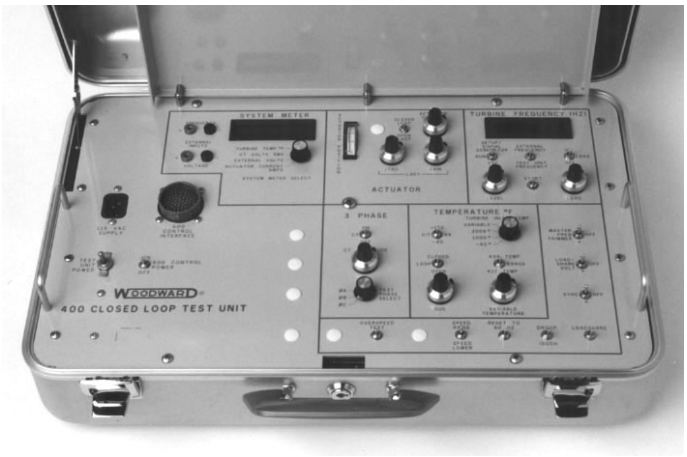
WOODWARD

Product Manual 55037
(Revision C)
Original Instructions



400 Closed Loop Test Unit (Suitcase Tester)

Procedures to Test 9900-323, A9900-413, and 9900-413

Operation Manual

IMPORTANT

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.

DEFINITIONS

- **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

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.

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.

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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.

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.

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*.

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

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Illustrations and Tables

Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. 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.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. 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.

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*.

