



Product Manual 82540
(Revision NEW)
Original Instructions

Dual Fuel Control

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

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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 Out-of-date translations are marked with .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.

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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.

Chapter 1.

General Information

2301 Electronic Governor

The 2301 electronic governor is one in which its actuator output (terminal) shaft position is directly proportional to the input signal from its electronic control unit. It can be used in an isochronous (constant speed) mode for single engine operation or when paralleled with similar units on an isolated bus. It can also be used in the droop mode for paralleling dissimilar units or operating on an infinite bus. The 2301 governor is used in the same type of service as many other governor models. It is particularly well suited, when used with some types of proportional actuators, to engines operated in tandem to drive a common load. In such installations, one electronic control is used to furnish the same input signal to the proportional actuator on each engine. Since each actuator receives the same current, their output shafts take the same position and give each engine the same amount of fuel.

The 2301 electronic governor consists of an electronic control unit, a speed setting potentiometer, and a hydraulic actuator. It may include various control functions such as frequency sensing, load sensing, speed sensing and ramp generator. Each function is usually a single component. The electronic control receives the input signals to the governor; its output serves as the input signal to the actuator. The actuator output controls the flow of energy medium to the prime mover. The speed setting potentiometer, used to adjust speed settings, provides one of the inputs to the electronic control.

The operation of the 2301 type governor is different and distinct from other electronic governors. The steady-state output of the electronic control is a level of voltage determined by the actuator terminal shaft position required to maintain a particular load on the prime mover. The voltage is always the same polarity. This type of control unit requires an actuator in which the output shaft takes a position proportional to the voltage of the input signal.

In contrast, the electronic control unit of the EG series electronic governor emits a nominally zero signal during conditions of on-speed, steady-state operation, and a large voltage signal only during off-speed or load-changing periods. In this type of system, the direction of actuator operation depends on signal polarity.



WARNING

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.

Dual Fuel Control

The dual fuel control is intended for use in systems where electronic frequency or speed sensing of dual fuel engines is a requirement. The dual fuel control does not perform speed and load control functions directly, instead its input circuit accepts a signal from Woodward (integrating type) control. These controls will include 24 V 2301 systems, 12 V 2301 electronic control with speed sensing failsafe, and 43027 systems. The schematic shown in Figure 1-1 represents the dual fuel control which contains the following functions:

- A transfer ramp function allows the control to change the output signal from all liquid actuator control to all gas actuator control at a rate of change independently adjustable in the two directions.
- Transfer is obtained by a simple switch function (closed for transfer to liquid, open to transfer to gas) or by an automatic function where momentary closure of a switch initiates the transfer.
- A gas transducer input is available to restrict transfer to the gas mode on failing gas supply. A total reversion to liquid mode can be initiated if the supply pressure or capacity falls below a preset level provided the system is operating in the automatic mode (momentary switch arrangement as with the transfer ramp function above).
- An internal stability control is provided to modify the response (transfer function) during change over and when in the gas mode.

