WOODWARD

Product Manual 55011
(Revision J, 05/2019)
Original Instructions

Portable Speed Loop Tester with Load Sensor

8909-555 for 2301/2301A/EGM

Installation and Operation Manual

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:

www.woodward.com/publications

The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

Proper Use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

Translated Publications

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

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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

Manual 55011

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Important Definitions

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

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

⚠WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE

Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

IMPORTANT

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

Chapter 1.
General Information

Introduction

The Woodward 8909-555 portable speed loop tester (suitcase tester) provides a convenient engine-and-actuator simulator needed to test and adjust 2301, 2301A, and EGM Woodward governors.

The tester provides both static and closed loop speed tests as well as test facilities for Load Sensor portions of the 2301 systems.

The tester can adequately test most functions of the governor system as well as many system accessories. It will not provide final adjustment of gain and stability, since these must be matched exactly to the engine to be controlled.

Tester Functions

The tester provides the following specific functions to check out a 2301, 2301A, or EGM governor system:

- Simulates proportional or integrating actuators.
- Produces an MPU (magnetic pickup) signal to a governor under test.
- Simulates engine load to increase required actuator voltage or upset the null voltage.
- Provides three different rates of simulated engine response.
- Accommodates testing of direct- and reverse-acting 2301 controls.
- Simulates potential transformer (PT) and current transformer (CT) to test Load Sensor capabilities.
- Provides bias voltage power supply to simulate paralleling, synchronizing, and biasing inputs to the control under test.
- Has a speaker to simulate engine noise.
- Has a start function to overcome an activated failsafe circuit in the control under test.
- Has an actuator voltage meter to measure the voltage across the 35 Ω resistor used to simulate an actuator.
- Provides a signal generator mode of operation to allow the checking of switch points or control set points.
- Has a digital frequency meter for the exact setting of speed or closed-loop operating frequency.
- Has a 24 Vdc power supply to power the control under test.

Principles of Operation

The suitcase tester (Figure 1-1) has been created to provide a convenient way to certify operation of 2301, 2301A, and EGM controls prior to placing them on an engine. The tester also provides a means of presetting the gain and stability settings on the controls, although final adjustment must be made on the engine. Four potentiometers are mounted on the test plate to allow the operator to provide critical simulated voltages or resistances to the control under test. A digital meter provides a frequency readout of the simulated MPU reading.

Special testing equipment included in the kit is an engine start schedule and a response ramp which provides a realistic simulation of an engine in the acceleration mode.

Convenient switches allow the operator to use the tester on either direct- or reverse-acting controls. An actuator Response Amplifier can be switched to test either the proportional 2301 system or the integrating EGM systems.

The 2301/2301A switch permits changing the PT functions in the tester to fit either a 2301 or a 2301A governor.

Block Diagram

The block diagram (Figure 1-2) offers a concise picture of the tester operation. Starting with the actuator input from the control, the tester adds an adjustable level or null signal, then further modifies the signal in the load adjust and engine response areas before sending an adjusted MPU signal back to the control being tested. Meters provide readings of the actuator operation signal from the control and of the digital frequency being sent to the control.

Separate portions of the block diagram indicate the adjustable bias voltage source and the two special switch signals provided by the tester.

Another area of the block diagram shows the input and power-supply signals as well at the load sensor transformer which allows testing the load sensing circuits in a control.

Actuator Input Amplifier

The input amplifier receives the 0 to 160 mA signal from the 2301/2301A control, or the ± voltage signal from the EGM control, and converts it into a voltage usable throughout the tester. The tester uses a 35 Ω resistor to simulate the actuator coil, and a 0 to 10 Vdc meter to monitor the voltage across this resistor. The 35 Ω resistance may not exactly match the resistance of the actuator used, in which case the tester will provide an adequate assurance that the control will operate, but will not allow absolute final adjustment of the control in advance of engine control.

The Actuator Meter ± switch is used to test the output driver of an EGM control. Again, the 35 Ω resistance may not exactly match the actual control loop.

Actuator Response Amplifier

The LEVEL/NULL potentiometer (10-turn) on the front panel adds a signal to the actuator voltage received by the tester. In the 2301/2301A modes, the potentiometer sets the amount of actuator voltage needed to cause the tester to output an MPU signal. In the EGM mode, the null voltage is set with the potentiometer. The 2301/EGM switch changes the tester response to proportional in the 2301 location and integrating in the EGM location.

The 2301/2301A switch selects the tester function when the 2301/EGM switch is set in the 2301 position. The EGM position provides EGM functions when the other switch is in either position.

The response of the amplifier in either mode is about 100 ms (0.1 seconds).

Direct- or Reverse-Acting

Moving the REV/NORM switch to the NORM position causes the tester to react to an actuator signal which varies from a low mA position for a minimum-fuel supply to a maximum signal for a maximum-fuel supply. A reverse-acting actuator requires a maximum signal for minimum-fuel position and a minimum signal for a maximum-fuel position. When the switch is in the REV position, the tester reacts to this type of reverse-acting signal. The 2301, 2301A, and EGM controls can be reverse acting. Reverse-acting controls are used in systems which go to maximum fuel should the electrical control fail. Direct-acting systems go to minimum fuel should the electrical system fail.

Engine Start Amplifier

The START switch adds a positive signal to the input signal for as long as it is held in the START position. This allows controls with a failsafe feature to start operation. After the start period, the signal is removed from the system, allowing normal closed-loop operation of the control.

Engine Load

A simulated load is provided through a combination of the LOAD ADJUST potentiometer (10-turn) and the LOAD ON/OFF switch. The potentiometer adjusts the amount of load which is simulated. The ON/OFF switch permits adding or subtracting the simulated load instantly to or from the control loop, testing the control's ability to be stable and to react to load swings.

The LOAD ADJ potentiometer produces a voltage that reduces the amount of actuator signal that the tester uses to set the MPU signal generator.

Engine Response Amplifier

The ACCELERATION switch slows the response of the tester to a change in actuator signal from the control. In the upper position, the response is slowed at 30 percent per second. At the lower position, the response is slowed at 50 percent per second. In the center position, the switch sets fast speed response to a change in actuator signal. The response rates will not exactly equal the response of any given engine, so the gain and stability settings on the control will have to be set to the exact positions after the engine is running.

Range Adjustment

The RANGE potentiometer (10-turn) is used to set the tester for the maximum MPU frequency desired. The MPU frequency is displayed on the digital frequency meter and is scaled in Hertz. The range adjustment is set with the control running in closed loop.

Speaker

A small speaker in the tester provides an audible translation of the frequency of the MPU simulation. The audible signal allows tuning the control “by ear”. This is particularly valuable when establishing stability and response settings on the control. The speaker may be turned off, if desired.

Power Supply to the Control Under Test

The 35 V terminal strip outputs are used to power the control under test when its requirements do not exceed a maximum of 1 A. If the output terminals are shorted, the circuit breaker will trip, but will not cause permanent damage to the power supply. Power is not provided for EGM controls which require 117 Vac or 48 Vdc. All portions of the tester are electronically protected by a circuit breaker (Figure 1-1). After correcting the cause of the trip, reset the circuit breaker by pushing it in.

Switches SW1 and SW2

These miscellaneous function switches can be wired to the control under test to simulate requirements such as input from shutdowns, overcurrent warnings, or other discrete inputs to the control being tested.

Load Sensor Test Sequence

Current transformer currents are selected, one phase at a time, by the L.S.T. rotary switch. The number 1 position on the switch is off, with the other three positions establishing a comparable phase in the current portions of the control. The CT current is 5 A, but in some conditions this may vary slightly. To all tester voltages to be transmitted to the control without change, use 1 mm² (18 AWG) wire and keep the lead from the test to the control under 600 mm (2 ft) in length.

Only one leg may be tested at a time because of the limited voltage input to the tester. If all three legs test correctly, the system should be compatible when connected to a three-phase system.

WARNING

HIGH VOLTAGE—The PT terminals can contain lethal voltages. When the DANGEROUS VOLTAGES indicator is on, voltages of up to 220 Vac are present at the PT output terminals. PT voltages are "ON" in L.S.T. positions 2 through 4 and "OFF" in position 1.

Bias Voltage Supply

The ±5 Vdc supply is available through the pin jacks on the front panel of the tester. When the BIAS VOLTS potentiometer's adjust-counting dial is on 5, the output is zero volts. For a positive voltage, turn the dial clockwise. The setting of 10 equals +5 volts. For a negative voltage, turn the dial counterclockwise from 5. The setting of 0 equals –5 volts. The BIAS VOLTAGE pot is connected only to the banana plug and does not affect tester operation.