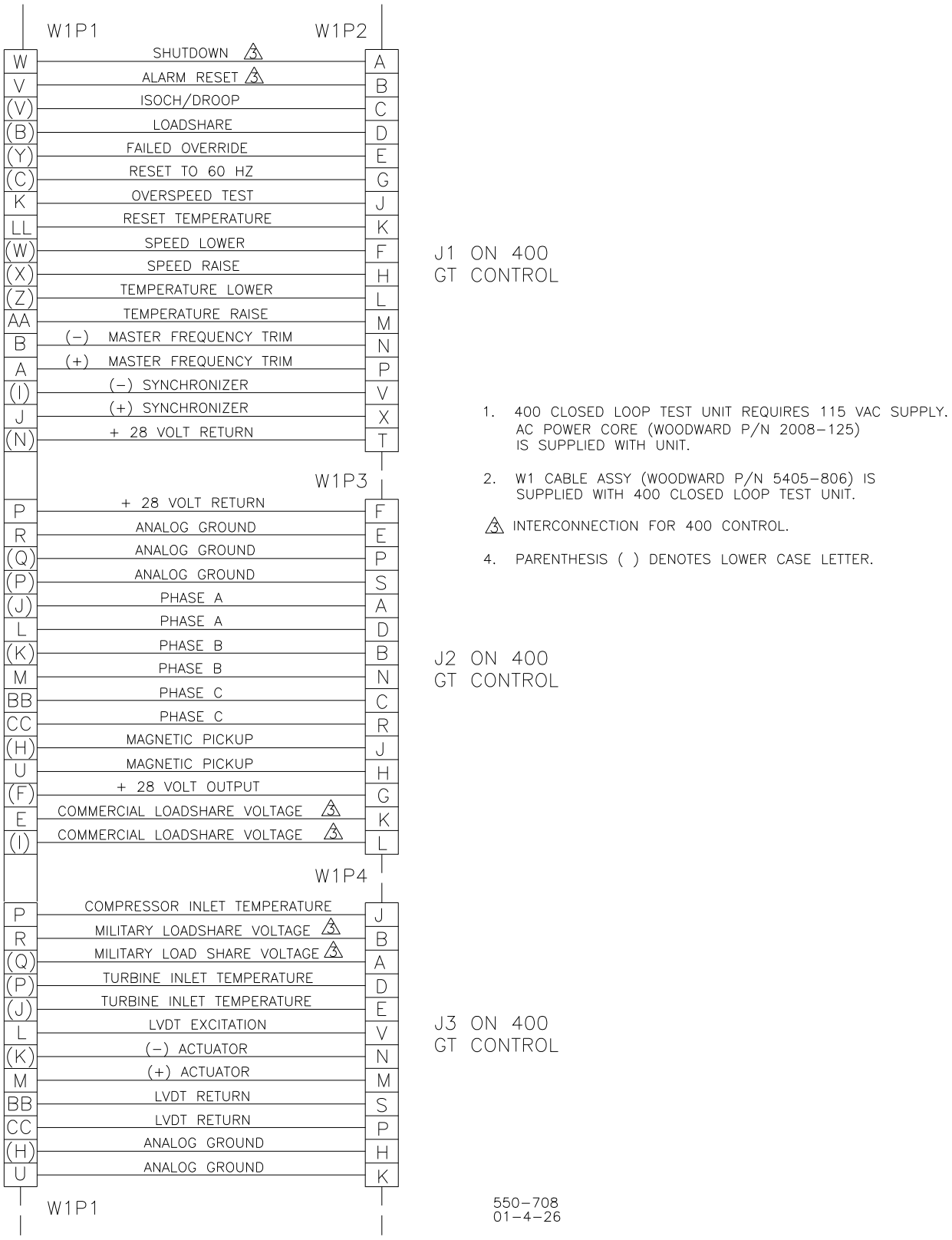


Figure 1-1. Plant Wiring Diagram for the 400 Closed Loop Test Unit

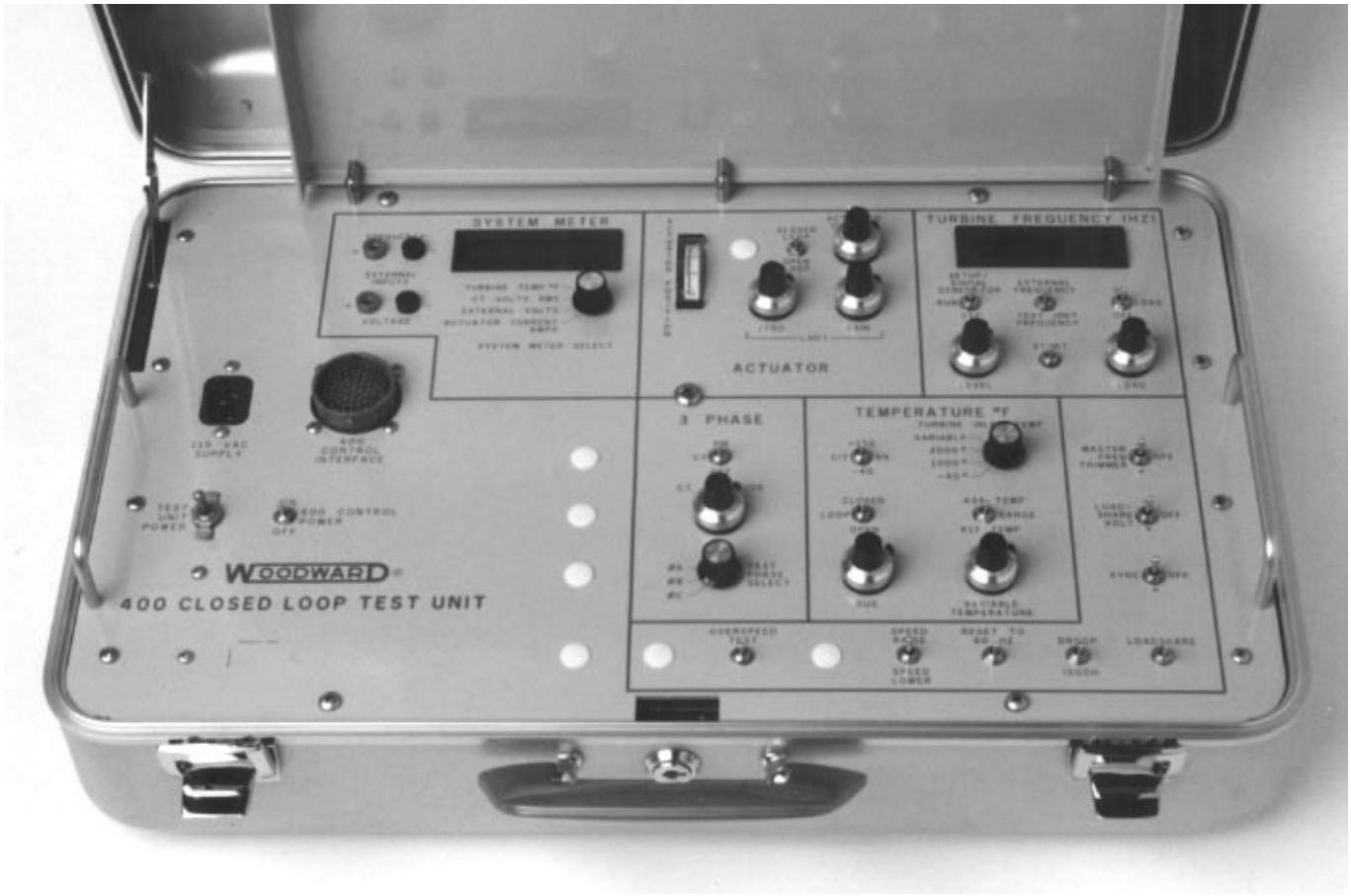


Figure 1-2. 400 Closed Loop Test Unit

Chapter 1.
Test Unit Description

Introduction

The 400 Closed Loop Test Unit provides a convenient method to test and calibrate Woodward 400 electronic fuel controls numbers 9900-323, A9900-413, and 9900-413. When properly connected to a 400 fuel control, the test unit provides meter readouts of all control functions and also will simulate turbine operation during start-up and under control. Switches on the test unit provide all the control features usually located on the turbine control panel.

Power to the test unit is provided from a 120 Vac source through a three-conductor power cord which is packaged with the test unit. A 24 Vdc power supply in the test unit provides operating power to the control under test.

Banana jacks on the test unit allow operational checks of external frequencies and external voltages. External inputs are checked from the speed and temperature module, the CIT (compressor inlet temperature) sensor, the master frequency trimmer, the SPM synchronizer, and the normal power supply. The testing of these functions is conducted through the test unit System Meter and Turbine Frequency meter.

The EGB-2P actuator and the 1907 liquid fuel valve should be tested on a test stand which provides the rotation and oil supply required by the actuator.

Explanation of Functions

Interface Cable

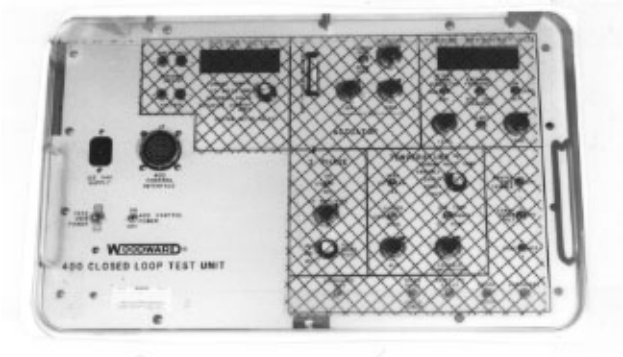
The W1 interface cable packed with the test unit provides all connections needed between a system under test and the test unit. Figure 1-1 (plant wiring diagram, page iii) shows the connections included with the interface cable.

IMPORTANT

Follow the plant wiring diagram when attaching the interface cable:
P1 attaches to J7 on the test box.
P2 on the interface cable attaches to J1 on the 400 control.
P3 on the interface cable attaches to J2 on the 400 control.
P4 on the interface cable attaches to J3 on the 400 control.
The plugs on the interface cable are keyed to prevent errors in connecting the Test Unit to the control.

The interface cable must be completely installed on both the control and on the test unit prior to plugging in the 120 Vac power-supply cable. The Test Unit Power switch and the 400 Control Power switch should be in the Off position when attaching the 120 Vac power cord.

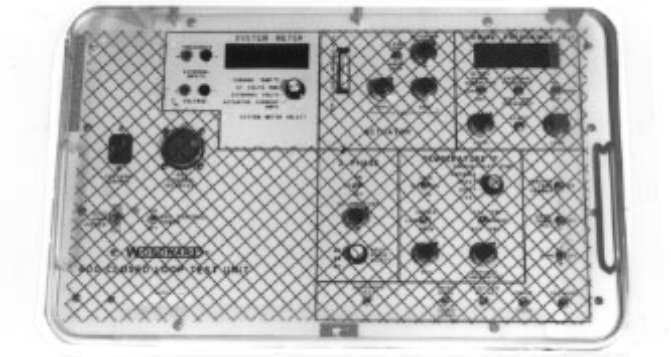
Power Switches



A Test Unit Power switch provides On–Off positions. In the Off position, no power is available to either the test unit or to any control attached to the test unit.

A 400 Control Power switch provides On–Off positions. In the Off position, 24 Vdc power is turned off to any attached 400 control. This switch is used to disconnect power to an attached control without powering down the entire test unit.

System Meter



The System Meter provides a digital readout of four different test-unit functions as selected with the System Meter Select switch.

Turbine Temperature

When Turbine Temp is selected, the System Meter provides a reading (in degrees Fahrenheit) of the turbine inlet temperature (TIT) being simulated by the test unit, up to 2000 °F (1093 °C).

CT Volts RMS

This position provides a reading of the simulated CT RMS volts produced by the test unit. This voltage is set by the CT Amplitude adjustment on the test unit.

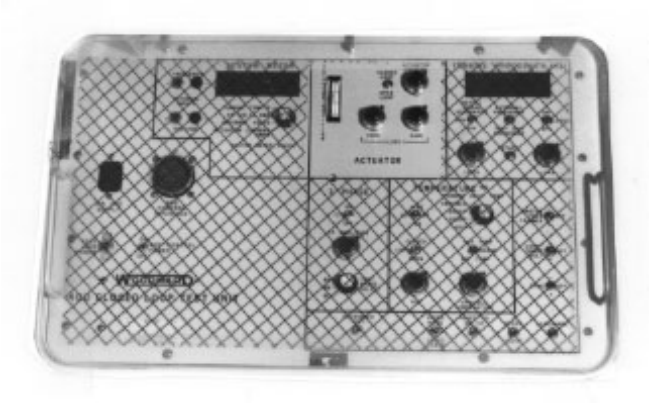
External Volts

At this position, the System Meter becomes a digital volt meter (DVM) for use with external dc voltage inputs through two banana jacks. The External Volts feature is used to test the output of other items in the control circuit and for potentiometer adjustment throughout the 400 control. The System Meter reads external volts to four digits with a maximum input of 200 Vdc.

Actuator Current Amps

This position reads the current to the actuator from the 400 control when the Actuator portion of the test unit is set for closed loop. When the Actuator portion of the test unit is set for open loop, the System Meter reads the current set by the Actuator Current dial on the test unit.

Actuator



The Actuator section provides readings of the actuator position as directed by the control unit under test. Simulated actuator current and LVDT signals are adjusted by the dials.

Actuator Position

The Actuator Position dial provides a 0 to 40 degree reading of actuator position as set by the actuator current being produced by the test unit or by the control under test.

Closed Loop/Open Loop

This switch determines if the actuator signal from the control under test is being used in the test unit or if the actuator signal produced by the test unit is being used.

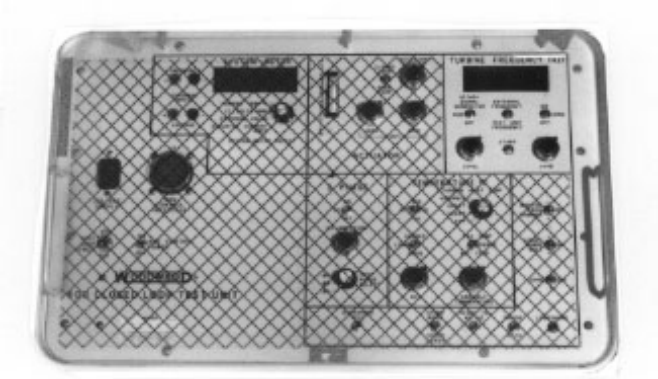
Actuator Current

This dial sets the amount of actuator current being produced by the test unit in Open Loop configuration.

LVDT

These produce a simulated LVDT signal to the control under test. Zero and Gain settings are set to simulate the fuel valve LVDT.

Turbine Frequency



This digital meter provides a constant reading of the MPU frequency currently being produced by the test unit or monitored by the test unit. The test unit produces a frequency of 0 to 15 000 Hz.

Setup/Signal Generator Switch

A three-position switch turns the frequency generator in the test unit on and off. In the Run position, the frequency generator is controlled by the actuator output from the control. This simulates a “closed loop” system. In the Setup position, the frequency generator is controlled by the Level pot on the suitcase. This simulates an “open loop” system because the fuel control is not controlling the frequency. Finally, in the Off position, the frequency generator is set to zero.

