WOODWARD

Product Manual 82448
(Revision B)
Original Instructions

EPG Electrically Powered Governor
Models 501 and 1701

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 *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:

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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 *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, 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 Out-of-date translations are marked with ⚠.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.

Manual 82448

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Important Definitions

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

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

⚠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.

Chapter 1.
General Information

Application

The Model 501 and Model 1701 Electrically Powered Governors (EPGs) are used to control the speed of diesel, gas, and gasoline engines, as well as gas turbines. The only difference between the two models is the actuator size. Installation of EPG actuators is simple because they require neither mechanical drive nor hydraulic supply.

IMPORTANT **This manual covers only the part numbers listed in Tables 1-2 and 1-3. Contact Woodward for information about other part numbers.**

Prime movers with mechanical loads and generator loads are handled equally well. Generator sets which will be paralleled require appropriate switch gear, current and potential transformers, and the Woodward 2500 Load Sensor.

An EPG is a three-component system. A magnetic pickup, speed control, and actuator are required.

Select the Model 501 EPG if the prime mover's fuel control requires up to 0.7 J (0.5 ft-lb) transient work. Select the Model 1701 EPG if the prime mover's fuel control requires between 0.7 and 2.3 J (0.5 to 1.7 ft-lb) transient work. The EPGs must be used only on prime movers that have low-mass, low-friction fuel controls. Some applications might need a Model 1701 EPG rather than a Model 501 due to friction which exceeds the limits of the Model 501.

A battery charger must be used to keep the battery charged. Steady state current consumption is 4 A for the 12 V Model 501, 1.5 A for the 24 V Model 501, and 3 A for the 24 V Model 1701.

Part Number Selection

Model 501 speed controls and actuators are available in versions which control prime movers with 12 and 24 volt batteries.

Additionally, speed controls are available for four ranges of magnetic pickup frequencies and for diesel engines and gas turbines or for gasoline and gas engines. Actuators are available with clockwise and counter clockwise rotation for increased fuel.

The magnetic pickup (MPU) frequency range is specified by a speed control prefix letter or its absence. Choose a speed control having a speed range which includes the magnetic pickup frequency at prime mover rated speed. The speed range of a control can be changed in the field if necessary. Follow the instructions for changing the speed range jumper in Chapter 2. In the equation, "N" is the number of gear teeth.

$$\text{MPU frequency (Hz)} = \frac{N \times rpm}{60}$$

Table 1-1. Speed Control Frequency Ranges

Speed Range (Hz)	First Part of Speed Control Part Number
750 to 1500	A 8290-
1500 to 3000	B 8290-
3000 to 6000	8290-
6000 to 12 000	C 8290-

Speed controls and actuators must be compatible. A speed control part number is compatible with an actuator part number if both are in the same box of Table 1-2 or Table 1-3. The 8256- numbers are for actuators. The 8290- numbers are for speed controls and can have a letter prefix as shown in Table 1-1.

Table 1-2. Model 501 EPGs

		Actuator Rotation for Increased Fuel	
Battery Voltage	**Prime Mover**	**CW**	**CCW**
12	Diesel or Gas Turbine	8290-029 8256-012	8290-029 8256-013
12	Gasoline or Gas	8290-032 8256-012	8290-032 8256-013
24	Diesel or Gas Turbine	8290-028 8256-010	8290-028 8256-011
24	Gasoline or Gas	8290-031 8256-010	8290-031 8256-011

Table 1-3. Model 1701 EPGs

		Actuator Rotation for Increased Fuel	
Battery Voltage	**Prime Mover**	**CW**	**CCW**
24	Diesel or Gas Turbine	8290-027 8256-008	8290-027 8256-009
24	Gasoline or Gas	8290-030 8256-008	8290-030 8256-009

Accessories

This manual includes some information about accessories frequently used with EPGs.

To Parallel Generators

Add the 2500 Load Sensor, 8271-644, to the EPG in paralleled generator applications. Woodward makes many accessories for paralleled generator applications.