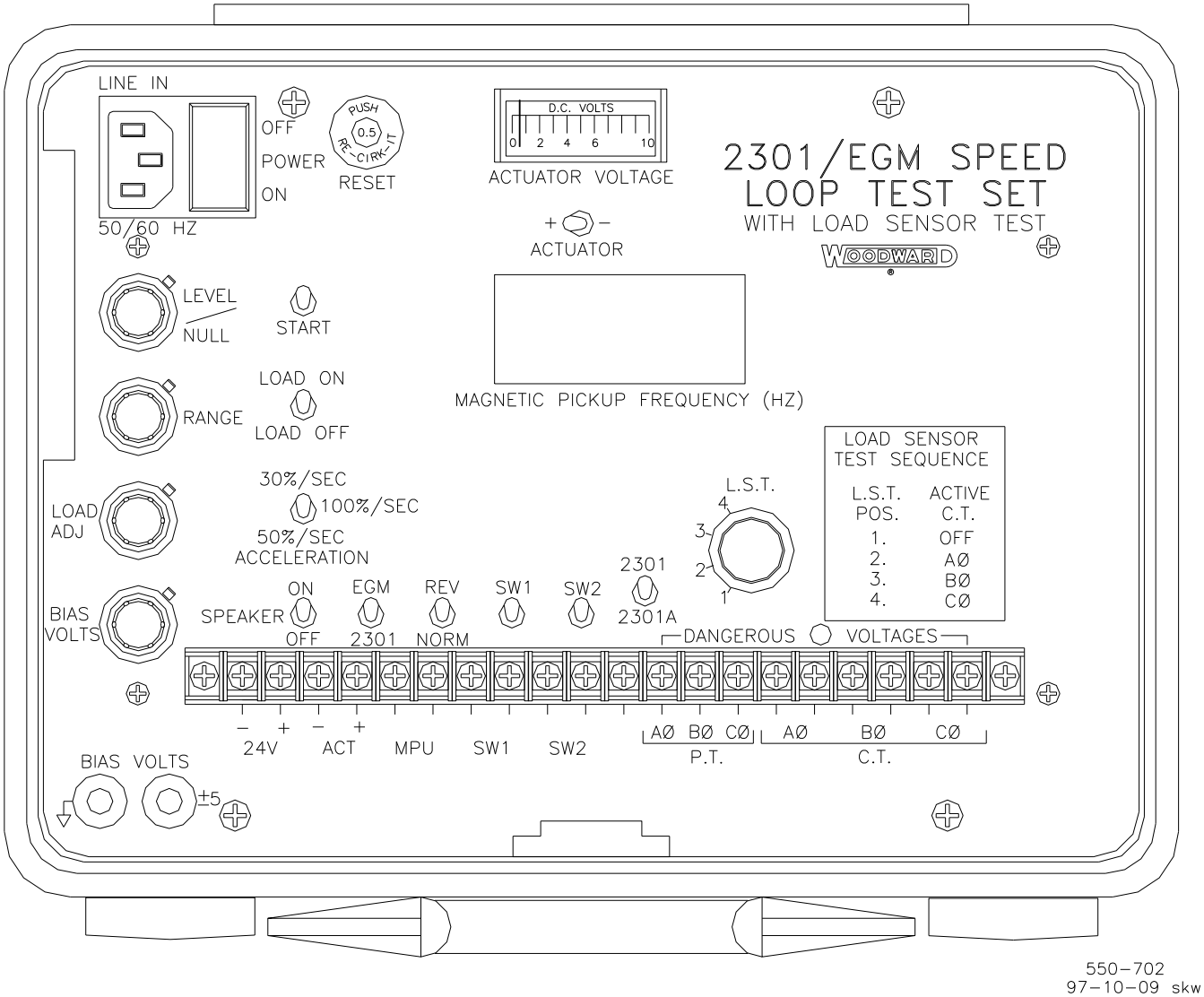

Figure 1-1. Suitcase Tester Control Panel

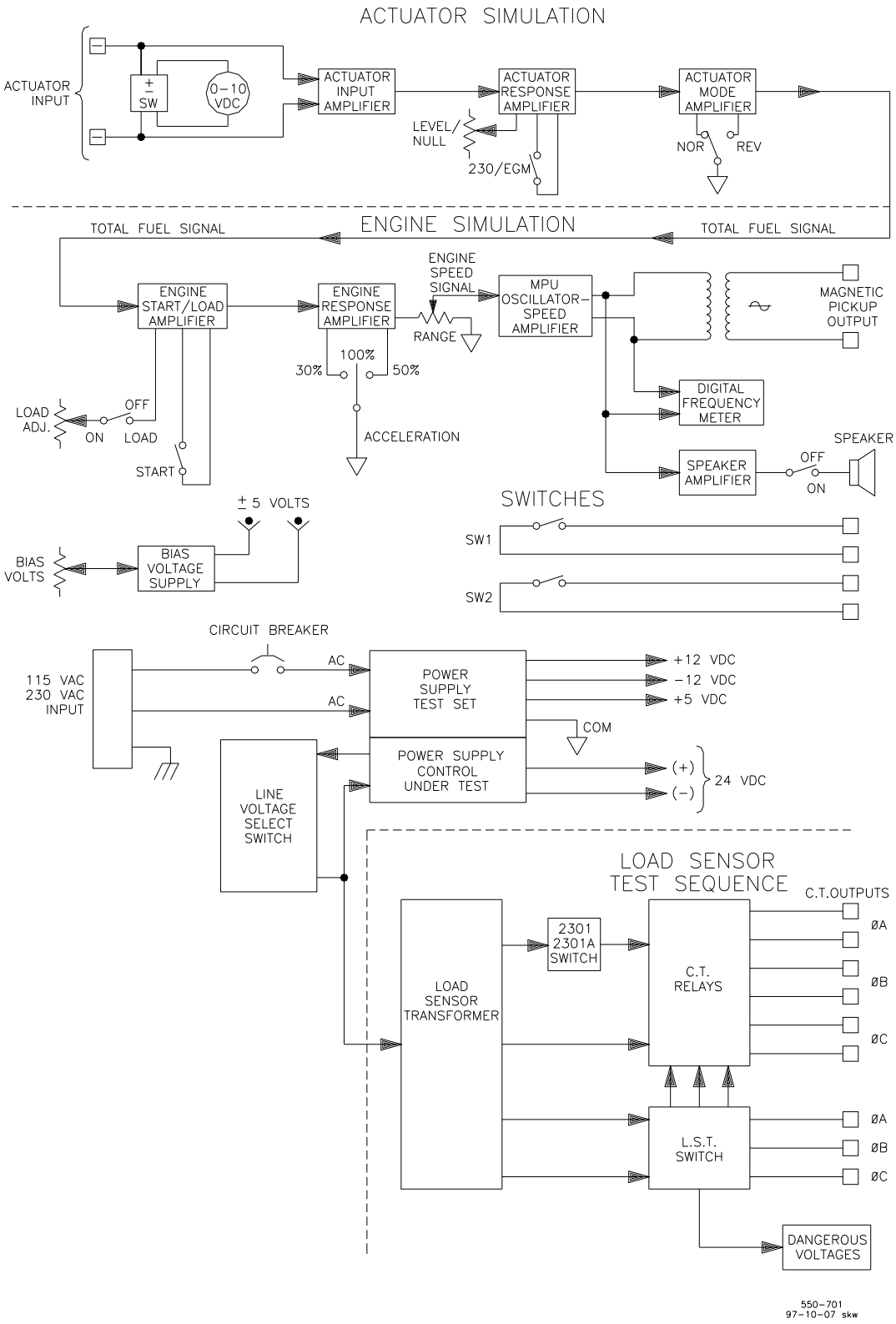

Figure 1-2. Suitcase Tester Block Diagram

Chapter 2.
Operating Procedures

Introduction

The following procedure is written to help you obtain the most use from your Portable Speed Loop Tester. It covers the setup procedures for testing 2301/2301A Speed Loop controls, EGM controls, open loop testing of EG and 2301 Load Sensing systems, and signal generator mode. This procedure is written with the assumption that the control under test is in working condition.

Setup Procedures for 2301 and 2301A Controls

(Direct Acting Type)

See the appendixes for step-by-step procedures for the most common 2301A and 2301 models.

1. Before connecting the control under test to the tester, make the following settings:
   - LEVEL/NULL to dial setting 5.5
   - LOAD ADJ to 0
   - LOAD ON/LOAD OFF switch to LOAD OFF
   - ACTUATOR meter switch to (+)
   - REV/NORM switch to NORM
   - EGM/2301 switch to 2301
   - L.S.T. switch to position 1
   - 2301/2301A to the position to match your actuator

2. Place the POWER switch in the ON position, and hold the START switch down for 5 seconds.

3. Hold the START switch in the down position, and use the RANGE adjust to set the MPU frequency for 10 percent over rated speed. Maximum rated speed is determined from the specifications of the control under test.

4. Set the ACCELERATION switch for one of the three rates. The acceleration is the percent-per-second change of maximum MPU frequency with a change of actuator input voltage from minimum to maximum in one step. Select the setting which most nearly matches the engine which the control will operate.

5. Place the POWER switch in the OFF position.

6. Connect the control under test to the terminal strip of the tester. Use the plant wiring diagram for the specific control under test. (See note for Reverse Actuator setting.)

IMPORTANT

If the control under test is designed to operate with a reverse-acting actuator, place the REV/NORM switch in the REV position at step 6. In step 8 of the procedure, adjust the LEVEL/NULL for 5.6 volts on the ACTUATOR VOLTAGE meter. In step 9, set the LOAD ADJ for 2 Vdc on the ACTUATOR VOLTAGE meter.

7. Place the POWER switch in the ON position. If the control under test has an active failsafe circuit, hold down the START switch for about 5 seconds.

8. When the control under test is controlling the speed of the tester, adjust the LEVEL/NULL for about 2 Vdc on the ACTUATOR meter.

9. Place the LOAD ON/LOAD OFF switch in the LOAD ON position and set the LOAD ADJ for about 5 Vdc on the ACTUATOR meter.

10. Adjust the control under test for the best stability and response of the system. The response is observed by watching the ACTUATOR VOLTAGE meter and by turning the SPEAKER switch to the ON position.

Setup Procedure for EGM Controls

1. Before connecting the control under test to the tester, make the following settings:
   - LEVEL/NULL to dial setting 1
   - LOAD ADJ to 0
   - LOAD ON/LOAD OFF switch to LOAD OFF
   - ACTUATOR meter switch to (–)
   - REV/NORM switch to NORM
   - EGM/2301 switch to 2301 (*you will change this to EGM in step 7*)
   - L.S.T. switch to position 1

2. Place the POWER switch in the ON position, and hold the START switch down for 5 seconds.

3. Hold the START switch in the down position, and use the RANGE adjust to set the MPU frequency for 10 percent over rated speed.

4. Set the ACCELERATION switch for one of the three rates.

5. Place the POWER switch in the OFF position.

6. Connect the control under test to the terminal strip of the tester. Use the plant wiring diagram for the specific control under test.

7. Place the EGM/2301 switch in the EGM position.

8. Turn on the power to the EGM control. Most EGM controls require either 115 Vac or 48 Vdc input power. A separate power source is necessary.

9. Place the POWER switch in the ON position. If the control under test has a failsafe circuit activated, the ACTUATOR VOLTAGE meter will read about –8 volts.

10. To start the tester in the EGM mode, reset the EGM failsafe.

11. Set the desired null voltage with the LEVEL/NULL adjust.

12. Place the LOAD ADJ to dial setting 2. Place the LOAD ON/LOAD OFF switch in the LOAD ON position. The actuator voltage will increase and then return to its original value. Place the LOAD ON/LOAD OFF switch in the LOAD OFF position. The actuator voltage will decrease and again return to its original value. Continue this while increasing the LOAD ADJ to obtain the maximum load setting.

13. Adjust the control under test for the best stability and response of the system. The response is observed by watching the ACTUATOR VOLTAGE meter and by listening to the speaker (SPEAKER switch ON).

Load Sensor Test Sequence

1. Place the POWER switch in the OFF position and the L.S.T. switch in position 1.

2. Connect the load sensor section of the control under test to the PT and CT terminals. The wires used for the CT connections should be 1 mm² (18 AWG) or larger.

3. Place the L.S.T. switch in positions 2, 3, and 4. The tester will output the proper sequence of line-to-line voltages and currents to test the control under test one phase at a time. The test sequence is listed below:

L.S.T. Position	Active CT
1	OFF
2	A phase
3	B phase
4	C phase

4. P.T. voltages are on in L.S.T. switch positions 2, 3, and 4. The P.T. voltages are off in position 1. All phases can carry 115 or 230 Vac, with the amount set with the order from the factory.

⚠WARNING

HIGH VOLTAGE—When the DANGEROUS VOLTAGES indicator is on, potentially lethal voltages are present on the PT and CT terminals. When the Load Sensor Test is not in use, return the L.S.T. switch to position 1. Make sure the DANGEROUS VOLTAGES indicator is off.

Signal Generator Mode

1. Place the POWER switch in the OFF position.

2. Disconnect the actuator + wire from the terminal strip. Make sure the loose wire does not come in contact with any other wires.

