to a simple reamed hole in the stationary housing. When the moving plate and the stationary housing are in contact, gas cannot pass from the groove in the moving plate to the reamed hole in the stationary housing.

The groove edge is the metering edge. Overlapped, flat lapped sealing surfaces, spring loading, and pressure imbalance across the moving plate provide excellent sealing while the valve is closed.

An array of springs, combined with pressure imbalance across the moving plate, rapidly close the SOGAV 2.2 valve once the solenoid is de-energized. The spring design centers the moving plate relative to the stationary housing. This centering technique eliminates sliding (wearing) motion.

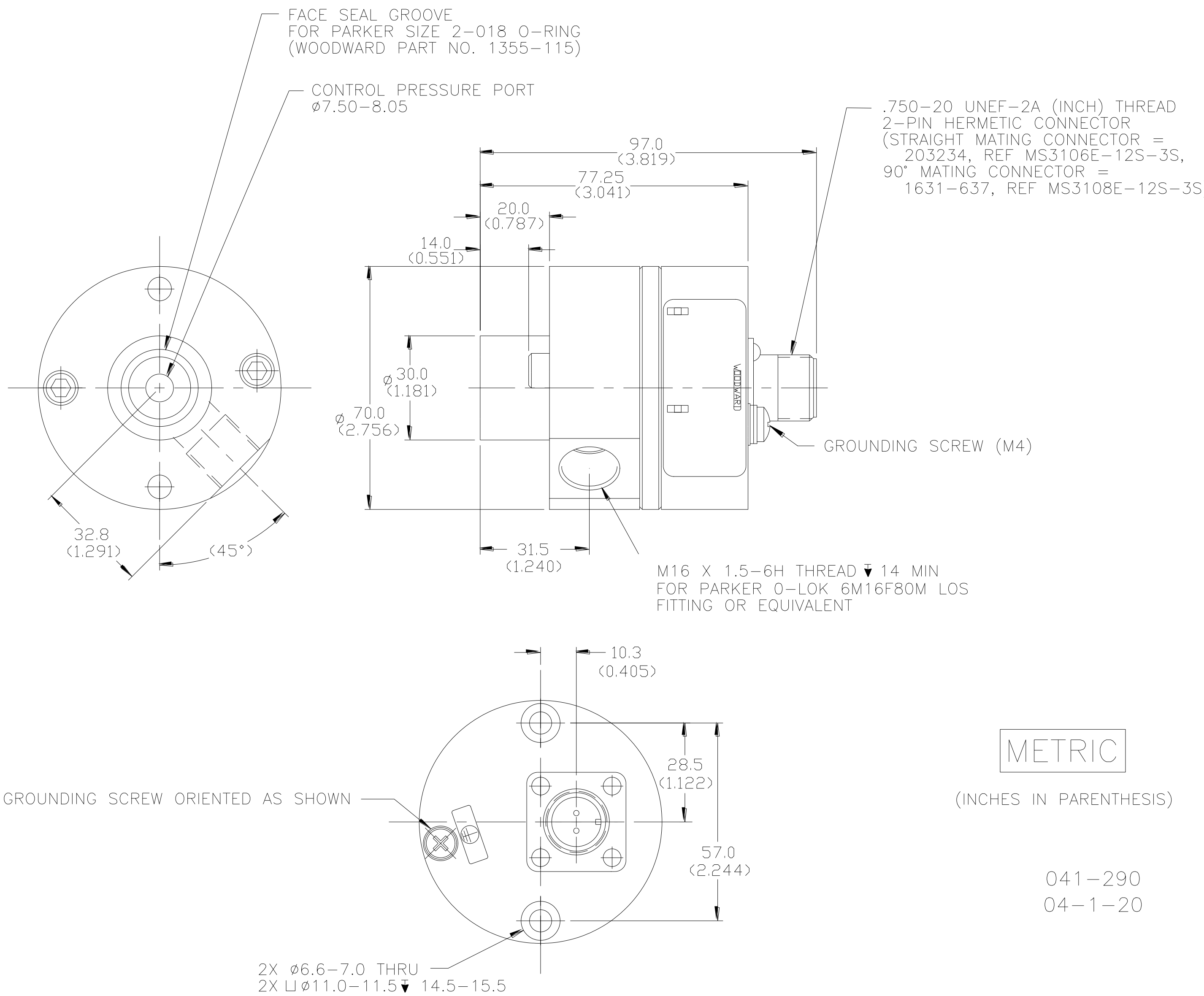


Figure 1-1a. SOGAV 2.2 Outline Drawing (MS Connector)

