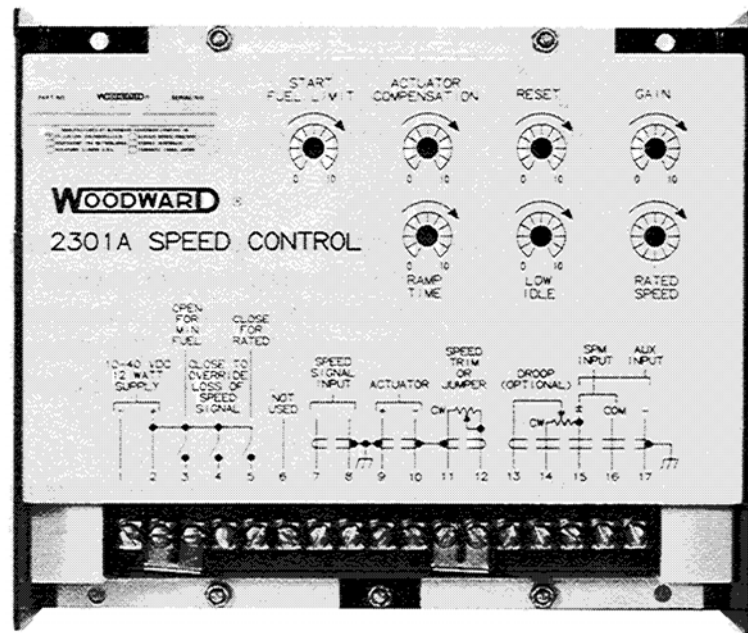




Installation and Operation Manual



2301A Speed Control

Manual 82020 (Revision C)

WARNING—DANGER OF DEATH OR PERSONAL INJURY



WARNING—FOLLOW INSTRUCTIONS

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.



WARNING—OUT-OF-DATE PUBLICATION

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, be sure to check the Woodward website:

www.woodward.com/pubs/current.pdf

The revision level is shown at the bottom of the front cover after the publication number. The latest version of most publications is available at:

www.woodward.com/publications

If your publication is not there, please contact your customer service representative to get the latest copy.



WARNING—OVERSPEED PROTECTION

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

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



WARNING—PROPER USE

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

CAUTION—POSSIBLE DAMAGE TO EQUIPMENT OR PROPERTY



CAUTION—BATTERY CHARGING

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



CAUTION—ELECTROSTATIC DISCHARGE

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

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

IMPORTANT DEFINITIONS

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

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Electrostatic Discharge Awareness

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

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).
2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.
4. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
 - Do not touch any part of the PCB except the edges.
 - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
 - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.



CAUTION—ELECTROSTATIC DISCHARGE

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

Chapter 1.

General Information

Description

The 2301A Speed Control controls the speed or load of diesel or gas engines, or steam or gas turbines. These power sources are referred to as "prime movers" throughout this manual.

The control is housed in a sheet-metal chassis and consists of a single printed circuit board. All potentiometers are accessible from the front of the chassis.

The 2301A Speed Control provides control in the isochronous mode with droop available through an externally wired potentiometer.

The isochronous mode is used for constant speed of the controlled prime mover as long as it is able to provide the load. Isochronous is also used when load sharing with a Woodward load sensor.

External droop is used for speed control as a function of load when a prime mover is operating on an infinite bus or when two or more prime movers are in parallel operation.

The 2301A system for a prime-mover includes:

- A 2301A electronic speed control,
- An external power source,
- A speed-sensing device (MPU), and
- A proportional actuator to position the fuel- or steam-metering device.

Part Number Table

Supply Voltage	Special Features	Part Number	
		Forward	Reverse
88–131 Vac or 90–150 Vdc	Tandem Actuators	9905-136	9905-138
10–40 Vdc	Tandem Actuators	9905-135	9905-137
88–131 Vac or 90–150 Vdc	Standard Speed Control	9905-132 9907-015*	9905-134 9907-017*
10–40 Vdc	Standard Speed Control	9905-131 9907-014*	9905-133 9907-016*
88–131 Vac or 90–150 Vdc	0–400 mA Output	9905-448	

Special controls with 4–20 mA or other outputs are available.

*—These part numbers are EU Directive Compliant.

Applications

2301A Speed Controls are available for forward- or reverse-acting applications for use with single or tandem actuators. High voltage models accept 88 to 132 Vac or 90 to 150 Vdc. Low voltage models accept 10 to 40 Vdc supply.

See the Part Number Table above for a listing of 2301A Speed Controls and applications.

Speed range is set on an internal dip switch, available inside the steel cover of the control. Speeds are set according to the sensor output frequency. The relationship between prime-mover speed and sensor-output frequency is expressed in the formula: Sensor Frequency in Hz equals the number of teeth on the speed-sensing gear times the revolutions per minute of the sensing gear, times the ratio of the engine speed to the sensing gear speed, divided by 60.

Reverse Acting

Most reverse acting 2301A Speed Controls will operate Woodward EGB governor/actuators. In reverse-acting systems, the actuator calls for more fuel when the actuator current decreases. Complete loss of signal to the actuator will drive the actuator to full fuel. This allows a backup mechanical ballhead governor to take control rather than shut down the prime mover as would a direct-acting system.

External wiring connections for reverse-acting controls are identical to those for direct-acting controls. However, changes must be made to the printed circuit board should a control need to operate the opposite type of actuator. Contact Woodward should it be necessary to change the type of 2301A Speed Control. Changing the supply voltage rating requires exchanging the unit for the properly rated control.

References

The following Woodward publications contain additional product or installation information on speed controls and related components. These publications are available on the Woodward website (www.woodward.com).

Manual

- 25070 Electronic Control Installation Guide
- 82510 Magnetic Pickups and Proximity Switches for Electronic Controls
- 82514 Speed Setting Potentiometers
- 82343 Digital Reference Unit

Product Specification

- 82516 EG-3P/-6P/-10P Actuators
- 82575 EGB-1P/-2P Governor/Actuator

Declaration of Incorporation

In accordance with the EMC Directive 89/336/EEC and its amendments, this controlling device, manufactured by the Woodward Governor Company, is applied solely as a component to be incorporated into an engine prime mover system. Woodward declares that this controlling device complies with the requirements of EN50081-2 and EN50082-2 when put into service per the installation and operating instructions outlined in the product manual.

NOTICE: This controlling device is intended to be put into service only upon incorporation into an engine prime mover system that itself has met the requirements of the above Directive and bears the CE mark.

Chapter 2. Installation

Introduction

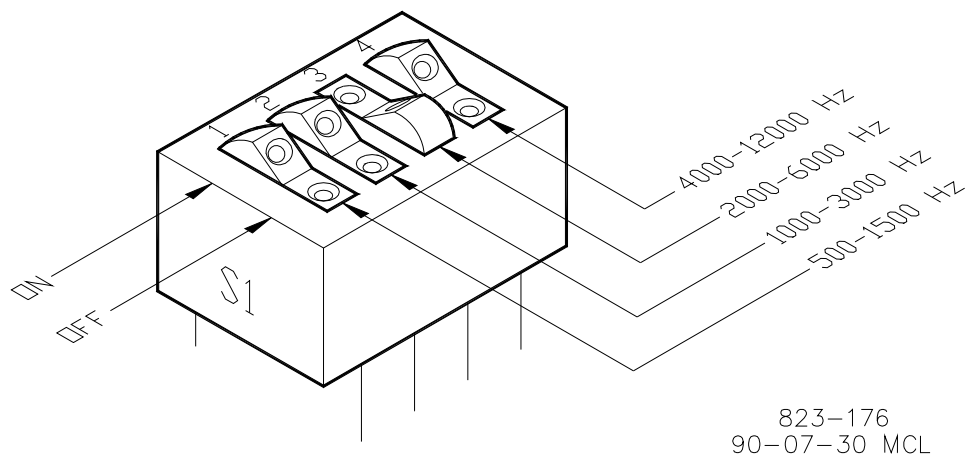
This chapter contains general installation instructions for the 2301A Speed Control. Power requirements, environmental precautions, and location considerations are included to determine the best location for the control. Additional information includes unpacking instructions, electrical connections, and an installation check-out procedure.

Unpacking

Before handling the control, read page ii, "Electrostatic Discharge Awareness". Be careful when unpacking the electronic control. Check the control for signs of damage such as bent or dented panels, scratches, and loose or broken parts. Notify the shipper of any damage.

Selection of Speed Range

A 4-pole mini-switch is located on the lower left-hand quarter of the printed circuit board. This switch sets the controlling speed range as sensed by the MPU. The speeds are related to the MPU frequency, which is proportional to engine rpm. The control is shipped with Switch 3 on for 2000 to 6000 Hz. Switch 1 provides 500 to 1500 Hz, Switch 2 provides 1000 to 3000 Hz, and Switch 4 provides 4000 to 12 000 Hz. Select only one switch on to match the control to the MPU frequency.



SWITCH S1

Figure 2-1. Speed Range Switch

Power Requirements

Power supply output must be low impedance (for example, directly from batteries). **DO NOT** power low-voltage versions of the control from high-voltage sources with resistors and zener diodes in series with the control power input. The 2301A control contains a switching power supply which requires a current surge to start properly.



CAUTION—CHECK INPUT VOLTAGE

To prevent damage to the control, do not power low-voltage versions of the control from high-voltage sources.

