



Installation and Operation Manual

Digital Reference Unit

9900-352

Manual 82324 (Revision A)

WARNING—DANGER OF DEATH OR PERSONAL INJURY



WARNING—FOLLOW INSTRUCTIONS

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.



WARNING—OUT-OF-DATE PUBLICATION

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WARNING—OVERSPEED PROTECTION

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—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.

CAUTION—POSSIBLE DAMAGE TO EQUIPMENT OR PROPERTY



CAUTION—BATTERY CHARGING

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.



CAUTION—ELECTROSTATIC DISCHARGE

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.

IMPORTANT DEFINITIONS

- A **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
- A **CAUTION** indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment or property.
- A **NOTE** provides other helpful information that does not fall under the warning or caution categories.

Revisions—Text changes are indicated by a black line alongside the text.

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Chapter 1.

General Information

Description

The Digital Reference Unit (Figure 1-1) gives a reference level output voltage. The unit is in a sheet steel chassis containing two printed circuit boards (PCBs). The terminal blocks are mounted directly on the PCBs. The PCBs have circuit paths on both sides with the components mounted on one side. The two PCBs are connected by a ribbon cable. All potentiometers are accessible from the front of the chassis under the cover.

Function

The function of the Digital Reference Unit is to give a reference voltage to other units in the system. The output reference level can be raised or lowered at one of four rates. Three reference settings can be selected.



WARNING—OVERSPEED PROTECTION

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.