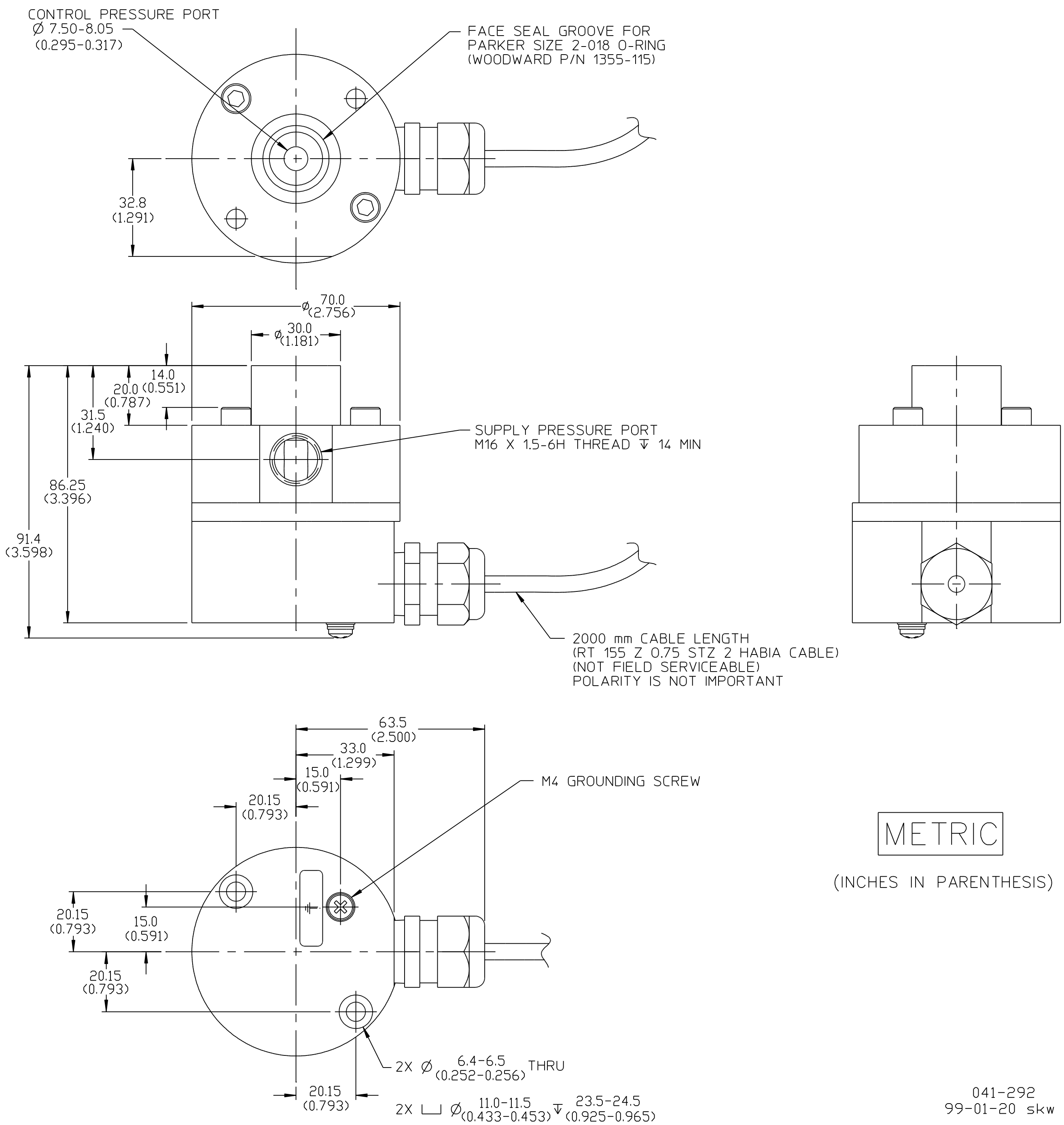


Figure 1-1b. SOGAV 2.2 Outline Drawing (Cable/Gland)
(for use in hazardous locations)