3. Place the REV/NORM switch in the REV position.

4. Place the POWER switch in the ON position.

5. Adjust the RANGE to set the desired frequency.

6. Measure the signal outputs at the MPU terminals.

Wire Harness

A wire harness with 1 mm²/18 AWG wire and spade connectors should be constructed for use with the tester. For convenience, the maximum wire length used in the harness should be about 60 cm/2 ft. A different color wire should be used throughout the harness, or at least the same colors should be used only at opposite ends of the tester terminal strip

Chapter 3.
Tester Performance Check

Required Instruments

Checking out the tester will require the following instruments to verify the operation of various parts of the tester and to provide verification that meters are providing consistent and correct results of governor readings.

DIGITAL VOLTMETER with RMS capability.
Fluke 8020 or equivalent

OSCILLOSCOPE with single wave capability.

CURRENT SOURCE 1 to 200 mA.
For calibration, must have known good dc current meter.

Performance Check

Initial Inspection

Open the suitcase and remove the power cord. Inspect the power cord, the tester box, and any other equipment for obvious damage. Listen for rattling as the suitcase is tipped end to end and side to side. Should there be any rattling, remove the test instrument from the suitcase by removing the four Phillips head screws located along the top and bottom of the front panel. The test box should not rattle.

Power Connection

Set the power supply switch inside the test box to either 115 or 230 Vac, as needed by the availability of electrical supply. Connect the power cord to the 50 or 60 Hz supply selected.

IMPORTANT **Newer testers do not have this switch. These units detect input voltage and adjust automatically.**

Test Box Setup

Initial Adjustment

Preset the tester as follows:

LEVEL/NULL	5.5
RANGE	10.0
LOAD ADJ	0.0
BIAS VOLTS	0.0
ACTUATOR	+
LOAD ON/LOAD OFF	OFF
ACCELERATION	100%/SEC
SPEAKER	OFF
EGM/2301	2301
REV/NORM	NORM

SW1	DOWN
SW2	DOWN
2301/2301A	2301
L.S.T.	1

Test Box Setup Procedure

1. Turn on the power. The frequency counter should read less than 5 Hz after 5 seconds.

2. Measure the voltage from 24 V (–) to 24 V (+). It should read 24 Vdc ± 2.4 Vdc.

3. Measure the resistances for SW1 and SW2 on the terminal block as labeled. Resistances should read infinity. Put both switches in the up position and repeat the procedure. The readings should now be 0 ± 0.4 Ω.

4. Measure the actuator resistance between ACT (–) and ACT (+). It should read 35 ± 2 Ω.

5. Place a 250 Ω load across the BIAS VOLTS jacks, with the BIAS VOLTS potentiometer at 0.0. The voltage across the jacks should read –4.8 to –5.3 Vdc. With the BIAS VOLTS potentiometer at 10.0, the voltage should read 4.8 to 5.3 Vdc. Return the BIAS VOLTS potentiometer to location 5.0.

6. Place the REV/NORM switch to REV. The frequency will increase to a value greater than 18 kHz. Return the REV/NORM switch to NORM.

7. Turn the power off and connect a known good 2301 control with a rated speed of 4800 Hz to the tester.

8. Turn the power on.

9. Press the START switch, the frequency will increase and the control should take command of the tester. Adjust the control for stable operation at a rated speed of 4800 Hz. Connect an external voltmeter across the actuator (ACT) connections, adjust the LEVEL/NULL for 2 ± 0.1 Vdc. The panel meter on the tester must have the same reading as the external meter (2 ± 0.2 Vdc).

10. Put the ACTUATOR switch to (–). The panel meter should peg against the low end. Return the switch to the (+) position.

11. Turn the LOAD ON/LOAD OFF switch ON and increase the LOAD ADJ. The ACTUATOR VOLTAGE meter will show an increase in voltage. As the load is increased, the actuator voltage will reach a maximum value (more than 7 Vdc but less than 10 Vdc). As the load is increased further, the frequency will decrease and eventually go to zero (the engine will die). Return the LOAD ADJ to zero and restart the tester. Now adjust the load for 5 Vdc on the panel meter, and turn the LOAD ON/LOAD OFF switch OFF.

12. Turn the speaker on, there should be an audible sound. Turn the speaker off.

13. Measure the MPU voltage at the MPU terminals. It should be more than 2 Vrms.

14. a. With an ac voltmeter measure the line voltage at the ac power receptacle and record it on the data sheet. With the L.S.T. switch in position 1, check all the PT outputs for 0 V. For the remaining L.S.T. switch positions, measure the PT voltages and record them on the data sheet as follows:

L.S.T. Position	Active PT	Voltage
1	none	none
2	A phase to B phase	110 V
3	B phase to C phase	110 V
4	C phase to A phase	0 V

All voltages are ±10 percent

b. With the L.S.T. switch in position 1, check all CT positions for 0 V. For the remaining L.S.T. positions, measure the CT voltages at the control according to the following:

L.S.T. Position	Active CT	Voltage
1	none	none
2	A phase	1.25 Vac
3	B phase	1.25 Vac
4	C phase	1.25 Vac

c. Verify that the DANGEROUS VOLTAGES indicator is on when the L.S.T. switch is in positions 2 through 4, and off in position 1.

d. With a control connected to the tester, put the L.S.T. switch in position 2. Adjust the control's LOAD GAIN VOLTAGE at the test point for 2.00 ± 0.1 Vdc. Positions 3 and 4 should read 2.00 ± 0.2 Vdc at the test points.

15. Move the LINE VOLTAGE SELECT switch to the 220 V position and put the L.S.T. switch In position 2. Measure the A Phase to B Phase PT voltage. It should be 1/2 the line voltage reading taken in step 14a. Return the L.S.T. to position 1. Return the LINE VOLTAGE SELECT switch to 115 V.

16. Turn off the power to the tester and remove the 2301 control. Attach an EGM control. Put the EGM/2301 switch in the EGM position.

Function	Connection on EGM Terminal Board
External Power Supply	Number 1 (+) Number 2 (–)
Actuator	Number 4 (–) Number 5 (+)
200 Ω Speed Potentiometer	Number 6 (wiper) Number 7 (ccw) Number 8 (cw)
Magnetic Pickup	Number 9 Number 10

17. Provide the power supply required by the particular EGM control (either 42 Vdc or 115 Vac). Turn on the control and set the ACTUATOR VOLTAGE meter for 2 Vdc with the tester LEVEL/NULL potentiometer. Turn the tester RANGE potentiometer in either direction and verify the speed changes while the ACTUATOR VOLTAGE meter stays at 2 Vdc. (This presumes the EGM control attached to the tester is in good running condition.) Set the speed to read 4800 Hz.

18. Put the ACTUATOR switch to (–) and adjust the LEVEL/NULL until the ACTUATOR VOLTAGE meter reads –2 Vdc. Adjust the tester RANGE potentiometer in either direction and observe that the speed changes while the actuator voltage stays at –2 Vdc. The speed should read 5200 Hz.

19. Turn the power off and remove the EGM from the tester. Return the EGM/2301 switch to 2301. Put the ACCELERATION switch in the center 100%/SEC position. Turn the power on to the tester. Select REV position on the REV/NORM switch and let the frequency rise. Adjust the range control for 5000 Hz. Connect an oscilloscope to the MPU output terminals and adjust for a single cycle across the screen. Move the tester REV/NORM switch to NORM and allow the frequency to drop to 0 Hz. Use a stop watch to measure the time it takes for the frequency to go from 0 to 5000 Hz when switching from NORM to REV. The elapsed time should be 1 ± 0.2 second.

    With the ACCELERATION switch at 50%/SEC, the elapsed time from 0 to 5000 Hz should be 2 ± 0.6 second.

    With the ACCELERATION switch at 30%/SEC, the elapsed time from 0 to 5000 Hz should be 3 ± 0.8 second.

Chapter 4.
Troubleshooting

Introduction

Most problems encountered when using the tester involve improper wiring of the tester to the control being tested. Always check the complete wiring between the two units before making any changes in the control or in the tester.

Problem Solving Hints

The following information is provided to aid in finding the solution to most simple problems involving the tester. There are no adjustments inside the tester as it is mounted in the suitcase. Should the tester malfunction, it must be returned to the factory for repair.

No Display

1. Possible loose power cord.
2. Possible tripped circuit breaker (push to reset; see Figure 1-1).

Governor Will Not Control

1. Possible incorrect connection between the governor and tester.
2. One or more switches incorrectly set.
3. Possible incorrect tester setup.
4. Possible governor defect. Confirm by checking a second governor, if practical.

Test Signal Fails

If any of the following signals or voltages is missing or is low, first carefully check the cable continuity. If the cables check out, send the tester to the factory for repair.

1. 24 Vdc at governor.
2. CT voltage at the A terminal on the tester.
3. Voltage reading at the MPU terminals on the tester.

PTs Are Low or Show 0 Voltage

Possible mis-setting of the LINE VOLTAGE SELECT switch.

CTs Are Low or Show 0 Voltage

Possible mis-setting of the 2301/2301A switch.

Counter Does Not Read Correctly

No adjustments, send to the factory for repair.

Chapter 5.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/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 at **www.woodward.com/directory**, which also contains the most current product support and contact information.

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

Products Used in Electrical Power Systems

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 (124) 4399500
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 (124) 4399500
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 (124) 4399500
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

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.

Appendixes. Functional Test Procedures for 2301 and 2301A Controls

Controls Listed

Appendix 1.
Functional Test for 2301
Model 8270-973

(Refer to Woodward manuals 82567 and 55012)

1. Remove all connections to the control.

2. Inspect the wiring, terminal blocks, and chassis for damage.

3. Set the multimeter to the highest resistance scale and measure between each terminal and the chassis. Each should read an open circuit.

4. Set the multimeter to the lowest resistance scale and measure between terminals 4 and 5, 6 and 7, and 8 and 9. Each measurement should read no greater than 0.60 Ω. This checks the burden resistors.

5. Measure between terminals 18 and 19. It should read approximately 220 Ω. This checks the primary winding of the magnetic pickup isolation transformer.

6. Connect jumpers between terminals 14 and 15, 20 and 21, 26 and 27, 29 and 30. Set the GAIN and RESET adjustments to the middle of their travel.

7. With the tester POWER switch In the OFF position, connect terminals 1 through 9, 16 and 17, 18 and 19 to the tester. Check that proper polarity is observed when connecting the actuator wires, and that the L.S.T. switch is at position 1. Set the LEVEL/NULL dial to 2. Set the LOAD ON/LOAD OFF switch OFF. While holding the START switch down, set RANGE for 10% over rated speed, or simply turn full clockwise. Select engine ACCELERATION at 30%/SEC, 50%/SEC, or 100%/SEC. (If unknown, set for 100%.) Turn POWER off. Select 2301 on the EGM/2301 switch, select 2301 on the 2301/2301A switch, select NORM on the REV/NORM switch.

8. Apply a 24 Vdc power supply to terminals 12(+) and 13(-) on the 2301 panel. (This must have at least 1 A capability from the supply. Do not use the suitcase simulator 24 Vdc supply.)

9. Press the START switch for 1 to 2 seconds, then release. If the control starts the tester properly, adjust the RATED SPEED on the control for 3600 Hz speed readout.

