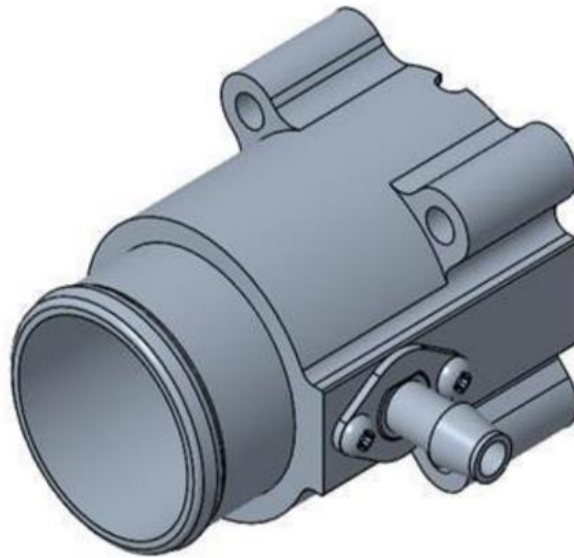




Product Manual 35217
(Revision -, 11/2022)
Original Instructions



MI-X Fuel Mixer

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. The latest version of most publications is available on the Woodward website.

www.woodward.com/publications

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. The latest version of most publications is available on the Woodward website.

www.woodward.com/publications

Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

If your publication is not on the Woodward website, please contact your customer service representative to get the latest copy.

Revisions— A bold, black line alongside the text identifies changes in this publication since the last revision.

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- MI-X

The following are trademarks of their respective companies:

- Bosch (Robert Bosch GmbH)

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Warnings and Notices

Important Definitions



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

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

WARNING

Lockout/Tagout LOTO

Ensure that personnel are fully trained on LOTO procedures prior to attempting to replace or service equipment on a “live” running engine. All safety protective systems (overspeed, over temperature, overpressure, etc.) must be in proper operational condition prior to the start or operation of a running engine. Personnel should be equipped with appropriate personal protective equipment to minimize the potential for injury due to release of hot hydraulic fluids, exposure to hot surfaces and/or moving parts, or any moving parts that may be activated and are located in the area of control of the unit.

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.

 **WARNING****IOLOCK**

IOLOCK: driving I/O into a known state condition. When a control fails to have all the conditions for normal operation, watchdog logic drives it into an IOLOCK condition where all output circuits and signals will default to their de-energized state as described below. *The system MUST be applied such that IOLOCK and power OFF states will result in a SAFE condition of the controlled device.*

- Microprocessor failures will send the module into an IOLOCK state.
- Discrete outputs / relay drivers will be non-active and de-energized.
- Analog and actuator outputs will be non-active and de-energized with zero voltage or zero current.

Network connections like CAN stay active during IOLOCK. This is up to the application to drive actuators controlled over network into a safe state.

The IOLOCK state is asserted under various conditions, including:

- Watchdog detected failures
- Microprocessor failure
- PowerUp and PowerDown conditions
- System reset and hardware/software initialization
- PC tool initiated

NOTE—Additional watchdog details and any exceptions to these failure states are specified in the related section of the product manual.

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. Touch your finger to a grounded surface to discharge any potential before touching the control, smart valve, or valve driver, or installing cabling connectors. Alternatively, ESD mitigation may be used as well: ESD smocks, ankle or wrist straps and discharging to a reference grounds surface like chassis or earth are examples of ESD mitigation.
 - ESD build up can be substantial in some environments: the unit has been designed for immunity deemed to be satisfactory for most environments. ESD levels are extremely variable and, in some situations, may exceed the level of robustness designed into the control. Follow all ESD precautions when handling the unit or any electronics.
 - I/O pins within connectors have had ESD testing to a significant level of immunity to ESD, however do not touch these pins if it can be avoided.
 - Discharge yourself after picking up the cable harness before installing it as a precaution.
 - The unit is capable of not being damaged or improper operation when installed to a level of ESD immunity for most installation as described in the EMC specifications. Mitigation is needed beyond these specification levels.