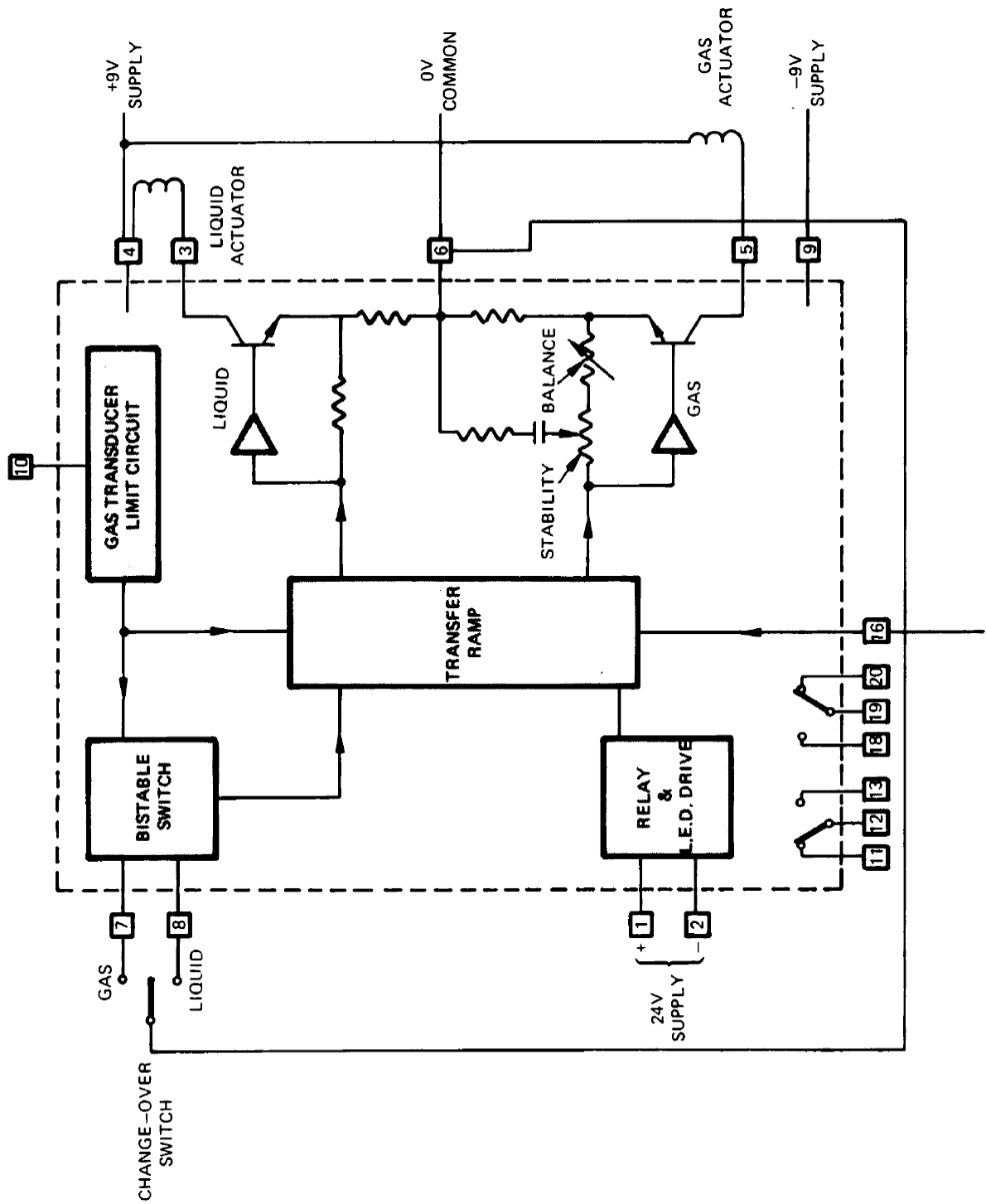


Figure 1-1. Dual Fuel Control Schematic

Chapter 2. Installation

Introduction

Electrically the dual fuel unit is normally installed as a part of a speed or frequency control panel having a proportional amplifier.

If the unit is added to an existing system, connect as shown in Figure 2-1.

Mechanically link the actuators and fuel rack such that equal signals on the gas and liquid actuators correspond to equal resultant torques. The dual fuel unit is designed to give a linear change-over from one fuel to the other in a ramp time of 3 to 30 seconds; therefore, a linear fuel rack/torque characteristic for both liquid and gas operation effects the smoothest change-over.

Gas Transducer Input

Link terminals 4 and 10 together if no gas supply transducer is used. For a rapid return to liquid mode open this link with a switch.

Pilot Liquid Fuel

Fix the pilot liquid fuel in the gas mode on dual fuel engines by a mechanical stop on the fuel rack. However, where it is desirable to increase the pilot liquid fuel with increase of gas fuel connect a resistor and diode in series between terminals 3 and 5 (anode to 3, resistor selected for required bias). This allows a flow of current from the gas control amplifier into the liquid actuator but prevents a complementary effect when in the liquid mode.

Minimum Fuel Stops

To establish minimum fuel stops for either fuel, connect a resistor between terminals 3 and 6 for diesel or 5 and 6 for gas (or both).