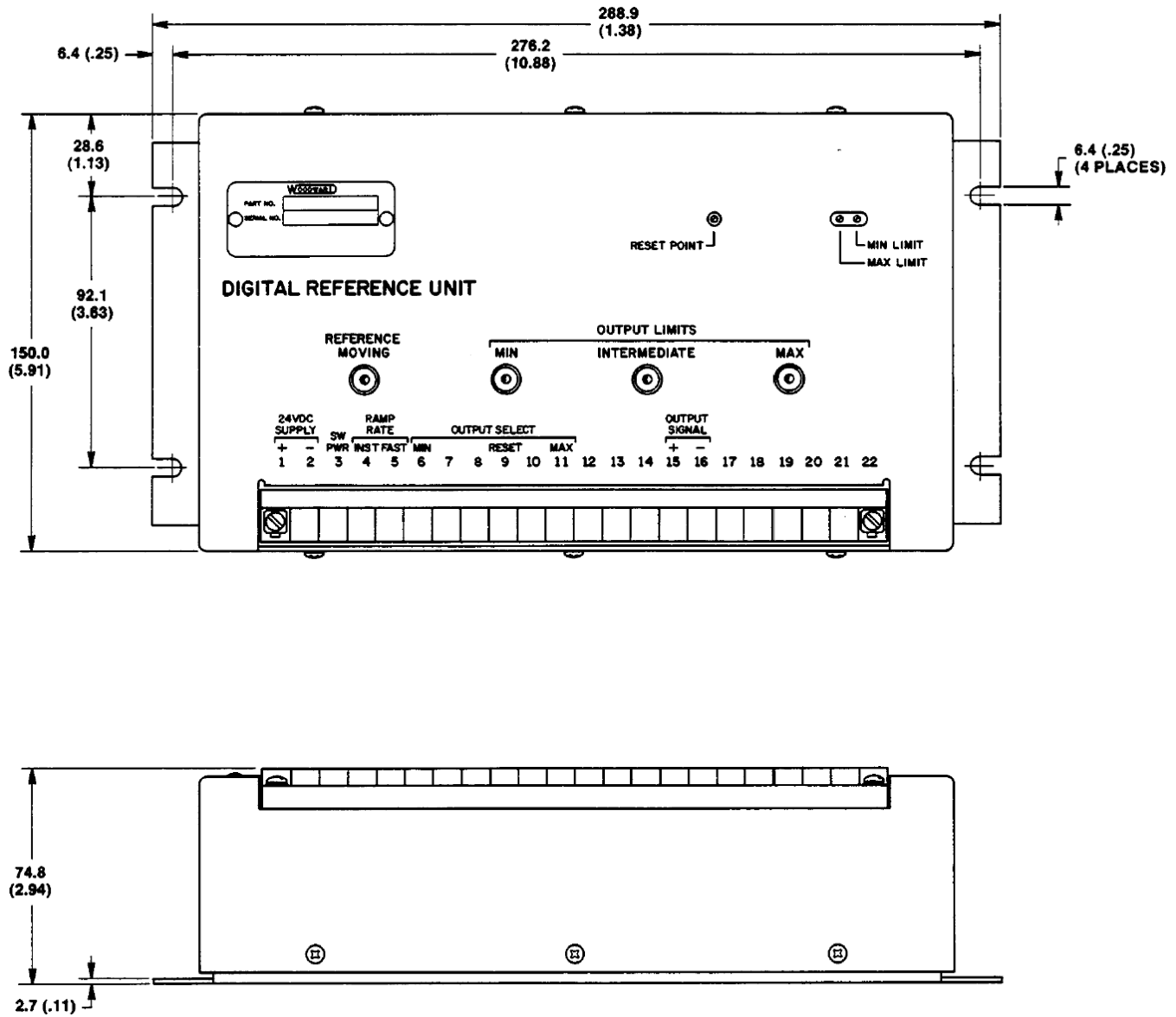


Figure 1-1. Digital Reference Unit

Chapter 2. Installation

Application Information

Power Requirements

The Digital Reference Unit is powered by 18 to 40 Vdc. The power input is connected to terminal 1 (+) and 2 (–). A battery can be used to supply the operating power. With a battery charger connected, the voltage must stay between 18 and 40 Vdc.

Environmental Cautions

The Digital Reference Unit operates within a temperature range of –40 to +160 °F (–40 to +71 °C). The unit can be mounted in any position with adequate ventilation and space for servicing.

Electrical Connections

The plant wiring diagram (Figure 2-1) shows all wiring connections of the Digital Reference Unit. Use the voltage on terminal 3 for connecting to the Instant, Fast, Minimum, Maximum, and Reset.

Reference Output

The reference output is between terminals 15 and 16. Terminal 15 is to be connected to the system reference input and terminal 16 is to be connected to the system circuit common for systems that use positive ramps. For systems that need negative ramps connect terminal 16 to the system circuit common and terminal 15 to the system reference input.

Static Checks

Visual Inspection

Before beginning the checkout procedure, visually inspect the Digital Reference Unit for damage such as bent or dented panels, and loose or broken components. If any damage is found, return the unit for repair.

Checkout Procedure

The plant wiring diagram (Figure 2-1) and block schematic (Figure 2-2) show all the input and output connections to the unit. Recommended test equipment for testing and troubleshooting the Digital Reference Unit is:

- Digital Multimeter (DMM): DC voltage accuracy of $\pm 0.3\%$, (Hewlett Packard 3476B or Fluke 8020A)
- Volt-Ohmmeter (VOM): 20 k Ω /V $\pm 2\%$ accuracy. (Simpson 260)
- Power Supply: 24 Vdc

1. With no wires connected to the unit, measure the resistance between each terminal and the chassis of the unit. The correct resistance reading is 10 M Ω minimum.
2. Connect the input power between terminals 1 (+) and 2 (-).
3. Check that the voltage on terminal 3 is 25.0 $\pm$ 1.5 Vdc when the reference is at the lower limit with the Lower LED illuminated and the Lower relay energized.

**NOTE**

All adjustments are turned clockwise to increase the output level.