High and low voltage models of 2301A Speed Controls are available. Low voltage models require a supply of 10 to 40 Vdc, 12 W. High voltage models require a supply of 88 to 120 Vac or 90 to 150 Vdc., 12 W. The ac supply may be 50 to 400 Hz.

If a battery is used for operating power, an alternator or other battery charging device is necessary to maintain a stable supply voltage.



CAUTION—BATTERY

To prevent damage to the control, make sure that the alternator or other battery-charging device is not connected to the control when the battery is disconnected from the control.

Location Considerations

Consider these requirements when selecting the mounting location:

- Adequate ventilation for cooling
- Space for servicing and repair
- Protection from direct exposure to water or to a condensation-prone environment
- Protection from high-voltage or high-current devices, or devices which produce electromagnetic interference
- Protection from excessive vibration
- An ambient operating temperature range of -40 to $+85$ °C (-40 to $+185$ °F)

Do not mount the control on the engine.

Electrical Connections

External wiring connections and shielding requirements for a typical control installation are shown in the plant wiring diagram, Figures 2-4 and 2-5. These wiring connections and shielding requirements are explained in the balance of this section.

Shielded Wiring

All shielded cable must be twisted conductor pairs. Do not attempt to tin the braided shield. All signal lines should be shielded to prevent picking up stray signals from adjacent equipment. Connect the shields to the grounding lug on the chassis plate below Terminal 9. Keep grounding connections under 2 inches (5 cm) length. A solid ground connection must be made from "earth" or ground to the grounding lug to provide proper chassis grounding. Refer to local wiring codes for proper grounding methods.

Wire exposed beyond the shield should be as short as possible, not exceeding 6 inches. The other end of the shields must be left open and insulated from any other conductor. Do not run shielded signal wires with other wires carrying large currents. See Woodward application note 50532, *EMI Control for Electronic Governing Systems*, for more information.

Where shielded cable is required, cut the cable to the desired length and prepare the cable as instructed below and shown in Figure 2-2.

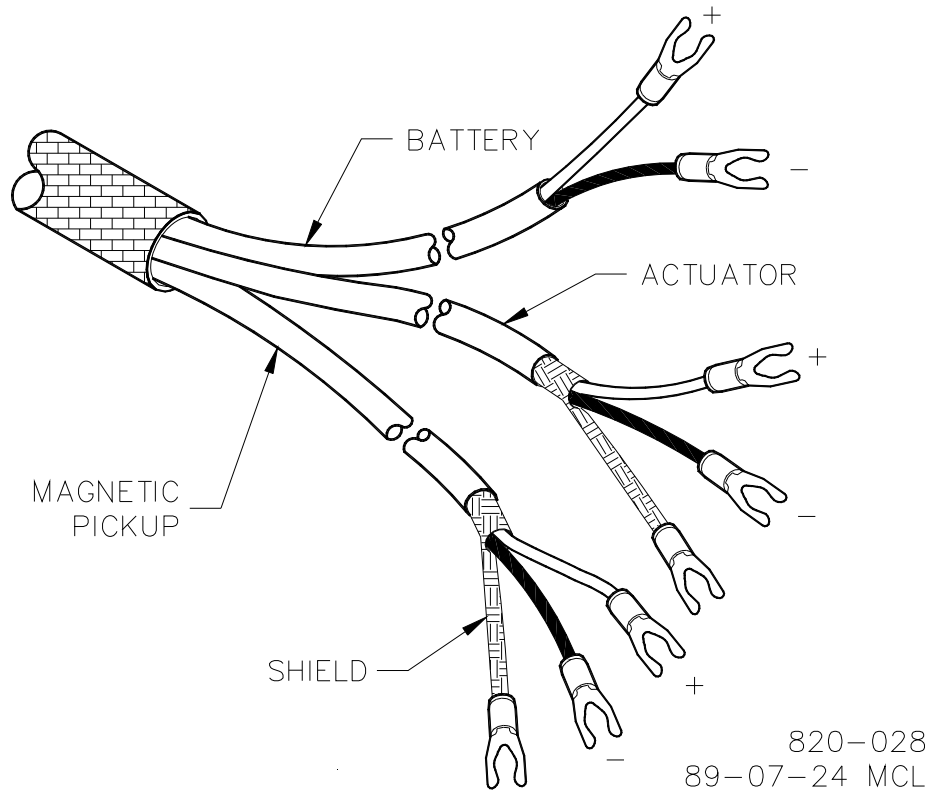


Figure 2-2. Preparation of Shielded Cables

1. Strip outer insulation from both ends, exposing the braided or spiral wrapped shield. Do not cut the shield on the control end. Cut off the shield on the end away from the 2301A control.
2. Use a sharp, pointed tool to carefully spread the strands of the shield.
3. Pull the inner conductors out of the shield. Twist braided shields to prevent fraying.

4. Connect lugs to the shield and to the control wires. Number 6 slotted or round crimp-on terminals are used for most installations. Connect the wires to the appropriate terminals on the control and the shield to the grounding lug below terminal 9.

Installations with severe electromagnetic interference (EMI) may require shielded wire run in conduit, double shielded wire, or other precautions. Contact Woodward for additional information.

External Adjustments

Speed Trim

A speed trim potentiometer or digital reference unit is connected to terminals 11 and 12. Use a high quality 100 Ω , 10-turn potentiometer (Woodward part 1657-537 or equivalent) to provide about $\pm 5\%$ speed adjustment. Terminals 11 and 12 must be jumpered if the speed trim potentiometer or digital reference unit is not used. The 2301A Speed Control will have a jumper installed in the factory and this must be removed if a speed-trim device is used.

Droop Potentiometer

A 2K potentiometer may be connected to provide a maximum of about 8% droop. Connect the potentiometer (ccw) to terminal 15, (cw) to terminal 14, and wiper to terminal 13. If droop is not desired make no connections to terminals 13 and 14.

Switch Options

Minimum Fuel Contact

The minimum-fuel contact between terminals 2 and 3 on the low-power models and 3 and 6 on the high-power models is intended as an optional means for a normal shutdown of the prime mover. The contact is connected as shown on the plant wiring diagram for the particular control. If a minimum fuel contact is not used, the terminals must be permanently jumpered.



WARNING—EMERGENCY STOP

Do NOT use the minimum-fuel contact as a part of any emergency stop sequence. The emergency may be caused by a governor malfunction which would also cause a malfunction of the minimum-fuel feature. Use of the minimum-fuel contact for an emergency stop sequence could cause overspeed of the prime mover and mechanical damage and personal injury, including death.

Failed Speed Signal Override

Circuits in the 2301A Speed Control constantly monitor the signal from the MPU. Should this signal be below a minimum threshold the control sends a minimum fuel signal to the actuator (maximum fuel signal on a reverse acting control).

Before start-up of the prime mover, the speed signal is nonexistent, activating the failed speed signal circuit. On units with cranking motors, the cranking speed is usually sufficient to provide a speed signal, so an override contact is not needed for starting. On some steam turbine systems, the Close for Override of Failed Speed Signal contact must be closed to allow the actuator to open and provide steam for starting.

The failed speed-signal override switch should be a momentary switch so the failed-speed-sensor circuit will be enabled after start-up.

Idle/Rated Ramp Contact

Connect a single-pole, single throw switch to terminal 5 as shown on the appropriate plant-wiring diagram. Close the contact for rated, open for idle. Oil pressure is often used to close this contact. When closed, 10 to 40 Vdc is applied to terminal 5, and the prime mover can be operated at a speed higher than idle. When the contact is open, the voltage is removed from terminal 5, and the prime mover's speed decelerates to idle. The ramp rate applies only to the acceleration mode. When the ramp time potentiometer is full cw the ramp time from idle to rated is 22 ± 4 seconds. When the ramp time potentiometer is fully ccw (**be careful not to overtorque the pot**), the ramp rate is less than 1 second from idle to rated.

The ramp time from rated to idle is always less than 1 second, regardless of the setting of the ramp-time potentiometer.

Actuator Output

The actuator wires connect to terminals 9 (+) and 10 (–). Use shielded wires with the shield connected to the grounded post on the panel. Do not connect the shield to the actuator or to any other point. The shield must have continuity the entire distance to the actuator and must be insulated from all other conductors.

Some 2301As may be used to operate prime movers in tandem by wiring the two actuators in series as shown in detail A of the wiring diagram. Tandem operation with a single 2301A control requires that the two engines provide identical power response to identical current signals to each of the actuators.



NOTE

Electromagnetic Interference (EMI) can be an intermittent condition. Improperly shielded installations can provide good control for a while and then cause problems. For this reason it is important to be sure all shields are properly installed.

External Speed Trim

A jumper must be connected between terminals 11 and 12 unless an optional remote Speed Trim potentiometer is used. If a Speed Trim potentiometer is used, connect it as shown in the plant wiring diagram, using shielded wire. A 100 Ω multiturn potentiometer will provide $\pm 5\%$ speed adjustment. Potentiometers of smaller values may be used if less adjustment is desired.

Speed and Phase Matching with an SPM-A Synchronizer

Connect the SPM-A (optional equipment) wires to terminals 15 (+/-) and 16 (com). Use shielded wire and connect the shield to the ground.