IMPORTANT

External wiring connections for reverse-acting controls are identical to those for direct-acting controls.

Chapter 1.

General Information

Introduction

The MI-X fuel mixer is designed for injector based mobile industrial (MI) fuel delivery systems. It is mounted directly to a throttle body, after the air cleaner and before the throttle, and will operate at atmospheric pressure or slight vacuum pressure created by the air filter.

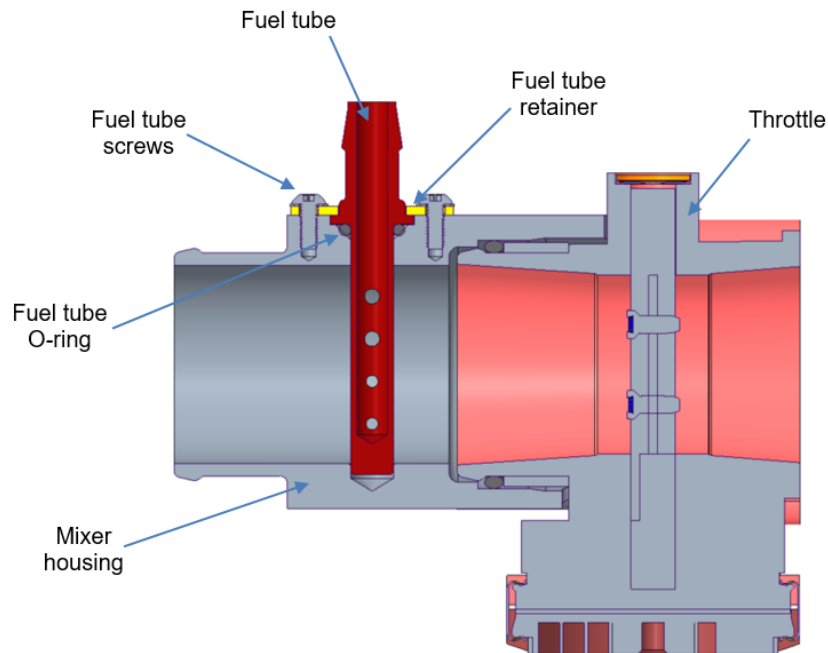


Figure 1-1. MI-X Mixer Components

Table 1-1. Mixer Specifications

Ambient Temperature Range	-40 °C to 120 °C (-40 °F to 248 °F)
Vibration	See Chapter 2
Fuel Types	LPG gas, blends including methane, propane, and butane
Operating Pressure	Mixer operates as an ambient or vacuum pressure device, installed between the air filter and the throttle.
Maximum Fuel Flow Tested	P/N 10-024-924: 17 kg/hr P/N 10-029-360: 10.5 kg/hr

Chapter 2. Application Overview

The MI-X fuel mixer is intended to be installed before the throttle with metered fuel coming from a metering device (typically an injector block). The mixer is designed to function with LPG fuels.