4. Select the Minimum Output selection. The Minimum Output LED must be illuminated. Record the output level.
5. Select the Max Output selection. The reference output level must not change and the Reference Moving LED must not be illuminated until the Mm Output selection is disconnected.
6. Disconnect the recorded values from steps 4 and 6, subtract the Minimum value from the Maximum value to find the range of control. If the range of control is incorrect, adjust Max Limit until you increase the set point to 1/2 of the difference required for proper range. Repeat steps 4 through 7 until the proper range values are obtained.
7. Using the recorded values from steps 4 and 6, subtract the Minimum value from the Maximum value to find the range of control. If the range of control is incorrect, adjust Max Limit until you increase the set point to 1/2 of the difference required for proper range. Repeat steps 4 through 7 until the proper range values are obtained.

Example

Desired range—6 Hz (57 to 63 Hz)

Actual range—4 Hz (58 to 62 Hz)

Range is to narrow by 2 Hz, adjust Max Limit to get 63Hz. Then recheck Minimum set point and adjust Mm Limit to get the minimum to its proper level. Continue until no further adjustment is required.

8. Disconnect the Mm Output and Max Output selections.

**NOTE**

In the following steps if an adjustment is made, the selections must be momentarily disconnected.

9. Select the Reset selection. The Reference Moving LED is illuminated and the reference output level goes to the Reset reference level. When the Reference Moving LED is not illuminated, the reference level is at the Reset level. If the reference output is not as specified, adjust Reset Point. Remove Reset input and select Mm or Max momentarily. Reselect Reset and check for proper level.

Rates are not adjustable. Check time for slow:

Slow = 60 s

Medium = 40 s

Fast = 60 s

Instant <1 s

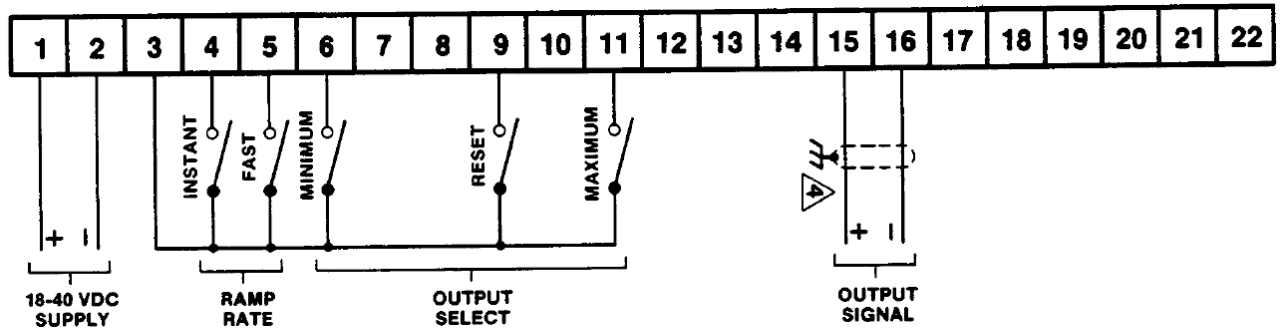


Figure 2-1. Typical Plant Wiring

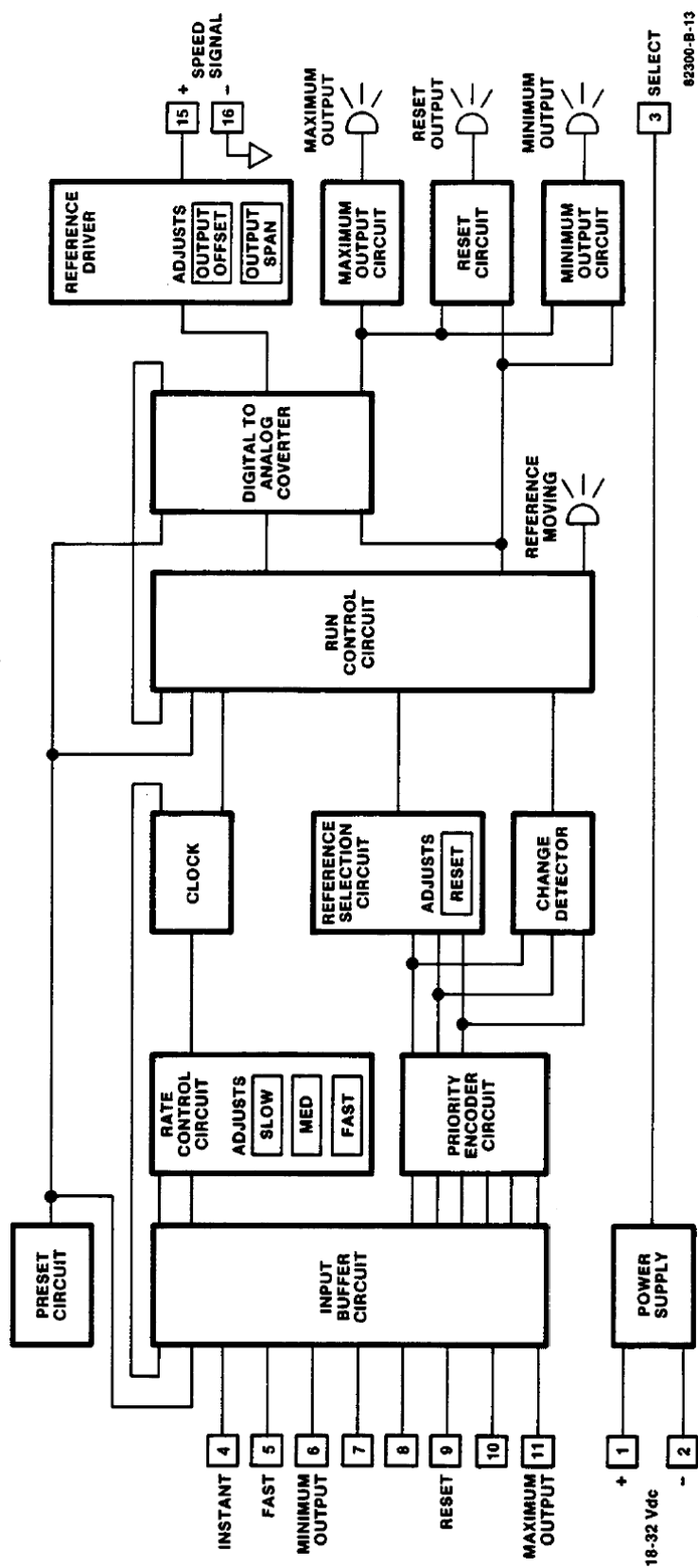
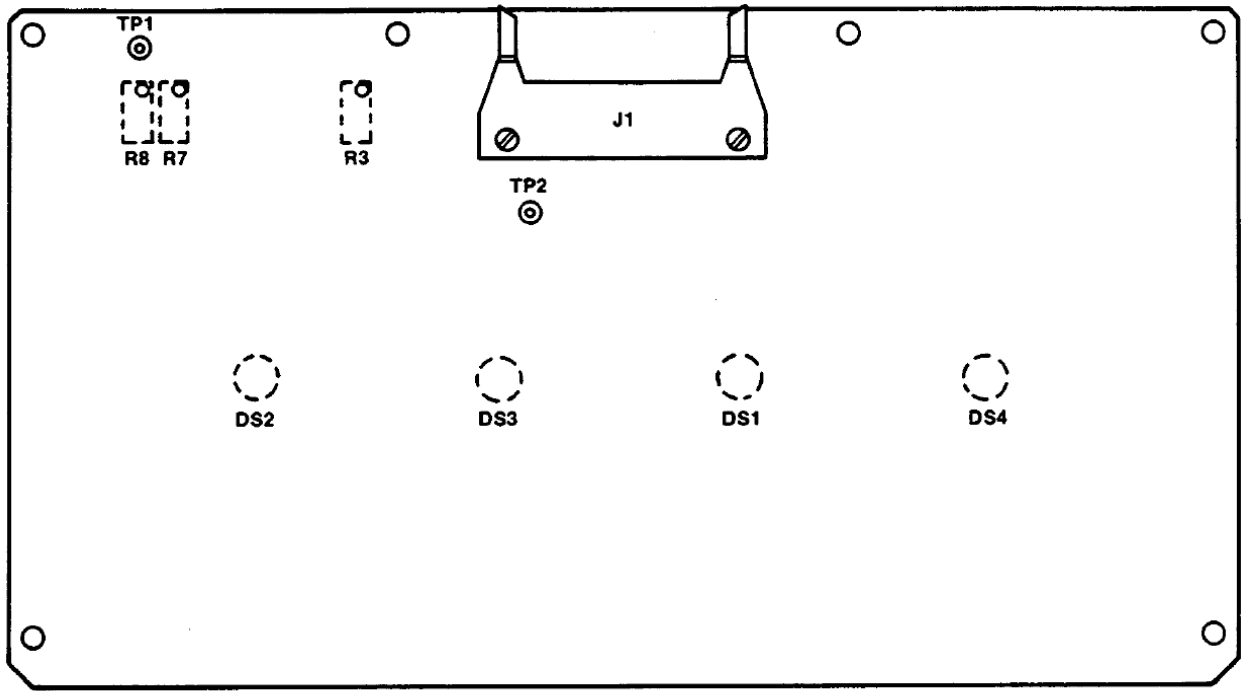