To Decrease Acceleration and Deceleration

The 2500 Ramp Generator or an optional, external capacitor can be used to increase the time to go from idle to rated speeds and vice versa. The 2500 Ramp Generator provides a linear ramp with times adjustable to 25 seconds in a typical case. It is useful in smoke limiting applications. Use the 8271-802 with 24 V batteries and the 8271-804 for 12 V batteries. The capacitor provides an exponential ramp with times up to four seconds. Exponential means it changes (speed in this case) rapidly at first but slows as it reaches its final value. See note 7 of Figure 2-11 for capacitor requirements.

Reference

These publications are available on the Woodward website (www.woodward.com).

25070 Electronic Control Installation Guide
82510 Magnetic Pickups and Proximity Switches for Electronic Governors

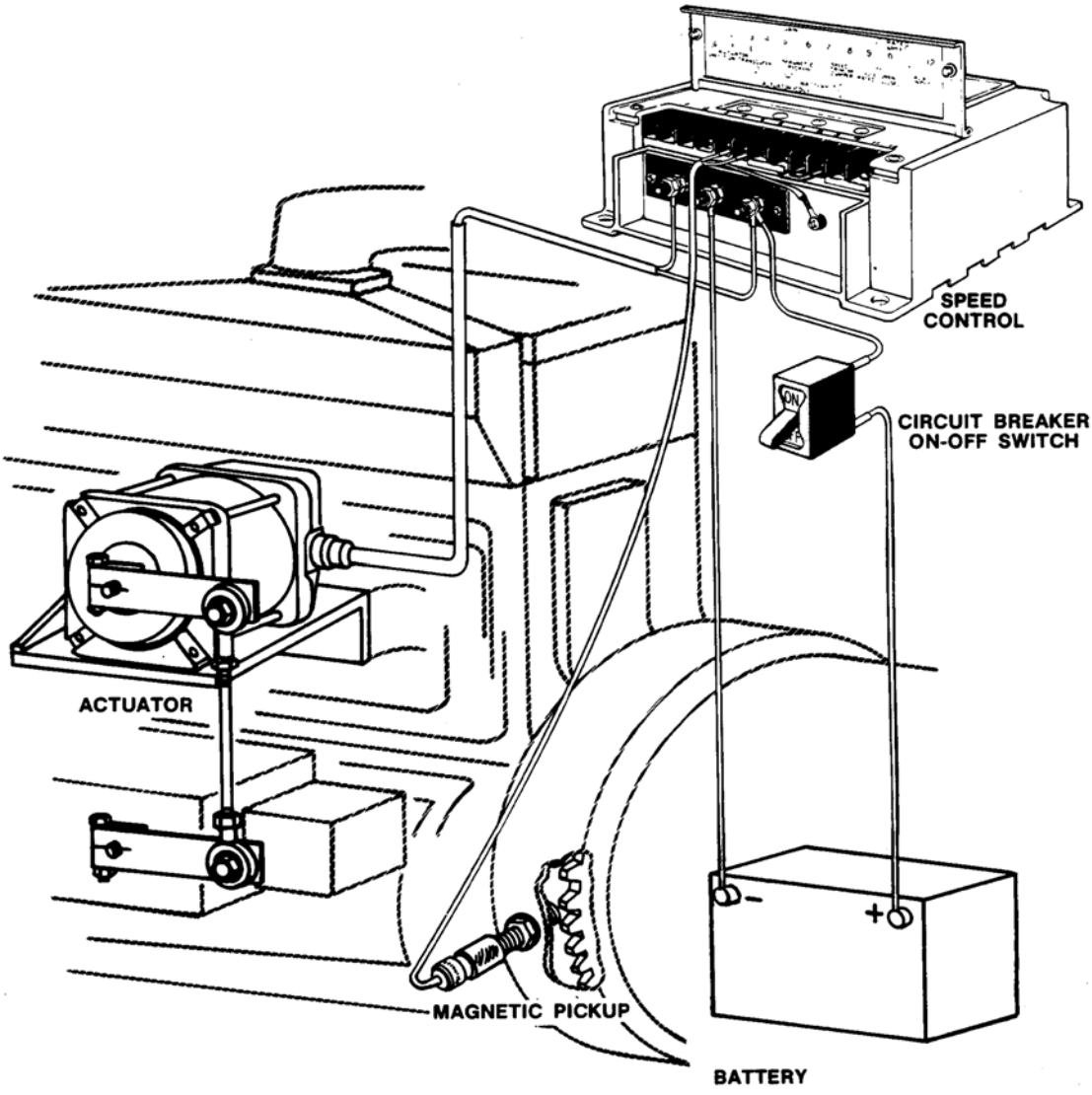


Figure 1-1. Basic EPG System

Chapter 2.
Installation, Check, and Calibration

General

Custom installation kits, including actuator mounting hardware, linkage, and actuator wiring harness are available for some specific engines. Contact Woodward for more information.

⚠WARNING

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

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

Speed Control Mounting

The speed control is designed to operate within a temperature range of –40 to +75 °C (–40 to +167 °F).