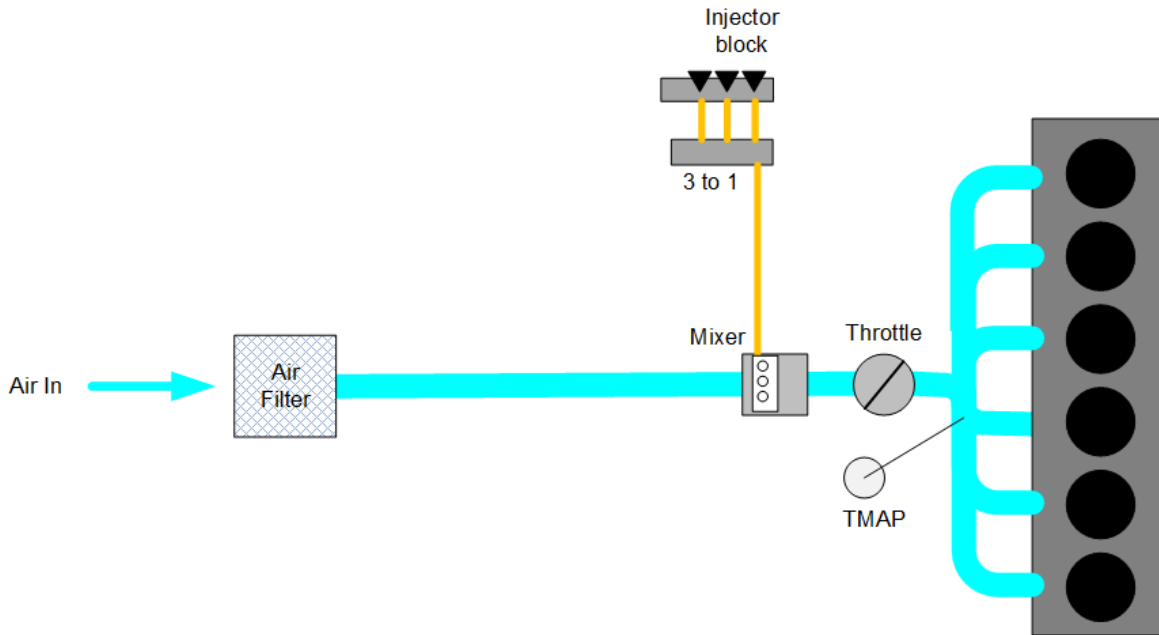


Figure 2-1. MI-X Operational Diagram

Mixer Sizing

Currently there are two mixer sizes to accommodate engines sized from approximately 2.4L–3.8 L. The fuel tube is designed to achieve fuel pressure drop of around 11 kPa at maximum fuel flow rate. Higher or lower flows than specified may be possible if mixing uniformity is confirmed in the application and maximum flow margins meet application requirements.

Table 2-1. Mixer Sizing

Approx. Engine Size	Mixer P/N	Throttle P/N	Maximum Fuel Flow	Mixer Air Barb Size	Mixer Fuel Barb Size
3.8L	10-024-924	6945-5001	17 kg/hr	50 mm	12 mm
2.4L	10-029-360	6945-5002	10.5 kg/hr	40 mm	12 mm

Orientation

There are no limitations on the orientation of the mixer. However, orientation of the mixer relative to the inlet elbow, throttle and intake manifold may impact mixing performance. Usually, packaging requirements will dictate an orientation, but if mixing problems exist alternative orientations may result in better mixing.

Application Management (AMP)

The Application Management Procedure (AMP) below is required to ensure correct performance of the mixer in the application and that product life targets can be met. Perform AMP items during engine development phase prior to production.

Table 2-2. AMP Checklist

Step	Description
1	Confirm air and fuel hose ID is correct for mixer size (Table 2-1).
2	Confirm ambient temperature range is $-40\text{ }^{\circ}\text{C}$ to $120\text{ }^{\circ}\text{C}$ ($-40\text{ }^{\circ}\text{F}$ to $248\text{ }^{\circ}\text{F}$).
3	Confirm application vibration levels are below the curve shown in Figure 2-3.
4	Confirm fuel mixing uniformity meets application requirements.
5	Confirm maximum flow margin (injector maximum duty cycle) at worst case pressure conditions meets application requirements.

Vibration Data Collection

For completion of the AMP, vibration data should be collected on engine (ideally on the vehicle application) across the full range of speed and load, weighted by application usage. The accelerometer location should be as shown below on the flat area behind the fuel tube. Since it may not be practical to collect vibration data on both the throttle and the mixer, vibration data collected on the throttle may also be used.