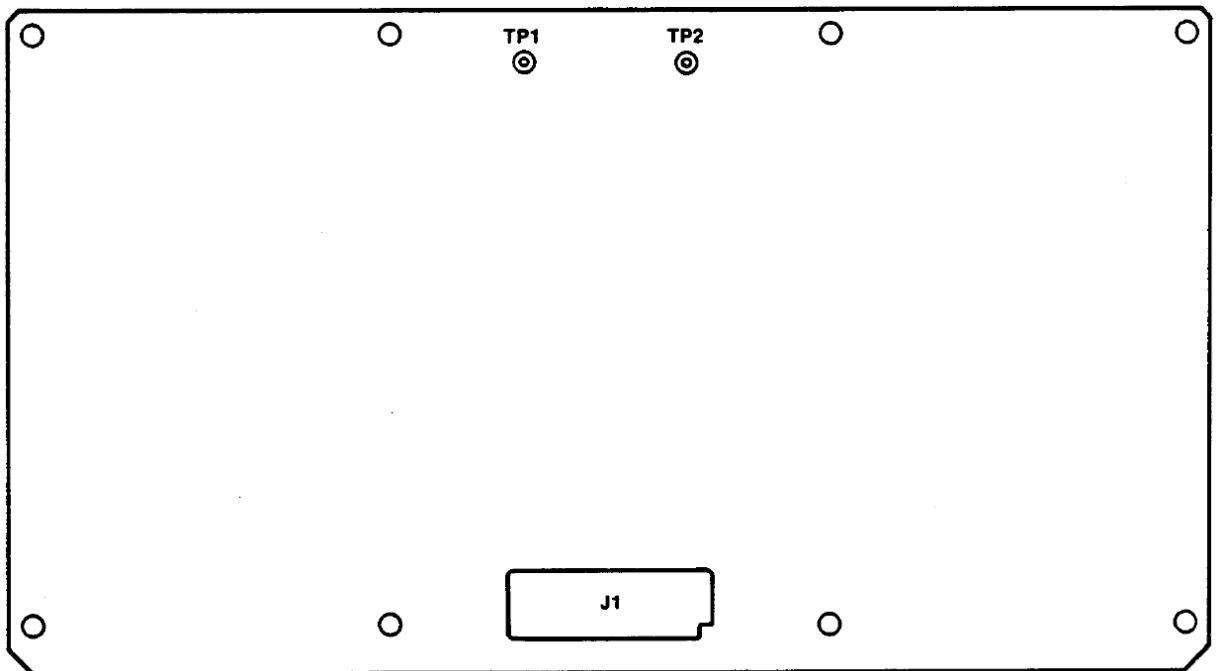
Figure 2-2. Typical Block Diagram



82300-A-54

(Note: Back View)

Figure 2-3. Front Board Potentiometer Location



82300-A-53

Figure 2-4. Back Board Test Point Location

Chapter 3.