Auxiliary Input

Terminals 17 (–) and 15 (+) are used for auxiliary input from a load sensor. Use of the load sensor and parallel lines allow the 2301A Speed Control to be used in isochronous load-sharing circuits. If the load sensor is not used, droop must be used to share load. (An exception is a multiple engine installation in which one engine is operated isochronously and all other engines are operated in droop.)

Speed Sensor

Connect a speed-sensing device (a magnetic pickup (MPU) is normally used) to terminals 8 and 7. No polarity is observed. Use shielded wire and connect the shield only at the 2301A control. The shield must have continuity the entire distance to the MPU. The shield is to be insulated from all other conductors and from the MPU.

Installation Check-Out Procedure

When the installation is completed perform the following check-out procedure before beginning the start-up adjustments in Chapter 3.

1. Visual Inspection:
 - a. Check the linkage between the actuator and the prime mover for looseness or binding. Refer to the appropriate actuator manual, and Woodward manual 25070, *Electronic Control Installation Guide*, for additional information on linkage.



WARNING—MINIMUM FUEL POSITION

The actuator lever should be near, but not at, the minimum position when the fuel or steam rack is at the minimum position. This could avoid a dangerous condition caused by an engine which will not shut down.

- b. Check for correct wiring according the plant wiring diagram.
 - c. Check for broken terminals and loose terminal screws. Make sure all terminal lugs are carefully and correctly installed. (Incorrectly installed crimp-on terminals can cause governor failure.)
 - d. Check the speed sensor (MPU) for visible damage. Check the clearance between the gear and the sensor, and adjust if necessary. See Woodward manual 82510, *Magnetic Pickups and Proximity Switches for Electronic Controls*.
2. Check for Grounds.

With the power off, check for grounds by measuring the resistance between each terminal and the grounding bolt located below terminal 9. Terminals 1 and 2 are power-input terminals. Either of these terminals may be grounded in accordance with local codes or through other equipment powered from the same supply. If either is grounded, a high resistance to ground will be evident at terminals 1 through 5 on low voltage models and terminals 1 through 4 on high voltage models. grounds present on these terminals will not normally affect operation, unless they interfere with the input power or switching logic. Grounds on terminals 7 through 17, detected by readings other than infinity, should be located and removed.

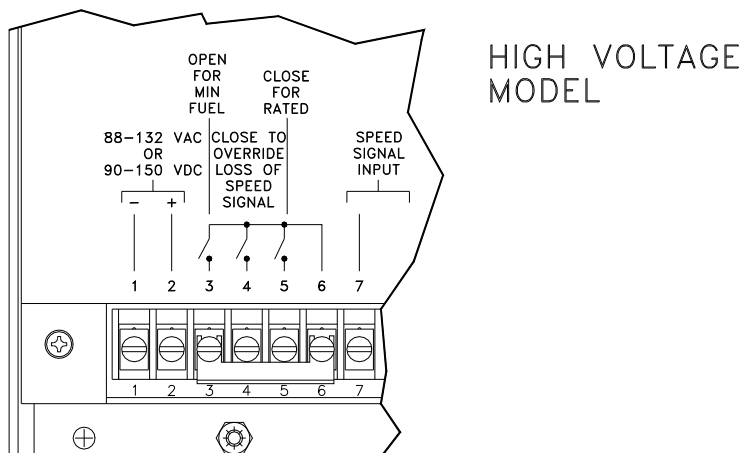
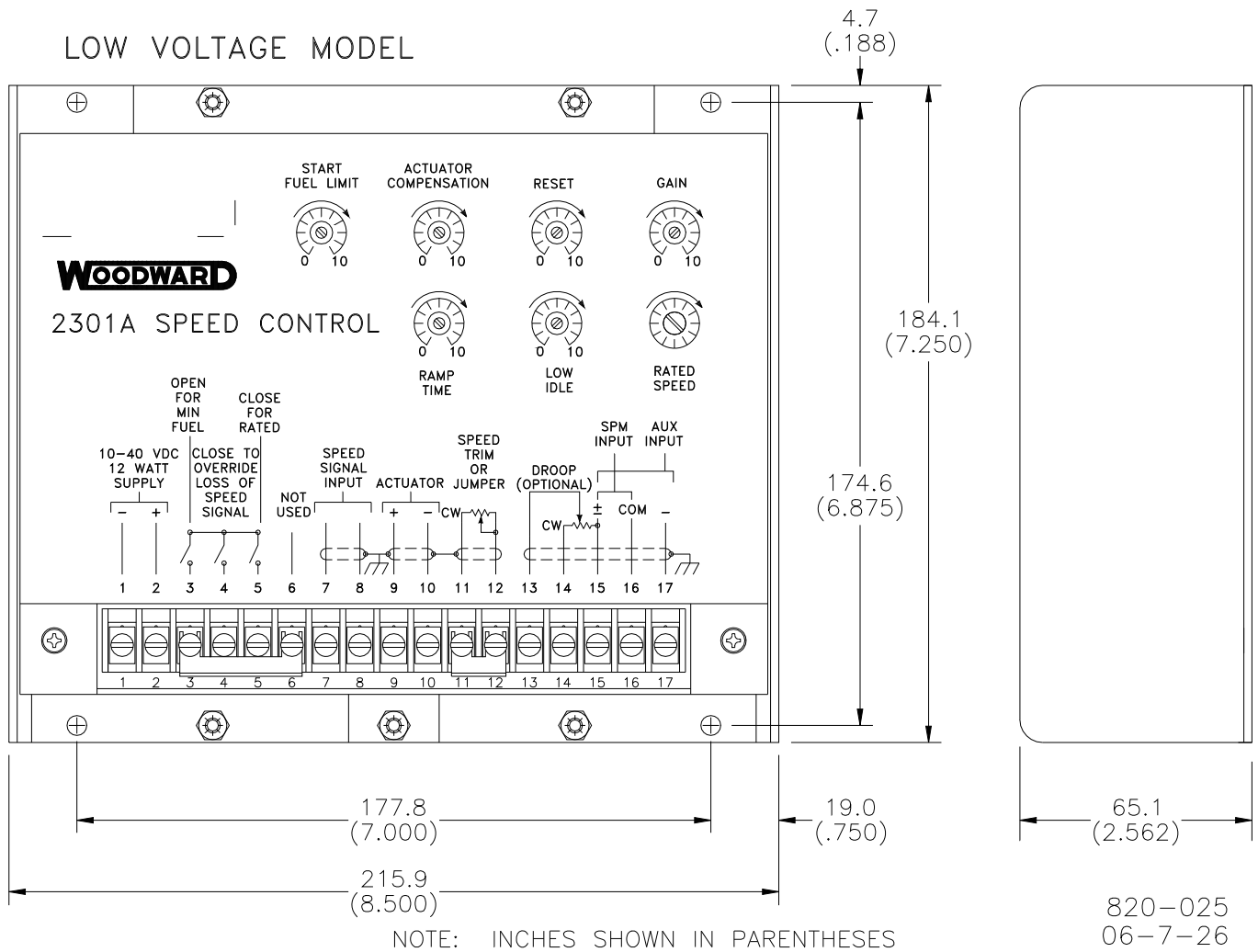


Figure 2-3. Outline Drawing of 2301A Speed Control

Heat in the circuit will open a circuit breaker in the 2301A. Circuit breaker will automatically reset after a cooldown.

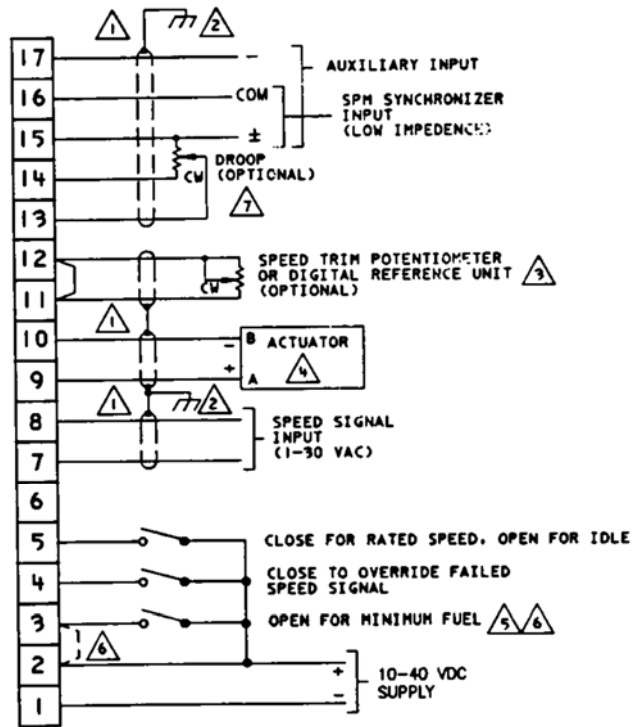
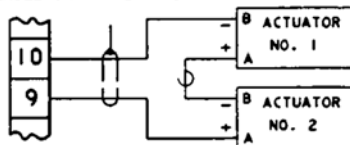


Figure 2-4. Low Voltage Plant Wiring Diagram

NOTES:

- 1 SHIELDED WIRES TO BE TWISTED PAIRS OR TRIPLETS WITH SHIELD GROUNDED AT CONTROL END ONLY.
- 2 GROUND SHIELDS AT GROUNDING LUG ON THE CHASSIS PLATE BELOW TERMINAL 9. KEEP GROUNDING CONNECTIONS UNDER 2 INCHES (5 CENTIMETERS) LENGTH.
- 3 REMOVE JUMPER BETWEEN TERMINALS 11 & 12. IF SPEED TRIM POTENTIOMETER OR DIGITAL REFERENCE UNIT IS USED. IF SPEED TRIM POTENTIOMETER IS USED, A HIGH QUALITY 100 OHM, 10 TURN, POTENTIOMETER SIMILAR TO WOODWARD P/N 1657-537 IS RECOMMENDED. 100 OHMS WILL GIVE APPROXIMATELY $\pm 5\%$ SPEED ADJUSTMENT.
- 4 FOR SERIES OR TANDEM OPERATION, SEE DETAIL "A".



