WOODWARD

Product Manual 04145
(Revision A)
Original Instructions

Electronic Rail Valve

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 Out-of-date translations are marked with ⚠.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

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.

Chapter 1.
Description and Specification

General

This manual describes the Woodward electronic rail valve. You will also need the outline drawing specific to your engine.

Description

The rail valve consists of two sections, the electric actuator and the high pressure valve. The actuator receives a voltage pulse from a driver. The voltage has the effect of generating a magnetic field between the solenoid and a flat plate (armature) attached to the valve. The valve is normally biased away from the actuator via a spring force. Whenever a voltage pulse is applied to the solenoid, the magnetic force overcomes the spring force and the valve is moved to its opposite stop (the inject position).

High pressure fluid is supplied to the valve through a high pressure rail. This fluid is sealed by the poppet valve. When the poppet is moved to its opposite stop, high pressure fluid moves from the supply to the control drilling. The rise in pressure in the control oil region activates an injection needle or piston, thereby allowing fluid (diesel, gas, water) to flow into the combustion chamber. To end injection, the voltage is removed, collapsing the magnetic field, which lets the valve return to the non-inject position under the influence of the spring. This allows the high pressure fluid in the control region to escape to drain, thus allowing the injector needle or piston to shut off the flow of fluid into the combustion chamber.

Specification

Maximum operating pressure:	370 bar
Normal operating pressure:	370 bar
Minimum operating pressure:	20 bar
Max. operating temperature:	110 °C
Normal operating temperature:	90 °C
Min. operating temperature:	0 °C for SAE 10W; 25 °C for SAE 40W
Fluid:	Engine oil, typically SAE 10W to SAE 40W; or synthetic oil (e.g., Mobil SHC524)
Desired filtration:	20 µm nominal
Back pressure valve setting:	10 ±2 bar
Valve response time:	less than 1.5 ms
Shot-to-shot response time repeatability:	less than 0.1 ms
Valve flow area:	5.3 mm²

Valve leakage:	less than 200 ml/min (maximum) at 370 bar supply pressure
Duration:	0 to 80 crank angle degrees
Voltage to coil:	nominal=110 V (pulse width modulated) maximum=140 V minimum=90 V
Hydraulic requirements:	(see also application section) High pressure pump flow rate = 0.5 to 2 L/min/rail valve, depending on application
Fittings:	Parker GE-M bite type depending on operating pressure
Interface O-rings:	per Parker Standard V884-75/V894-90 (ASTM FKM)
Valve material:	hardened steel
Storage:	The rail valve should be protected from moisture during storage.
Safety:	The rail valve operates at high pressure. Care must be taken to ensure adequate design of the pipework and the fittings. The rail valve is supplied with 110 V nominal voltage. The connector to the rail valve should not be removed during operation. The current duration to the rail valve should not exceed 20 ms at 4 A.
Electrical Connection:	Receptacle pins A and B. Polarity to pins is not important. Valve will operate with plus (+) on A or B. There is a separate ground terminal. See Figure 1-1.