10. With the LOAD ON/LOAD OFF switch ON, turn the tester LOAD ADJ clockwise until a continuous decrease in speed is noted (overload condition). The ACTUATOR VOLTAGE meter should now be at least 6.5 Vdc. Return the LOAD ADJ counterclockwise until the ACTUATOR VOLTAGE meter is 5 Vdc. (You may have to press the START switch to re-start the tester.)

11. Check that the speed returns to the same setting within 2 Hz whether the LOAD ON/LOAD OFF switch is ON or OFF.

12. Set the multimeter for DC (10 V scale) and plug it into the 2301 LOAD SENSOR test jacks on the control. Turn the L.S.T. switch to position 2 and turn the LOAD GAIN adjustment from one end of its travel to the other. The meter reading should vary smoothly from about 0 V at the counterclockwise end, to 2–5 V at the clockwise end. Repeat for positions 3 and 4. The voltage at the test jack should be the same for switch positions 2, 3, and 4. Return the switch to position 2. Set LOAD GAIN to the full clockwise position.

13. Turn the DE-DROOP adjustment from one end to the other, and the speed should vary. Set the DE-DROOP adjustment so that turning the L.S.T. switch from position 1 to position 2 causes no speed change. Leave the switch at position 2.

14. Turn the DROOP adjustment fully clockwise, remove the jumper between terminals 26 and 27, and place the jumper on terminals 27 and 28. Also add a jumper from terminals 10 to 11. The speed should decrease. Turn the DROOP fully counterclockwise and the speed should increase. Remove the jumper from 27 to 28 and place on 26 and 27. Remove the jumper from 10 to 11. Turn the L.S.T. switch to position 1.

15. Turn the SPEED adjustment slowly from one end of its travel to the other. Adjust GAIN and RESET as necessary for stable operation at all speeds, but no erratic actuator voltage changes should occur. Return the rated speed to 3600. (This verifies that the ten-turn SPEED pot is OK.)

16. Remove the jumper between terminals 14 and 15. The speed should decrease. Turn the LOW SPEED SETTING adjustment from one end to the other and the speed should vary over a wide range. Leave the LOW SPEED SETTING at the middle of its travel. The tester may have to be restarted. Set LOW SPEED SETTING to the desired idle frequency.

17. Turn the ACCELERATE adjustment fully clockwise. Reconnect the jumper between terminals 14 and 15. The speed should increase to 3600 in 3 to 5 seconds. Disconnect the jumper and turn the ACCELERATE fully counterclockwise. Reconnect the jumper and speed should increase to 3600 in about 10–12 seconds. Set to the desired ramp rate.

18. Disconnect one of the magnetic pickup leads from the control, and the actuator voltage should immediately drop to zero. Disconnect the jumper between terminals 29 and 30, and the actuator voltage should go to maximum. Replace the jumper first and then the pickup lead and restart the tester.

19. Short across terminals 22 and 23. The actuator voltage should go to zero.

20. Set SPEED ADJ to the desired speed for the unit.

Appendix 2.
Functional Test for 2301
Model 8271-444

(Refer to Woodward manuals 82407 and 55012)

1. Remove all connections to the control.

2. Check that the appropriate jumper is installed on the back of the printed circuit board. This test will assume the jumper is on position 3 for this procedure and steps 9 and 17 (reference manual 82407).

3. Inspect the chassis, terminal block, and printed circuit board for damage.

4. Set the multimeter to the highest resistance scale and measure between each terminal and the chassis. Each should read an open circuit.

5. Set the multimeter to the lowest resistance scale and measure between terminals 4 and 5, 6 and 7, and 8 and 9. Each measurement should read no greater than 0.30 Ω. This checks the burden resistors.

6. Measure between terminals 18 and 19. It should read approximately 220 Ω. This checks the primary winding of the magnetic pickup isolation transformer.

7. Connect jumpers between terminals 14 and 15, 20 and 21, 26 and 27, 29 and 30. Set the GAIN and STABILITY adjustments to the middle of their travel.

8. With the tester POWER switch in the OFF position, connect terminals 1 through 9, 12 and 13, 16 and 17, 18, and 19 to the tester. Check that proper polarity is observed when connecting the 24 V, actuator wires, and that the L.S.T. switch is at position 1, REV/NORM switch is to REV, EGM/2301 switch is to 2301.

9. Turn the POWER switch on. Check terminals 12 (+) and 13 (–) for 24Vdc. Check for 10 ± 1 Vdc on terminals 28 (+) and 30 (–), and 21 ± 2 Vdc on terminals 28 (+) and 13 (–). Press the START switch for 1 to 2 seconds, then release. If the control starts the tester properly, adjust the RATED SPEED on the control for 3600 Hz speed readout.

10. Set Null Adjust so the ACTUATOR VOLTAGE meter reads 6 to 6.5 Vdc. Adjust Gain and Stability as needed.

11. With the LOAD ON/LOAD OFF switch ON, turn the LOAD ADJ on the tester slowly clockwise until a continuous decrease in speed is noted (overload condition). The ACTUATOR VOLTAGE meter should now be 0.0 Vdc. Return the LOAD ADJ counterclockwise until the ACTUATOR VOLTAGE meter is 2 Vdc. (Your may have to press the START switch to restart the tester, and then set the actuator voltage to 2 V by adjusting the LOAD ADJ) (If the unit is unstable with load, again adjust GAIN and STABILITY.)

12. Check that the speed returns to the same setting within 2 Hz whether the LOAD ON/LOAD OFF switch is ON or OFF.

13. Turn the LOAD ON/LOAD OFF switch OFF, as it will not be used beyond this step.

14. Set the multimeter for DC (10V scale) and plug it into the LOAD SIG jacks on the control. Turn the L.S.T. switch to position 2, and turn the LOAD GAIN adjustment from one end of its travel to the other. The meter reading should vary smoothly from 0.0 Vdc at the counterclockwise end to its maximum reading of 2–4 Vdc. Repeat for positions 3 and 4. The LOAD SIG voltages for position 3 and 4 should be about the same as position 2. Return the switch to position 2. Set LOAD GAIN to the full clockwise position.

15. Turn the DE-DROOP adjustment from one end to the other, and the speed should vary. Set the DE-DROOP adjustment so that turning the L.S.T. switch from position 1 to position 2 causes no speed change. Leave the switch at position 2.

16. Turn the DROOP adjustment fully clockwise, and remove the jumper between terminals 26 and 27. The speed should decrease. Turn the DROOP fully counterclockwise, and the speed should increase to 3600. Reconnect the jumper and turn the L.S.T. switch to position 1.

17. Turn the RATED SPEED adjustment slowly from one end of its travel to the other. Adjust GAIN and STABILITY as necessary for stable operation at all speeds, but no erratic actuator voltage changes should occur. Return the rated speed to 3600. (This verifies that the ten-turn RATED SPEED pot is OK.)

18. Remove the jumper between terminals 14 and 15. The speed should decrease. Turn the LOW IDLE SPEED adjustment from one end to the other, and the speed should vary over a wide range. (If the unit shuts down, return LOW IDLE to mid position and press START.) Leave the LOW IDLE SPEED at the middle of its travel or set LOW IDLE SPEED to the desired idle frequency.

19. Turn the RAMP TIME adjustment fully counterclockwise. Reconnect the jumper between terminals 14 and 15. The speed should increase to 3600 in 0 to 5 seconds. Disconnect the jumper and turn the RAMP TIME fully clockwise. Reconnect the jumper and the speed should increase to 3600 in about 10–12 seconds. Set to the desired ramp rate.

20. Recheck the LOW IDLE SPEED adjustment for desired idle frequency.

21. Disconnect one of the magnetic pickup leads from the control, and the actuator voltage should immediately go to maximum voltage and shut the unit down (do Not reconnect yet). Disconnect the jumper between terminals 29 and 30 and the actuator voltage should go to zero. Replace the jumper first and then the pickup lead and restart the tester.

22. Short across terminals 22 and 23. The actuator voltage should go to maximum. Remove the short, and restart the unit.

23. Set RATED SPEED ADJ to the desired speed for the unit.

Appendix 3.
Functional Test for 2301 Models 8271-308/-442/-467/-500/-652/-706

(Refer to Woodward manuals 82406, 82595, and 55012)

1. Remove all connections to the control.

2. Check that the appropriate jumper is installed on the back of the printed circuit board. This test will assume that the jumper is on position 3 for this procedure and steps 9 and 17 (reference manuals 82406 and 82595).

3. Inspect the chassis, terminal block, and printed circuit board for damage.

4. Set the multimeter to the highest resistance scale and measure between each terminal and the chassis. Each should read an open circuit.

5. Set the multimeter to the lowest resistance scale and measure between terminals 4 and 5, 6 and 7, and 8 and 9. Each measurement should read no greater than 0.30 Ω. This checks the burden resistors.

6. Measure between terminals 18 and 19. It should read approximately 200 Ω. This checks the primary winding of the magnetic pickup isolation transformer.

7. Connect jumpers between terminals 20 and 21, 26 and 27, 29 and 30. Set the GAIN and STABILITY adjustments to the middle of their travel.

   a) On the tester, set the LEVEL dial to "1"; LOAD switch off.

   b) Hold START down for about 5 seconds and set RANGE for 10% over rated speed, or simply turn full clockwise.

   c) Select engine ACCELERATION 30%/SEC, 50%/SEC, or 100%/SEC. (If unknown, set for 100%.)

   d) Turn POWER off.

   e) Select 2301 on the 2301/2301A switch, select 2301 on the EGM/2301 switch, select NORM on the REV/NORM switch.

8. With the tester POWER switch in the off position, connect terminals 1 through 9, 12 and 13, 14 and 15, SW1, 16 and 17, 18 and 19 to the tester. Check that proper polarity is observed when connecting the 24 Vdc actuator wires, and that the L.S.T. switch is at position 1.

9. Turn the POWER switch on. Check terminals 12 (+) and 13 (–) for 24 Vdc. Check for 10 ± 1 Vdc on terminals 28 (+) and 30 (–), and 21 ± 2 Vdc on terminals 28 (+) and 13 (–). Press the START switch for 1 to 2 seconds, then release. If the control starts the tester properly, adjust the RATED SPEED on the control for 3600 Hz speed readout, and continue to the next step. If not, turn RATED SPEED clockwise about 3 turns and press START for 1 to 2 seconds again. If still no results, turn LEVEL/NULL counterclockwise 1/2 turn and press START 1 to 2 seconds again. If the unit now starts properly, set RATED SPEED on the control for 3600 Hz speed readout, and continue to the next step. If not, replace the 2301 control.

   Set LEVEL/NULL so the actuator voltage reads 1.5 to 2 Vdc.

10. Adjust GAIN and STABILITY as needed.

11. With the LOAD switch on, turn the LOAD ADJ on the tester clockwise until a continuous decrease in speed is noted (overload condition). The ACTUATOR VOLTAGE meter should now read at least 6.5 Vdc. Return the LOAD ADJ counterclockwise until the ACTUATOR VOLTAGE meter reads 5 Vdc. (You may have to press the START switch to restart the tester.) If the unit is unstable with load, again adjust GAIN and STABILITY.