IMPORTANT **The frequency shown on the meter is the simulated MPU frequency, not the turbine/generator frequency.**

External Frequency/Test Unit Frequency Switch

When in the External Frequency position, the meter monitors the frequency input to the test unit at the External Inputs from an external source. The external source may be 0 to 20 000 Hz, 15 V peak-to-peak maximum.

Level

The Level setting is used to control the test unit frequency when the Setup/Signal Generator switch is in the Setup mode.

Load

The Load dial sets a simulated load which the test unit produces when the load switch is turned to the On position.

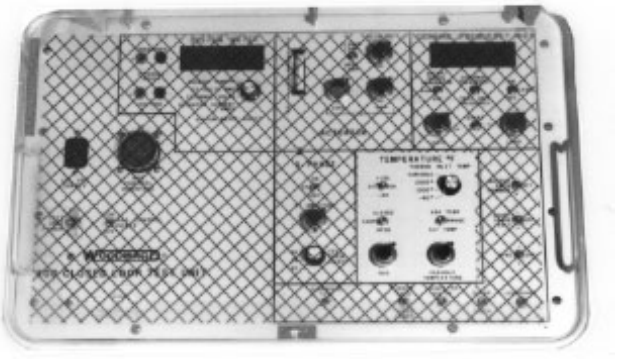
Start

This momentary switch starts the frequency generator in the test unit as a starter would start rolling an engine. As test unit engine speed increases, more actuator position will be generated by the 400 control. After enough simulated fuel flow is generated, the control and test unit will sustain speed and continue to accelerate to rated speed.

IMPORTANT **Since military actuators are reverse-acting, the Start switch will not normally be needed.**

Temperature

This feature produces a 0 to 10 Vdc signal to the fuel control, simulating a signal from the Allison speed and temperature module. All controls require a direct reading (0 V equals 0 °F [–18 °C], 10 V equals either 2000 °F [1093 °C] for the K17 or 2250 °F [1232 °C] for the K34).



Turbine Inlet Temp

A four-position switch provides automatic temperature simulations of –40, 1000, or 2000 °F (–40, 538, or 1093 °C). from the test unit to the control. The temperature being simulated by the test unit may be verified on the System Meter. In the Variable position, the test unit produces a temperature simulation as set on the Variable Temperature dial. The variable temperatures are only available with the Closed Loop/Open Loop switch in the Open Loop position. When the test unit is in closed loop simulation, the speed is set on the bus dial. The temperature will vary according to the actuator position. This reading is available on the System Meter.

CIT (Compressor Inlet Temperature)

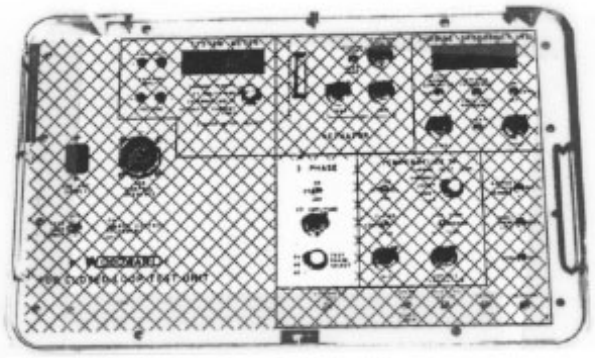
This provides a simulated CIT signal as indicated. The three-position switch provides automatic temperature simulations of –40, 59, and 130 °F (–40, 15, and 54 °C). from the test unit to the control.

Closed/Open Loop

In the Open Loop position, the TIT selected is sent to the control being tested. In the Closed Loop position, the bus signal sets the speed of the test unit as if the generator and turbine were tied to the utility bus. The speed of the Bus potentiometer should be set slightly less than rated speed. As speed to the governor is decreased, the actuator position should increase. This will increase the temperature output signal until the temperature control point is reached. This allows closed loop control on a temperature basis for checking of the control under this condition.

3 Phase

This section provides a CT simulation for use by the control. CT voltage can be simulated one phase at a time. The amplitude of the simulation is adjustable and may be read on the system meter. The test unit also provides a constant simulated PT signal.

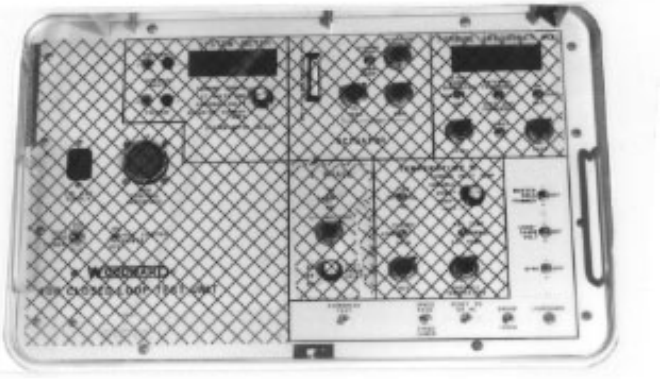


System Switches

Eight switches on the test unit panel provide all of the control panel features of the 400 control.

Overspeed Test

In the up position, this switch enables the control to ramp the speed up and over the raise limit for Overspeed Testing.



Speed Raise/Speed Lower

This three-position switch simulates the speed-reference control on the control panel.

Reset To 60 Hz

In the up position this switch simulates the control panel speed-reference reset switch.

Droop/Isoch

In the Droop position this switch sets droop in the control. In the Isoch position this switch sets isochronous operation (0 droop) in the control.

Loadshare

Activates or deactivates the Loadshare circuit in the 400 control under test.

Sync

Provides a ±1.5 Vdc signal to the SPM input of the control. This simulates the input from a synchronizer.

Loadshare Volt

Provides a ±1.5 Vdc signal to the Loadshare input. This simulates the Loadshare command input.

Master Freq Trimmer

Provides ±1.5 Vdc signal to the control under test. This simulates the signal from a frequency trimmer.

Chapter 2.
Testing the Test Unit

Test Unit Checkout

The following procedure provides a check of the test unit to assure proper operation. The unit should be sent to an authorized repair facility if it fails any of the tests.

WARNING

HIGH VOLTAGE—Be careful when probing pins in J7 while unit power switch is on. There is 120 Vac present on several of these pins. It is safest to use insulated leads.

IMPORTANT

The LVDT portions cannot be readily checked without a control and fuel valve (LVDT). Do not change the positions of these dials during the test unit checking procedure. The best way to set the LVDT portions of the test unit is to first set up a control connected to a turbine, then connect this control to the test unit, and then adjust the LVDT Zero and Gain potentiometers to provide appropriate response in the control. The test unit is now adjusted to properly calibrate a second control which will run the same turbine and actuator as the first control. Should the LVDT or turbine be changed, it will be necessary to re-calibrate the control and the test unit.

1. Plug 120 Vac supply into the test unit. Turn the Test Unit Power switch to On, the 400 Control Power switch to Off. Allow at least 15 minute warm-up before calibrating the test unit. Use an external digital meter for the following procedures, if possible.

2. Connect a dc voltmeter across J7-U (+) to J7-n (–). It should read 0.00 ± 0.05 Vdc.

3. Set the 400 Control Power switch to On. J7-U (+) to J7-n (–) should read 28.0 ± 4.0 Vdc. Turn the Test Unit Power switch to Off, and the reading should go to zero. Turn both switches to On.

4. Set the System Meter Select to External Volts. Attach a lead from J7-P to External Inputs/Voltage (–).

5. Attach the (+) lead from External Inputs/Voltage to J7-K. Turn the Overspeed Test switch to on (up). The Overspeed Test switch should provide a +28.0 ± 4.0 Vdc signal. Turn the Overspeed Test switch off (down).

6. Attach the (+) lead from External Inputs/Voltage to J7-x. Hold the Speed Raise switch on (up). The Speed Raise switch should provide a +28.0 ± 4.0 Vdc signal. Release the switch.

7. Attach the (+) lead from External Inputs/Voltage to J7-w. Hold the Speed Lower switch on (down). The Speed Lower switch should provide a +28.0 ± 4.0 Vdc signal. Release the switch.

8. Attach the (+) lead from External Inputs/Voltage to J7-c. Turn the Reset To 60 Hz on (up). The Reset to 60 Hz switch should provide a +28.0 ± 4.0 Vdc signal. Turn the Reset To 60 Hz switch off (down).