Principles of Operation

Power Supply

The Digital Reference Unit has power supplies that change the 18 to 40 Vdc input voltage into the voltages needed by the unit. These voltages are internally regulated. The input voltage can be supplied by a battery and battery charger system but must not be greater than 40 Vdc.

Input Buffer

The Input Buffer gives the connections between the Mm Output, Reset, Max Output, Fast and Instant input terminals and the reference circuits. The Input Buffer gives signals to the Priority Encoder and Rate Control circuits to control the reference output of the unit and the rate at which the reference changes.

Priority Encoder Circuit

The Priority Encoder circuit uses the outputs from the Input Buffer to control the reference selected. If more than one input is selected, the input with the lowest reference level is selected by the Priority Encoder. The Priority Encoder generates a digital code for the reference selected. The digital code is used by the Reference Selection and Change Detector circuits.

Reference Selection Circuit

The Reference Selection circuit uses the digital codes to connect the reset potentiometer to the Run Control circuit. The reference levels are between the maximum and minimum counts of the Digital to Analog Converter (DAC) output.

Rate Control and Clock Circuits

The Rate Control circuit uses the rate signals from the Input Buffer circuit to control the frequency of the Clock circuit output. The Clock circuit generates the pulses counted by the DAC circuit.

Change Detector Circuit

The Change Detector circuit uses the digital codes from the Priority Encoder to control if the reference selection is changed. When a change is detected, the circuit gives a signal to the Run Control circuit.

Run Control and Digital to Analog Converter Circuits

The Run Control circuit uses the signals from the Clock, Reference Selection, Change Detector and DAC circuits. When the signal from the Change Detector indicates a change in reference level is needed, the clock pulses are given to the counters. The circuit compares the output level of the DAC with the reference selection output to control if the counters count up or down. When the DAC and reference selection signals are equal, the clock pulses are disconnected. When the Clock pulses are being counted, the Moving LED on the front is illuminated. The DAC circuit counts the clock pulses and gives an analog output that is proportional to the count. The DAC analog output is used for setting the size of the reference output. The DAC circuit gives digital signals to the indication circuits.

Switch Point Circuits

The Switch Point Circuits and Minimum Output, Reset and Maximum Output. These circuits indicate when the counters in the DAC circuit are at the set limits, Minimum or Maximum Output level. The Maximum Output circuit illuminates the Maximum Output LED when the Run Control and DAC circuits indicate that the reference is at the Maximum Output level. The Reset circuit illuminates the reset LED when the Run control and the DAC circuits indicate that the reference is at the Reset Output level. The Maximum Output circuit illuminates the Maximum Output LED when the counters in the DAC circuit reach the maximum count.

Speed Reference Drive and Preset Circuits

The output of the DAC circuit is used by the Reference Driver circuit. The Reference Driver changes the DAC circuit output to the system reference needs. The Preset circuit sets the Run Control, Input Buffer and the counters in the DAC circuit for the Minimum Output level when the power is first connected to the Digital Reference Unit.

Operation

The following gives the operating information on test points, adjustments, function indicators, selectable inputs, and outputs.

The Digital Reference Unit can increase or decrease the reference output by selecting the Max Output or Mm Output terminal. The reference rate of change can be selected from four rates, Slow, Medium, Fast, or Instant. The reference levels can be selected by connecting the Mm Output Reset or Max Output inputs to the select output (Terminal 3). All selections can be selected manually and/or automatically depending on the system.

Test Points and Adjustments

The test points and adjustments are located under the cover of the unit. For each test point and adjustment, the function is given in the following list. For the location of the test points and adjustment (see Figure 2-3).