Fuel Tracking

In some applications (gas turbine), it is desirable to track the running fuel by the alternative fuel, to a figure of approximately 10%. Connect a resistor between terminals 3 and 5. Resistor value determines the bleed current to the appropriate actuator to provide a percentage of the controlling fuel.

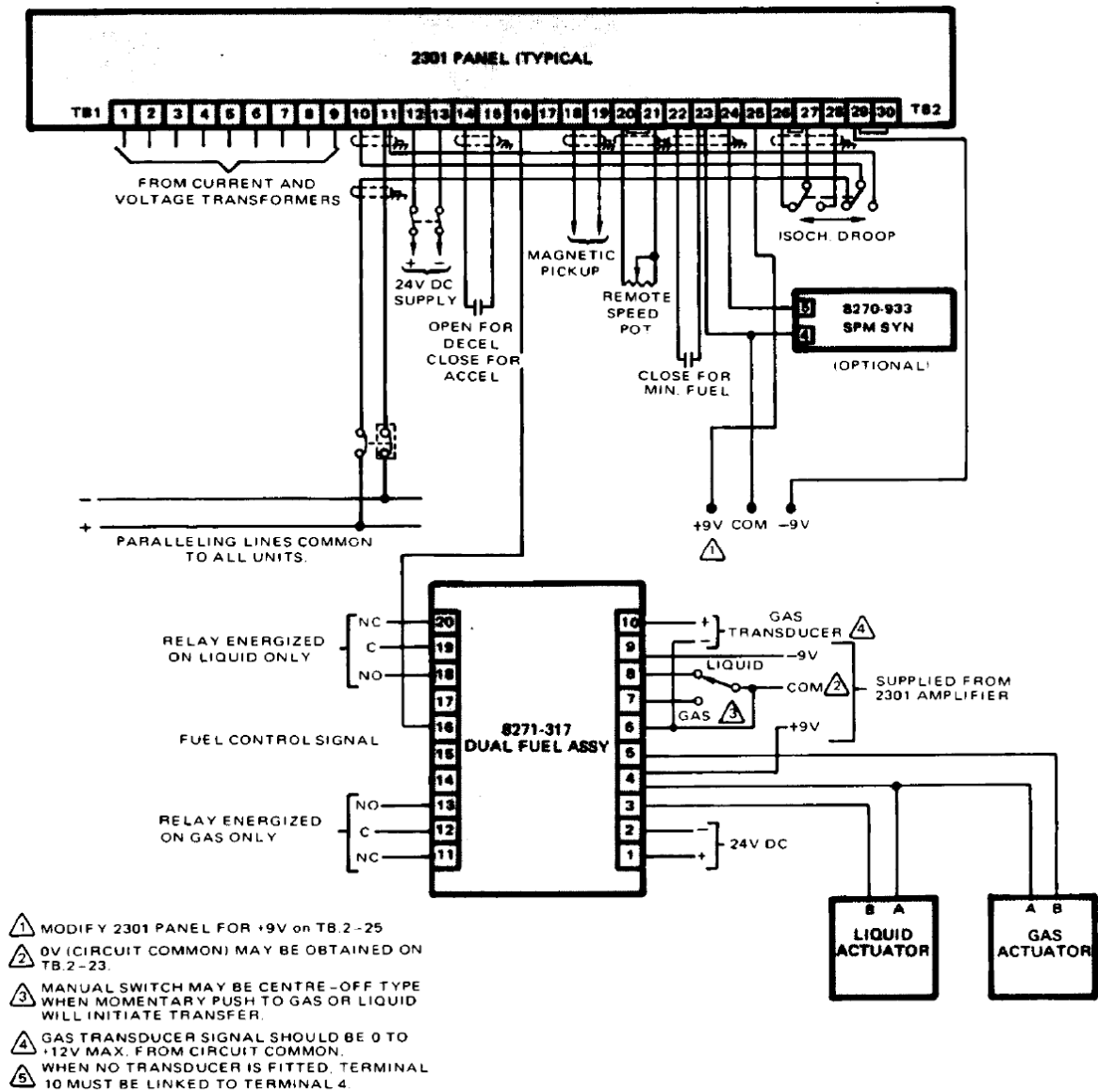


Figure 2-1. Dual Fuel Control Plant Wiring Diagram