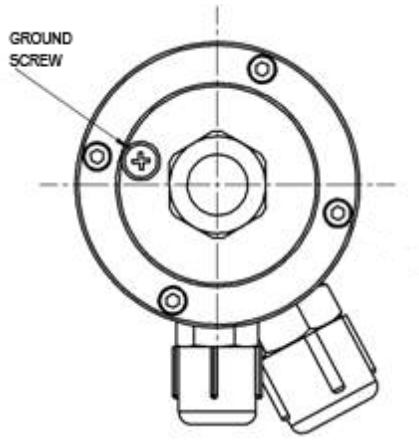

Figure 1-1. Location of Ground Screw

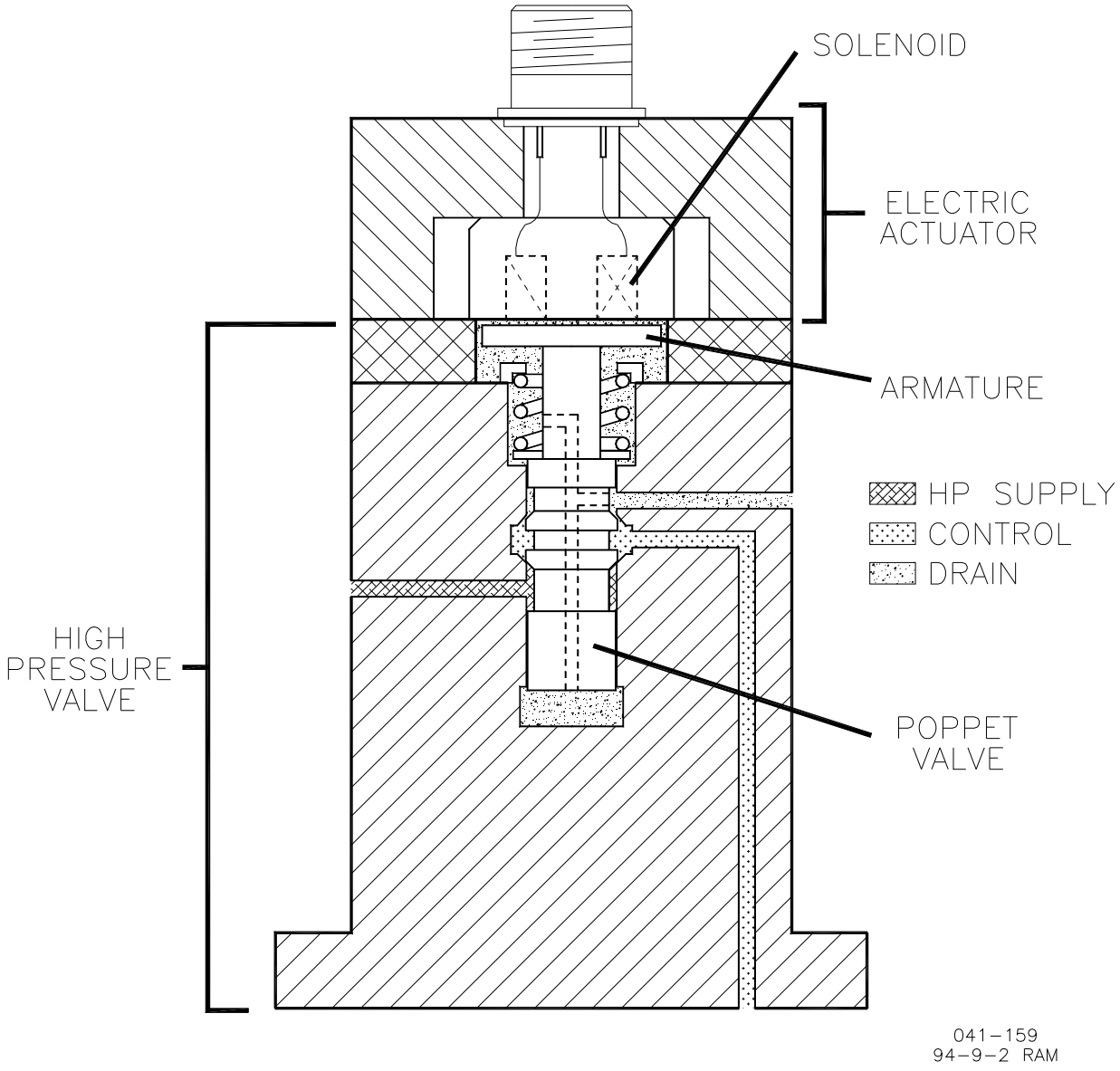

Figure 1-2. Rail Valve

Chapter 2.
Operation

Assembly and Disassembly

The solenoid can be removed by means of four bolts. Before installing the solenoid, take care that the parts are clean and that the o-rings located in the aluminum spacer are not pinched during tightening of the solenoid bolts.