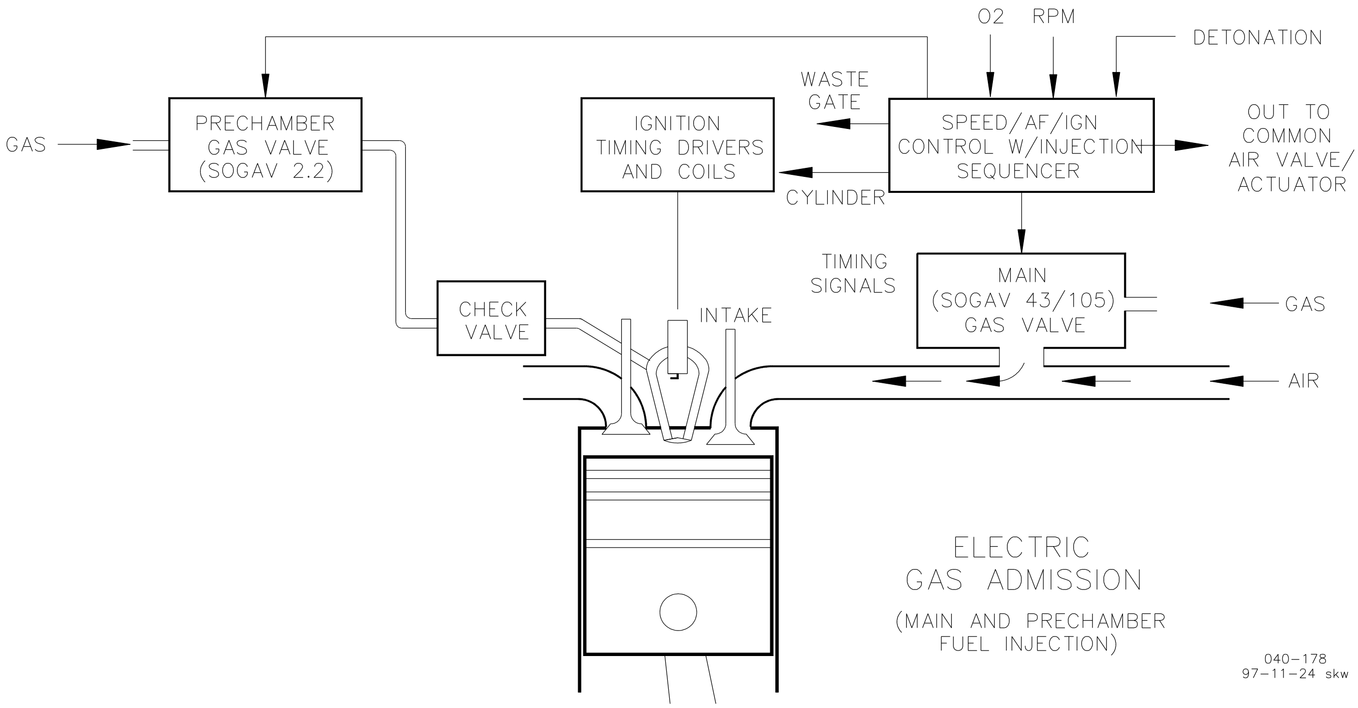


Figure 1-2. Electric Gas Admission (Main and Pre-Chamber Fuel Injection)

Chapter 2.
Installation/Adjustment

Introduction

⚠WARNING	**Explosion Hazard—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.** **Substitution of components may impair suitability for Class I, Division 2 or Zone 2.**

IMPORTANT	**It is imperative that the interior of all gas manifolding be absolutely clean prior to SOGAV™ installation and engine start-up. There must be no dirt, weld slag, metal chips, etc., present. Contamination of this type can prevent the valve from operating properly and can damage the engine if the contamination passes through the valve or by overfueling if the valve is stuck open.**

General

Gas must be clean, dry, and filtered (5 µm maximum particle size). Excessively oily or dirty gas will adversely affect valve performance.

The region around the SOGAV 2.2 installation pad must also be very clean so that no debris gets into the air manifold during SOGAV 2.2 installation.

Locate the appropriate O-ring (specified on the outline drawing) in the groove on the base of the SOGAV 2.2 valve.

Mount the SOGAV 2.2 valve to the cylinder head or air intake manifold runner using either M6 or ¼" socket head screws. Socket head screws are required for bolt head clearance. Tighten these screws evenly to a torque recommended by the engine manufacturer.

Install the gas inlet line to the inlet side of the SOGAV 2.2 valve using a Parker O-Lok 6M16F80MLOS fitting or equivalent (per DIN 3852 Part 1).

The cable connector should be installed last. Assure that the knurled locking nut is well secured.

Connect the ground terminals on the SOGAV 2.2 solenoid to earth ground.

The hazardous location approved solenoid cable must be terminated at the engine mounted fuel injection driver. The cable connection at the solenoid is not field-serviceable.

Initial Operation/Adjustment

There are no field adjustments that can be made to the SOGAV 2.2 valve.

After installation, pressurize the gas manifold system (preferably with air or inert gas) and check for leaks around all valves and all interface flanges, by brushing on a soap and water solution.

Refer to the overall control system documentation for start-up/operation procedures. These procedures will vary from application to application.

If background noise is minimal, basic valve operation can be confirmed by an audible ticking sound.