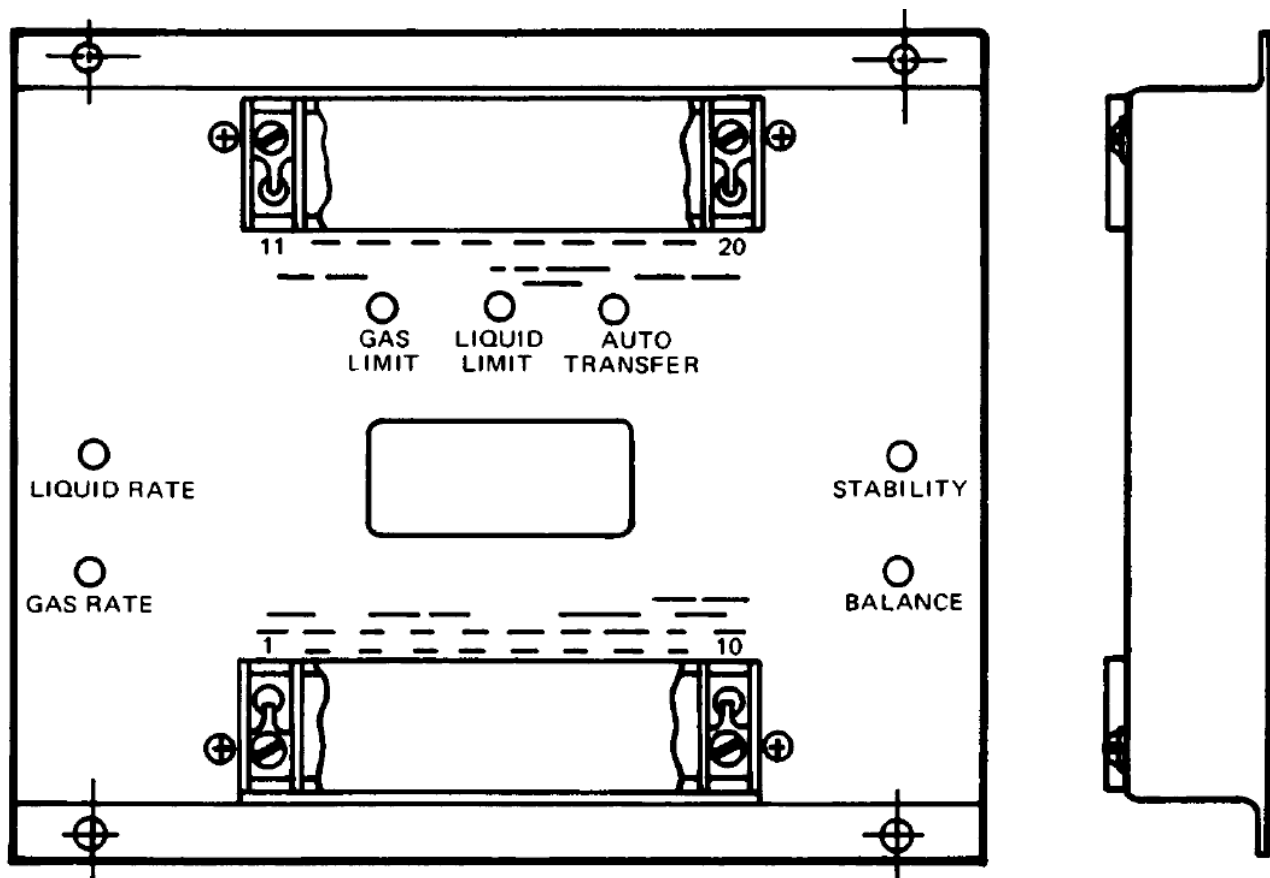


Figure 2-2. Dual Fuel Control Layout

Chapter 3. Operation

Introduction

The dual fuel unit can only be used as an adjunct to a 2301 or similar electronic speed governing panel, therefore the controls are limited to two ramp rate potentiometers, a balance control, and a stability control. Transfer from one fuel to the other is initiated by an external change over switch.