9. Attach the (+) lead from External Inputs/Voltage to J7-v. Turn the Isoch/Droop switch to the Isoch position. The Isoch switch should provide a +28.0 ± 4.0 Vdc signal. Set the switch to Droop. The voltage at J7-v will go to 0.00 ± 0.05 Vdc.

10. Attach the (+) lead from External Inputs/Voltage to J7-b. Turn the Loadshare switch on (up). The Loadshare switch should provide a +28 ± 4.0 Vdc signal. Turn the Loadshare switch off (down).

11. Attach the (+) lead from External Inputs/Voltage to J7-J. Attach the (–) lead from External Inputs/Voltage to J7-i. Hold the Sync switch in the (+) position. Sync (+) should provide a +1.5 ± 0.1 Vdc signal. Release the switch.

12. Attach the (+) lead from External Inputs/Voltage to J7-i. Attach the (–) lead from External Inputs/Voltage to J7-J. Hold the Sync switch in the (–) position. Sync (–) should provide a +1.5 ± 0.1 Vdc signal. Release the switch.

13. Attach the (+) lead from External Inputs/Voltage to J7-D. Attach the (–) lead from External Inputs/Voltage to J7-e. Hold the Loadshare Volt switch in the (–) position. Loadshare Volt (–) should provide a +1.5 ± 0.1 Vdc signal. Hold the Loadshare Volt switch in the (+) position. Loadshare Volt (+) should provide a -1.5 ± 0.1 Vdc signal. Release the switch.

14. Attach the (+) lead from External Inputs/Voltage to J7-B. Attach the (–) lead from External Inputs/Voltage to J7-A. Hold the Master Freq Trimmer switch in the (–) position. Master Freq Trimmer (–) should provide a +1.5 ± 0.1 Vdc signal. Release the switch.

15. Attach the (+) lead from External Inputs/Voltage to J7-A. Attach the (–) lead from External Inputs/Voltage to J7-B. Hold the Master Freq Trimmer switch in the (+) position. Master Freq Trimmer (+) should provide a +1.5 ± 0.1 Vdc signal. Release the switch.

16. Set the System Meter Select to CT Volts RMS. Turn the CT switch in the 3 Phase section to On. The CT voltage should be adjustable from 0 to approximately 6 Vac with the CT Amplitude dial. Turn the CT switch to Off. The CT Volts RMS should go to 0.0 ± 0.1.

⚠WARNING

HIGH VOLTAGE—Dangerous voltages (120 Vac) are exposed in steps 17 through 22. Cycle unit power off before connecting ac RMS voltmeter. Turn power on to make the measurement. Turn power off before disconnecting.

17. Set the Test Phase Select to ØA. Attach an ac RMS voltmeter from J7-j to J7-k. Read a constant 120 Vac (approximate) PT signal.

18. Attach the ac RMS voltmeter to J7-L and R. Turn the CT switch to On. The RMS voltage should be adjustable with the CT Amplitude potentiometer from 0 to approximately 6 Vac. Turn the CT switch Off.

19. Turn the Test Phase Select to ØB. Attach the ac RMS voltmeter from J7-k to J7-BB. Read a constant 120 Vac (approximate) PT signal.

20. Attach the ac RMS voltmeter to J7-M and q. Turn the CT switch On. The RMS voltage should be adjustable with the CT Amplitude potentiometer from 0 to approximately 6 Vac. Turn the CT switch Off.

21. Turn the Test Phase Select to ØC. Attach the ac RMS voltmeter from J7-BB to J7-j. Read a constant 120 Vac (approximate) PT signal.

22. Attach the ac RMS voltmeter to J7-CC and p. Turn the CT switch On. The RMS voltage should be adjustable with the CT Amplitude potentiometer from 0 to approximately 6 Vac. Turn the CT switch Off.

23. Set the System Meter Select to External Volts. Attach the External Inputs/Voltage leads J7-a (+) and J7-T (–). Attach a 5 kA resistor between J7-a and J7-T. Select CIT +130 °, and the System Meter should read about 1.64 ± 0.01 Vdc. Select CIT 59 °, and the System Meter should read about 1.44 ± 0.01 Vdc. Select CIT –40 °, and the System Meter should read about 1.17 ± 0.01 Vdc. Remove the 5 kA resistor.

24. Attach the External Inputs/Voltage leads to J7-g (+) and J7-F (–). Select Range K17 Temp and set the Temperature Loop switch to Open. Select External Volts on the System Meter Select. Readings on the System Meter as the Turbine Inlet Temp switch is changed should be: about –0.20 ± 0.01 Vdc when TIT = –40 °F; about +5.00 ± 0.05 Vdc when TIT = 1000 °F, and about 10.0 ± 0.1 Vdc when TIT 2000 °F.

25. Select Range K34 Temp. Select External Volts on the System Meter Select. Readings on the System Meter as the Turbine Inlet Temp switch is changed should be: about –0.18 Vdc at –40 °F; about +4.4 Vdc at 1000 °F, and about +8.9 Vdc at 2000 °F.

26. Select Range K17 Temp. Set the System Meter Select for Turbine Temp and the Turbine Inlet Temp for Variable. Read about –100 to +2250 ° on the System Meter when adjusted by the Variable Temperature potentiometer. Set the System Meter Select to External Volts and read about –0.6 to +11 Vdc. Select Range K34 Temp and read about –0.5 to +10 Vdc.

IMPORTANT

When the Turbine Temperature reading is showing only four digits, the readings will always read about 100 degrees low. However, the actual output to the control will be correct.

27. Remove the leads from J7 and from the External Inputs/Voltage. Plug the banana plugs into the External Inputs/Frequency. Attach the (+) lead to J7-H. Attach the (–) lead to J7-h. Set the Actuator switch to Open Loop. Set the System Meter Select to Actuator Current Amps. Adjust the Actuator Current dial for 160 mA on the meter.

28. Set the External Frequency/Test Unit Frequency switch to Test Unit Frequency. Set the Temperature Loop switch for Closed. Set the Setup/Signal Generator switch to Run. Adjust the Temperature Bus dial to read about 8500 Hz on the Turbine Frequency Meter. Set the External Frequency/Test Unit Frequency switch to External Frequency. The Turbine Frequency Meter should display the same frequency as in the Test Unit Frequency position. Set the switch in the Test Unit Frequency position. The Turbine Frequency meter should go to 0 Hz when the Temperature Loop Open position is selected.

29. Set the Actuator switch to Open Loop. Set the System Meter Select to Actuator Current Amps. Adjust the Actuator Current potentiometer for 20 mA on the meter. Read an actuator position of about 40 ° on the Actuator Position Meter.

30. Turn the Actuator Current dial clockwise until the Actuator Position meter reads 0 °.

31. Set the Temperature Loop switch to Closed. Set the System Meter Select to Turbine Temp. When the Actuator Position meter reads about 0 °, the temperature on the System Meter should read about 800 °. As the Actuator Position meter reading is increased, by adjusting the Actuator Current potentiometer counterclockwise, the temperature on the System Meter should also increase.

32. Remove all external input wires from the test unit.

Chapter 3.
Testing a 400 Fuel Control

Tools Required

In addition to the 400 Closed Loop Test Unit and associated interface cable and power cord, the user will need a 3 inch (76 mm) jumper with pin jacks at both ends, a potentiometer-adjusting tool, and at least two leads with banana jacks at one end and pin jacks at the other end. These will be used for the external meter and should be 20 AWG wire (0.5 mm²), 3 feet (0.9 m) long. Contrasting colors are recommended.

Multimeter

The test unit includes a digital voltmeter. However, test procedures will be more convenient with a second meter available.

The ohmmeter must be capable of reading zero and infinity resistance.

Initial Setup

1. Remove the cables connecting the 400 control to the turbine, control panel, and actuator.

2. Locate the 400 control in a work area where it will be readily accessible and the test technician can easily make adjustments to the boards in the control. (An ideal situation would locate the control on a workbench with room for the test box and related equipment on the same bench.)

NOTICE	**Do not use a "Hi Pot" or "Megger" for testing. This control contains solid state circuits which may be damaged or destroyed.**

3. Turn the Test Unit Power and 400 Control Power switches to Off.

Setting the Test Unit

4. Set the Overspeed Test, Loadshare, 3 Phase CT, and Turbine Frequency Load switches to Off (down).

5. Set the Temperature Range switch to K34 Temp, the Temperature Loop switch to Open, and the Actuator switch to Open Loop.