Chapter 3.
Application Guidelines

Introduction

IMPORTANT **For units with agency markings, wiring must be in accordance with North American Class I, Division 2 or European Zone 1 wiring methods, as applicable, and in accordance with the authority having jurisdiction.**

The SOGAV™ electrically actuated, high response, gas admission valve provides pre-chamber or in-manifold (port) fuel admission. One SOGAV 2.2 valve is required for each cylinder. If the SOGAV valve is used for pre-chamber fuel admission, a check valve must be in place between the pre-chamber and the SOGAV 2.2 valve to prevent backflow of combustion gases. The SOGAV 2.2 valve is capable of 6 bar (600 kPa/87 psi) back pressure without backflow through the valve.

The SOGAV valve is the electro-mechanical valve portion of an overall Woodward fuel admission system consisting of:

- Electronic Fuel Injection Control (In-Pulse™ unit: valve driver and timing/sequencer; Woodward manual 02983)
- SOGAV (main fuel admission valve)
- SOGAV 2.2 valves (this manual 04153)
- SOGAV 43/105 valve (Woodward manual 04144)
- the main speed/air-fuel ratio/engine sequencing control
- miscellaneous valves, actuators, regulators, sensors, cables, and safety devices

In addition to fuel admission, the main speed/air-fuel ratio control must regulate air manifold and gas manifold pressures.

Governing is usually done by way of valve opening duration, and individual cylinders can be electronically balanced by duration and timing bias within the In-Pulse unit.

This section does not cover overall system design, nor does it cover the electronic controls used with the SOGAV valve.

The SOGAV valve can be mounted in any orientation. Take care to keep the SOGAV valve and wiring from being exposed to extremely hot surfaces (such as exhaust systems).

Wiring

The wiring connecting the Driver unit to the valves should be shielded, twin-lead wire with an insulation adequate for the on-engine environment. The shielding should be grounded through the Driver connector, but not grounded on the SOGAV end. Connect the ground terminal on the SOGAV 2.2 solenoid to earth ground.

The mating connector is defined on the outline drawing.

The cables do not need to all be the same length as long as each cable meets the following length/wire gauge criteria:

- up to 15 m (up to 49 ft) cable length: 1 mm² (18 AWG) required
- 15 to 25 m (49 to 82 ft) cable length: 1.5 mm² (16 AWG) required
- 25 to 30 m (82 to 98 ft) cable length: 2 mm² (14 AWG) required

Sizing

Always consult a Woodward application engineer to determine the appropriate system and hardware for the specific application.

To determine if the SOGAV 2.2 valve is sized appropriately for an application, use the following methodology:

1. Assuming the full speed and full load condition:
   a. Port Injection: Determine the air manifold pressure required to achieve the desired A/F ratio. Call this variable P2 and use units of bar (absolute).
   b. Pre-chamber Injection: Determine the pre-chamber air pressure required to achieve the desired A/F ratio. Call this variable P2 and use units of bar (absolute).
2. Determine the properties of the poorest quality gas expected to be used on this application. In addition to energy content, the following properties are required:
   - Specific Gravity relative to air. Call this variable sg (unitless).
   - Ratio of specific heats (CP/CV). Call this variable k (unitless).
3. Assuming the full speed and full load condition and the fuel energy content, determine the mass (in grams) of the fuel charge required per combustion event.
4. Determine the maximum allowable SOGAV 2.2 admission time duration per combustion event (in seconds). Subtract 0.002 seconds to compensate for SOGAV valve opening and closing times.
5. Using the data from steps 3 and 4 above, determine the required mass flow rate while the valve is in the open condition. Call this variable MR and use units of grams/second.
6. Using a P1 (gas manifold pressure) of 2 bar greater than P2, perform the following calculation. Determine if the available flow (MA) exceeds the required flow (MR) calculated in step 5 above.

Available Flow Rate (with valve in full open condition):

MA = Z*((2*k/(k-1))*sg*P1^2*(293.15/(273.15+Tg))*((P2/P1)^(2/k)–(P2/P1)^((k+1)/k)))^.5

where:
MA = available gas mass flow rate (g/s)
Z = valve constant (use 2.2 for the SOGAV 2.2 valve)
k = ratio of specific heats (Cp/Cv)
sg = gas specific gravity (relative to air)
P1 = gas absolute upstream pressure at valve entry (bar)
P2 = gas absolute downstream pressure at valve exit (bar)
Tg = gas temperature (°C)

The above equation is valid only for ratios of P2/P1 greater than 0.544. For P2/P1 ratios less than 0.544, flow is choked (sonic or critical). To make the equation valid for P2/P1 ratios less than 0.544, use P2/P1 = 0.544 instead.