Two small indicators serve to show when the system is in the all liquid (red) or all gas (green) mode. A third (amber) indicator, lights when the transfer to gas is limited by a falling gas supply signal. See Figure 2-2 for control positions.

Liquid Rate

The setting of this control determines the transfer time in the gas to liquid direction within the range of 3 to 30 seconds. Clockwise rotation increases ramp rate.

Gas Rate

This sets the liquid to gas transfer time, clockwise rotation increases ramp rate. These two times may be set independently.

Balance

Adjust this control which operates on the gas channel to obtain equal gain through the two channels. Change of its setting affects the stability adjustment below. Proceed as follows:

Insert a dc ammeter in series with the liquid actuator; normal maximum current 170 to 180 mA. Link terminal 16 to terminal 9 (–9 V). Switch to the fully liquid mode. red indicator on, and note the liquid actuator current.

Transfer the ammeter to the gas actuator and switch to the fully gas mode, green indicator on. Adjust the balance control to obtain a gas actuator current equal to that noted in the liquid actuator; clockwise rotation increases current.

Remove the ammeter and link and restore the external connections to terminal 16.

Rapid Return to Liquid

A falling voltage on the gas transducer input, terminal 10, results in a return from gas to liquid control at a rate dependant on the rate of fall of voltage. 100% gas condition is obtainable for +6 V input with respect to 0 V common rail (terminal 6) while 0% gas condition is obtained for 0 V. A switch is available for insertion in series with the gas transducer input. Opening this switch provides a rapid return to liquid. This switch is available whether or not a gas transducer is fitted.

Stability

The stability circuit is incorporated in the gas channel in an attempt to raise the response on gas to that obtainable with liquid fuel. Make adjustments while controlling an engine. Adjusting the control does not affect the balance setting. Clockwise rotation increases the response of the gas channel.

External Change-over Switch

This is a single pole change-over switch which in one position selects gas mode and in the other liquid. If the switch has a spring biased center-off position, change over by switching in either direction. Automatic reversion to liquid is available from the gas mode.

Chapter 4.

Principles of Operation

The principal function of the dual fuel change-over system is to execute a smooth transition from the liquid-controlled mode to the gas-controlled mode without undue disturbance of the engine speed and without permitting the combined fuel flow to exceed the full load engine requirement. This last factor is ensured by control of liquid and gas actuators in an inversely proportional manner.

The 2301 system uses a proportional actuator with an integrating amplifier, thus full fuel demand corresponds to a maximum signal condition on the actuator. When a fuel change-over is demanded, while in the maximum fuel condition, a ramp circuit applies a progressive increase of signal to one actuator simultaneous with a corresponding reduction of signal to the other. For example; at the instant when the gas actuator receives a signal corresponding to 20% throttle, the liquid actuator receives an 80% signal. The ramp or change-over rate may be preset in the range of 3 to 30 seconds.

Normal governing action is achieved by reduction, according to engine needs of the two signals. This governing signal is received by the dual fuel unit from the output of the normal governor amplifier. During change-over at partial throttle openings, the dual fuel circuit sets the ratio of actuator signals while the governor signal limits the total actuator signal to meet the fuel requirements.

Change-over is initiated by a bi-stable circuit which is triggered by manual switch or, in the gas to liquid direction, automatically on gas failure. This latter action is achieved by means of an external gas transducer. When running on gas, a decreasing positive signal applied to the transducer input (terminal 10) causes the liquid actuator signal to increase and the gas signal to reduce.

The gas transducer may measure any parameter considered significant to the application, for example; gas pressure or gas capacity limitation. The input impedance at terminal 10 is approximately 7.5 k Ω to the common 0 V rail. Do not allow the input to exceed 12 V.

Chapter 5.

Maintenance and Troubleshooting

Although special equipment can be built to check the dual fuel control, a few simple tests according to these instructions can be used to check the components for proper operation. Use a voltmeter with at least 20 k Ω /V. Most multi-purpose meters have this rating.

Check the complete wiring against the wiring diagram (Figure 2-1). Be sure that the power supply and the connections between the actuator and the control box have the right polarity. Start the engine and control the speed manually, close to rated speed. Turn the speed setting potentiometer until the governor takes over (if possible).