Mount the control in a location with space for adjustment and wiring access. If mounted on the prime mover do not expose the speed control to sources of radiant heat such as exhaust manifolds or turbochargers. Also choose a protected location so it won't be knocked off when moving the prime mover or when equipment is moving near by. Mount the control close to the actuator and battery to meet the wire length requirements. Refer to the Wiring paragraph in this chapter. Allow for adequate ventilation.

Actuator Mounting and Linkage

If you are using a Woodward supplied installation kit, follow its instructions and skip the next four paragraphs. Start with "Make sure the actuator is capable...". If not using an installation kit, use the following general instructions.

Actuator location must allow installation of a suitable linkage. The actuators are designed to operate within a temperature range of –40 to +82 ° C (–40 to +180 °F). Do not expose the actuator to sources of radiant heat. Actuator temperature can rise to 38 °C (100 °F) above ambient while operating.

Match the actuator's direction of rotation for increased fuel with the fuel control's direction of rotation for increased fuel by choosing a suitable linkage.

Also match linkage linearity to the fuel control. Use a linear linkage as shown in Figure 2-1 unless the prime mover has a carburetor or other non-linear fuel control. See Figures 2-2 and 2-3 for a carburetor compensating linkage. Contact Woodward if a linkage different from those shown is required. Incorrect linearity matching can cause stable operation at some fuel settings but oscillation at other fuel settings.