For example, assuming for a SOGAV 2.2, Z=2.2, k=1.31, sg=0.55, P1=4.0 bar, P2=3.0 bar, and Tg = 20 °C, steady state full open flow would be approximately 3.91 g/s.

For a 45 ms gas admission event, the mass of gas admitted would be approximately 168 mg (0.043 s x 3.91 g/s).

Input Power Limitations

Woodward solenoids are labeled with maximum rated values of input current and input power. These input ratings must not be exceeded during continuous solenoid operation, to prevent exceeding a prescribed coil temperature rise at the maximum rated ambient operating temperature. These solenoids must be driven by specially designed current limiting drivers, providing periodic, two-tier current waveforms. Details on how to determine and interpret these values are in the Appendix.

Safety

In addition to normal safety systems used with gas engines, the gas manifold should be immediately de-pressurized and evacuated after engine shutdown. This is required to prevent possible leaks of gas into the pre-chamber or inlet port (through the SOGAV valve) after shutdown. Gas leaks of this type can cause over-fueling during the next start-up. The SOGAV valve is not a positive shutoff valve.

Chapter 4.
Servicing

Service life of the SOGAV™ valve is highly dependent on the following variables, which are beyond the control of the manufacturer:

- Engine speed
- Fuel quality/contaminants
- Fuel filtration
- Temperature
- Vibration
- Driver electronics used

Therefore, SOGAV maintenance/reconditioning should be carried out at intervals determined by the engine manufacturer for the particular application.

For optimum service/reconditioning, return SOGAV valves to Woodward, where trained personnel and sophisticated reconditioning and test equipment are available.

If on-site maintenance or troubleshooting is required, refer to Chapter 5.

Chapter 5.
Maintenance/Troubleshooting

NOTICE

Depressurize the fuel system before removal of the SOGAV™ valve to prevent the escape of hazardous gases.

Introduction

Some SOGAV valve troubleshooting and minor valve maintenance can be done in the field. However, the lack of flow and response testing facilities often limits the ability to analyze the problem and verify the solution. If time permits, it is always advisable to return the SOGAV valves to Woodward for service.

WARNING

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

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

Troubleshooting

If a SOGAV valve is suspected of having a problem, one of four tests will most likely isolate the problem. If the SOGAV valve passes the four tests, the problem is probably not with the SOGAV valve, and disassembly should not be required. The following tests assume that the valve has been removed from the engine. The tests should be done in the order listed.

Coil Integrity

1. Measure coil resistance from one connector pin to the other. At room temperature, the coil resistance should be 2.3 to 2.6 Ω for the MS connector version of the SOGAV 2.2 valve or 2.5 to 2.9 Ω for the cable with gland nut version of the SOGAV 2.2 valve. Because of the low resistance levels, make sure to compensate for the meter lead resistance. If outside of this tolerance, the solenoid assembly should be replaced.

   Additional indication of a coil problem can be observed by comparing coil resistance of a suspect SOGAV valve to one that is known to be good. This is particularly helpful if the meter's accuracy at low resistances is questionable.

2. Check for a ground fault. Measure resistance from either pin to the solenoid housing. If a low resistance is measured, a ground fault exists and the solenoid assembly should be replaced.

   Generally, a properly operating coil will measure infinite resistance to ground; however sometimes a high resistance will be measured at first (> 10 MΩ) and the reading will gradually increase until the meter reads infinite. This is not a problem. This is a result of the meter's charging of the coil's natural capacitance.

Valve Leakage

Install a pressurization adapter to the gas inlet. Use the Parker O-Lok 6M16F80MLOS fitting or equivalent for the SOGAV 2.2 valve (per DIN 3852 Part 1).

Apply 200 kPa/2.0 bar gauge (29 psig) of air pressure to the SOGAV inlet. In a quiet area, listen to the outlet of the SOGAV valve. If the leakage is inaudible or barely audible, the valve is OK. If the leakage is appreciable, either the valve plates are damaged or contamination is present between the valve plates. In either case, disassembly and corrective action is required.

If instrumentation is available, measure the leakage flow rate and compare to the specified maximum defined in the specification (Chapter 6).

Actuator Strength

Apply 200 kPa/2.0 bar gauge (29 psig) of air pressure to the inlet of the SOGAV valve as was done during the leakage test.

Using a power supply capable of 4 A at 24 Vdc, set up as follows:
current limit: 4 A (Do not use the solenoid assembly to set up this current.)
voltage limit: > 24 Vdc

Install a switch between the power supply and SOGAV solenoid assembly. Turn off the switch and turn on the power supply.

Turn the switch ON and then immediately OFF.