12. Check that the speed returns to the same setting within 2 Hz whether the LOAD ON/LOAD OFF switch is on or off.

13. Turn the LOAD ON/LOAD OFF switch OFF, as it will not be used beyond this step.

14. Set the multimeter for DC (10V scale) and plug it into the LOAD SIG jacks on the control. Turn the L.S.T. switch to position 2 and turn the LOAD GAIN adjustment from one end of its travel to the other. The meter reading should vary smoothly from about 1.5 Vdc for 8271-308, and 8271-500. It will be 0 V for 8271-442, 8271-467, 8271-452, and 8271-706 at the counterclockwise end. Repeat for positions 3 and 4. Return the switch to position 2. Set LOAD GAIN to the full clockwise position.

15. Turn the DE-DROOP adjustment from one end to the other and the speed should vary. Set the DE-DROOP adjustment so that turning the L.S.T. switch from position 1 to position 2 causes no speed change. Leave the switch at position 2.

16. Turn the DROOP adjustment fully clockwise and remove the jumper between terminals 26 and 27. The speed should decrease. Turn the DROOP fully counterclockwise, and the speed should increase to 3600. Reconnect the jumper and turn the L.S.T. switch to position 1.

17. Turn the RATED SPEED adjustment slowly from one end of its travel to the other. Adjust GAIN and STABILITY as necessary for stable operation at all speeds, but no erratic actuator voltage changes should occur. Return the rated speed to 3600. (This verifies that the ten-turn RATED SPEED pot is OK.)

18. Turn off (open) SW1. The speed should decrease. Turn the LOW IDLE SPEED adjustment from one end to the other, and the speed should vary over a wide range. Leave the LOW IDLE SPEED at the middle of its travel. The tester may have to be restarted. Set LOW IDLE SPEED to the desired idle frequency.

19. Turn the RAMP TIME adjustment fully counterclockwise. Turn on (close) SW1. The speed should increase to 3600 in 3 to 5 seconds. Turn off SW1 and turn the RAMP TIME fully clockwise. Turn on SW1, and the speed should increase to 3600 In about 10 to 12 seconds. Set to the desired ramp rate.

20. Recheck the LOW IDLE SPEED adjustment for desired idle frequency.

21. Disconnect one of the magnetic pickup leads from the control, and the actuator voltage should immediately drop to zero. (Do not reconnect yet). Disconnect the jumper between terminals 29 and 30, and the actuator voltage should go to maximum. Replace the jumper first and then the pickup lead, and restart the tester.

22. Short across terminals 22 and 23. The actuator voltage should go to zero.

23. Set the RATED SPEED adjustment to the desired speed for the unit.

24. Turn SW1 on (up).
    Turn the REV/NORM switch to NORM.
    Turn the EGM/2301 switch to 2301.
    Turn the ACTUATOR meter switch to (+).
    Apply 1.5 Vdc to the MPU terminals. Speed should increase. Apply 1.5 Vdc to the SW1 terminals. Speed should decrease.

25. With LOAD GAIN full clockwise, and a jumper on terminals 26 and 27, apply 1.5 Vdc to the SW2 terminals. Speed should increase.

Appendix 4.
Functional Test for 2301A Reverse-Acting Models 8270-290/-291/-293

IMPORTANT

Before testing, read manual 82312 on the 2301A control and this manual 55011. Shielding is not normally used during testing of a 2301A control. However, all shielding indicated in the plant wiring diagrams should be completed when a control is installed to control an engine.

Pre-Check of the 2301A Control

1. Remove all connections to the control.
2. Inspect the chassis, terminal block, and printed circuit board for damage.
3. Set the multimeter for the highest resistance scale and measure between each terminal and the chassis. Each should read an open circuit.
4. Set the multimeter to the lowest resistance scale and measure between terminals 4 and 5 (A>CT), 6 and 7 (B>CT), and 8 and 9 (C>CT). Each measurement should read as a short circuit. This checks the Load Sensor CT inputs.
5. Measure between terminals 28 and 29. This should read about 220 Ω. This checks the primary winding of the magnetic pickup isolation transformer.

Pre-Setup of 2301A Control

6. Terminal 16 provides power for the control contacts on terminals 14, 17, 18, and 19. Connect jumpers between terminal 16 and 14 (simulates CB Aux contact closer), 17 (removes minimum fuel condition), 18 (overrides failed speed signal failsafe), and 19 (imitates rated speed condition).

IMPORTANT

The "Override Faded Speed Signal" contacts (terminal 16 to 18) must always be closed for the reverse-acting 2301A control to function correctly. The permanent jumper must be replaced at the completion of the test.

7. Install a jumper between terminals 23 and 24 (sets speed trim at maximum).
8. Set the GAIN and RESET adjustments to the middle of their travel. Set the START FUEL LIMIT full clockwise to allow maximum fuel when starting.

Power Up of Tester and 2301A Control

9. The tester requires 115 Vac, 60 Hz supply. The tester provides the 24 Vdc power needed by the 2301A.
10. Connect power to both the tester and the control. Turn the power to the control OFF.

11. Make the following initial settings on the tester:
    Turn POWER to ON
    LEVEL/NULL dial at 2
    LOAD ON/LOAD OFF to OFF
    While holding the START switch down, set the RANGE for 10% over rated speed on the frequency readout. (Notice that the speed is set for Hz, not rpm.)
    Select engine ACCELERATION at 30%/SEC, 50%/SEC, or 100%/SEC. (If unknown, set at 100%/SEC.)
    REV/NORM to REV
    EGM/2301 to 2301
    2301/2301A to 2301A
    Now turn POWER to OFF.

Setup Wiring for 2301A

12. Make sure that the tester POWER switch is OFF.

13. Connect terminals 1 through 9 (Load Sensor wiring), 15 and 16 (Power Supply inputs), 20 and 21 (actuator outputs), 28 and 29 (speed signal input) to the tester. Check that proper polarity is observed when connecting the actuator wires to terminals 20 and 21.

14. Set the L.S.T. rotary switch at position 1.

Simulation Startup

15. Turn power to the 2301A control on. Turn the tester POWER switch to on. Turn the RATED speed pot to mid position. Press the tester START switch for 1 to 2 seconds, then release. If the control starts the tester properly, adjust RATED SPEED on the control for rated speed readout, and continue to step 16. If not, turn the tester LEVEL/NULL clockwise about 1.5 turns and press START for 1 to 2 seconds again. If still no results, turn LEVEL/NULL clockwise another 1.5 turns and press START 1 to 2 seconds again. If the unit now starts properly, set RATED SPEED on the control for rated speed readout, and continue to step 16. If the unit still does not start, it is a probable failure of the 2301A control.

Setup of Tester

16. Set the tester LEVEL/NULL so actuator voltage reads 4.5 to 5.0 Vdc.

17. Adjust 2301A GAIN and RESET as needed.

Speed Loop Loading

18. With the tester LOAD ON/LOAD OFF switch on, turn the LOAD ADJ on the tester clockwise until a continuous decrease in speed is noted (overload condition). The actuator voltage should now be no more than 0 Vdc. Return the LOAD ADJ counterclockwise until the actuator voltage is 1.5 to 2.0 Vdc. (You may have to press the START switch to re-start the tester.) (If the unit is unstable with load, again adjust the 2301A GAIN and RESET.)

19. Check that the speed returns to the same setting within 2 Hz whether the LOAD ON/LOAD OFF switch is on or off.

20. Turn the tester LOAD ON/LOAD OFF switch off, as it will not be used beyond this step.

Verification of Rated Speed Pot

21. Turn the 2301A RATED SPEED adjustment slowly from one end of its travel to the other. Adjust the 2301A GAIN and RESET as necessary for stable operation at all speeds, but no erratic actuator voltage changes should occur. Return the RATED SPEED pot to rated speed. (This verifies that the ten-turn RATED speed pot can control over the entire speed range.)

Control Part Number	Speed Range (Hz)	Rated (for this test)
8272-290	500–1500	1300
8272-291	1000–3000	2500
8272-292	2000–6000	5000
8272-293	4000–12 000	10 000

Verification of Idle Pot

Desired Idle setpoint can be adjusted.

22. Remove the jumper between terminals 16 and 19 (open for idle). The speed should decrease. Turn the 2301A LOW IDLE SPEED adjustment from one end to the other, and the speed should vary over a wide range. If the engine simulator in tester dies, leave the LOW IDLE SPEED at the middle of its travel (the test then needs to be restarted). Set LOW IDLE SPEED to the desired idle frequency.

Idle/Rate Ramp Time Checkout and Setup

23. Turn the 2301A RAMP TIME adjustment fully counterclockwise. Close terminal 16 to 19 (close for rated). The speed should increase to rated in 0 to 5 seconds. Open terminal 16 to 19 (open for idle) and turn RAMP TIME fully clockwise. Close terminal 16 to 19 (Close for Rated), and the speed should increase to rated in about 8 to 18 seconds. (Time is dependent on Idle/Rated speed range.) Set to the desired ramp rate.

Check of MPU Failsafe and Override

24. Disconnect one of the MPU leads from the control, and the actuator voltage should increase to 100% immediately. (Do not reconnect yet.) Connect a jumper between terminals 16 and 18 (close to override failed speed signal), and the actuator voltage should drop to zero (with START FUEL LIMIT clockwise).

Start Fuel Limit

25. Start Fuel Limit must always be completely clockwise for reverse-acting controls. Check that the pot on the 2301A control is fully clockwise.

26. Remove the jumper across terminals 16 and 18 (close to override failed speed signal). Reconnect the magnetic pickup lead and restart the tester.

Minimum Fuel Circuit Checkout

27. Remove the jumper across terminals 16 and 17 (minimum fuel). The ACTUATOR VOLTAGE meter should go to maximum (at least 6.5 Vdc). Reconnect the jumper and restart the tester.

Load Sensor Checkout

28. Set the multimeter for DC (10 V scale) and connect to terminals 12(–) and 13 (+) (the 2301A load signal). Turn the tester L.S.T. switch to position 2 (A> checkout) and turn the 2301A LOAD GAIN adjustment from one end of its travel to the other. The meter reading should vary smoothly from about 1 Vdc at the counterclockwise end to at least 3 Vdc full clockwise. Repeat for position 3 (B> checkout) and 4 (C> checkout). Return the switch to position 2. Set Load Gain to the full clockwise position.

Load Sensor Droop Checkout

29. Turn the DROOP adjustment fully clockwise and remove jumper CB Aux between terminals 16 and 14 (Open for Droop). The speed should decrease. Turn the DROOP fully counterclockwise, and the speed should increase to rated speed (±2 Hz). Reconnect the jumper and turn the tester L.S.T. switch to position 1, Load Sensor simulation off.