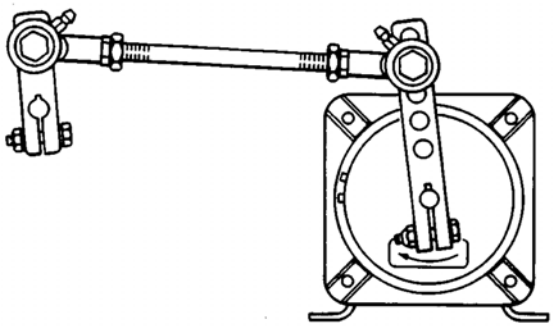


Figure 2-1. Linear Linkage

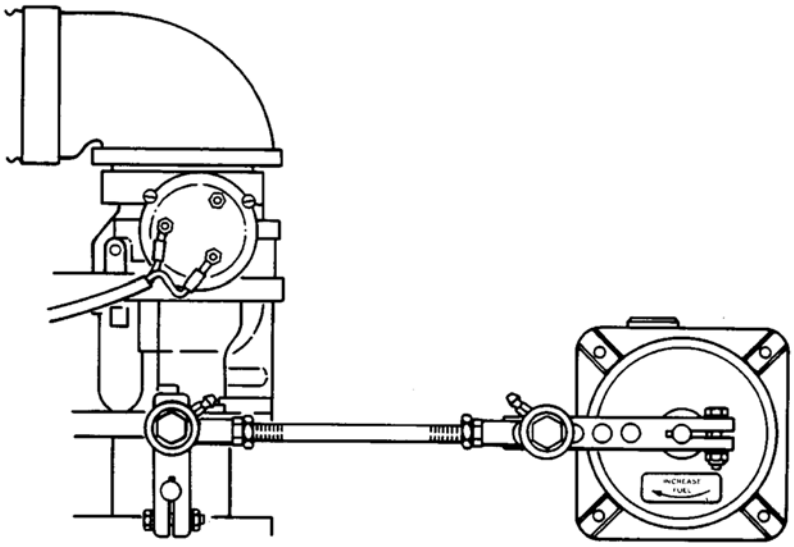


Figure 2-2.Carburetor Compensating Linkage at Minimum Fuel

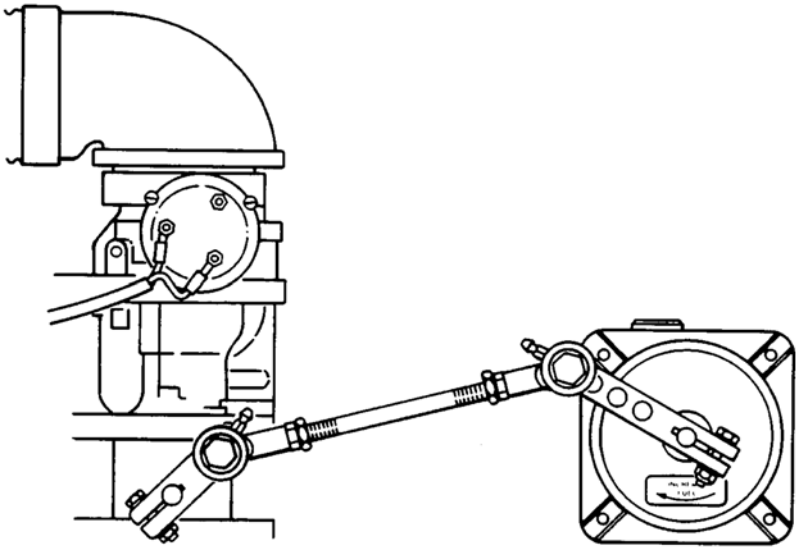


Figure 2-3.Carburetor Compensating Linkage at Maximum Fuel

Manually stroke the fuel control linkage from stop to stop as if the actuator were moving it. The linkage must move freely without friction and without backlash. Lubricate or replace linkage or fuel control parts as required.

Mount the actuator and install a suitable linkage.

A return spring is included in the actuator. Do not use an additional return spring. (Low force return springs that may be located in an engine's valve cover usually don't affect EPG performance.)

Make sure the actuator is capable of moving the fuel control to maximum and minimum limits. Let the fuel control limit actuator travel. Set the linkage so the actuator is just above minimum when the fuel control is at its minimum stop and, except for Detroit Diesel engines, so the actuator is just below maximum when the fuel control is at its maximum stop. It is recommended that Woodward installation kits be used for Detroit Diesel engines.

Use good rod end connectors. The link connecting the actuator lever to the fuel control lever must not be so long that it flexes when the prime mover is running.

Install Magnetic Pickup (MPU)

Mount the magnetic pickup through a housing or rigid bracket. Make sure the sensed gear is of magnetic material. The gap between the pickup and the outside diameter of the gear should be set to approximately 1.02 mm (0.040") at the closest point (radial runout). Using the pickup with small gears may require spacing as close as 0.25 mm (0.010").

If you cannot measure the gap directly, it can be set in this manner: with the prime mover shut down, turn the pickup in until it touches the outside diameter of a tooth. Then back out the pickup ccw approximately three-quarter turn. Run gear slowly through 360 degree rotation to check clearance of pickup. When the gap is set, tighten the jam nut securely against the housing or bracket.

The standard models of pickups require mating connectors, MS 3102R-18-3P. The connectors are not furnished with the pickup, but may be ordered from Woodward if desired. Contact Woodward or see manual 82510, *Magnetic Pickups and Proximity Switches for Electronic Governors*, for more information.