DO NOT LEAVE THE SOLENOID ASSEMBLY ENERGIZED WITH 4 A FOR MORE THAN 2 SECONDS. The coil will overheat if left continually energized with 4 A for more than 2 seconds. Also, remember that two 1-second bursts in rapid succession are equivalent to one 2-second burst. Allow one minute cool down between bursts. (The coil does not overheat in operation because the In-Pulse™ driver limits the 4 A "on" time to a maximum of 0.002 seconds per event. This is not possible using the manual switch method.)

If a pop is heard (like a balloon bursting), the actuator strength is adequate.

If no pop is heard and the current was applied properly, the valve should be disassembled and evaluated. Most likely, one of two situations exist:
There is debris between the moving valve plate and the solenoid assembly; or
Excessive wear has occurred.

Valve Travel

In the absence of elaborate flow test apparatus, a fair check of flow capacity can be inferred from valve travel.

Reset the power supply used in the previous test to a 4 A current limit.

With no pressure applied to the SOGAV 2.2 valve, turn the switch ON and quickly reduce the current to 1.5 A (the valve can be continually operated at this current level without overheating).

Using a depth micrometer or dial indicator, measure the distance from the SOGAV valve's base flange down to the face of the moving valve plate. Then de-energize the coil (turn switch OFF) and repeat the measurement. The difference in measurements (travel) should be 0.230 to 0.267 mm (0.009" to 0.011").

The depth micrometer or dial indicator should have a stem with a diameter less than 7 mm. The lapped face of the moving valve plate can be accessed by inserting the stem through the outlet hole in the base or stationary housing.

If the travel is less than 0.230 mm, debris is probably present between the moving valve plate and the solenoid assembly. If the travel is greater than 0.267 mm, some wear probably exists and the valve should be disassembled and the parts evaluated.

Comments

If the SOGAV valve passes the tests above, there should be no reason to disassemble it. The problem most likely lies elsewhere. In addition to suspecting the electronic controls (outside the scope of this manual), the following possibilities should be considered:

- Does the pressure difference (ΔP) across the valve exceed 300 kPa/3.0 bar (43.5 psi)? This will prevent valve pull-in.
- Are the cables and connectors in good condition? Each lead should have less than 0.4 Ω resistance. Have the cables been burnt? Are there intermittent connections at the connectors? Are the connectors tight?

Chapter 6. Specifications

Construction Materials

All parts exposed to the gas are resistant to corrosion and stress corrosion cracking (a problem associated with hydrogen sulfides, which are sometimes present in natural gas).

Environment

1. Operating Temperature: –20 to +105 °C (–4 to +221 °F)

2. Vibration:
Contact Woodward for vibration qualification data and analysis.

3. Humidity, Salt Spray, Pressure Wash Resistance, etc:
The unit withstands exposure to pressure washing, salt spray, etc., without adverse corrosion or infiltration. The SOGAV™ valve is not IP rated.

Performance

Response (assumes the use of a Woodward In-Pulse™ control) is dependent on current wave form. The following times require an inlet pressure of 4 bar, outlet pressure of 2 bar, and the valve exit oriented down with respect to gravity. Typical wave form results below:

- Time to full open after signal on: 0.005 seconds max (0.003 s typical)
- Time to full closed after signal off: 0.005 seconds max (0.003 s typical)

Steady State Flow Rate (with valve in full open condition)
See the flow equation defined previously in the sizing section (Chapter 3).

Maximum Leakage When Closed
Less than 0.3% of the rated steady state flow rate (i.e., 0.3% of the flow calculated in Steady State Flow Rate above)

Filtration Required—5 µm absolute max particle size

Coil Heat Dissipation
10 W (maximum)

Expected Maximum Gas Supply Pressure (P1)
(not a limiting specification)—500 kPa/5 bar absolute (72.5 psi absolute)

Expected Maximum Air Manifold or Pre-Chamber Pressure (P2)
(not a limiting specification)—300 kPa/3.0 bar absolute (43.5 psi absolute)

Maximum Gas Manifold to Air Manifold Pressure Difference
(the limiting specification: P1 – P2)—300 kPa/3.0 bar (43.5 psi)

Maximum Backfire Pressure Spike (without backflowing through valve)
600 kPa/6.0 bar (87 psi) above the current gas manifold pressure

Expected Maximum Gas Supply Temperature—80 °C (176 °F)

Chapter 7.
Product Support and Service Options

Product Support Options

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

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

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

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

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.

- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.

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

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- 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 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.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic 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.

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. 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 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's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- 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.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor 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 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 one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at **www.woodward.com/directory**.