DETAIL "A"
CONNECTION FOR SERIES
OR TANDEM OPERATION

- 5 **WARNING:** DO NOT USE FOR EMERGENCY SHUTDOWN. THE PRIME MOVER SHOULD BE EQUIPPED WITH A SEPARATE OVERSPEED, OVERTEMPERATURE OR OVERPRESSURE SHUT-DOWN DEVICE(S), TO PROTECT AGAINST RUNAWAY OR DAMAGE TO THE PRIME MOVER WITH POSSIBLE PERSONAL INJURY OR LOSS OF LIFE.
- 6 REMOVE JUMPER IF MINIMUM FUEL SWITCH IS USED.
- 7 USE A 2K POTENTIOMETER FOR UP TO 7.5% DROOP WHEN USING 2/3 ACTUATOR TRAVEL FOR 0 TO 100% LOAD. MAKE NO CONNECTION TO TERMINALS 13 AND 14 IF DROOP IS NOT REQUIRED.
- 8 GROUND AS REQUIRED BY LOCAL WIRING CODE.
- 9 A SOLID GROUND CONNECTION MUST BE MADE FROM "EARTH" OR "GROUND" TO THE GROUNDING LUG ON THE CHASSIS PLATE BELOW TERMINAL 9 TO PROVIDE PROPER CHASSIS GROUNDING. REFER TO LOCAL WIRING CODES FOR PROPER GROUNDING METHODS.

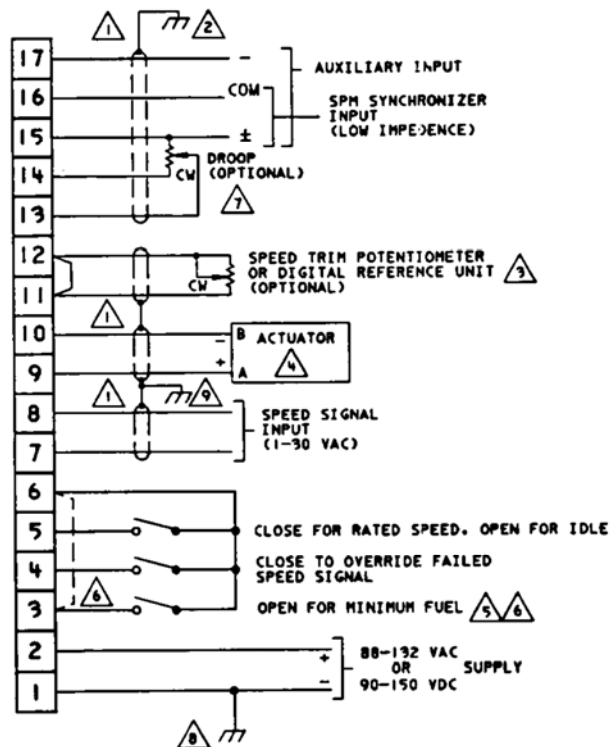


Figure 2-5. High Voltage Plant Wiring Diagram

Chapter 3. Operation and Adjustment

Initial Pre-Start Settings



WARNING—OVERSPEED

Overspeed with resultant equipment damage, personal injury, or death is possible when setting up a control system. Read this entire procedure before starting the prime mover for the first time.



CAUTION—DO NOT TURN POTS BEYOND THEIR STOPS

The Rated Speed potentiometer is the only multi-turn pot in this control. All other pots are single-turn. Take care not to turn these pots beyond their stops.

1. RATED SPEED
 - a. Set the RATED SPEED potentiometer to minimum (fully counterclockwise on ten-turn potentiometer).
 - b. Set the external SPEED TRIM, if used, to mid-position.
2. RESET—Set at mid-position. (One-turn potentiometer)
3. GAIN—Set at mid-position. (One-turn potentiometer)
4. RAMP TIME—Set at minimum (fully ccw, one-turn potentiometer—**be careful not to overtorque the pot**).
5. LOW IDLE SPEED—Set at minimum (fully ccw one-turn potentiometer—**be careful not to overtorque the pot**).
6. DROOP—Set optional external droop (if used) at minimum (fully counterclockwise, one-turn potentiometer—**be careful not to overtorque the pot**).
7. ACTUATOR COMPENSATION (One-turn potentiometer)
 - a. DIESEL, GAS TURBINE, FUEL-INJECTED GASOLINE PRIME MOVERS: Set the ACTUATOR COMPENSATION potentiometer at 2 on the 0 to 10 scale.
 - b. CARBURETED GAS OR GASOLINE or STEAM TURBINE PRIME MOVERS: Set the ACTUATOR COMPENSATION potentiometer at 6 on the 0 to 10 scale.
8. START FUEL LIMIT—Set at maximum (fully cw one-turn potentiometer—**be careful not to overtorque the pot**).
9. Be sure the actuator is connected to terminals 9 (+) and 10 (–).

Start-up Adjustments

1. Complete the installation checkout procedure in Chapter 2, and the initial prestart settings above.

2. Close the Close for Rated contact. If the external droop feature is being used it should already be set at isochronous, fully ccw (***be careful not to overtorque the pot***).

**NOTE**

This is for initial prime mover start-up only. For normal start-up, the Close for Rated contact should be open if the prime mover is to start at idle.

3. Apply input power to the control.
4. Preset rated speed.

If a signal generator is not used, set the RATED SPEED potentiometer at minimum (fully counterclockwise).

If a signal generator is used set the signal for the frequency of the speed sensor at rated speed, and connect it to terminals 7 and 8. (The rated speed frequency in Hz equals the rated engine speed in RPM times the number of teeth on the speed sensing gear, times the ratio of engine speed to speed-sensing-gear speed, divided by 60.) Put the Close For Rated contact in rated (closed) position. Set the speed trim potentiometer (if used) to mid-position. Connect a dc analog voltmeter to terminals 9 (+) and 10 (–) to read actuator voltage.

If the actuator voltage is at minimum (about 0 volts) slowly turn the RATED SPEED potentiometer clockwise (counterclockwise for reverse acting controls) until the voltage just begins to move toward maximum.

If the actuator voltage is at maximum, slowly turn the RATED SPEED potentiometer counterclockwise (clockwise for reverse-acting controls) until the voltage just begins to move toward minimum.

Continue to very slowly adjust the RATED SPEED potentiometer in the appropriate direction, trying to stop the actuator voltage between the minimum and maximum voltages. Because it is not possible to stop the motion, cease adjusting when the voltage changes very slowly. The RATED SPEED potentiometer is now set very close to the desired speed. A slight adjustment when the engine is running will achieve the exact speed.

5. Check the speed sensor.

Minimum voltage required from the speed sensor to operate the electronic control is 1.0 Vrms, measured at cranking speed or the lowest controlling speed. For this test, measure the voltage while cranking, with the speed sensor connected to the control. Before cranking, be sure to prevent the prime mover from starting. At 5% of the lower value of the control's speed range, the failed speed sensing circuit is cleared. For example 100 Hz is required on the 2000 to 6000 Hz speed range ($2000 \text{ Hz} \times .05 = 100 \text{ Hz}$).

**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.

Adjust for Stable Operation

If prime-mover operation is stable, go to the "Speed Setting Adjustment" procedure.

If the prime mover is hunting at a rapid rate, slowly decrease the gain (turn the potentiometer counterclockwise) until performance is stable. Adjusting the gain may cause a momentary speed change which can be minimized by turning the gain potentiometer slowly.

If the prime mover is hunting at a slow rate, increase the RESET setting (turn the potentiometer clockwise) until the prime mover stabilizes. If increasing the RESET potentiometer setting does not stabilize the prime mover, it also may be necessary to either:

- Slowly decrease the GAIN (turn the potentiometer counterclockwise) or
- Slowly decrease the GAIN and increase the ACTUATOR COMPENSATION.

Speed Setting Adjustment

With the prime mover operating stably, and the external speed trim potentiometer (if used) set at mid-position, adjust the RATED SPEED potentiometer to bring the prime mover to the desired operating speed.

Dynamic Adjustment

The object of the GAIN AND RESET potentiometer adjustments is to obtain the optimum, or desired, stable prime-mover-speed response.



NOTE

Adjusting the GAIN may cause momentary changes in speed which can be minimized by turning the GAIN potentiometer slowly.

Increasing the setting of the GAIN potentiometer provides faster transient response (decreases the magnitude of the speed change from a sudden change in load). To achieve optimum response, slowly increase the GAIN (turn the potentiometer clockwise) until the actuator becomes slightly unstable, then slowly turn the GAIN back counterclockwise as necessary to stabilize the actuator. Step load the generator, or bump the actuator terminal shaft, to make sure that the prime mover returns to the proper speed with little overshoot or undershoot of the speed setting. To reduce overshoot, increase the RESET setting (turn the potentiometer clockwise).