30. Set the RATED SPEED adjustment to the desired speed for your prime mover.

SPM Speed Bias Circuit Checkout

31. Apply 1.5 Vdc to terminals 25(+) and 26 (–) (SPM Sync. Input). Speed should increase. Apply 1.5 Vdc to terminals 25 (–) and 26 (+). Speed should decrease. Remove voltage.

Load Sharing Bias Circuit Checkout

32. With LOAD GAIN full clockwise, and a jumper from terminal 14 to 16 (Isoch), apply 1.5 Vdc to terminals 10 (+) and 11 (–). Speed should increase.

    THIS COMPLETES THE TEST. Remove 24 Vdc power from the control. Turn off the tester.

Appendix 5.
Functional Test for 2301A Direct-Acting Models 8272-268/-287/-288/-289

IMPORTANT

Before testing, read manual 82312 on the 2301A control and this manual 55011. Shielding is not normally used during testing of a 2301A control. However, all shielding indicated in the plant wiring diagrams should be completed when a control is installed to control an engine.

Pre-Check of the 2301A Control

1. Remove all connections to the control.
2. Inspect the chassis, terminal block, and printed circuit board for damage.
3. Set the multimeter for the highest resistance scale and measure between each terminal and the chassis. Each should read an open circuit.
4. Set the multimeter to the lowest resistance scale and measure between terminals 4 and 5 (A>CT), 6 and 7 (B>CT), and 8 and 9 (C>CT). Each measurement should read as a short circuit. This checks the Load Sensor CT inputs.
5. Measure between terminals 28 and 29. This should read about 220 Ω. This checks the primary winding of the magnetic pickup isolation transformer.

Pre-Setup of 2301A Control

6. Terminal 16 provides power for the control contacts on terminals 14, 17, 18, and 19. Connect jumpers between terminal 16 and 14 (simulates CB Aux contact closer), 17 (removes minimum fuel condition), 18 (overrides failed speed signal failsafe), and 19 (imitates rated speed condition).
7. Install a jumper between terminals 23 and 24 (sets speed trim at maximum).
8. Set the GAIN and RESET adjustments to the middle of their travel. Set the START FUEL LIMIT full clockwise to allow maximum fuel when starting.

Power Up of Tester and 2301A Control

9. The tester requires 115 Vac, 60 Hz supply. The tester provides the 24 Vdc power needed by the 2301A.
10. Connect power to both the tester and the control. Turn the power to the control OFF.

11. Make the following initial settings on the tester:
    Turn POWER to ON
    LEVEL/NULL dial at 2
    LOAD ON/LOAD OFF to OFF
    While holding the START switch down, set the RANGE for 10% over rated speed on the frequency readout. (Notice that the speed is set for Hz, not rpm.)
    Select engine ACCELERATION at 30%/SEC, 50%/SEC, or 100%/SEC. (If unknown, set at 100%/SEC.)
    REV/NORM to NORM
    EGM/2301 to 2301
    2301/2301A to 2301A
    Now turn POWER to OFF.

Setup Wiring for 2301A

12. Make sure that the tester POWER switch is OFF.

13. Connect terminals 1 through 9 (Load Sensor wiring), 15 and 16 (Power Supply inputs), 20 and 21 (actuator outputs), 28 and 29 (speed signal input) to the tester. Check that proper polarity is observed when connecting the actuator wires to terminals 20 and 21.

14. Set the L.S.T. rotary switch at position 1.

Simulation Startup

15. Turn power to the 2301A control on. Turn the tester POWER switch to on. Turn the RATED speed pot to mid position. Press the tester START switch for 1 to 2 seconds, then release. If the control starts the tester properly, adjust RATED SPEED on the control for rated speed readout, and continue to step 16. If not, turn the tester LEVEL/NULL clockwise about 1.5 turns and press START for 1 to 2 seconds again. If still no results, turn LEVEL/NULL clockwise another 1.5 turns and press START 1 to 2 seconds again. If the unit now starts properly, set RATED SPEED on the control for rated speed readout, and continue to step 16. If the unit still does not start, it is a probable failure of the 2301A control.

Setup of Tester

16. Set the tester LEVEL/NULL so actuator voltage reads 1.5 to 2.0 Vdc.

17. Adjust 2301A GAIN and RESET as needed.

Speed Loop Loading

18. With the tester LOAD ON/LOAD OFF switch on, turn the LOAD ADJ on the tester clockwise until a continuous decrease in speed is noted (overload condition). The actuator voltage should now be at least 6.5 Vdc. Return the LOAD ADJ counterclockwise until the actuator voltage is 5 Vdc. (You may have to press the START switch to re-start the tester.) (If the unit is unstable with load, again adjust the 2301A GAIN and RESET.)

19. Check that the speed returns to the same setting within 2 Hz whether the LOAD ON/LOAD OFF switch is on or off.

20. Turn the tester LOAD ON/LOAD OFF switch off, as it will not be used beyond this step.

Verification of Rated Speed Pot

21. Turn the 2301A RATED SPEED adjustment slowly from one end of its travel to the other. Adjust the 2301A GAIN and RESET as necessary for stable operation at all speeds, but no erratic actuator voltage changes should occur. Return the RATED SPEED pot to rated speed. (This verifies that the ten-turn RATED speed pot can control over the entire speed range.)

Control Part Number	Speed Range (Hz)	Rated (for this test)
8272-286	500–1500	1300
8272-287	1000–3000	2500
8272-288	2000–6000	5000
8272-289	4000–12 000	10 000

Verification of Idle Pot

Desired Idle setpoint can be adjusted.

22. Remove the jumper between terminals 16 and 19 (open for idle). The speed should decrease. Turn the 2301A LOW IDLE SPEED adjustment from one end to the other, and the speed should vary over a wide range. If the engine simulator in tester dies, leave the LOW IDLE SPEED at the middle of its travel (the test then needs to be restarted). Set LOW IDLE SPEED to the desired idle frequency.

Idle/Rate Ramp Time Checkout and Setup

23. Turn the 2301A RAMP TIME adjustment fully counterclockwise. Close terminal 16 to 19 (close for rated). The speed should increase to rated in 0 to 5 seconds. Open terminal 16 to 19 (open for idle) and turn RAMP TIME fully clockwise. Close terminal 16 to 19 (Close for Rated), and the speed should increase to rated in about 8 to 18 seconds. (Time is dependent on Idle/Rated speed range.) Set to the desired ramp rate.

Check of MPU Failsafe and Override

24. Disconnect one of the MPU leads from the control, and the actuator voltage should decrease to 0% immediately. (Do not reconnect yet.) Connect a jumper between terminals 16 and 18 (close to override failed speed signal), and the actuator voltage should go to 100% (with START FUEL LIMIT clockwise).

Start Fuel Limit

25. Check Start Fuel Limit by turning the START FUEL LIMIT adjustment counterclockwise. Actuator voltage should be adjustable from 100% down to 25% of its maximum. Set the START FUEL LIMIT for about 100% above the output voltage for rated speed.

26. Remove the jumper across terminals 16 and 18 (close to override failed speed signal). Reconnect the magnetic pickup lead and restart the tester.

Minimum Fuel Circuit Checkout

27. Remove the jumper across terminals 16 and 17 (minimum fuel). The ACTUATOR VOLTAGE meter should go to minimum (0 Vdc). Reconnect the jumper and restart the tester.

Load Sensor Checkout

28. Set the multimeter for DC (10 V scale) and connect to terminals 12(–) and 13 (+) (the 2301A load signal). Turn the tester L.S.T. switch to position 2 (A> checkout) and turn the 2301A LOAD GAIN adjustment from one end of its travel to the other. The meter reading should vary smoothly from about 1 Vdc at the counterclockwise end to at least 3 Vdc full clockwise. Repeat for position 3 (B> checkout) and 4 (C> checkout). Return the switch to position 2. Set Load Gain to the full clockwise position.

Load Sensor Droop Checkout

29. Turn the DROOP adjustment fully clockwise and remove jumper CB Aux between terminals 16 and 14 (Open for Droop). The speed should decrease. Turn the DROOP fully counterclockwise, and the speed should increase to rated speed (±2 Hz). Reconnect the jumper and turn the tester L.S.T. switch to position 1, Load Sensor simulation off.

30. Set the RATED SPEED adjustment to the desired speed for your prime mover.

SPM Speed Bias Circuit Checkout

31. Apply 1.5 Vdc to terminals 25(+) and 26 (–) (SPM Sync. Input). Speed should increase. Apply 1.5 Vdc to terminals 25 (–) and 26 (+). Speed should decrease. Remove voltage.

Load Sharing Bias Circuit Checkout

32. With LOAD GAIN full clockwise, and a jumper from terminal 14 to 16 (Isoch), apply 1.5 Vdc to terminals 10 (+) and 11 (–). Speed should increase.

THIS COMPLETES THE TEST. Remove 24 Vdc power from the control. Turn off the tester.

Appendix 6.
Functional Test for 2301A High-Voltage Reverse-Acting Model 9905-031

IMPORTANT

Before testing, read manual 82389 on the 2301A control and this manual 55011. Shielding is not normally used during testing of a 2301A control. However, all shielding indicated in the plant wiring diagrams should be completed when a control is installed to control an engine.

Pre-Check of the 2301A Control

1. Remove all connections to the control.
2. Inspect the chassis, terminal block, and printed circuit board for damage.
3. Set the multimeter for the highest resistance scale and measure between each terminal and the chassis. Each should read an open circuit.
4. Set the multimeter to the lowest resistance scale and measure between terminals 4 and 5 (A>CT), 6 and 7 (B>CT), and 8 and 9 (C>CT). Each measurement should read as a short circuit. This checks the Load Sensor CT inputs.
5. Measure between terminals 28 and 29. This should read about 220 Ω. This checks the primary winding of the magnetic pickup isolation transformer.

Pre-Setup of 2301A Control

6. Terminal 0 provides power for the control contacts on terminals 14, 17, 18, and 19. Connect jumpers between terminal 0 and 14 (simulates CB Aux contact closer), 17 (removes minimum fuel condition), 18 (overrides failed speed signal failsafe), and 19 (imitates rated speed condition).

IMPORTANT

The "Override Faded Speed Signal" contacts (terminal 0 to 18) must always be closed for the reverse-acting 2301A control to function correctly. The permanent jumper must be replaced at the completion of the test.

7. Install a jumper between terminals 23 and 24 (sets speed trim at maximum).
8. Set the GAIN and RESET adjustments to the middle of their travel. Set the START FUEL LIMIT full clockwise to allow maximum fuel when starting.

Power Up of Tester and 2301A Control

9. The tester and the control both require 115 Vac, 60 Hz supply. The same supply may be used for both units. A switch should be installed in the supply to the control box. The tester includes a power on/off switch.

10. Connect power to both the tester and the control. Turn the power to the control OFF.

WARNING

HIGH VOLTAGE—115 V power to the control can cause personal injury. Use all customary precautions when bringing power to the control. Always turn the power to the control to OFF before making any connections or changes in the wiring on the control terminal strip.