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

Products Used In Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used In Engine Systems

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

Products Used In Industrial Turbomachinery Systems

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

For the most current product support and contact information, please visit our website directory at **www.woodward.com/directory**.

Technical Assistance

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

General

Your Name	
Site Location	
Phone Number	
Fax Number	

Prime Mover Information

Manufacturer	
Engine Model Number	
Number of Cylinders	
Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.)	
Power Output Rating	
Application (power generation, marine, etc.)	

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

Control/Governor #2

Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

Control/Governor #3

Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

Symptoms

Description	

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

Appendix. Interpreting Solenoid Ratings

Procedure for interpreting the "Equivalent Average Direct Current" (EADC) and "Equivalent Average Power" (EAP) ratings of Woodward Solenoids

Introduction

Woodward solenoids are labeled with maximum rated values of input current and input power. These input ratings must not be exceeded during continuous solenoid operation, to prevent exceeding a prescribed coil temperature rise at the maximum rated ambient operating temperature. These solenoids must be driven by specially designed current limiting drivers, providing periodic, two-tier current waveforms (see example waveform in Figure A-1).

The first tier is the relatively large "pull-in" current pulse. The second tier is the lesser "hold-in" current pulse. Solenoid applications vary in regard to the current waveform required to achieve the desired solenoid performance, considering the device being actuated by the solenoid, the frequency of solenoid operation, etc. The parameters "Equivalent Average Direct Current" (EADC) and "Equivalent Average Power" (EAP) are used as ratings for these solenoids to achieve a rating procedure that can be applied to varying solenoid applications.

Equivalent Average Direct Current (EADC)

Equivalent Average Direct Current (EADC) equates to the equivalent dc current (I) that can be continuously applied to a solenoid, having the highest expected coil resistance and operating at the maximum rated ambient temperature, while not exceeding the rated solenoid coil temperature rise. The EADC rating can be related to various periodic, two-tier solenoid current waveforms used to drive the solenoids.

The average area under an "I^2 vs. time" solenoid current waveform plot depicts the solenoid coil heating effect. If the area under the "I^2 vs. time" waveform of a two-tier current waveform is equal to, or less than, the rated EADC of the solenoid, the two-tier waveform is acceptable (it will not overheat the coil) if the solenoid is operated at maximum rated ambient temperature. This approach is applied, in detail, as follows:

1. A solenoid application is established and a suitable, worst case, two-tier current waveform is defined, in terms of the parameters defined in Figure A-1, that achieve the desired solenoid dynamic performance.

2. The current waveform parameters are applied to the EADC equation as shown in the example calculation of Figure A-1. The resulting calculated EADC value must not exceed the solenoid's rated EADC value, indicated on the solenoid nameplate.

3. The above analysis must include the "worst case" operating condition, which is the highest expected "duty cycle" waveform. The highest "duty cycle" waveform is a waveform whereby the duration of the current "ON" time, relative to the total time between periodic current waveform cycles, is the greatest.

Equivalent Average Power (EAP)

While EADC, as discussed above, is the most accurate and preferred parameter for determining suitability of two-tier waveforms, Equivalent Average Power (EAP) is another parameter that defines solenoid input limitations.

Equivalent Average Power (EAP) equates to the equivalent input power that can be continuously applied to a respective solenoid, operating at the maximum rated ambient temperature, without overheating the solenoid coil. The EAP rating can be related to typical periodic two-tier solenoid current waveforms used to drive the solenoids.

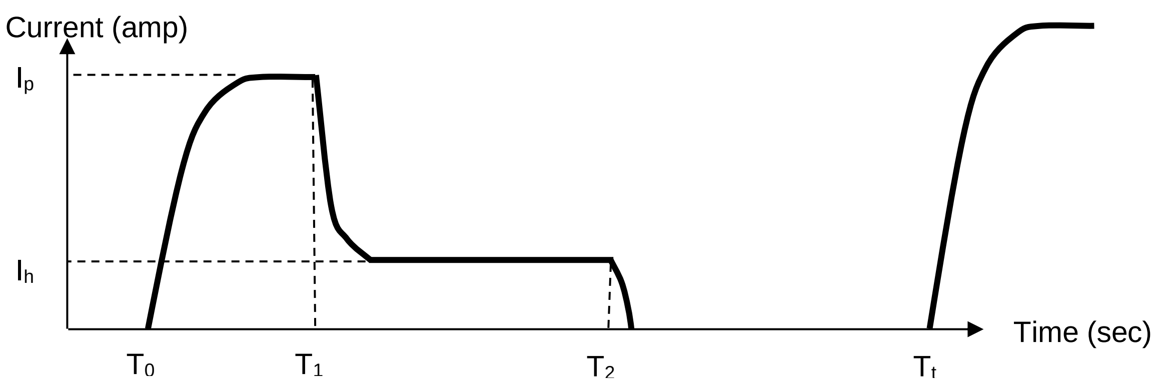
The product of (average coil current)² and coil resistance (I^2R) describes the solenoid coil heating effect (input power). For a given set of conditions, if the EADC (amps) of a two-tier current waveform is known, and if the associated solenoid coil resistance Rc (ohms) is known, the associated EAP can be calculated by the relationship:

$$EAP = EADC^2 * Rc \text{ (watts)}$$

If the calculated EAP of a two-tier current waveform is equal to, or less than, the rated EAP of the solenoid, the two-tier waveform is acceptable in that it will not overheat the solenoid coil when operating at maximum rated ambient temperature. This approach is applied, in detail, as follows:

1. The value of EADC is calculated for a given two-tier current waveform as described above.
2. The highest expected nominal solenoid coil resistance (Rc max), for the object solenoid, at the rated coil temperature (including temperature rise) is determined from the table in Appendix B.
3. Entering the calculated EADC value and listed coil resistance into the above equation will result in the EAP value for a given solenoid part number.

Two-Tier Solenoid Current Waveform



I_p = Pull-in Current
I_h = Hold-in Current
T_o = Initial Current Rise
T_1 = Initial Fall of Pull-in Current
T_2 = Initial Fall of Hold-in Current
T_t = Total Time of One Complete Current Waveform

Figure A-1. Two Tier Current Waveform Parameters

EXAMPLE CALCULATION—Equivalent Average Direct Current (EADC)

Let: $T_o = 0.0$ s $I_p = 10$ A
$T_1 = 0.002$ s $I_h = 2$ A
$T_2 = 0.020$ s
$T_t = 0.100$ s

EADC = $[\{(T_1 - T_0) * (I_p)^2 + (T_2 - T_1) * (I_h)^2\} / (T_t - T_0)]^{0.5}$ (amps)

EADC = $[\{(0.002 * (10)^2\} + \{0.018 * (2)^2\} / \{0.100\}]^{0.5}$ = $[(0.2 + 0.072) / (0.100)]^{0.5}$

EADC = 1.649 A

Solenoid Part No.	Coil Resistance (max) (ohms)
5852-118	3.81
5852-149	4.25
5852-157	4.25
5852-177	4.25
5852-197	4.25
5852-231	4.25
5852-237	4.25
5852-1087	4.25

Table A-1. Maximum Solenoid Coil Resistance (Rc) Values for Woodward SOGAV 2.2 Solenoids

IMPORTANT

Coil resistance values listed represent the expected coil resistance when the coil has reached its maximum allowed operating temperature. In each case, the resistance, at a coil temperature of 21 °C, is assumed to be the maximum value allowed by the coil design specification.

Revision History

Changes in Revision P—
- Added pressure requirements in Specifications section

Changes in Revision N—
- Added new solenoid part number (Table A-1)

Changes in Revision M—
- Removed disassembly information, since field disassembly is not recommended

Declarations

DECLARATION OF CONFORMITY
According to EN 45014

Manufacturer's Name:	WOODWARD GOVERNOR COMPANY (WGC) Industrial Controls Group
Manufacturer's Address:	1000 E. Drake Rd. Fort Collins, CO, USA, 80525
Model Name(s)/Number(s):	110 Newton, 400 Newton, 800 Newton, and 1200 Newton Solenoids 5852-118, 5852-116, 5852-173, 5852-125 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 73/23/EEC COUNCIL DIRECTIVE of 19 February 1973 on the harmonization of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits.
Applicable Standards:	EN61010-1:2001 Safety requirements for electrical equipment for measurement, control and laboratory use Part 1: General requirements EN50028: 1987 Electrical apparatus for potentially explosive atmospheres Part 8. Encapsulation 'm'

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

MANUFACTURER

Signature

James D. Rudolph
Full Name

Engineering Manager
Position

WGC, Fort Collins, CO, USA
Place

11/14/02
Date

5-09-1183 Rev 8, 2-May-2003 00112-04-CE-02-01

Declaration of Incorporation

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

Product: **Solenoid Operated Gas Admission Valves**
SOGAV 0.8, 2.2, 36, 43, 63, 105, 245, and 250

The undersigned hereby declares, on behalf of Woodward Governor Company of Loveland and Fort Collins, Colorado, that the above-referenced products are 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

Doug W. Salter
Full Name

Engineering Manager
Position

WGC, Fort Collins, CO, USA
Location

1/29/03
Date

5-09-1182 (REV. 1) 06-Dec-2000 00147-04-CE-02-01

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 04153P.

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