6. The amplitude dials should be left as they were when the test unit was tested.

   (If the test unit has not been set up for a control, set the CT Amplitude, the Bus, the Variable Temperature, the Turbine Frequency Load and Level, and the Actuator Current dials all counterclockwise.)

7. Set the Droop/Isoch switch to Droop.

8. Set the Test Phase Select to ØA.

9. Set the Turbine Inlet Temp rotary switch to –40 °.

10. Set the External Frequency/Test Unit Frequency switch to Test Unit Frequency.

11. Set the Reset To 60 Hz switch to the On (up) position.

This completes the initial preparation of the test unit to test a 400 control.

Testing the Control

With the cover removed from the control, but none of the cables connected between the control and the test unit:

1. Measure the resistance from each contact in J1, J2, and J3 to the chassis. All readings must be infinity (ohms).

2. Measure the resistance from J2-F to J1-R, J1-S, J2-T and J3-W. All readings must be zero ohms.

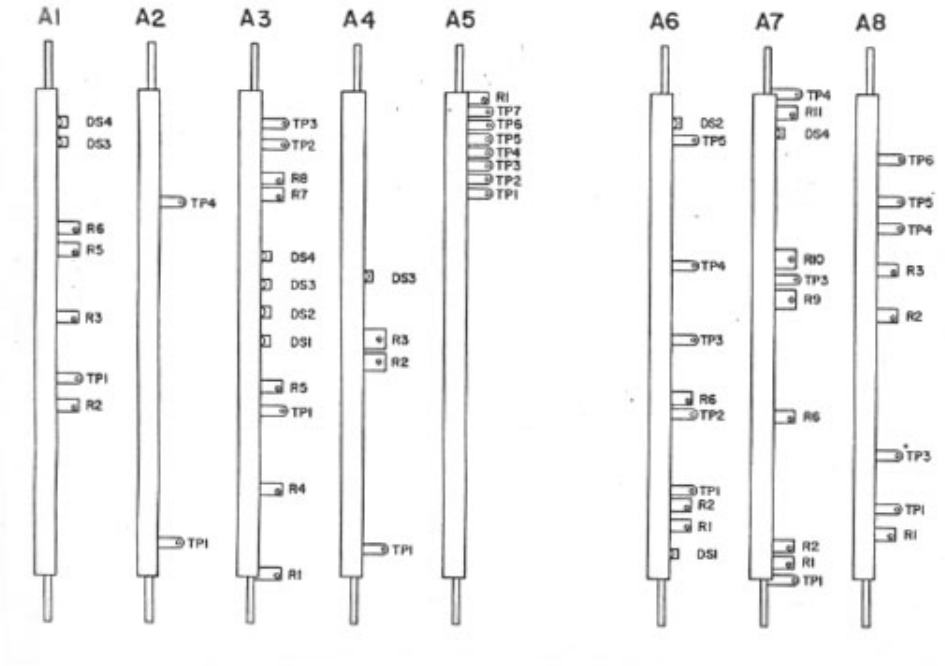
3. Measure the resistance from A5-TP3 to J1-W, J2-U, J3-C, and J3-X. All readings must be zero ohms.

IMPORTANT

The boards in the control are designated A1 through A8. The boards do not have to be removed during the following check unless a faulty board is discovered during a test.

Potentiometers are designated "R", test points are designated "TP", and LEDs on the boards are designated "DS". (A1-TP1 designates a specific test point on board A1. A3-R7 designates a specific potentiometer located on board A3.

See the following illustration of the board layouts as viewed from the top with the cover removed from the 400 control.)



4. Attach a 120 Vac power source to the test unit, and connect the interface cable between the test unit and the 400 control (J7 to J1, J2, and J3). See the plant wiring diagrams in this manual (Figure 1-1) and in manuals 82453 or 82315.

5. Turn the Test Unit Power to On. Leave the 400 Control Power switch Off. Allow the test unit to warm up for at least 15 minutes.

6. Select CT Volts RMS on the System Meter Select. Turn the 3 Phase CT switch On. Using the CT Amplitude dial, set the CT Amplitude to 1.6 ± 0.2 Vac. Turn the 3 Phase CT switch to Off.

7. Remove the cover from the 400 control.

8. Install a jumper between A5-TP1 and A5-TP2 to activate the LEDs.

9. Turn the 400 Control Power switch on the test unit to On.

NOTICE

When testing a new control, or when testing a control which does not have a known control defect, do not move any of the potentiometer settings. The procedures to set Gain and Stability for either speed or temperature control are given to adjust a new board or a new control. Reference and control voltage settings are also given for use when setting up a new control. Any major errors found in an existing control or in a new control probably indicate a major circuit disruption, not a movement in potentiometer setting.

Test and Calibration of the Control

1. If a new control is being calibrated, set the following control potentiometers (when testing an existing control, do not move the potentiometers from the pre-set position):
   A4-R2 Mid
   A4-R3 Mid
   A4-R9 Mid
   A7-R9 Mid
   A7-R10 Mid

IMPORTANT **All voltage measurements and waveform checks will be made with respect to A5-TP3 (circuit common) unless otherwise noted.**

Power Supply Test Module A5

1. Check for +7.5 ± 0.1 Vdc at A5-TP6 (common at A5-TP3). Record the reading, even if out of tolerance. This is a reference voltage—if the control functions adequately, the setting should not be changed even if the voltage is out of tolerance. If A5-R1 is adjusted to bring the reference voltage into tolerance, it will make careful calibration of the entire control necessary. **Do not adjust the setting on a functioning 400 control.**

2. Record the voltage at A5-TP7. The reading should be -7.5 ± 0.5 Vdc.

3. Record the voltage at A5-TP5. The reading should be –12 ± 0.5 Vdc.

4. Record the voltage at A5-TP4. The reading should be +12 ± 0.5 Vdc.

If any of the three voltages is out of tolerance, replace the power supply board.

Final Driver Test Module A8

1. If the test unit LVDT has been calibrated to a known control (as in steps 1a through 1g) skip to step 2.

   a. Disconnect the test unit from the unit under test and connect the test unit to a control that has been calibrated according to the manual for that control.

   b. Set the System Meter Select to Actuator Current Amps and use the Actuator Current dial to set the actuator current at 20 mA on the System Meter.

   c. Adjust the LVDT Gain on the test unit for a reading of –5.7 Vdc at A8-TP4. (This measurement can be made by switching the System Meter Select to External Volts and connecting the external inputs to A8-TP4 (+) and A5-TP3 (–).

   d. Set the Actuator Current to 160 mA on the System Meter. (The System Meter Select must be set to Actuator Current Amps).

e. Adjust the LVDT Zero dial on the test unit for a reading of –0.7 Vdc at A8-TP4 (measurement made as in step 1c).

f. Repeat steps 1b through 1e until voltage conditions are met at both 20 mA and 160 mA actuator current.

g. Reconnect the test unit to the control needing calibration.

2. Test the LVDT circuits.

   a. Set the System Meter Select to Actuator Current Amps and use the Actuator Current dial to set the Actuator Current at 20 mA on the System Meter.

   b. Adjust potentiometer A8-R3 (LVDT Feedback Gain) for a reading of –5.7 Vdc at A8-TP4.

   c. Set the Actuator Current to 160 mA on the System Meter.

   d. Adjust A8-R2 (LVDT Feedback Offset) for a reading of –0.7 Vdc at A8-TP4.

   e. Repeat steps 2a through 2d until the voltage is correct at 20 mA and 160 mA.

3. Close the actuator loop by setting the Actuator switch to Closed Loop, and set the Setup/Signal Generator switch to Run.

4. Adjust A4-R2 (Stability) and A4-R3 (Gain) for stable operation as shown on the Actuator Position meter. To check the response of the actuator, load the system by turning the Turbine Frequency Load switch On. Then watch the Actuator Position meter for a smooth and quick response.

IMPORTANT **LED A4-DS3 (Speed Control) must be ON, or these dynamic adjustments will have no effect.**

5. Set the Turbine Frequency Load switch on the test unit to On, and adjust the Load potentiometer on the test unit for 60 mA actuator current on the System Meter.

Speed Reference Test Module A3 9900-323 (K17)

Speed reference tests are provided for 400 controls 9900-323 and A9900-413. Select the test that fits your control. The test for A9900-413 begins on page 26.