11. Make the following initial settings on the tester:
    Turn POWER to ON
    LEVEL/NULL dial at 2
    LOAD ON/LOAD OFF to OFF
    While holding the START switch down, set the RANGE for 10% over rated speed on the frequency readout. (Notice that the speed is set for Hz, not rpm.)
    Select engine ACCELERATION at 30%/SEC, 50%/SEC, or 100%/SEC. (If unknown, set at 100%/SEC.)
    REV/NORM to REV
    EGM/2301 to 2301
    2301/2301A to 2301A
    Now turn POWER to OFF.

Setup Wiring for 2301A

12. Make sure that the tester POWER switch is OFF. Make sure that the 115 Vac power to the control is OFF.

13. Connect terminals 1 through 9 (Load Sensor wiring), 20 and 21 (actuator outputs), 28 and 29 (speed signal input) to the tester. Check that proper polarity is observed when connecting the actuator wires to terminals 20 and 21.

14. Make sure that the speed range switch on the 2301A is set for the desired range (see Setting Speed Range in manual 82389).

15. Set the L.S.T. rotary switch at position 1.

Simulation Startup

16. Turn power to the 2301A control on. Turn the tester POWER switch to on. Turn the RATED speed pot to mid position. Press the tester START switch for 1 to 2 seconds, then release. If the control starts the tester properly, adjust RATED SPEED on the control for rated speed readout, and continue to step 17. If not, turn the tester LEVEL/NULL clockwise about 1.5 turns and press START for 1 to 2 seconds again. If still no results, turn LEVEL/NULL clockwise another 1.5 turns and press START 1 to 2 seconds again. If the unit now starts properly, set RATED SPEED on the control for rated speed readout, and continue to step 17. If the unit still does not start, it is a probable failure of the 2301A control.

Setup of Tester

17. Set the tester LEVEL/NULL so actuator voltage reads 6.0 to 6.5 Vdc.

18. Adjust 2301A GAIN and RESET as needed.

Speed Loop Loading

19. With the tester LOAD ON/LOAD OFF switch on, turn the LOAD ADJ on the tester clockwise until a continuous decrease in speed is noted (overload condition). The actuator voltage should now be no more than 0.5 Vdc. Return the LOAD ADJ counterclockwise until the actuator voltage is 1 Vdc. (You may have to press the START switch to re-start the tester.) (If the unit is unstable with load, again adjust the 2301A GAIN and RESET.)

20. Check that the speed returns to the same setting within 2 Hz whether the LOAD ON/LOAD OFF switch is on or off.

21. Turn the tester LOAD ON/LOAD OFF switch off, as it will not be used beyond this step.

Verification of Rated Speed Pot

22. Turn the 2301A RATED SPEED adjustment slowly from one end of its travel to the other. Adjust the 2301A GAIN and RESET as necessary for stable operation at all speeds, but no erratic actuator voltage changes should occur. Return the RATED SPEED pot to rated speed. (This verifies that the ten-turn RATED speed pot can control over the entire speed range, as selected with the internal 2301A DIP switch.)

Verification of Idle Pot

Desired Idle setpoint can be adjusted.

23. Remove the jumper between terminals 0 and 19 (open for idle). The speed should decrease. Turn the 2301A LOW IDLE SPEED adjustment from one end to the other, and the speed should vary over a wide range. If the engine simulator in tester dies, leave the LOW IDLE SPEED at the middle of its travel (the test then needs to be restarted). Set LOW IDLE SPEED to the desired idle frequency.

Idle/Rate Ramp Time Checkout and Setup

24. Turn the 2301A RAMP TIME adjustment fully counterclockwise. Close terminal 0 to 19 (close for rated). The speed should increase to rated in 0 to 5 seconds. Open terminal 0 to 19 (open for idle) and turn RAMP TIME fully clockwise. Close terminal 0 to 19 (Close for Rated), and the speed should increase to rated in about 8 to 18 seconds. (Time is dependent on Idle/Rated speed range.) Set to the desired ramp rate.

Check of MPU Failsafe and Override

25. Disconnect one of the MPU leads from the control, and the actuator voltage should increase to 100% immediately. (Do not reconnect yet.) Connect a jumper between terminals 0 and 18 (close to override failed speed signal), and the actuator voltage should drop to zero (with START FUEL LIMIT clockwise).

Start Fuel Limit

26. Start Fuel Limit must always be completely clockwise for reverse-acting controls. Check that the pot on the 2301A control is fully clockwise.

27. Remove the jumper across terminals 0 and 18 (close to override failed speed signal). Reconnect the magnetic pickup lead and restart the tester.

Minimum Fuel Circuit Checkout

28. Remove the jumper across terminals 0 and 17 (minimum fuel). The ACTUATOR VOLTAGE meter should go to maximum (at least 6.5 Vdc). Reconnect the jumper and restart the tester.

Load Sensor Checkout

29. Set the multimeter for DC (10 V scale) and connect to terminals 12(–) and 13 (+) (the 2301A load signal). Turn the tester L.S.T. switch to position 2 (A> checkout) and turn the 2301A LOAD GAIN adjustment from one end of its travel to the other. The meter reading should vary smoothly from about 1 Vdc at the counterclockwise end to at least 3 Vdc full clockwise. Repeat for position 3 (B> checkout) and 4 (C> checkout). Return the switch to position 2. Set Load Gain to the full clockwise position.

Load Sensor Droop Checkout

30. Turn the DROOP adjustment fully clockwise and remove jumper CB Aux between terminals 0 and 14 (Open for Droop). The speed should decrease. Turn the DROOP fully counterclockwise, and the speed should increase to rated speed (±2 Hz). Reconnect the jumper and turn the tester L.S.T. switch to position 1, Load Sensor simulation off.

31. Set the RATED SPEED adjustment to the desired speed for your prime mover.

SPM Speed Bias Circuit Checkout

32. Apply 1.5 Vdc to terminals 25(+) and 26 (–) (SPM Sync. Input). Speed should increase. Apply 1.5 Vdc to terminals 25 (–) and 26 (+). Speed should decrease. Remove voltage.

Load Sharing Bias Circuit Checkout

33. With LOAD GAIN full clockwise, and a jumper from terminal 0 to 14 (Isoch), apply 1.5 Vdc to terminals 10 (+) and 11 (–). Speed should increase.

    THIS COMPLETES THE TEST. Remove 115 V power from the control. Turn off the tester.

Appendix 7.
Functional Test for 2301A 24 Vdc Reverse-Acting Model 9905-133

IMPORTANT

Before testing, read manual 82020 on the 2301A control and this manual 55011. Shielding is not normally used during testing of a 2301A control. However, all shielding indicated in the plant wiring diagrams should be completed when a control is installed to control an engine.

Pre-Check of the 2301A Control

1. Remove all connections to the control.
2. Inspect the chassis, terminal block, and printed circuit board for damage.
3. Set the multimeter for the highest resistance scale and measure between each terminal and the chassis. Each should read an open circuit.
4. Measure between terminals 7 and 8. This should read about 220 Ω. This checks the primary winding of the magnetic pickup isolation transformer.

Pre-Setup of 2301A Control

5. Terminal 2 provides power for the control contacts on terminals 3, 4, and 5. Connect jumpers between terminal 2 and 3 (removes minimum fuel condition), 4 (overrides failed speed signal failsafe), and 5 (imitates rated speed condition).

IMPORTANT

The "Override Faded Speed Signal" contacts (terminal 2 to 4) must always be closed for the reverse-acting 2301A control to function correctly. The permanent jumper must be replaced at the completion of the test.

6. Set the GAIN and RESET adjustments to the middle of their travel. Set the START FUEL LIMIT full clockwise to allow maximum fuel when starting.

Power Up of Tester and 2301A Control

7. The tester requires 115 Vac, 60 Hz supply. The tester provides the 24 Vdc power needed by the 2301A [control terminals 1(–) and 2(+)].
8. Connect power to both the tester and the control. Turn the power to the control OFF.

9. Make the following initial settings on the tester:
   Turn POWER to ON
   LEVEL/NULL dial at 2
   LOAD ON/LOAD OFF to OFF
   While holding the START switch down, set the RANGE for 10% over rated speed on the frequency readout. (Notice that the speed is set for Hz, not rpm.)
   Select engine ACCELERATION at 30%/SEC, 50%/SEC, or 100%/SEC. (If unknown, set at 100%/SEC.)
   REV/NORM to REV
   EGM/2301 to 2301
   2301/2301A to 2301A
   Now turn POWER to OFF.

Setup Wiring for 2301A

10. Make sure that the tester POWER switch is OFF. Make sure that the control power is OFF.

11. Connect terminals 9(+) and 10(–) (actuator outputs), 7 and 8 (speed signal input) to the tester. Check that proper polarity is observed when connecting the actuator wires.

12. Make sure that the speed range switch on the 2301A is set for the desired range (see Setting Speed Range in manual 82020).

Simulation Startup

13. Turn power to the 2301A control on. Turn the tester POWER switch to on. Turn the RATED speed pot to mid position. Press the tester START switch for 1 to 2 seconds, then release. If the control starts the tester properly, adjust RATED SPEED on the control for rated speed readout, and continue to step 14. If not, turn the tester LEVEL/NULL clockwise about 1.5 turns and press START for 1 to 2 seconds again. If still no results, turn LEVEL/NULL clockwise another 1.5 turns and press START 1 to 2 seconds again. If the unit now starts properly, set RATED SPEED on the control for rated speed readout, and continue to step 14. If the unit still does not start, it is a probable failure of the 2301A control.

Setup of Tester

14. Set the tester LEVEL/NULL so actuator voltage reads 4.5 to 5.0 Vdc.

15. Adjust 2301A GAIN and RESET as needed.

Speed Loop Loading

16. With the tester LOAD ON/LOAD OFF switch on, turn the LOAD ADJ on the tester clockwise until a continuous decrease in speed is noted (overload condition). The actuator voltage should now be no more than 0.5 Vdc. Return the LOAD ADJ counterclockwise until the actuator voltage is 2 Vdc. (You may have to press the START switch to re-start the tester.) (If the unit is unstable with load, again adjust the 2301A GAIN and RESET.)

17. Check that the speed returns to the same setting within 2 Hz whether the LOAD ON/LOAD OFF switch is on or off.

18. Turn the tester LOAD ON/LOAD OFF switch off, as it will not be used beyond this step.

Verification of Rated Speed Pot

19. Turn the 2301A RATED SPEED adjustment slowly from one end of its travel to the other. Adjust the 2301A GAIN and RESET as necessary for stable operation at all speeds, but no erratic actuator voltage changes should occur. Return the RATED SPEED pot to rated speed. (This verifies that the ten-turn RATED speed pot can control over the entire speed range, as selected with the internal 2301A DIP switch.)

Verification of Idle Pot

Desired Idle setpoint can be adjusted.

20. Remove the jumper between terminals 2 and 5 (open for idle). The speed should decrease. Turn the 2301A LOW IDLE SPEED adjustment from one end to the other, and the speed should vary over a wide range. If the engine simulator in tester dies, leave the LOW IDLE SPEED at the middle of its travel (the test then needs to be restarted). Set LOW IDLE SPEED to the desired idle frequency.