When the RESET potentiometer is in the lower part of its adjustment (0 to 3 on the scale), increasing the RESET clockwise may require decreasing the GAIN (turning the GAIN potentiometer counterclockwise) to maintain stable operation.

If the prime mover is slow in returning to the proper speed, decrease the RESET by turning the potentiometer counterclockwise.

Figure 3-1 illustrates prime mover starts with the RAMP TIME potentiometer fully counterclockwise (no ramp—**be careful not to overtorque the pot**), step loadings at four different RESET potentiometer settings, and stable, steady-state running conditions. These are typical performance curves on a naturally aspirated (non-turbocharged) diesel engine.

**NOTE**

Optimum performance is not necessarily obtained with the GAIN potentiometer at the maximum stable clockwise position. In some cases, the gain must be reduced slightly to ensure stability under widely varying conditions.

Actuator Compensation Adjustment

If the ACTUATOR COMPENSATION is set as described under INITIAL PRESTART SETTINGS, no further adjustment is normally required. If a slow, periodic instability remains, slightly increase the ACTUATOR COMPENSATION (turn the potentiometer clockwise) and repeat the GAIN and RESET adjustments. Continue to increase the ACTUATOR COMPENSATION and readjust the GAIN and RESET until stability is achieved.

If a fast instability or extremely active actuator is evident, slightly decrease the ACTUATOR COMPENSATION (turn the potentiometer counterclockwise). If necessary, the ACTUATOR COMPENSATION may be set fully counterclockwise (**be careful not to overtorque the pot**). This may be required when engine torsionals cause excessive fuel-linkage movement.

Low Idle Speed Adjustment

1. The prime mover should be at rated speed with the LOW IDLE SPEED potentiometer set at maximum (fully clockwise—**be careful not to overtorque the pot**). Open the external CLOSE FOR RATED contact.
2. Decrease the LOW IDLE SPEED (turn the potentiometer counterclockwise) until the recommended idle speed is reached.

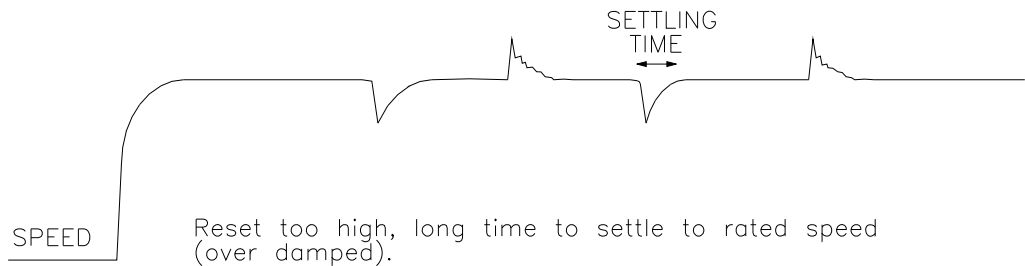
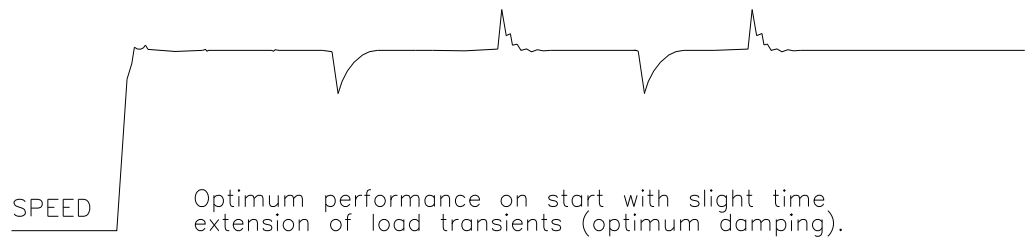
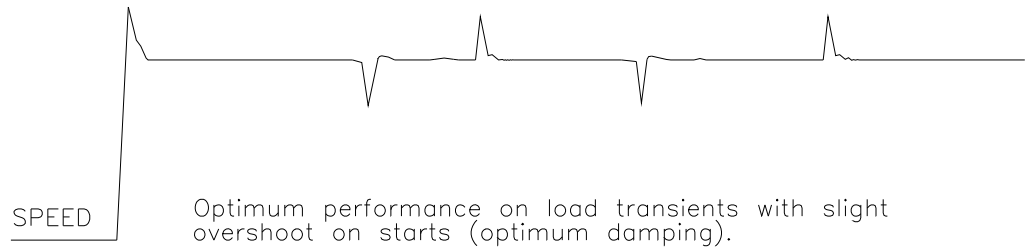
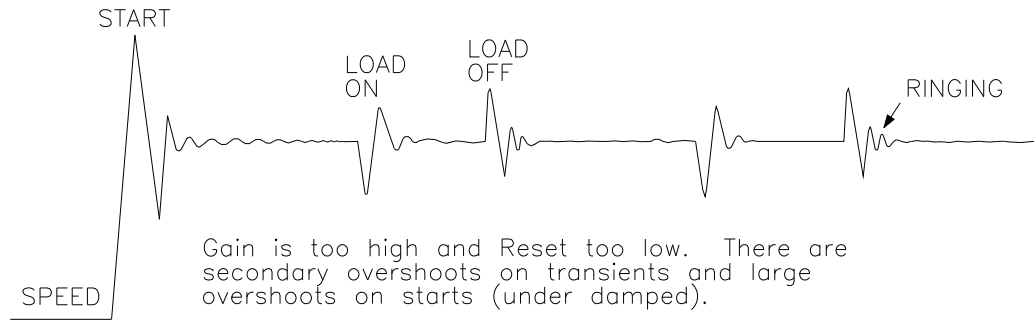
If the RATED SPEED setting is changed, LOW IDLE SPEED will also be changed and may require readjustment. Changing the LOW IDLE SPEED does not change the RATED SPEED setting.

**NOTE**

Make certain that the prime-mover speed is controlled by the LOW IDLE SPEED potentiometer in a range above the minimum-fuel position (mechanical stop) of the actuator or prime-mover fuel rack.

Ramp Time Adjustment

Adjust the RAMP TIME potentiometer to achieve satisfactory prime mover acceleration to rated speed with minimum overshoot. First start at the fully clockwise (maximum ramp time—**be careful not to overtorque the pot**) position and work back in the counterclockwise direction until the unit ramps as rapidly as desired. (Ramp time will be adjustable from 1 to 22 seconds from idle to rated.



825-303
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Figure 3-1. Diesel Engine Performance Curve

Start Fuel Limit Adjustment

**NOTE**

Start-fuel limit is not recommended for use with reverse-acting controls. With loss of speed signal, the reverse acting control will position the actuator at the start-fuel level if the failed-speed-signal override is activated. Reverse-acting systems normally require the control to demand full fuel on loss of speed signal to allow the mechanical backup governor to control the system. The Start Fuel Limit can be deactivated by turning the potentiometer fully clockwise (*be careful not to overtorque the pot*).

With the prime mover operating at rated speed and no load, record the voltage across the actuator terminals 9 (+) and 10 (–). Shut down the prime mover and activate the Failed Speed Signal Override by closing the override contact. The voltage to the actuator should now be adjustable by the START FUEL LIMIT potentiometer. Set the actuator voltage about 30% higher than the voltage obtained at rated speed for forward-acting controls and 30% lower than rated speed voltage for reverse-acting controls. Remove the Failed Speed Signal Override contact if not required to start the prime mover.

Start the prime mover and observe the start time, overshoot of speed setting, and exhaust smoke obtained. If the prime mover does not start, turn the START FUEL LIMIT potentiometer slightly clockwise until the prime mover starts. The START FUEL LIMIT may be adjusted as required to optimize the prime-mover starting characteristics. The fuel-limiting function is turned off automatically when the speed control takes over.

**NOTE**

For prime movers not requiring start-fuel limiting, the START FUEL LIMIT function can be deactivated by turning the potentiometer fully clockwise (*be careful not to overtorque the pot*).

Speed Sensor Check

If the sensor is a magnetic pickup, measure the voltage across terminals 7 and 8 to be sure there is a minimum of 1.0 volts at cranking speed, and a maximum of 30 Vrms at rated speed. If the voltage exceeds 30 volts, increase the gap of the speed sensor, and be sure that there is still a minimum of 1.0 volts at cranking speed.

Droop Adjustment

The amount of droop is not critical in many installations. If the engine needs to run in droop but the amount is not critical set the droop potentiometer in mid-position, then adjust load with the speed-setting potentiometer.

When paralleled with an infinite bus, the generator frequency cannot change, and unless a load- sensing module is being used, the control must be in droop to maintain stable operation. With the droop potentiometer at mid-position, parallel the generator, then increase the Rated Speed potentiometer until the desired amount of load on the engine is achieved.

Too much droop will cause the engine to overspeed should the load be suddenly lost. Excessive droop will also cause the engine to be sluggish in response to load changes.

Too little droop will cause instability, similar to that experienced with improperly adjusted GAIN and RESET.