Speed Reference 9900-323

1. Turn the test unit Load switch to Off. Turn the test unit Reset To 60 Hz switch to Off (down). Set the Actuator switch to Closed Loop. Set the Droop/Isoch switch to Isoch.

2. Select and hold the Speed Lower switch on the test unit. LED A3-DS3 (Run) should light and LED A3-DS4 (Reset) should go out. The speed on the Turbine Frequency meter should ramp down, and LED A3-DS2 (Lower Limit) should light. LED A3-DS3 (Run) should go out. Release the Speed Lower switch.

3. The Turbine Frequency meter should read 8753 ± 10 Hz when the Lower Limit LED is on. Adjust A3-R8 (Speed Reference Offset), if necessary.

4. Put the Overspeed Test switch in the up position. After ramping up, LED A3-DS3 will go out and LED A3-DS1 (Upper Limit) should light.

5. Adjust A3-R7 (Output Span) for a controlling frequency of 9871 ± 10 Hz on the test unit Turbine Frequency meter.

6. Set the Overspeed Test switch to the down position. Repeat steps 2 through 5 until the lower and upper limit speeds are within specification.

7. Set the Overspeed Test switch in the down position. Set the Reset To 60 Hz switch on the test unit to the up position. After ramping, LED A3-DS4 (Reset) should light. Adjust A3-R1 (Reset Set Point) for a controlling frequency of 9213 ± 10 Hz on the test unit Turbine Frequency meter.

IMPORTANT

When adjusting A3-R1, the speed position will not change as the potentiometer is adjusted. The Reset To 60 Hz must be turned Off and then back On after every adjustment of A3-R1 to check the speed setting. Allow the speed to stop ramping before re-adjusting A3-R1.

8. Turn the Reset To 60 Hz Off (down) Select Speed Raise. After ramping, adjust A3-R4 (Raise Limit) for a controlling frequency of 9520 ± 10 Hz on the Turbine Frequency meter. Release the Speed Raise switch.

9. Turn the 400 Control Power switch to Off.

10. Turn the 400 Control Power switch to On. LED A3-DS4 (Reset) should light and, after restarting, the control frequency should return to 9213 ± 10 Hz on the Turbine Frequency meter.

11. Select External Frequency on the Turbine Frequency meter.

12. Connect A3-TP1 to the External Frequency (+) input and A5-TP3 to the External Frequency (–) input on the test unit.

13. Adjust A3-R5 (Clock Speed/Ramp Rate) for a frequency of 51 Hz on the Turbine Frequency meter.

14. Remove the external frequency connections between the 400 control and the test unit.

Load Sensor Module A1 9900-323

1. Select Test Unit Frequency and Droop. LED A1-DS4 (Isoch/Droop) should be off. Select Isoch, and LED A1-DS4 should light.

2. Set the Loadshare switch to the up position. LED A1-DS3 (Parallel-On) should light. Turn Loadshare to Off (down).

3. Turn the 3 Phase CT switch to On. Select Test Phase Select ØA and set System Meter Select to CT Volts RMS. Adjust the CT Amplitude to 1.6 ± 0.1 Vrms.

4. Select ØB and ØC and check for 1.6 ± 0.1 Vrms at each position.

5. Return to ØA. Switch the System Meter Select to External Volts. Connect external leads from the voltage terminals on the test unit to A1-TP1 (+) and A5-TP3 (–). Adjust A1-R2 (Load Gain) for –2.00 ± 0.10 Vdc at A1-TP1 (Load Gain Voltage).

6. Check ØB and ØC for –2.00 ± 0.25 Vdc.

7. Turn the 3 Phase CT switch to Off, and switch the System Meter Select to External Volts. The voltage at A1-TP1 (Load Gain Voltage) should go to 0.0 ± 0.1 Vdc.

8. Turn the 3 Phase CT switch to On. Set A1-R5 (De-Droop) for the same controlling frequency of 9213 ± 10 Hz on the Turbine Frequency meter with the CT switch On or Off.

9. With the CT switch On, select Droop on the Droop/Isoch switch.

10. Adjust A1-R6 for a controlling frequency of 9096 ± 15 Hz. Select Isoch, and turn the CT switch to Off.

11. Set the Loadshare switch to the up position and hold the Loadshare Volt switch to the (+) position. The Turbine Frequency should go to 9400 ± 50 Hz.

12. Switch and hold the Loadshare Volt switch to (–). Turbine Frequency should go to 9000 ± 50 Hz.

13. Set the Loadshare switch to Off (down). Turbine Frequency should return to 9213 ± 10 Hz.

Isolation Test Module A2 9900-323

1. Switch the Master Freq Trimmer switch to (+) and hold. Turbine Frequency should go to 9300 ± 50 Hz.

2. Switch the Master Freq Trimmer switch to (–) and hold. Turbine Frequency should go to 9100 ± 50 Hz.

3. Switch the Sync switch to (+) and hold. Turbine Frequency should go to 9300 ± 50 Hz.

4. Switch the Sync switch to (–) and hold. Turbine Frequency should go to 9100 ± 50 Hz.

Speed Channel Module A4 9900-323

Do not use any of the following procedures if you are testing a governor which has already been set up.

1. Select the Variable position on the Turbine Inlet Temp rotary switch.

2. Increase the Temperature by adjusting the Variable Temperature potentiometer clockwise until the temperature channel takes control of the system (LED A4-DS3 turns off and LED A7-DS4 lights). Reduce the Variable Temperature to 1000 °F as the speed channel resumes control. [If the unit drops out of control, unload and restart (Start switch). Then load again.] LED A7-DS4 (Temperature Control Mode) should turn off and LED A4-DS3 (Speed Control Mode) should light. Temperature may be monitored on the System Meter by selecting Turbine Temperature.

IMPORTANT **Speed control dynamic adjustments should be attempted only by knowledgeable, qualified personnel.**

3. Adjust the speed control dynamics, if necessary, with A4-R2 (Stability) and A4-R3 (Gain). Dynamics on the speed control channel are acceptable under the following conditions:

   a. Steady state actuator current varying less than 0.2 mA in both load and no load conditions.

   b. Check transient response by momentarily switching Load Off and On. Load is adjusted for 60 mA and no load should be about 155 mA.

   c. Transient response has minimum settling time with only one overshoot. Long settling time indicates Stability is too high. Rapid oscillations indicate Gain is too high.

IMPORTANT **Speed dynamics will have to be fine tuned to the actual turbine when the governor is installed.**

Temperature Channel Module A7 9900-323

1. Set the CIT switch to –40 °, and adjust A7-R11 (CIT Offset) for 0.0 ± 0.2 Vdc at A7-TP4 (CIT Voltage). Use External Volts on the System Meter or a separate voltmeter.

2. Set the CIT switch to +130 °, and the voltage should be 4.65 ± 0.2 Vdc at A7-TP4.

IMPORTANT **The suitcase Temp Meter is used for the following steps. This meter is accurate in the 000.0 to 1999.9 °F (–17.8 to +1093.3) range. Above 2000 °F (1093 °C) the signal to the control is correct but the meter will read low.**

3. Set the Setup/Signal Generator switch to Setup/Signal Generator. Set the System Meter Select to Turbine Temp. Adjust the Level potentiometer for a frequency of 8500 Hz. Switch the 400 Control Power switch Off and back On. LED A6-DS1 (Run) should light.

4. Select Range K17 Temp, and adjust the Variable Temperature dial until the System Meter reads 1600 °F.

5. Slowly increase the Variable Temperature until the System Meter reads 1920 °F. Adjust A7-R6 (Run Temperature Reference) until LED A7-DS4 (Temperature Control Mode) just comes on. Check the adjustment by lowering the Variable Temperature potentiometer until A7-DS4 turns off, and then increase the Variable Temperature until the LED just comes on. Turbine Temp on the System Meter should be 1920 ± 20 °.

6. Set the CIT switch to –40 ° and set the Setup/Signal Generator switch to Off. Adjust the Variable Temperature potentiometer until LED A7-DS4 (Temperature Control Mode)is off. Then increase the Variable Temperature until A7-DS4 just lights. Turbine Temp on the system meter should be 1250 ± 20 ° with K17 Temp selected on the Range switch.