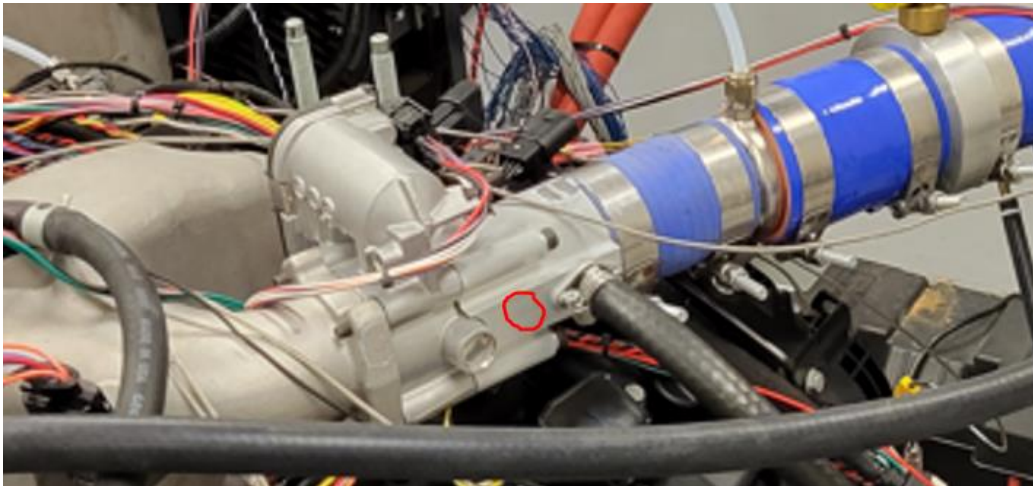


Figure 2-2. Accelerometer Location for AMP Vibration Data

Compare the application data to the profile shown in Figure 2-3. The profile predicts a 5000-hour life based on the validation test conducted which was RV2 profile for 37 hours per axis. The profile uses the inverse power law to calculate an equivalent vibration profile for 5000-hour life.

Total GRMS	5.99
time per axis	1,667
total time	5,000

New Profile Break Points

J AXIS

Engine

Resultant

G²/Hz Slope
(PSD_En (dB/octave)
gine_Res (interim calc)

Frequency	ultant)	(interim calc)	G ² (interim calc)
10	0.0022		
100	0.0218	3.0103	1.077546534
1000	0.0218	0	19.62382668
2000	0.0109	-3.0103	15.13155356