Units running against an isolated bus often need droop set to a particular level, to prevent excessive off speed when load changes. Droop is usually expressed as a percentage and calculated by the following formula:

$$\% \text{ Droop} = \frac{\text{No Load Speed} - \text{Full Load Speed}}{\text{No Load Speed}} \times 100$$

To set a specified amount of droop using an isolated bus for the load:

1. Set the droop potentiometer to mid-position. (Use a 2K potentiometer, connected to terminal 14 (cw), 13 (wiper), and 15 (ccw).
2. Start the prime mover and adjust the RATED SPEED potentiometer for rated speed with no load.
3. Apply full load.*
4. Adjust the droop potentiometers to give desired speed.

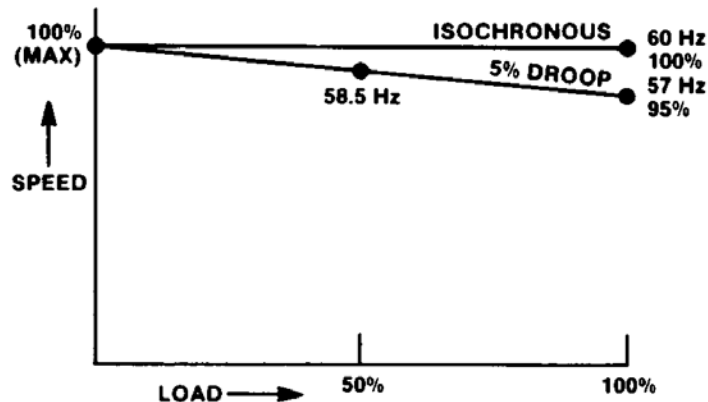


Figure 3-2. Droop Adjustment

5. Remove the load and repeat steps 2 through 4 until engine speed returns to 60 Hz when the load is removed.

Example: Operating at 60 Hz, 57 Hz at full load indicates 5% droop.

*—If only 50% loading is possible, 58.5 Hz would indicate 5% droop. See Figure 3-3.

To set a specified amount of droop on an infinite bus load:

1. With the generator not paralleled, adjust the RATED SPEED (or speed trim) potentiometer to give a speed setting above 60 Hz by the percentage of droop required.

Example: Droop of 5% would require raising the speed to 63 Hz.

2. Mark the potentiometer position and re-adjust the RATED SPEED (or speed trim) potentiometer for 60 Hz.
3. Turn the external droop potentiometer full cw for maximum droop.

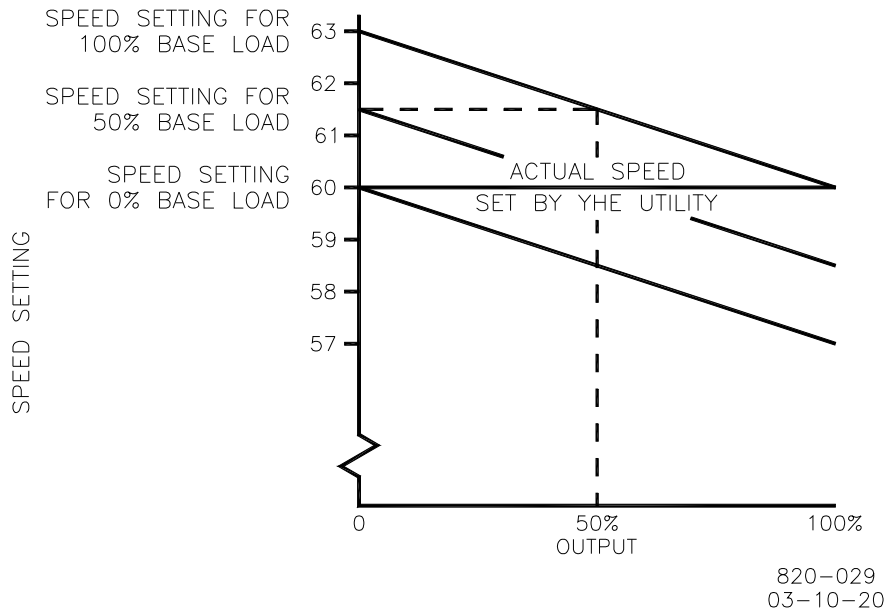


Figure 3-3. Droop Base Load with 5% Droop

4. Synchronize the generator with the bus and close the tie-breaker.
5. Return the RATED SPEED potentiometer to the mark made in step 2.
6. Load the generator by turning the droop potentiometer counterclockwise until full load is achieved.
7. Unload the generator by turning the RATED SPEED (or Speed Trim) potentiometer ccw until no load is achieved.
8. Open the tie-breaker and repeat steps 1 through 6 until no further adjustment of the external droop is required in step 6.

**NOTE**

- Droop is 10% per volt.
- Auxiliary is 3% per volt.
- Synchronizer Input is 0.667 of 1% per volt.
- Speed Trim is 10% per volt.

Chapter 4.

Description of Operation

Introduction

The 2301A Speed Control monitors prime-mover speed and maintains it at the correct operating level. With the addition of a load sensor the system will share the load with other generators when two or more systems are running in parallel.

Speed Control

The system, as shown in Figure 4-1, consists of:

- A magnetic pickup (MPU), to sense the speed of the prime mover.
- A frequency to voltage converter, to convert MPU frequency to a voltage for use in the 2301A internal circuits.
- A speed reference to which the prime mover speed is compared. (Idle and Rated speed references are provided by the 2301A Speed Control. The speed reference being used is selected by the operator with an external switch.)
- A speed summer/amplifier with an output proportional to the amount of fuel or steam required to maintain the reference speed at any given load.
- An actuator to position the fuel or steam mechanism (injector rack or steam valve) of the prime mover.

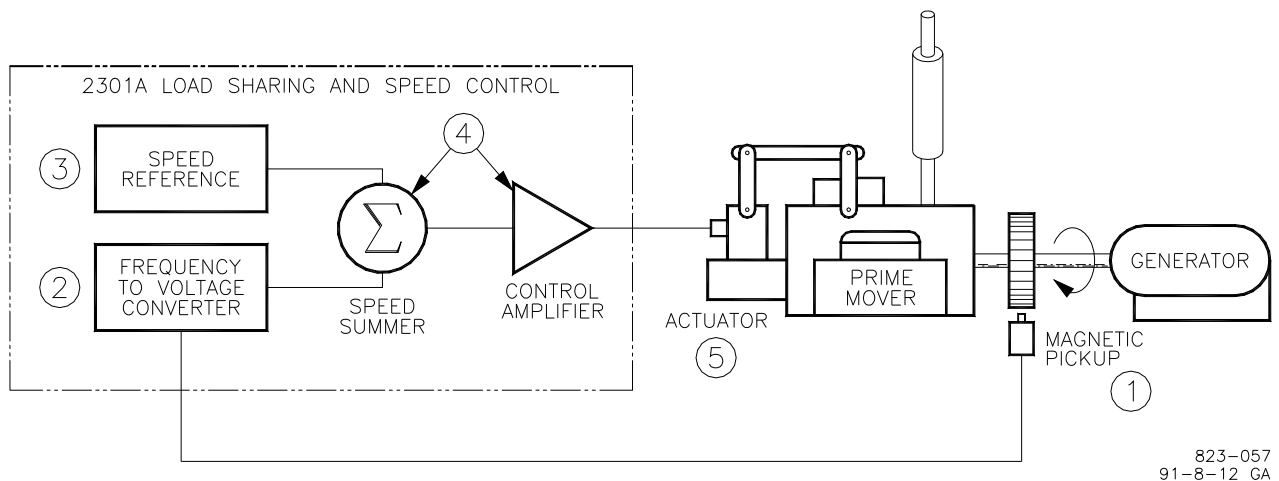


Figure 4-1. Speed Control System

The MPU generates an ac signal with a frequency proportional to prime-mover speed.

The frequency-to-voltage converter receives the MPU frequency signal and changes it to a proportional dc voltage.

The speed-reference circuit generates a dc reference voltage to which the speed signal voltage is compared.

The speed-signal voltage is compared to the reference voltage at the summing point. If the speed-signal voltage is lower or higher than the reference voltage, a signal is sent by the control amplifier calling for an increase or decrease in speed. The actuator is controlled by this signal, repositioning the fuel valve or rack until the speed-signal voltage and the reference voltage are equal.

Auxiliary Inputs

Terminals 11 through 17 are used for auxiliary inputs which change the reference voltage and thus the output of the speed control. These inputs include speed trim, droop, SPM synchronizer, and the auxiliary input, (usually from a load sensor and parallel lines).

Failed Speed Signal Circuit

A failed-speed-signal circuit monitors the speed-signal input. When no signal is detected, it calls for minimum fuel. The minimum-fuel signal is sufficient to cause the actuator to go to the minimum position. Incorrect linkage adjustments or other restrictions in the external system may prevent prime-mover shutdown.

For controls with actuator current of 20 to 160 mA, minimum fuel is defined as:

- Actuator current of less than 10 mA for forward-acting controls.
- Actuator current greater than 180 mA for reverse-acting controls.

For controls with actuator current of 40 to 320 mA, minimum fuel is defined as:

- Actuator current of less than 20 mA for forward acting controls.
- Actuator current of more than 360 mA for reverse-acting controls.