The dual fuel control power input at terminals 1 and 2 must be between 24 and 28 Vdc. The dc input from the governor control amplifier at terminal 16 should be between 0 and -8 V with respect to terminal 6, under normal operation. That is, connect the control amplifier for low voltage operation.

The output of the dual fuel control appearing across terminals 3 and 4, (liquid), and 4 and 5, (gas), varies with the required position of the terminal shaft for each actuator. When the engine speed is below the set speed, the governor control voltage is approximately 8 to 9 V negative from terminal 6 and the actuators move to provide maximum fuel.

During an overspeed condition when the engine speed exceeds the set speed, the governor control voltage is zero and the actuators move to minimum fuel.

When the governor controls engine speed via the dual fuel control the voltage at the actuator varies between 1 and 2 V at no load with the terminal shaft just off minimum, and 6 V at full load with the terminal shaft at the full fuel position.

When the dual fuel control is in the liquid or gas mode, one actuator only operates the linkage to maintain the correct fuel level. However, when the control is in a condition of transfer either by selection of the other mode or by effective partial transfer via the gas transducer both actuators respond to the fuel requirements at a percentage dictated by the extent of the transfer.

If engine control cannot be achieved, remove all connections from the main terminal strip of the dual fuel control except the dc supplies; 24V to terminals 1 and 2 and +9 V, 0, -9V to 4, 6 and 9. Connect a 35 Ω resistor between terminals 3 and 4 to simulate the liquid actuator. Connect a 35 Ω resistor between terminals 4 and 5; this simulates the gas actuator. Connect a link between terminals 4 and 10. In this condition the output voltage is 0.7V \pm 0.1 V on each resistor. Connect a link between 9 and 16; the gas resistor should remain at 0.7 V, while the liquid resistor should increase to 5.6 \pm 0.2 V. Short out terminals 6 and 8. The control should reduce the voltage progressively on the liquid resistor from 5.6 V to 0.7 V while the gas resistor should increase from 0.7 V to 5.6 V. The rate of transfer is dictated by the ramp timing potentiometers. Remove the link between 4 and 10, the liquid resistor should immediately go to 5.6 V while the gas resistor goes to 0.7 V. The gas light illuminates when the contacts at 18 and 19 are closed and the ramp function is fully transferred. The liquid light illuminates when the contacts across 12 and 13 are closed and the control is fully transferred to liquid.

Determine the exact threshold of the gas transducer input by connecting a potentiometer (1K to 10K in value) between terminals 4 and 9 with its wiper to terminal 10. Set the unit into the gas mode by momentarily closing terminal 6 to terminal 8. Gradually decrease the voltage on terminal 10 until the control starts to change over to liquid operation. This gives the voltage at which the gas control begins to limit. Continue to decrease the voltage slowly until the control automatically reverts to liquid mode. Having reached this condition, increasing the voltage again on terminal 10 should not cause the control to revert to gas mode, it should remain in liquid mode. This automatic latching action occurs at 2 to 3 V, positive, with respect to terminal 6.

Should the above conditions not be met, then return the control to Woodward for repair.