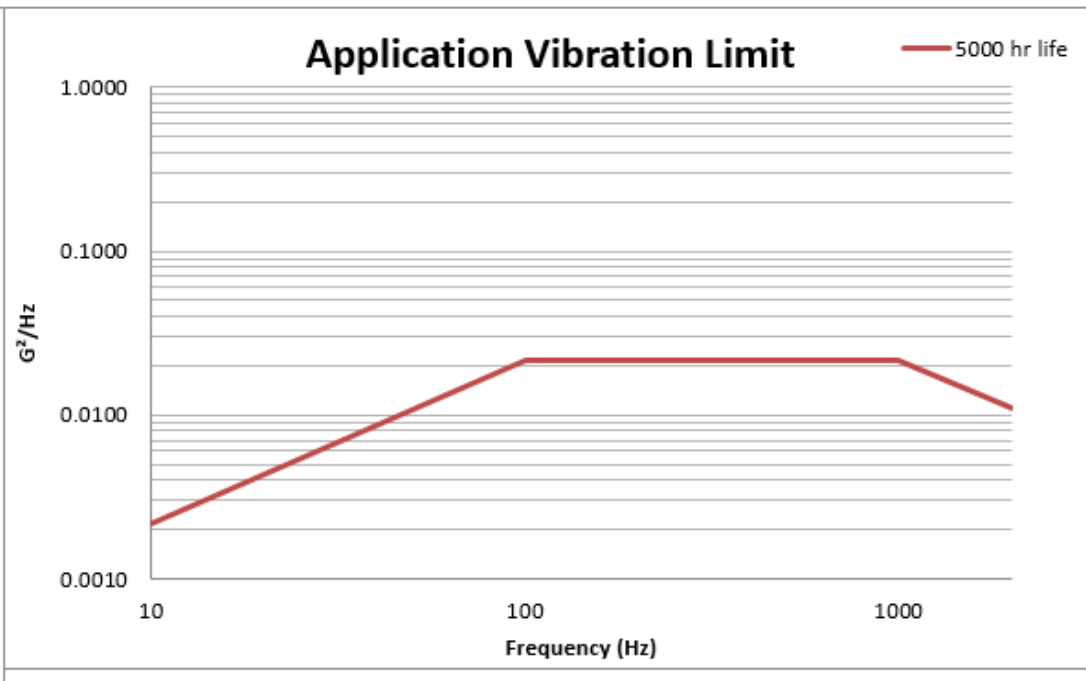


Figure 2-3. Allowed Application Vibration Profile

Chapter 3. Installation

The MI-X mixer is installed directly onto a Bosch throttle over top of the throttle inlet hose barb. An O-ring and spacer (not supplied by Woodward) are required to seal correctly against the throttle. The fuel tube and air inlet are connected by hose correctly sized to the hose bars specified in Table 2-1.

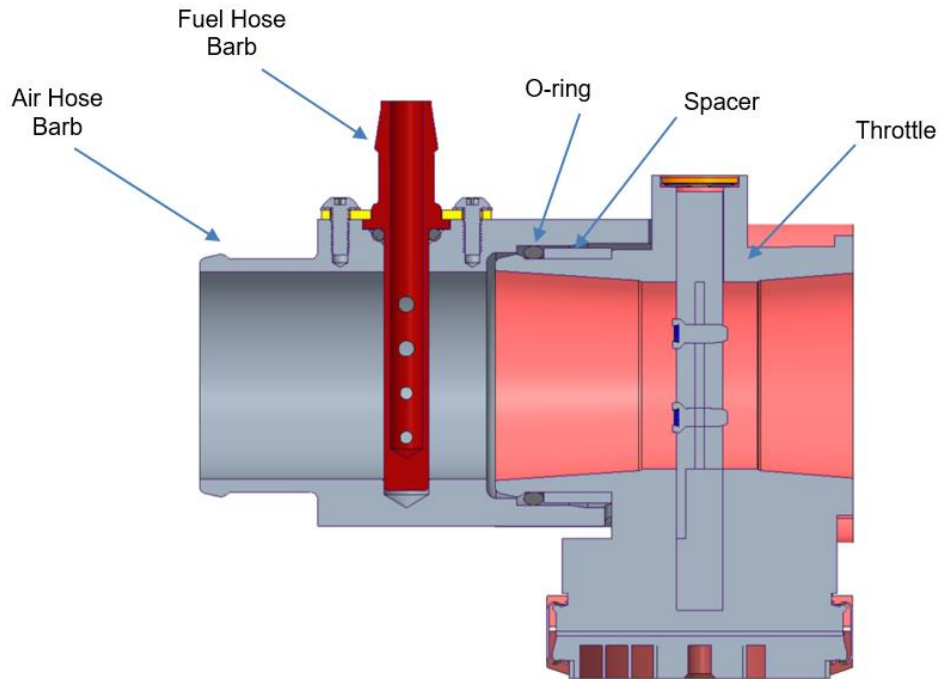


Figure 3-1. MI-X Mixer Installation

Chapter 4. Service

The MI-X mixer fuel tube can be cleaned if any build-up of contamination occurs that results in fueling error faults. The fuel tube ID and fuel holes can be cleaned with a nylon brush and solvent.

When re-installing fuel tube, be sure to remember the O-ring and lock washers. Torque the screws to 1.8-2.4 Nm. Re-install fuel hose and hose clamp according to manufacturer specifications.