Wiring

Wire the speed control as shown in Figure 2-11. Refer to Figure 1-1 which shows the minimum connections required.

Make all connections using insulated terminals.

The actuator to speed control and the battery to speed control wiring should be as short as possible. The wire length from the actuator to the speed control must be less than 4.6 m (15 ft) for 12 V battery applications. The wire length must be less than 23 m (75 ft) for 24 V battery applications. The same length requirements apply to the wiring from the battery to the speed control. Use 3 mm^2 (12 AWG) stranded wire for these connections. The fuse and switch or circuit breaker must be in the non grounded battery lead. Use a fuse or circuit breaker as specified in Table 2-1. Do not use a fuse of higher current rating. Starter relays make good EPG power switches.

NOTICE

Make sure the battery connections have the correct polarity. Terminal 15 is battery + and terminal 14 is battery –. Incorrect polarity will damage the speed control.

Table 2-1. Switch and Fuse Requirements

Model	Voltage	Switch Rating	Fuse
501	12	20 A	10 A Slow Blow
501	24	20 A	5 A Slow Blow
1701	24	20 A	10 A Slow Blow

Table 2-2. Wire Harness Part Numbers

	Wire Length				
Connector	3.0 m 10 ft	4.6 m 15 ft	6.1 m 20 ft	7.6 m 25 ft	12.2 m 40 ft
Straight	5404-971	5404-969	5404-967	5404-965	5404-963
Right Angle	5404-961	5404-959	5404-957	5404-955	5404-953