Idle/Rate Ramp Time Checkout and Setup

21. Turn the 2301A RAMP TIME adjustment fully counterclockwise. Close terminal 2 to 5 (close for rated). The speed should increase to rated in 0 to 5 seconds. Open terminal 2 to 5 (open for idle) and turn RAMP TIME fully clockwise. Close terminal 2 to 5 (Close for Rated), and the speed should increase to rated in about 8 to 18 seconds. (Time is dependent on Idle/Rated speed range.) Set to the desired ramp rate.

Check of MPU Failsafe and Override

22. Disconnect one of the MPU leads from the control, and the actuator voltage should increase to 100% immediately. (Do not reconnect yet.) Connect a jumper between terminals 2 and 4 (close to override failed speed signal), and the actuator voltage should drop to zero.

Start Fuel Limit

23. Start Fuel Limit must always be completely clockwise for reverse-acting controls. Check that the pot on the 2301A control is fully clockwise.

24. Remove the jumper across terminals 2 and 4 (close to override failed speed signal). Reconnect the magnetic pickup lead and restart the tester.

Minimum Fuel Circuit Checkout

25. Remove the jumper across terminals 2 and 3 (minimum fuel). The ACTUATOR VOLTAGE meter should go to maximum (at least 6.5 Vdc). Reconnect the jumper and restart the tester.

Droop Checkout

26. Connect a 2 kΩ pot to terminals 14 (cw), 13 (wiper), and 15 (ccw). Turn the pot full counterclockwise (zero droop). Apply full load to the tester, using the LOAD ON/LOAD OFF switch (ON). The speed should remain constant from no load to full load. Return the LOAD ON/LOAD OFF switch to the OFF position.

27. Turn the DROOP adjustment fully clockwise.

28. Apply full load by turning the LOAD ON/LOAD OFF switch ON. The speed should decrease. Adjust the droop pot to give the desired full-load speed droop.

29. `Repeat steps 27 and 28 until engine speed returns to the desired rated frequency when load is removed, and desired droop is seen when load is applied.

30. Remove the droop pot if continuing with the test.

31. Set the RATED SPEED adjustment to the desired speed for your prime mover.

SPM Speed Bias Circuit Checkout

32. Apply 1.5 Vdc to terminals 15(+) and 17(–) (SPM Sync. Input). Speed should increase about 9 percent. Remove the voltage and speed should return to normal. Reverse the polarity of the voltage input, and the speed should decrease by about the same amount.

    THIS COMPLETES THE TEST. Remove 24 Vdc power from the control. Turn off the tester.

Appendix 8.
Functional Test for 2301A 24 Vdc Direct-Acting Model 9905-131

IMPORTANT

Before testing, read manual 82020 on the 2301A control and this manual 55011. Shielding is not normally used during testing of a 2301A control. However, all shielding indicated in the plant wiring diagrams should be completed when a control is installed to control an engine.

Pre-Check of the 2301A Control

1. Remove all connections to the control.
2. Inspect the chassis, terminal block, and printed circuit board for damage.
3. Set the multimeter for the highest resistance scale and measure between each terminal and the chassis. Each should read an open circuit.
4. Measure between terminals 7 and 8. This should read about 220 Ω. This checks the primary winding of the magnetic pickup isolation transformer.

Pre-Setup of 2301A Control

5. Terminal 2 provides power for the control contacts on terminals 3, 4, and 5. Connect jumpers between terminal 2 and 3 (removes minimum fuel condition), 4 (overrides failed speed signal failsafe), and 5 (imitates rated speed condition).
6. Set the GAIN and RESET adjustments to the middle of their travel. Set the START FUEL LIMIT full clockwise to allow maximum fuel when starting.

Power Up of Tester and 2301A Control

7. The tester requires 115 Vac, 60 Hz supply. The tester provides the 24 Vdc power needed by the 2301A [control terminals 1(–) and 2(+)].
8. Connect power to both the tester and the control. Turn the power to the control OFF.
9. Make the following initial settings on the tester:
   Turn POWER to ON
   LEVEL/NULL dial at 2 if using the 2301A on a diesel engine or gas turbine; at 6 if using the 2301A on a gas engine or steam turbine
   LOAD ON/LOAD OFF to OFF
   While holding the START switch down, set the RANGE for 10% over rated speed on the frequency readout. (Notice that the speed is set for Hz, not rpm.)
   Select engine ACCELERATION at 30%/SEC, 50%/SEC, or 100%/SEC. (If unknown, set at 100%/SEC.)
   REV/NORM to NORM
   EGM/2301 to 2301
   2301/2301A to 2301A
   Now turn POWER to OFF

Setup Wiring for 2301A

10. Make sure that the tester POWER switch is OFF. Make sure that the control power is OFF.

11. Connect terminals 9(+) and 10(–) (actuator outputs), 7 and 8 (speed signal input) to the tester. Check that proper polarity is observed when connecting the actuator wires.

12. Make sure that the speed range switch on the 2301A is set for the desired range (see Setting Speed Range in manual 82020).

Simulation Startup

13. Turn power to the 2301A control on. Turn the tester POWER switch to on. Turn the RATED speed pot to mid position. Press the tester START switch for 1 to 2 seconds, then release. If the control starts the tester properly, adjust RATED SPEED on the control for rated speed readout, and continue to step 14. If not, turn the tester LEVEL/NULL clockwise about 1.5 turns and press START for 1 to 2 seconds again. If still no results, turn LEVEL/NULL clockwise another 1.5 turns and press START 1 to 2 seconds again. If the unit now starts properly, set RATED SPEED on the control for rated speed readout, and continue to step 14. If the unit still does not start, it is a probable failure of the 2301A control.

Setup of Tester

14. Set the tester LEVEL/NULL so actuator voltage reads 1.5 to 2.0 Vdc.

15. Adjust 2301A GAIN and RESET as needed.

Speed Loop Loading

16. With the tester LOAD ON/LOAD OFF switch on, turn the LOAD ADJ on the tester clockwise until a continuous decrease in speed is noted (overload condition). The actuator voltage should now be at least 7 Vdc. Return the LOAD ADJ counterclockwise until the actuator voltage is below 5 Vdc. (You may have to press the START switch to re-start the tester.) (If the unit is unstable with load, again adjust the 2301A GAIN and RESET.)

17. Check that the speed returns to the same setting within 2 Hz whether the LOAD ON/LOAD OFF switch is on or off.

18. Turn the tester LOAD ON/LOAD OFF switch off, as it will not be used beyond this step.

Verification of Rated Speed Pot

19. Turn the 2301A RATED SPEED adjustment slowly from one end of its travel to the other. Adjust the 2301A GAIN and RESET as necessary for stable operation at all speeds, but no erratic actuator voltage changes should occur. Return the RATED SPEED pot to rated speed. (This verifies that the ten-turn RATED speed pot can control over the entire speed range, as selected with the internal 2301A DIP switch.)

Verification of Idle Pot

Desired Idle setpoint can be adjusted.

20. Remove the jumper between terminals 2 and 5 (open for idle). The speed should decrease. Turn the 2301A LOW IDLE SPEED adjustment from one end to the other, and the speed should vary over a wide range. If the engine simulator in tester dies, leave the LOW IDLE SPEED at the middle of its travel (the test then needs to be restarted). Set LOW IDLE SPEED to the desired idle frequency.

Idle/Rate Ramp Time Checkout and Setup

21. Turn the 2301A RAMP TIME adjustment fully counterclockwise. Close terminal 2 to 5 (close for rated). The speed should increase to rated in 0 to 5 seconds. Open terminal 2 to 5 (open for idle) and turn RAMP TIME fully clockwise. Close terminal 2 to 5 (Close for Rated), and the speed should increase to rated in about 8 to 18 seconds. (Time is dependent on Idle/Rated speed range.) Set to the desired ramp rate.

Check of MPU Failsafe and Override

22. Disconnect one of the MPU leads from the control, and the actuator voltage should decrease to 0% immediately. (Do not reconnect yet.) Connect a jumper between terminals 2 and 4 (close to override failed speed signal), and the actuator voltage should go above 7 Vdc (with START FUEL LIMIT clockwise).

Start Fuel Limit

23. Check Start Fuel Limit by turning the START FUEL LIMIT adjustment counterclockwise. Actuator voltage should be adjustable from 100% down to 24% of its maximum. Set the START FUEL LIMIT for 40% to 50% above the output voltage for rated speed.

24. Remove the jumper across terminals 2 and 4 (close to override failed speed signal). Reconnect the magnetic pickup lead and restart the tester.

Minimum Fuel Circuit Checkout

25. Remove the jumper across terminals 2 and 3 (minimum fuel). The ACTUATOR VOLTAGE meter should go to minimum (0 Vdc). Reconnect the jumper and restart the tester.

Droop Checkout

26. Connect a 2 kΩ pot to terminals 14 (cw), 13 (wiper), and 15 (ccw). Turn the pot full counterclockwise (zero droop). Apply full load to the tester, using the LOAD ON/LOAD OFF switch (ON). The speed should remain constant from no load to full load. Return the LOAD ON/LOAD OFF switch to the OFF position.

27. Turn the DROOP adjustment fully clockwise.

28. Apply full load by turning the LOAD ON/LOAD OFF switch ON. The speed should decrease. Adjust the droop pot to give the desired full-load speed droop.

29. `Repeat steps 27 and 28 until engine speed returns to the desired rated frequency when load is removed, and desired droop is seen when load is applied.

30. Remove the droop pot if continuing with the test.

31. Set the RATED SPEED adjustment to the desired speed for your prime mover.

SPM Speed Bias Circuit Checkout

32. Apply 3 Vdc to terminals 15(+) and 17(–) (SPM Sync. Input). Speed should increase about 9 percent. Remove the voltage and speed should return to normal. Reverse the polarity of the voltage input, and the speed should decrease by about the same amount.

    THIS COMPLETES THE TEST. Remove 24 Vdc power from the control. Turn off the tester.

Tester Specifications

Woodward Part Numbers:	
8909-555	Speed Loop Tester with Load Sensor for 2301/2301A/EGM
Line Input	115/230 Vac 50/60 Hz (switch selectable on older units; automatic selection on newer units)
Power Supply	24 Vdc, 350 mA maximum
Actuator Input	0–200 mA maximum
Actuator Input Resistance	35 Ω
MPU Output	2 Vrms at 4800 Hz
MPU Range	0–19 kHz
Actuator Meter	0–10 Vdc ±2%
Digital Frequency Meter	19 999 ±1 Hz
Bias Voltage	±5 Vdc, 20 mA
SW1 and SW2	125 Vac, 1 A maximum
PT Voltages	*110/220 V L–L
CT Voltages	*1.5/3.0 Vac
CT Currents	*5 A, 0.50 Ω burden resistor *5 A, 0.25 Ω burden resistor

(*) Factory installation to be specified with order

Revision History

Changes in Revision J—

- Replaced 110 V measurement with 0 V in Test Box Setup Procedure, step 14a

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Released

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 55011.

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