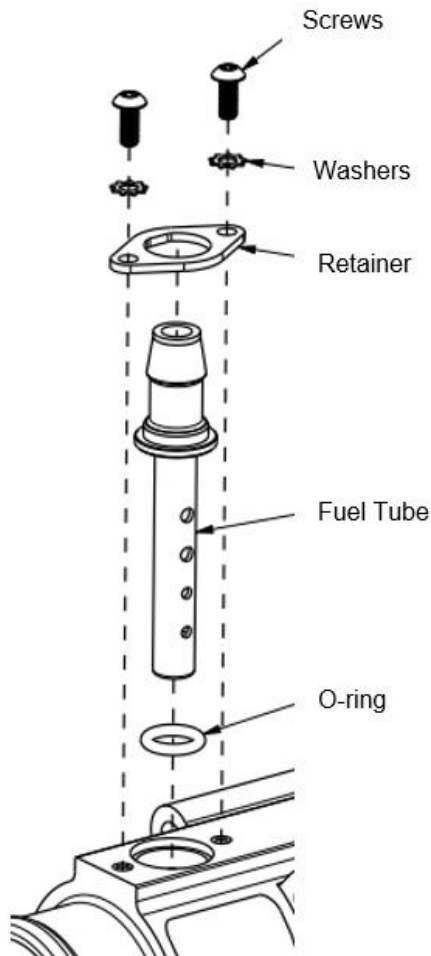


Figure 4-1. Fuel Tube Assembly

When installing the fuel tube be sure to align the indexing “D” feature on the fuel tube to the retainer. The flat can go on either side, left or right.

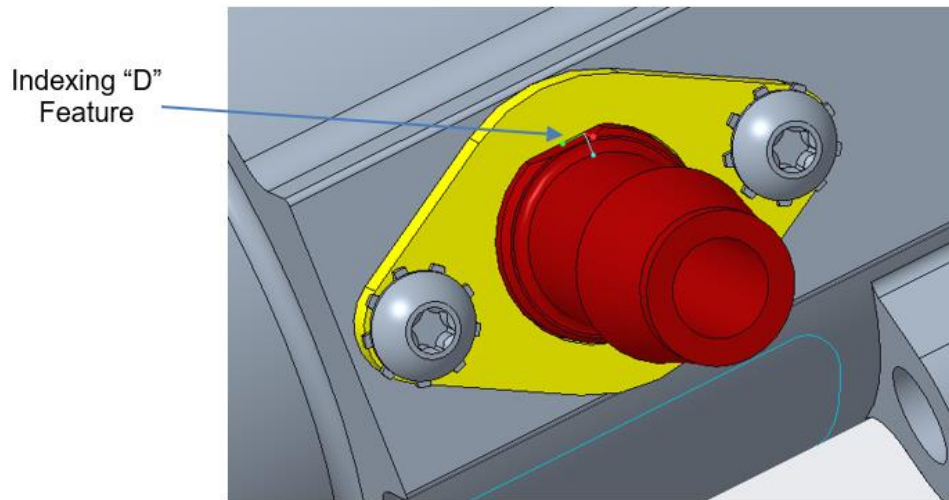


Figure 4-2. Fuel Tube Index Feature

Chapter 5.

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/local-partner.

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/local-partner.

Contacting Woodward's Support Organization

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

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

Products Used in Electrical Power Systems

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany:	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (32) 422-5551
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (32) 422-5551
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (32) 422-5551
The Netherlands	+31 (23) 5661111
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

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

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number _____

Prime Mover Information

Manufacturer _____

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.

Revision History

New Manual—

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication **35217**.



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PO Box 1519, Fort Collins CO 80522-1519, USA
1041 Woodward Way, Fort Collins CO 80524, USA
Phone +1 (970) 482-5811

Email and Website—www.woodward.com

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