Test Points

<u>Bottom Board</u>	<u>Function</u>
TP1	Clock Output
TP2	Circuit Common

<u>Top Board</u>	<u>Function</u>
TP1	DAC Output
TP2	Circuit Common

Adjustments

<u>Top Board</u>	<u>Function</u>
R3	Reset Adjust
R7	Range Adjust
R8	Offset Level Adjust

Output Adjustments

Offset Level Adjust—Sets the location of the window (see Figure 3-1).

Reset—Sets the output to the reset level.

Range Adjust—Sets the range of control window (see Figure 3-1).

Operation

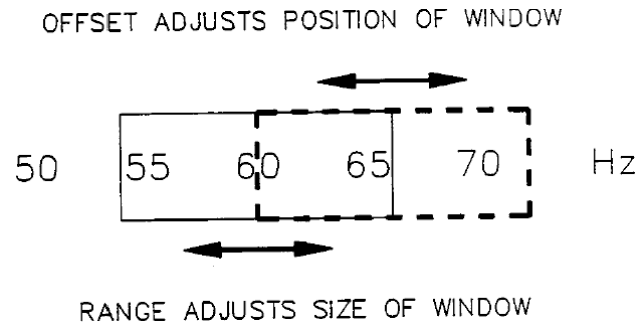


Figure 3-1. Range and Offset Adjustment

Function Indicators

The function indicators are the Light Emitting Diodes (LEDs) located on the front of the Digital Reference Unit.

Maximum Output—Illuminates when the reference reaches the maximum output level.

Reset point—Illuminates when the reference reaches the Reset output level.

Minimum Output—Illuminates when the reference reaches the minimum output level.

Reference Moving—Illuminates while the reference level is changing.

Selectable Inputs

Rate Selection

Slow—Not connecting terminal 3 to the Instant or Fast terminal, selects the Slow Rate.

Med—Connecting terminal 3 to both the Instant and Fast terminal, selects the Med Rate.

Fast—Connecting terminal 3 to the Fast Terminal, selects the Fast Rate.

Instant—Connecting terminal 3 to the Instant Terminal, selects the Instant Rate.

Reference Selections

**NOTE**

The lowest reference selection controls the output of the Digital Reference Unit.

Min Output—Connecting terminal 3 to the Mm Output terminal, selects the minimum reference level.

Reset—Connecting terminal 3 to the Reset terminal, selects the Reset reference level.

Max Output—Connecting terminal 3 to the Max Output terminal, selects the maximum reference level.

Outputs

Speed Signal—Reference output connected to terminals 15 (+) and 16 (–) for a positive ramp. Reference output connected to terminals 15 (+) and 16 (–) for a negative ramp.

Chapter 4. Troubleshooting

Visual Inspection

Before troubleshooting the Digital Reference Unit, visually inspect the unit for burned or broken parts, bad wire connections or bad solder joints. A burned resistor often indicates a shorted transistor or a shorted wire. Be sure all connections are tight and making good contact. If nothing is found, proceed with the troubleshooting.



NOTE

A difference in the color of the potting compound on the power resistors is common and does not indicate a burned out condition.

Initial Troubleshooting Setup

1. Connect all wires to the terminals as needed.
2. Connect the power input.
3. Using a digital voltmeter, check the voltage on terminal 3 for 25.0 ± 1.5 Vdc with the Lower LED illuminated and the Lower relay energized.
4. Connect a voltmeter between terminals 15 (+) and 16 (–).