7. Set the CIT switch to +130 ° and increase the Variable Temperature potentiometer until LED A7-DS4 (Temperature Control Mode) just lights. Temperature should be 1350 ± 20 ° with K17 Temp selected.

8. Set the Setup/Signal Generator switch to Setup/Signal Generator. Adjust the Level potentiometer to about 7555 Hz on the Turbine Frequency meter. LED A6-DS1 (Run) should be off. If LED A6-DS1 is lit, cycle the Turbine Frequency switch Off, then back to Setup/Signal Generator. Turn the Variable Temperature potentiometer until LED A7-DS4 (Temperature Control Mode) just lights. Temperature should be 1550 ± 20 ° with K17 Temp selected.

9. Set the Actuator switch to Closed Loop. Set the System Meter Select to Actuator Current Amps. Set the Setup/Signal Generator switch to Run and the Turbine Inlet Temp switch to 1000 °. Adjust the Load potentiometer counterclockwise. Turn Load On and adjust the Load potentiometer so that the Actuator Current is 70 mA on the System Meter. Turn the Load switch Off, then back On. The Temperature Control Mode LED A7-DS4 should momentarily turn on as the Load switch is turned On. Failure to light indicates the temperature dynamics are incorrect.

10. Turn the Load switch Off.

Fuel Limiter Module A6 9900-323

1. Set the Setup/Signal Generator switch to Off. LED A6-DS1 (Run) should be off. Turn the Load switch Off.

2. Set the CIT switch to 59 °, select Range K17 Temp, and set the Turbine Inlet Temp switch to 1000 °. The voltage at A8-TP6 (Control Voltage) should be 1.1 ± 0.1 Vdc.

3. Set the Generator switch to Run and use the Reset To 60 Hz switch to adjust the frequency to 9213 ± 10 Hz. LED A6-DS1 (Run) should light.

4. Hold the Start switch up to drive the actuator to minimum. The voltage at A8-TP6 (Control Voltage) should be less than 0.05 Vdc. Release the start switch.

5. Set the Setup/Signal Generator switch to Setup/Signal Generator, and adjust the Level potentiometer for a Turbine Frequency just above 8700 Hz. Turn the 400 Control Power switch Off and back On. Use the Level pot to slowly decrease the Turbine Frequency until LED A6-DS1 just goes out. Turbine Frequency should be 5600 +/- 100 Hz.

6. Verify the fuel schedules by measuring the voltage at A6-TP4 (Fuel Limiter Voltage) under the following conditions:

   a. Set the Temp Range switch to K17 Temp.

   b. Set the Setup/Signal Generator switch to Off, Turbine Inlet Temp to 1000 °, and CIT to 59 °. Voltage at A6-TP4 should be 0.70 ± 0.2 Vdc.

   c. Set the Turbine Inlet Temp to –40 °. A6-TP4 should be 1.17 ± 0.2 Vdc.

   d. Set the Setup/Signal Generator switch to Setup/Signal Generator, and adjust the Level potentiometer for 6000 Hz on the Turbine Frequency meter. The voltage at A6-TP4 should be 2.80 ± 0.2 Vdc.

   e. Set the CIT switch to –40 °. The voltage at A6- TP4 should be 2.95 ± 0.2 Vdc.

   f. Set the CIT switch to +130 °. The voltage at A6- TP4 should be 2.68 ± 0.2 Vdc.

   g. Set the CIT switch to +59 ° and the Turbine Inlet Temp to 1000 °. The voltage at A6-TP4 should be 2.35 ± 0.2 Vdc.

   h. Adjust the Level potentiometer for 7000 Hz. The voltage at A6-TP4 should be 2.90 ± 0.2 Vdc.

   i. Adjust the Level potentiometer for 8700 Hz. The voltage at A6-TP4 should be 3.89 ± 0.2 Vdc.

   j. Adjust the Level potentiometer for 9000 Hz. The voltage at A6-TP4 should be 5.31 ± 0.2 Vdc.

Final Procedure

1. Turn Off the 400 Control Power switch and the Test Unit Power switch. Remove the jumper from A5-TP1 and A5-TP2 on the 400 control.

2. Remove the test cable and test unit from the 400 control.

3. Put the cover back on the control.

Speed Reference Test Module A3 A9900-413 (K34)

Speed reference tests are provided for 400 controls 9900-323 and A9900-413. Select the test that fits your control. The test for 9900-323 begins on page 20.

Speed Reference A9900-413

1. Turn the test unit Reset To 60 Hz switch Off (down) and the Load switch to Off. Set the Actuator Switch to Closed Loop. Set the Droop/Isoch switch to Isoch.

2. Select and hold the Speed Lower switch on the test unit. LED A3-DS3 (Run) should light and LED A3-DS4 (Reset) should go out. The speed on the Turbine Frequency Meter should ramp down, and LED A3-DS2 (Lower Limit) should light. LED A3-DS3 (Run) should go out. Release the Speed Lower switch.

3. The Turbine Frequency meter should read 8976 ± 10 Hz when the Lower Limit LED is on. Adjust A3-R8 (Speed Reference Offset) if necessary.

4. Set the Overspeed Test switch to the up position. The Lower Limit LED A3-DS2 will go out and the Run LED A3-DS3 will come on. After ramping, the A3-DS3 LED will go out and the A3-DS1 LED (Upper Limit) should light.

5. Adjust A3-R7 (Output Span) for a controlling frequency of 10 236 ± 10 Hz on the test unit Turbine Frequency meter.

6. Set the Overspeed Test switch to the down position. Repeat steps 2 through 5 until the lower and upper limit speeds are within specification.

7. De-select Overspeed Test. Select Reset to 60 Hz on the test unit. After ramping, LED A3-DS4 (Reset) should light. Adjust A3-R1 (Reset Set Point) for a controlling frequency of 9560 ± 10 Hz on the Turbine Frequency meter.

IMPORTANT

When adjusting A3-R1, the speed position will not change as the potentiometer is adjusted. The Reset To 60 Hz switch must be turned Off and then On after every adjustment of A3-R1 to check the speed setting. Allow the speed to stop ramping before readjusting A3-R1.

8. Set the Reset To 60 Hz switch Off (down). Select and hold the Speed Raise switch. After ramping, adjust A3-R4 (Raise Limit) for a controlling frequency of 9762 ± 10 Hz on the Turbine Frequency meter. Release the Speed Raise switch.

9. Turn the 400 Control Power switch to Off.

10. Turn the 400 Control Power switch to On. LED A3-DS4 (Reset) should light and, after restarting, the control frequency should return to 9560 ± 10 Hz on the Turbine Frequency Meter.

11. Select External Frequency on the Turbine Frequency Meter.

12. Connect A3-TP1 to the External Frequency input and A5-TP3 to the External Frequency (–) input on the test unit.

13. Adjust A3-R5 (Clock Speed/Ramp Rate) for a frequency of 51 Hz on the Turbine Frequency meter.

14. Remove the External Frequency connections between the 400 control and the test unit.

Load Sensor Module A9900-413

1. Select Test Unit Frequency and set the Droop/Isoch switch to Droop. LED A1-DS4 (Isoch/Droop) should be out. Select Isoch, and LED AI-DS4 should light.

2. Set the Droop/Isoch switch to Isoch. Set the Loadshare switch to the up position. LED A1-DS3 (Parallel-On) should light. Turn Loadshare to Off (down).

3. Turn the 3 Phase CT switch to On. Select ØA and set the System Meter Select to CT Volts RMS. Adjust the CT amplitude to 1.6 ± 0.1 Vrms.

4. Select ØB and ØC and check for 1.60 ± 0.1 Vrms.

5. Return to ØA. Switch the System Meter Select to External Volts. Connect external leads from the External Input voltage jacks on the test unit to A1-TP1 (+) and A5-TP3 (–). Adjust A1-R2 (Load Gain) for -2.00 ± 0.10 Vdc at A1-TP1 (Load Gain Voltage).

6. Check ØB and ØC for -2.0 ± 0.25 Vdc.

7. Turn the 3 Phase CT switch to Off. The voltage at A1-TP1 (Load Gain Voltage) should go to 0.0 ± 0.1 Vdc.

8. Turn the 3 Phase CT switch to On. Set A1-R5 (De-Droop) for the same controlling frequency of 9560 ± 10 Hz, on the Turbine Frequency Meter, with the CT switch On or Off.

