

Product Manual 85108 (Revision A) Original Instructions

Digital Frequency Control

Installation and Operation Manual



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:

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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.



If the cover of this publication states "Translation of the Original Instructions" please note:

Translated Publications

The original source of this publication may have been updated since this translation was made. Be sure to check manual 26311, Revision Status &
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Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

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Contents

WARNINGS AND NOTICES II
ELECTROSTATIC DISCHARGE AWARENESSIII
CHAPTER 1. GENERAL INFORMATION. 1 Applications 1 Construction 1 Switches 1 Supply Voltage 1
CHAPTER 2. INSTALLATION
CHAPTER 3. SELECTIONS
CHAPTER 4. DESCRIPTION OF OPERATION
CHAPTER 5. SERVICE OPTIONS 10 Product Service Options 10 Woodward Factory Servicing Options 11 Returning Equipment for Repair 11
Replacement Parts 12 Engineering Services 12 How to Contact Woodward 13 Technical Assistance 13

Illustrations and Tables

Figure 1-1. Digital Frequency Control Outline Drawing	2
Figure 2-1. Plant Wiring Diagram	4
Figure 4-1. DFC Switches and Indicators	6
Figure 4-2. Optional Switch Setting	7
Figure 5-1. DFC Block Diagram	9

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.

	The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against
Overspeed /	loss of life, or property damage.
Overtemperature / Overpressure	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.
	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

Personal Protective Equipment

- Eye Protection
- Hearing Protection
- Hard Hat
- Gloves

limited to:

- 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.



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

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.

Battery Charging Device

Electrostatic Discharge Awareness

NOTICE	Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:
Electrostatic Precautions	 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

Applications

The Woodward 8239-003 Digital Frequency Control (DFC) is recommended for use in power generation systems which must carry plant load when separated from the utility. It is designed for use with electronic controls which operate in droop and accept speed-reference raise and lower signals, including Woodward 501, 503, and 505 digital electronic controls and 43027 controls.

The DFC provides a convenient method of operating these controls at a precise 50 or 60 Hz when in droop mode while carrying plant load and separated from a utility bus.

Construction

All components of the DFC are mounted on a printed circuit board (PCB). The PCB is enclosed in a steel housing. The terminal block, located on the lower front of the housing, is soldered directly to the PCB, eliminating an internal wiring harness. Control dimensions are shown in the outline drawing, Figure 1-1.

Switches

Switches located on the printed circuit board provide all adjustments available. The DFC may be set for either 50 or 60 Hz with one of the internal switches. Other switches determine the deadband limits of the frequency control and the rate at which the unit returns to frequency after a load swing.

Supply Voltage

The DFC will accept either 115 or 230 Vac supply directly from the generator being controlled. One transformer in the DFC provides voltages used in the control. A second transformer provides the frequency signal of the generator, used for comparison purposes in the control. The DFC uses the frequency of the generator output to control the speed of the turbine or engine.



CONVERSIO	N CHART
MM	INCH
3.2	. 125
5.0	.197
5.6	.219
18.0	.710
55.6	2.188
200.4	7.890
210.4	8.284
278.5	10.966
314.6	12.386

Figure 1-1. Digital Frequency Control Outline Drawing

Chapter 2. Installation

Unpacking

Be careful when unpacking the DFC. Inspect the unit for bent or dented panels, scratches, and loose or broken parts. Notify the carrier and Woodward of any damage.

Environmental Precautions

The DFC is designed to operate within an ambient temperature range of -40 to +158 °F (-40 to +70 °C). The unit may be installed in any attitude.

Location Considerations

The DFC is usually installed on the control panel. Select a location that provides adequate ventilation and room for servicing and repair. The DFC produces a minimal amount of heat. The distance from the generator and from the control should be held to a minimum. An enable/disable switch, either automatic or manual, must be provided by the installer.

Although the DFC is not vibration sensitive, the mounting location should have as little vibration as possible. The DFC is not suitable for installation directly on the motor or generator.

Installation

Install the DFC using the four mounting holes located at each corner of the back plate. The cover can be removed without removing the backing plate or circuit board by removing the two nuts from the cover's top flange, and the two mounting screws from the lower flange. 3/16 (inch) screws are normally used to mount the DFC.

Power Requirements

The DFC is powered by voltage supply connections to the 115 or 230 Vdc generator. Power consumption is less than 2 W.

For 115 Vac, remove the jumper between terminals 3 and 4, install jumpers between 2 and 3, and 4 and 5, then connect the generator to terminals 2 and 5.

For 230 Vac remove the jumpers between 2 and 3, and 4 and 5, install a jumper between 3 and 4, then connect the generator to terminals 2 and 5.

Connections to the Control

Connect a switch between terminals 10 and 13. The DFC will be enabled when the switch is closed, disabled when the switch is open.

Connect DFC terminals 15 and 16 to the raise speed setting terminals on the control. Connect DFC terminals 17 and 18 to the lower speed setting terminals on the control.

The DFC will close the raise or lower connection in order to change the speed setting. The circuits are opened and closed by relays which are an integral part of the DFC. The relays are rated at 10 A.

FREQUENCY CONTROL



Figure 2-1. Plant Wiring Diagram

Chapter 3. Selections

The DFC cover must be removed to change or make selections which determine the speed with which the frequency control changes the speed setting of the control.