A contact to override the failed-speed-signal circuit can be connected in series with terminal 4 and low voltage dc power. (This power is available on terminal 2 for units supplied with 10 to 40 Vdc power and from terminal 6 on those units supplied with about 120 V ac or dc power.) Temporarily closing the contact overrides the failed-speed-signal circuit as required for start-up.

The control must be tuned to each system for optimum performance. The potentiometers for setting and adjusting these circuits are located in the upper right corner of the control as shown in Figure 4-2. They include:

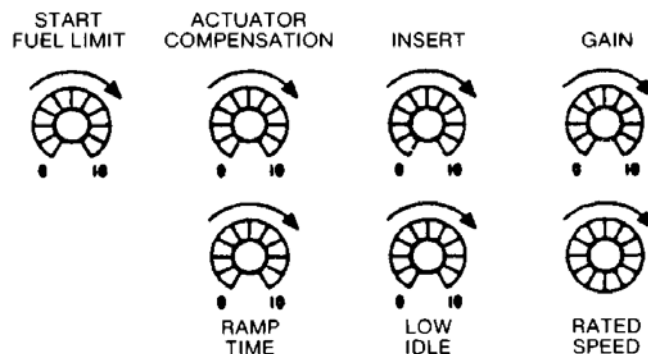


Figure 4-2. Speed Control Adjustments

- The RATED SPEED potentiometer, adjusted so the converter-speed voltage and the reference-speed voltage are equal at the desired operating speed.
- The LOW IDLE potentiometer, adjusted so the reference voltage is correct for the desired idle speed.
- The START FUEL LIMIT potentiometer to provide a means of limiting the fuel-rack position when starting diesel engines. Adjustment of the potentiometer sets the maximum actuator position from no speed until the speed control calls for a fuel setting lower than the setting of the start-fuel limit. The limit is automatically placed in the circuit whenever the speed monitor input declines below the Failed Speed Signal level. Setting the Start Fuel Limit potentiometer full cw will raise the limit above the maximum fuel position, making the limit non-effective.
- RESET, GAIN, and ACTUATOR COMPENSATION potentiometers adjust the control amplifier to accommodate various types of prime-movers. Reset adjustment affects reaction time when recovering after a sudden load change. The magnitude of the speed change resulting from a sudden change in load is controlled by adjusting the Gain potentiometer. Actuator Compensation compensates for the time the actuator and prime-mover system take to react to signals from the control.
- The RAMP TIME potentiometer sets the time required for the prime mover to accelerate from idle to rated speed.

**NOTE**

Droop and Speed Trim settings change at 10% of the existing reference per volt. The Auxiliary input causes a 3% speed change per volt. The Synchronizer input causes a 0.666% change of reference speed per volt.

Actuator Circuit Protection

The speed control is protected from shorts or overloads in the actuator circuit at terminals 9 and 10 by an automatic circuit breaker. The circuit breaker will reset automatically after the short or overload is corrected and the control has a few minutes to cool down.

Reverse Acting Controls

The reverse-acting 2301A Speed Control and its actuator are designed so that zero voltage to the actuator corresponds to maximum fuel to the prime mover. The actuator usually used with a reverse-acting control has a mechanical governing mechanism included (see Figure 4-3). The speed setting of this mechanical governor is slightly higher than the speed setting of the 2301A. Should the electronics fail, the actuator will try to go to maximum fuel but will be stopped when it gets to the speed setting of the mechanical governor, providing continued operation of the prime mover, although at a speed which is slightly higher than the electronic control speed reference.

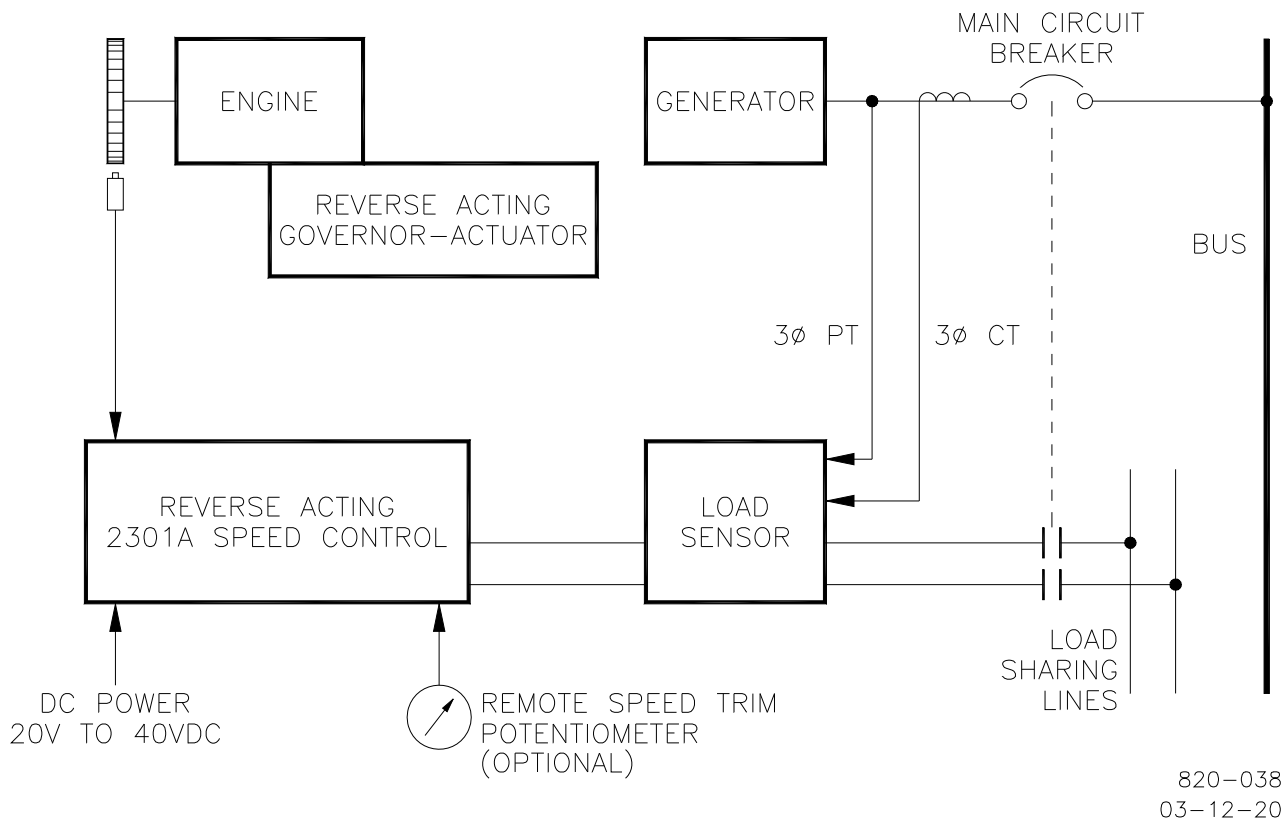


Figure 4-3. Reverse Acting System

Chapter 5.

Troubleshooting

The following troubleshooting guide is an aid in isolating trouble to the control box, actuator, plant wiring, or elsewhere. The guide assumes that the system wiring, soldering connections, switch and relay contacts, and input and output connections are correct and in good working order. Make the checks in the order indicated.



NOTE

The wrong voltage can damage the control. When replacing a control, check the power supply, battery, etc., for the correct voltage as indicated on the name tag on the control. Both high-voltage and low-voltage models of 2301A speed controls are available. The low-voltage model will be damaged if connected to a high-voltage supply. The high-voltage model will not operate with a low-voltage supply.

Symptom	Cause	Remedy
Prime mover will not start. Actuator not moving to start-fuel position.	DC supply voltage polarity reversed, no supply voltage, or supply voltage is low.	Check for supply voltage within limits indicated on control name tag. Reverse leads if dc polarity is incorrect.
	Actuator not responding to input signal from control. NOTE Hydraulic actuators must have oil pressure and either gear rotation or oil motor rotation to operate.	If there is a voltage output at terminals 9 and 10, but the actuator does not move, the wiring to the actuator should be checked for opens or shorts. With the EG3P actuator, remember that terminals C and D of the mating plug must be jumpered. Coil resistance in a Woodward actuator with terminals 9 and 10 disconnected, is about 35 Ω .
Prime mover will not start. Actuator not moving to start-fuel position.	Start fuel limit set too low.	Turn start fuel limit cw until prime mover starts. Check actuator and linkage for proper installation and operation. Problems may be oil supply, direction of rotation, insufficient drainage, linkage, worn actuator components, or improper adjustment.
	No actuator voltage at terminals 9 and 10 while cranking.	Stop cranking. Check for shorted or grounded actuator leads by removing wires to terminals 9 and 10. Close terminal 4, short terminal 11 to 12. Check for 18 to 22 volts at terminals 9 and 10 for forward acting controls and 0 to 1 volts for reverse acting controls. While cranking, check for at least 1 Vrms at terminals 7 and 8, and at least 30 to 80 Hz. If these readings are not available close terminal 4 to override failed-speed signal while cranking. MPU sensor spaced too far from gear. Make sure there are no metal chips on end of pickup. Check MPU wiring and shields. Speed setting too low on initial start. Control may be set for the wrong speed range. Check speed sensor frequency versus control part number. Speed setting may be lower than cranking speed. Control should be set for rated speed. Increase RATED SPEED setting clockwise (cw). Be sure and return rated speed setting full ccw if adjusting cw does not produce the correct output.