9. With the CT switch On, select Droop on the Droop/Isoch switch.

10. Adjust A1-R6 for a controlling frequency of 9439 ± 10 Hz. Select Isoch and turn the CT switch to Off.

11. Set the Loadshare switch to the up position. Hold the Loadshare Volt switch to (+). The Turbine Frequency should go to 9754 ± 50 Hz.

12. Hold the Loadshare Volt switch to (–). The Turbine Frequency should go to 9338 ± 50 Hz.

13. Set the Loadshare switch Off (down), and the Turbine Frequency should return to 9560 ± 10 Hz.

Isolation Test Module A2 A9900-413

1. Switch the Master Freq Trimmer switch to (+) and hold. The Turbine Frequency should go to 9640 ± 50 Hz.

2. Switch the Master Freq Trimmer switch to (–) and hold. The Turbine Frequency should go to 9450 ± 50 Hz.

3. Switch the Sync switch to (+) and hold. The Turbine Frequency should go to 9640 ± 50 Hz.

4. Switch the Sync switch to (–) and hold. The Turbine Frequency should go to 9450 ± 50 Hz.

Speed Channel Module A4 A9900-413

Do not use any of the following procedures if you are testing a governor which has already been set up.

1. Select the Variable position on the Turbine Inlet Temp switch.

2. Increase the temperature by adjusting the Variable Temperature potentiometer clockwise until the temperature channel takes control of the system (LED A4-DS3 goes out and LED A7-DS4 lights). Reduce the Variable Temperature until the speed channel resumes control. [If the unit drops out of control, unload and restart (Start switch). Then load again.] LED A7-DS4 (Temperature Control Mode) should go out, and LED A4-DS3 (Speed Control Mode) should light. Temperature may be monitored on the System Meter by selecting Turbine Temp.

IMPORTANT **Speed Control Dynamic adjustments should only be attempted by knowledgeable, qualified personnel.**

3. Adjust the Speed Control Dynamics, if necessary, with A4-R2 (Stability) and A4-R3 (Gain). Dynamics on the Speed Control Channel are acceptable under the following conditions:

   a. Steady state actuator current varying less than 0.2 mA in both load and no load conditions.

   b. Check transient response by momentarily switching Load Off and On. Load is adjusted for 60 mA and no load should be about 155 mA.

   c. Transient response has minimum settling time with only one overshoot. Long settling time indicates Stability is too high. Rapid oscillations indicate Gain is too high.

IMPORTANT **Speed dynamics will have to be fine tuned to the actual turbine when the governor is installed.**

Temperature Channel Module A7 A9900-413

1. Set the CIT switch to –40 ° and adjust A7-R11 (CIT Offset) for 0.00 ± 0.02 Vdc at A7-TP4 (CIT Voltage). Use the External Volts input on the System Meter or a separate voltmeter.

2. Set the CIT switch to +130 ° and the voltage should be 4.65 ± 0.05 Vdc at A7-TP4.

3. Set the Setup/Signal Generator switch to Setup/Signal Generator. Set the System Meter Select to Turbine Temp. Adjust the Level potentiometer for a Turbine Frequency of 9600 Hz. Switch the 400 Control Power Off and back On. LED A6-DS1 (Run) should light.

4. Select K34 Temp and adjust the Variable Temperature dial until the System Meter reads 1600 °.

5. Slowly increase the Variable Temperature dial until the System Meter Turbine Temp reads 2200 °. Adjust A7-R6 (Run Temperature Reference) until LED A7-DS4 (Temperature Control Mode) just comes on. Check adjustment by lowering the Variable Temperature potentiometer until A7-DS4 turns off, and then increase the temperature until the LED just comes on. Temperature on the System Meter should be 2200 ± 20 °.

6. Set the CIT switch to –40 ° and set the Setup/Signal Generator switch to Off. Adjust the Variable Temperature potentiometer until LED A7-DS4 (Temperature Control Mode) is off. Then increase the Variable Temperature dial until A7-DS4 just lights. The temperature on the System Meter should be 1175 ± 20 ° with K34 Temp selected on the Range switch.

7. Set the CIT switch to +130 ° and increase the Variable Temperature potentiometer until LED A7-DS4 (Temperature Control Mode) just lights. Temperature should be 1372 ± 20 ° with K34 selected.

8. Set the Setup/Signal Generator switch to Setup/Signal Generator. Adjust the Level potentiometer to about 6000 Hz on the Turbine Frequency meter. LED A6-DS1 (Run) should be off. If LED A6-DS1 is lit, cycle the Setup/Signal Generator switch to Off, then back to Setup/Signal Generator. Turn the Variable Temperature potentiometer until LED A7-DS4 (Temperature Control Mode) just lights. Temperature should be 1586 ± 20 ° with K34 selected.

9. Set the Actuator switch to Closed Loop. Set the System Meter Select to Actuator Current Amps. Set the Setup/Signal Generator switch to Run and the Turbine Inlet Temp switch to 1000 °. Adjust the Load potentiometer counterclockwise. Turn the Load switch to On and adjust the Load potentiometer so that the Actuator current is 70 mA on the System Meter. Turn the Load switch Off then back On. The Temperature Control Mode LED A7-DS4 should momentarily turn on, as the Load is switched On. Failure to light indicates the temperature dynamics are incorrect.

10. Set the Load switch to Off.

Fuel Limiter Module A6 A9900-413

1. Set the Setup/Signal Generator switch to Off. LED A6-DS1 (Run) should be off. Set the Load switch to Off.

2. Set the CIT switch to 59 °, select Range K17 Temp, and set the Turbine Inlet Temp switch to 1000 °. The voltage at A8-TP6 (Control Voltage) should be 0.80 ± 0.05 Vdc.

3. Set the Signal Generator switch to Run. Use the Reset To 60 Hz switch to adjust the Turbine Frequency to 9560 ± 10 Hz. LED A6-DS1 (Run) should light.

4. Hold the Start switch up to drive the actuator to minimum. The voltage at A8-TP6 (Control Voltage) should be less than 0.05 Vdc. Release the Start switch.

5. Set the Setup/Signal Generator switch to Setup/Signal Generator and adjust the Level potentiometer for a Turbine Frequency just above 8700 Hz. Turn the 400 Control Power switch Off and back On. Slowly decrease the Turbine Frequency until LED A6-DS1 just goes out. The Turbine Frequency should be 5753 ± 100 Hz.

6. Verify the fuel schedules by measuring the voltage at A6-TP4 (Fuel Limiter Voltage) under the following conditions:

   a. Set the Temp Range switch to K34 Temp.

b. Set the Setup/Signal Generator switch to Off, Turbine inlet temp to 1000 °, and CIT to 59 °. The voltage at A6-TP4 should be 0.70 ± 0.03 Vdc.

c. Set the Turbine Inlet Temp to –40 °. A6-TP4 should have 1.20 ± 0.06 Vdc.

d. Set the Setup/Signal Generator switch to Setup/Signal Generator and adjust the Level dial for 7000 Hz Turbine Frequency. The voltage at A6-TP4 should be 3.07 ± 0.06 Vdc.

e. Set the CIT switch to –40 °. The voltage at A6-TP4 should be 3.76 ± 0.07 Vdc.

f. Set the CIT switch to +130 °. The voltage at A6-TP4 should be 2.94 ± 0.06 Vdc.

g. Set the CIT switch to +59 ° and the Inlet Turbine Temp to 1000 °. Adjust the Level pot for a Turbine Speed of 5800 Hz. The voltage at A6-TP4 should be 2.30 ± 0.04 Vdc.

h. Adjust the Level potentiometer for a Turbine Frequency of 7000 Hz. The voltage at A6-TP4 should be 2.72 ± 0.2 Vdc.

i. Adjust the Level potentiometer for a Turbine Frequency of 8700 Hz. The voltage at A6-TP4 should be 4.20 ± 0.2 Vdc.

j. Adjust the Level potentiometer for a Turbine Frequency of 9000 Hz. The voltage at A6-TP4 should be 4.77 ± 0.2 Vdc.

Final Procedure

1. Turn off the 400 Control Power switch and the Test Unit Power switch. Remove the jumper from A5-TP1 and A5-TP2 on the 400 control.

2. Remove the test cable and test unit from 400 control.

3. Put the cover back on the control.

Chapter 4.
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

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used In Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used In Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

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 55037C.

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Email and Website—www.woodward.com

**Woodward has company-owned plants, subsidiaries, and branches,
as well as authorized distributors and other authorized service and sales facilities throughout the world.**

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

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