See Figure 3-1 for location of the switches. The table of selections available from the switches follows Figure 3-1.

The Test Mode and Test Selection switches are only used for factory calibration and check of the unit. Switch 1 must be in the off position when the DFC is being used. Location of test selection switches 2, 3, and 4 do not affect the DFC as long as switch 1 is in the off position.

Select the desired frequency reference with switch 7. Off is 60 Hz, on is 50 Hz.

Deadband Limits determine the amount of frequency error which the DFC will allow before changing the speed setting. The positions of switches 5 and 6 provide deadband limits of 0.1, 0.2, 0.4, and 0.6 percent deadband. Deadband is the amount of frequency error permitted without closing a raise or lower relay. Increasing the amount of deadband will increase the amount of frequency error permitted before the frequency control changes the reference speed.

Pulse-width modulation, set with switches 8 and 9, determines the rate at which the speed setting of the droop governor is changed when frequency error occurs. 0.25 Hz is the fastest rate of return to the selected frequency and 1.00 Hz is the slowest rate of return to the selected frequency.

The pulse-width modulation circuit pulses raise or lower commands on and off to bring the actual frequency to the desired point. When the frequency error is large the raise or lower command will be left on continuously until the actual frequency reaches the pulse width modulation limits. At this point the raise/lower command will turn on for most of a one-second period and off for the rest. As the actual frequency gets closer to the desired frequency the "on" time will get less and the "off" time will increase. When the actual frequency is almost equal to the desired frequency the raise or lower command will be of a very short pulse and off for the remainder of the one-second period. Raise/lower pulses are overridden by the deadband circuit when the frequency error is less than the deadband limits.

The switches are the only adjustments on the DFC.



Figure 4-1. DFC Switches and Indicators

Digital Frequency Control

OPTIONAL SWITCH SETTINGS		
OPTION	SWITCH NO./FUNCTION	
TEST MODE	SWITCH NO.1 OFF - DISABLED ON - ENABLED	
TEST SELECTION Available for factory use only. Position of switches has no affect when Switch 1 is OFF.	SWITCH2,3,4 OFF OFF OFF OFF $TEST$ OFF OFF ON $TEST$ 1 OFF ON OFF $TEST$ 2 OFF ON ON $TEST$ 3 ON OFF OFF $TEST$ 4 ON OFF OFF $TEST$ 5 ON ON OFF $TEST$ 6 ON ON ON ON $TEST$ ON ON ON ON $TEST$ 7	
DEADBAND LIMITS	SWITCH 5, 6 OFF OFF 0.6% OFF ON 0.4% ON OFF 0.2% ON ON 0.1%	
FREQUENCY REFERENCE SELECTION	SWITCH 7 OFF - 60Hz ON - 50Hz	
PULSE WIDTH MODULATION LIMITS	SWITCH 8, 9 ON ON - 0.25Hz ON OFF - 0.33Hz OFF ON - 0.50Hz OFF OFF - 1.00Hz	

Figure 4-2. Optional Switch Setting

Chapter 4. Description of Operation

The general operating principles of the DFC are shown in the block diagram, Figure 4-1. The following description follows the block diagram.

The generator provides either 115 or 230 Vac power (50 or 60 Hz.) to the DFC. The DFC transforms this power to the needed dc current to power the unit and converts the sine wave frequency to a square wave frequency which is one-half of the actual frequency.

When the enable switch is closed, the square-wave frequency is measured and then compared to the reference frequency by the Central Processing Unit (CPU). The CPU determines the amount of error and causes either the raise or lower relay to activate as necessary to keep the frequency produced by the generator at the exact frequency selected.

The DFC uses a crystal frequency reference to accurately measure the frequency of the generator.

The deadband-limit-select switches establish the amount of deadband the DFC allows. The Pulse Width Modulation switches (8 and 9) setting provides the CPU with the rate at which speed-setting change is achieved.

There are three LED indicators on the DFC. The LEDs on newer units are visible from the front of the unit, while the LEDs on older units are visible only when the cover of the unit is removed.

The Enabled LED shows green while the enable switch is closed. The enable switch is provided by the customer.

The adjusting LED shows green when the CPU has closed either the raise or lower contacts.

The Operational LED shows green when the generator is providing power to the DFC.



Figure 5-1. DFC Block Diagram

Chapter 5. 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: <u>www.woodward.com</u>.

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	Engine Systems	Turbine Systems
FacilityPhone Number	FacilityPhone Number	FacilityPhone Number
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+49 (0) 21 52 14 51	Germany +49 (711) 78954-510	India+91 (129) 4097100
India+91 (129) 4097100	India+91 (129) 4097100	Japan +81 (43) 213-2191
Japan +81 (43) 213-2191	Japan +81 (43) 213-2191	Korea +82 (51) 636-7080
Korea +82 (51) 636-7080	Korea +82 (51) 636-7080	The Netherlands- +31 (23) 5661111
Poland+48 12 295 13 00	The Netherlands- +31 (23) 5661111	Poland+48 12 295 13 00
United States +1 (970) 482-5811	United States +1 (970) 482-5811	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	

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 85108A.



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

Email and Website—www.woodward.com

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Complete address / phone / fax / email information for all locations is available on our website.