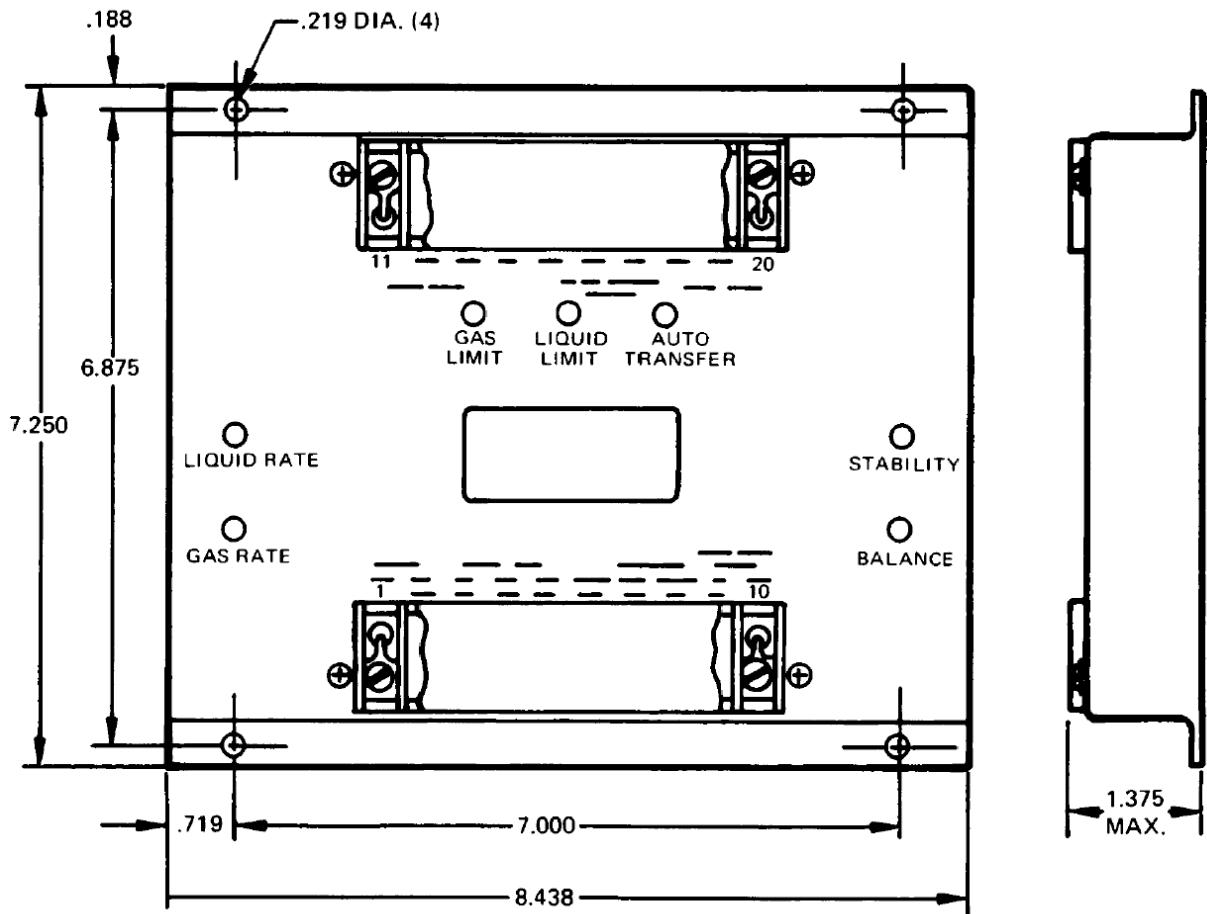


Figure 5-1. Outline Drawing
(Do not use for construction.)

Chapter 6.

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		Products Used In Engine Systems		Products Used In Industrial Turbomachinery Systems	
<u>Facility</u> -----	<u>Phone Number</u>	<u>Facility</u> -----	<u>Phone Number</u>	<u>Facility</u> -----	<u>Phone Number</u>
Brazil -----	+55 (19) 3708 4800	Brazil -----	+55 (19) 3708 4800	Brazil -----	+55 (19) 3708 4800
China -----	+86 (512) 6762 6727	China -----	+86 (512) 6762 6727	China -----	+86 (512) 6762 6727
Germany:		Germany-----	+49 (711) 78954-510	India -----	+91 (129) 4097100
Kempen----	+49 (0) 21 52 14 51	India -----	+91 (129) 4097100	Japan-----	+81 (43) 213-2191
Stuttgart--	+49 (711) 78954-510	Japan-----	+81 (43) 213-2191	Korea -----	+82 (51) 636-7080
India -----	+91 (129) 4097100	Korea -----	+82 (51) 636-7080	The Netherlands-	+31 (23) 5661111
Japan-----	+81 (43) 213-2191	The Netherlands-	+31 (23) 5661111	Poland-----	+48 12 295 13 00
Korea -----	+82 (51) 636-7080	United States----	+1 (970) 482-5811	United States----	+1 (970) 482-5811
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.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 82540.



B82540:NEW



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

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