Symptom	Procedure	Results
Not able to select a new reference level.	Check that when the new level is selected the Reference Moving LED is illuminated.	If the Reference Moving LED is not illuminated, go to the next step.
The reference level cannot be raised or lowered. (The voltage on terminals 15 (+) and 16 (–) will not change.)	Check that the lower terminal is not selected. Check that the Output Span adjustment is not ccw.	If the Lower terminal is not selected, go to the next step. If correct, return the unit for repair.
Limit LEDs are not working.	Check that the Range adjustment (R7) is not ccw.	If the inputs are correct, return the unit for repair.
Not able to change the rate.	Check that the input voltages on the Instant and Fast terminals are correct. Connect a scope or counter to TP1 on the back board. With Slow selected; select fast and then slow; then medium. The clock rate must change. Repeat the procedure for the Fast and Med. adjustments.	No voltage on both for Slow Rate. Select voltage on both for Med. Rate. Select voltage on Fast for Fast Rate. Select voltage on Instant for Instant Rate. If the switching has no effect or the instant is not instant, return the unit for repair.

Chapter 5. Service Options

Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

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 also a flat rate structured program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call 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 Woodward facility as explained below (see “Returning Equipment for Repair” later in this chapter).

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 to Woodward within 60 days, Woodward will issue a credit for the core charge. [The core charge is the average difference between the flat rate replacement/exchange charge and the current list price of a new unit.]

Return Shipment Authorization Label. To ensure prompt receipt of the core, and avoid additional charges, the package must be properly marked. A return authorization label is included with every Replacement/Exchange unit that leaves Woodward. The core should be repackaged and the return authorization label affixed to the outside of the package. Without the authorization label, receipt of the returned core could be delayed and cause additional charges to be applied.

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 to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the item(s), attach a tag with the following information:

- 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.



CAUTION—ELECTROSTATIC DISCHARGE

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*.

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.

Return Authorization Number

When returning equipment to Woodward, please telephone and ask for the Customer Service Department [1 (800) 523-2831 in North America or +1 (970) 482-5811]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the item(s) to be repaired. No work can be started until a purchase order is received.



NOTE

We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at 1 (800) 523-2831 in North America or +1 (970) 482-5811 for instructions and for a Return Authorization Number.

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.

How to Contact Woodward

In North America use the following address when shipping or corresponding:

Woodward Governor Company
PO Box 1519
1000 East Drake Rd
Fort Collins CO 80522-1519, USA

Telephone—+1 (970) 482-5811 (24 hours a day)
Toll-free Phone (in North America)—1 (800) 523-2831
Fax—+1 (970) 498-3058

For assistance outside North America, call one of the following international 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.

<u>Facility</u>	<u>Phone Number</u>
Brazil	+55 (19) 3708 4800
India	+91 (129) 230 7111
Japan	+81 (476) 93-4661
The Netherlands	+31 (23) 5661111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (www.woodward.com) for the name of your nearest Woodward distributor or service facility.

Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Contact information:

Telephone—+1 (970) 482-5811

Toll-free Phone (in North America)—1 (800) 523-2831

Email—icinfo@woodward.com

Website—www.woodward.com

Technical Support is available through our many worldwide locations or our authorized distributors, depending upon the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical support, please contact us via telephone, email us, or use our website and reference **Customer Services** and then **Technical Support**.

Product Training is available at many of our worldwide locations (standard classes). 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. For information concerning training, please contact us via telephone, email us, or use our website and reference **Customer Services** and then **Product Training**.

Field Service engineering on-site support is available, depending on the product and location, from one of our many worldwide locations or from one of our authorized 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 field service engineering assistance, please contact us via telephone, email us, or use our website and reference **Customer Services** and then **Technical Support**.

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:

General

Your Name _____
Site Location _____
Phone Number _____
Fax Number _____

Prime Mover Information

Engine/Turbine Model Number _____
Manufacturer _____
Number of Cylinders (if applicable) _____
Type of Fuel (gas, gaseous, steam, etc) _____
Rating _____
Application _____

Control/Governor Information

Please list all Woodward governors, actuators, and electronic controls in your system:

Woodward Part Number and Revision Letter _____

Control Description or Governor Type _____

Serial Number _____

Woodward Part Number and Revision Letter _____

Control Description or Governor Type _____

Serial Number _____

Woodward Part Number and Revision 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 include the manual number from the front cover of this publication.



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