Symptom	Cause	Remedy
Prime mover will not start. Actuator not moving to start-fuel position (cont.).	LOW IDLE SPEED setting may be too low.	Adjust LOW IDLE SPEED potentiometer cw.
	Minimum Fuel contact open. See "MINIMUM FUEL CONTACT" in Chapter 2.	Check switch at terminal 3. Minimum-fuel contact must be closed for normal operation. Check for 0 to 3 Vdc from terminal 2 (+) to 3 (–) on low-voltage controls. (Between terminals 6 (+) and 3 (–) on high-voltage controls.
	If voltage exceeds 3 volts, the switch or wiring is faulty.	
	MPU not supplying signal to control.	Check MPU wiring for proper connection, check shields for proper installation. Magnetic pickup may be open-circuited or shorted. Check resistance with the leads disconnected from the control. Resistance should be about 100 to 300 Ω .
Prime mover will not start. Actuator not moving to start-fuel position.	Terminals 11 and 12 are open.	Verify that terminals 11 and 12 are jumpered if optional external speed trim is not used. Check the voltage from terminal 11 (+) to 12 (–). It should be less than 2 volts.
	Faulty speed trim potentiometer.	With power OFF, check speed-trim potentiometer with an ohmmeter.
	Faulty 2301A Speed Control.	Replace unit.
Prime mover overspeeds only on starts.	Ramp adjustment.	Increase RAMP TIME (cw). This decreases acceleration rate (from low idle to rated.)
	RATED SPEED setting too high.	Set RATED SPEED as described in Chapter 3.
	Amplifier adjustment.	2301A may be adjusted for sluggish operation, causing overspeed on start. Slowly adjust GAIN for fastest stable response. RESET may be adjusted too low. Increase RESET setting.
	Engine is malfunctioning.	Verify that the fuel rack is not binding and the linkage is properly adjusted. Determine if the fuel rack is quickly following the actuator input voltage. Verify proper operation of overspeed protection devices to determine if a shutdown is occurring without an overspeed condition.
	2301A Speed Control.	If the control does not cut back the actuator voltage when the speed setting is completely ccw the 2301A control may be faulty, or may have the wrong speed range. If the voltage is cut back, (increased on reverse acting controls) look for a problem in the linkage or actuator.
Prime mover overspeeds after operating at rated speed for some time.	Prime mover.	Check for proper operation of prime-mover fuel system. If actuator moves toward minimum fuel during overspeed, problem is in fuel system.
	MPU and 2301A control.	Check MPU voltage at speeds above idle (at least 1.0 Vrms). If MPU fails and the switch at terminal 4 is closed, the 2301A will call for maximum fuel.
	2301A dynamics adjustment.	Control the prime mover manually at rated speed and adjust the RATED SPEED setting fully ccw. If the output voltage is not zero, replace the control. (Voltage should be about 7 volts for 0-200 mA reverse acting controls or maximum current time actuator resistance for controls of other ratings.)
Prime mover has momentary speed change when adjusting GAIN.	GAIN adjustment made too quickly.	Make GAIN adjustment slowly. Momentary speed change when adjusting GAIN is normal.

Symptom	Cause	Remedy
Low speed is not regulated by LOW IDLE SPEED potentiometer.	NOTE On carbureted prime movers, the minimum fuel stop rpm setting will vary with prime mover temperature. An improper cold setting may interfere with the Low Idle Speed Setting when the prime mover is hot.	The Low Idle Speed setting may be below the min-fuel position of the actuator or prime-mover fuel stop. In this case, the output voltage to the actuator will be zero (maximum for reverse acting controls). The engine will be maintained at the min-fuel position by the actuator or the prime mover min-fuel stop. The conditions indicate that the min-fuel position should be decreased by linkage adjustment (diesel) or low-idle set screw (gas engine), or the LOW IDLE SPEED setting should be raised. If this does not correct the problem, the 2301A control may be faulty.
	LOW IDLE SPEED potentiometer.	If adjustment of the LOW IDLE SPEED potentiometer causes erratic behavior, replace the control.
Prime mover does not decelerate when Close for Rated contact is open.	Faulty Close for Rated contact or wiring.	The voltage from terminal 5 (–) to 2 (+) on low voltage controls or 5 (–) to 6 (+) on high voltage controls must be less than 2 volts. Replace the contact or wiring as necessary.
	LOW IDLE SPEED set fully cw (<i>be careful not to overtorque the pot</i>).	Turn LOW IDLE SPEED setting ccw with terminal 5 open.
	2301A ramp circuitry. WARNING—OVERSPEED The speed-setting controls have sufficient range to override the ramp and bring the prime-mover speed up to rated while still in the low-idle mode (because of control or switching defect). A Close for Rated contact that is intermittent may cause the prime mover to overspeed if the RATED SPEED setting is adjusted for rated speed with terminal 5 open.	A faulty Close for Rated contact may remain in the accelerate position with the contact open. If the Close for Rated contact is operative, loss of idle control may be due to a faulty circuit. In general, adjustment of LOW IDLE SPEED will vary the speed of the prime mover with the Close for Rated contact in the decelerate (open) position. Adjustment of LOW IDLE SPEED should not affect prime mover speed when the Close of Rated contact is closed.
Prime mover will not stabilize at rated no-load speed. The instability may occur at no load or it may vary with load. Control may be erratic.	2301A Speed Control.	Adjust GAIN, RESET, and ACTUATOR COMPENSATION as described in "Adjust for Stable Operation" and "Dynamic Adjustment" in Chapter 3.
	Speed setting controls.	If adjustment of external speed trim causes instability, check potentiometer with ohmmeter for erratic behavior. (Turn power off). Use non-lubricating electrical cleaner if necessary. If internal potentiometer is faulty, replace control.
	Improper linkage adjustment.	Make sure the actuator moves about 2/3 of its travel from no load to full load. Be sure linkage provides a proportional change in power for every change in actuator terminal-shaft position. Refer to the actuator manual for more detailed linkage instructions.
	Necessary wires not properly shielded.	Electrical noise, caused by wiring carrying an ac voltage or stray magnetic fields, can be picked up by improperly shielded wire. Noise will cause instability. See "Shielding" in Chapter 3.

Symptom	Cause	Remedy
Prime Mover will not stabilize.	Prime mover not receiving fuel as called for by the actuator.	Check actuator linkage to fuel-controlling mechanism for lost motion, binding, or excessive loading. Check for a steady fuel pressure of proper value.
	Prime mover not operating properly.	Prime mover may be causing speed variations. Control engine manually to determine if instability is in prime mover or governor/actuator control.
	Input voltage low.	Check voltage supply.
Prime mover unstable or will not accept full load.	EGB governor/actuator.	Verify that mechanical speed setting of EGB governor/actuator is above the set electronic speed reference at full load. Mechanical droop can cause speed setting of ballhead governor to be below electronic speed setting at full load.

Chapter 6.

Service Options

Product Service Options

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

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

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

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

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

A current list of Woodward Business Partners is available at www.woodward.com/support.

Woodward Factory Servicing Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

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

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in "like-new" condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:

- return 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.



CAUTION—ELECTROSTATIC DISCHARGE

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

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact us via telephone, email us, or use our website and reference **www.woodward.com/support**, and then **Customer Support**.

How to Contact Woodward

For assistance, call one of the following Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Electrical Power Systems

<u>Facility</u>	<u>Phone Number</u>
Australia-----	+61 (2) 9758 2322
Brazil-----	+55 (19) 3708 4800
China-----	+86 (512) 6762 6727
Germany:	
Kempen ---	+49 (0) 21 52 14 51
Stuttgart ----	+49 (711) 78954-0
India-----	+91 (129) 4097100
Japan-----	+81 (43) 213-2191
Korea-----	+82 (51) 636-7080
Poland-----	+48 12 618 92 00
United States-----	+1 (970) 482-5811

Engine Systems

<u>Facility</u>	<u>Phone Number</u>
Australia-----	+61 (2) 9758 2322
Brazil-----	+55 (19) 3708 4800
China-----	+86 (512) 6762 6727
Germany:	
Stuttgart ----	+49 (711) 78954-0
India-----	+91 (129) 4097100
Japan-----	+81 (43) 213-2191
Korea-----	+82 (51) 636-7080
The Netherlands -	+31 (23) 5661111
United States-----	+1 (970) 482-5811

Turbine Systems

<u>Facility</u>	<u>Phone Number</u>
Australia-----	+61 (2) 9758 2322
Brazil-----	+55 (19) 3708 4800
China-----	+86 (512) 6762 6727
India-----	+91 (129) 4097100
Japan-----	+81 (43) 213-2191
Korea-----	+82 (51) 636-7080
The Netherlands -	+31 (23) 5661111
United States-----	+1 (970) 482-5811

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

For the most current product support and contact information, please refer to the latest version of publication **51337** at **www.woodward.com/publications**.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

General

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

Prime Mover Information

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

Control/Governor Information

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

Woodward Part Number and Revision Letter _____

Control Description or Governor Type _____

Serial Number _____

Woodward Part Number and Revision Letter _____

Control Description or Governor Type _____

Serial Number _____

Woodward Part Number and Revision Letter _____

Control Description or Governor Type _____

Serial Number _____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please include the manual number from the front cover of this publication.



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Email and Website—www.woodward.com

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

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