NOTICE

The high pressure valve is assembled and checked for alignment at the factory. It should not be disassembled since incorrect re-assembly could cause the valve to jam during operation and result in an extended injection.

Application

A synthetic oil (such as Mobil SHC524) has a higher resistance to shear forces at high pressure and has better viscosity versus temperature characteristics than regular engine oil. However, for under the rocker engine applications, engine oil is generally preferred because of simplicity and because mixing of oils is not a concern.

The high pressure pump should be sized according to the application. Generally, the flow rate requirement is between 0.5 and 2 liters per minute per rail valve.

The supply line to the rail valve should have a minimum internal diameter of 4 mm. If 4 mm internal diameter is used, a maximum length of 1.5 meters is recommended before a larger “rail” pipe diameter is used.

The drain line should have a minimum internal pipe diameter of 5 mm for a maximum length of 1.5 meters before expanding into a larger diameter.

If multiple supply or drain lines connect into each other, the main (rail) line should be sized according to how many cylinders are connected together. Generally, a 10 mm ID rail pipe with adequate wall thickness can serve as a rail.

NOTICE

When operating at 370 bar, pressure waves as high as 450 bar can exist in the supply line. Pressure pulses as high as 100 bar can exist in the drain line under normal operation. Therefore at 370 bar, the supply line should be designed for a minimum dynamic pressure of 450 bar and the drain line for a minimum dynamic pressure of 100 bar.

A drain line back pressure is essential to the correct operation of the rail valve. The actual drain pressure can fluctuate but should not fall below 5 bar. In the absence of back pressure, the fluid momentum at the end of injection can cause an evacuation of the control oil drilling. Back pressure opposes the fluid momentum and assists in filling any voids that might occur. The recommended set pressure is 10 ±2 bar.

The drain line from the rail valve acts as a damper for pressure pulses at the end of injection. It also acts as a small reservoir for filling any voids that might occur in the control oil line at the end of injection. For this reason, a minimum of 0.8 meter of 6 mm ID drain pipe should be used to preserve a reservoir of flow and to absorb the pressure wave at the end of injection. The 0.8 meter applies if no additional “rail” line is used.

The back pressure valve in the drain line should have a fully opened area equivalent to or greater than a 6 mm diameter pipe.

The flow through the drain line is very small, but an instantaneously flow rate can be very high. Typically the quantity is less than 500 mm^3/ms with a duration of less that 3 ms.

Chapter 3. Troubleshooting

Introduction

Some simple field tests can be made to determine if the valve coil is intact, or if the valve is not sealing. For complete testing of the time to pull in, and the flow characteristics, the valve must be tested on a flow bench using the proper driver.

Coil Integrity

The coil can be tested for resistance to see if it is open. If the resistance between pins A and B on the connector is 1.6 to 2.2 Ω, the coil is normal. Make sure the resistance of the leads is subtracted from the reading.

Do not energize the coil with more than 2 A. It is designed to be energized by a high current for only 20 ms during each cycle. Prolonged current may burn out the coil.

Valve Leakage

Pressurize the high pressure supply. The valve should positively seal. With a supply of 370 bar, the leakage should not exceed 200 ml/min.

⚠WARNING **Take care if the drain line is disconnected in order to observe the leakage flow. High leakage across the poppet seat can result in a strong jet of oil from the drain port.**

If the valve has excessive leakage, it may be from wear or debris caught in the seat. With the coil removed, the armature may be carefully raised in an attempt to dislodge the debris. Supply pressure should be reduced to 10-15 bar for this exercise.

If the valve must be disassembled, it is recommended it be returned to the factory. The internal parts are match-ground and alignment must be held within 6 µm.

Installation Leakage

When removing the valve from the installation, investigate for extruded or damaged o-rings. Be sure the surfaces are flat and free from debris when installing. Leaking seals can cause low injection pressure.

Life

The rail valve poppet seats wear out over time. This time depends on the quality of oil used. If the rail valve is no longer capable of meeting the leakage specification, it should be replaced.

Chapter 4.
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.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 04145A.

WOODWARD

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**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.

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