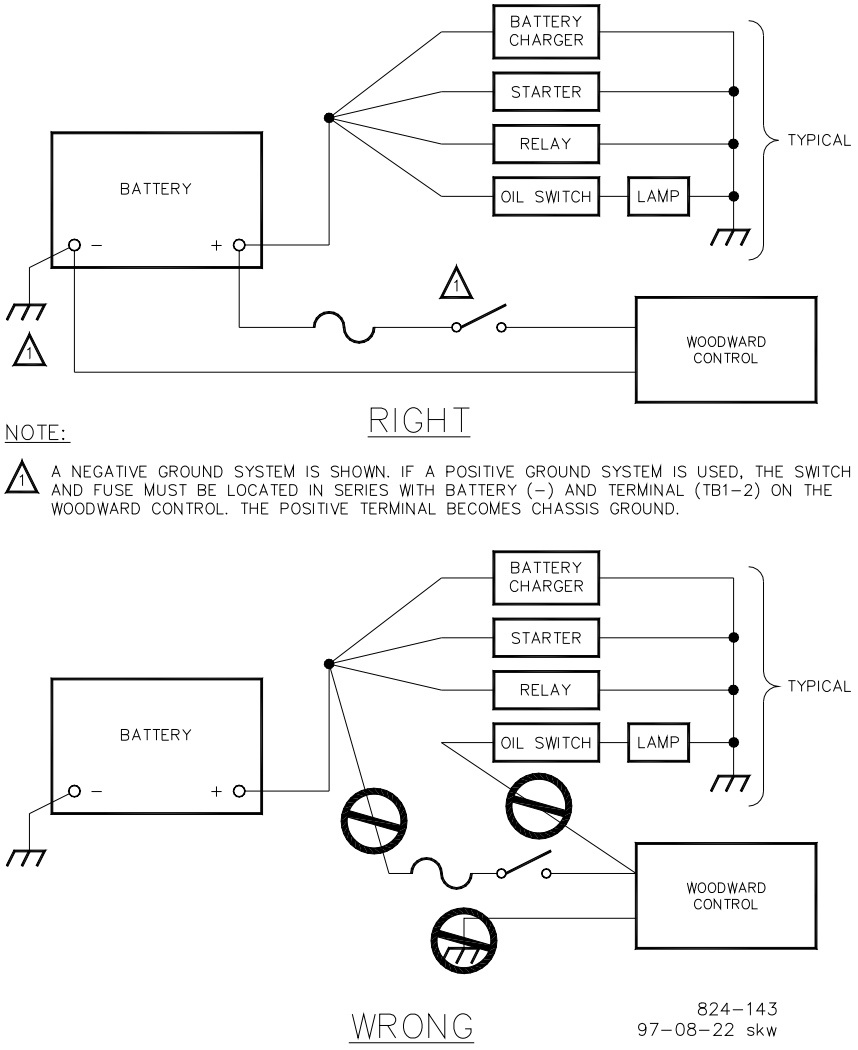


Figure 2-4. Correct and Incorrect Wiring to Battery

Figure 2-5. Typical Wiring Harness

The battery connection to speed control terminals 14 and 15 must be directly from the terminals, not through distribution points. See Figure 2-4.

NOTICE

Connect power wires directly to the battery terminals. The speed control can be damaged if these wires are connected to distribution points. See Figure 2-4.

NOTICE

To prevent damage to the control disconnect the battery charger from the battery before disconnecting the leads from the control to the battery.

Do not connect any other wires to terminals 14 and 15 except the power for the 2500 Ramp Generator, 8271-909 or 8271-910, if used.

The wire harnesses shown in Table 2-2 can be ordered from Woodward. Actuator mating connectors, without wires attached, can be ordered from Woodward. The 90° connector part number is 1631-647. The straight connector part number is 1631-191.

Shields

Connect shields as shown in Figure 2-11. Terminate shields at the chassis screw on the front edge provided for this purpose. Only one end of each shield, the end nearest the speed control, should be tied to ground. All shields are usually tied to the same point.

When passing shields through connectors and terminal block treat each shield as if it were a signal wire. Each shield must be given its own pin or terminal and be kept insulated from nearby wires and metal conductors. Do not tin (solder) braided shields.

Connect the speed control chassis to system ground ( ).

Wiring for Wide Range Speed Adjustment (optional)

Use a 10 turn, 1 kΩ potentiometer rated for 1 W and 10% tolerance. Connect the potentiometer as shown in Figure 2-11. These lines must be shielded.

Additional Wiring for 2500 Ramp Generators (optional)

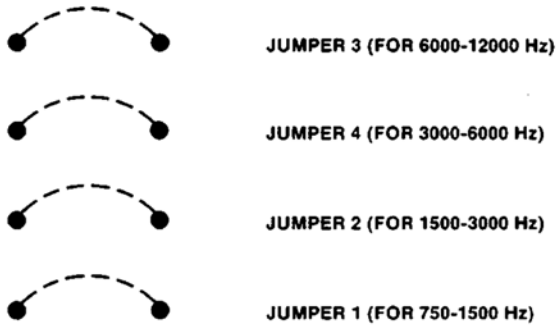
Connect the 2500 Ramp Generator terminals 1 and 2 to speed control terminals 15 and 14, respectively. Do not connect any wires other than those shown in Figure 2-11. to speed control terminals 14 and 15. Connect 2500 ramp Generator terminal 4 to speed control terminal 10 with a shielded wire. Connect the shield, at the speed control, to the grounding screw provided. Do not connect the shield at the ramp generator end.

Mount the 2500 Load Sensor where it will be between –40 and +71 °C (–40 and +160 °F). Do not mount it on the prime mover. The best location is usually the switchgear cabinet which has the CTs and PTs. Wire the 2500 Load Sensor as shown in Figure 2-12. Careful attention to correct CT and PT wiring can save time during the phasing checks later on. Install appropriate voltage selection jumpers at terminals 17 through 20. Refer to notes 6 and 7 in Figure 2-12.

Contact Woodward before connecting anything other than the 8271-644 Load Sensor to terminals 11 and 12 of the speed control.

Changing the Speed Range Jumper

The speed range can be changed by moving the jumper on the bottom of the printed circuit board. This operation requires the dc supply be disconnected from the control and that a battery powered soldering iron be used. Alternatively, an iron with the tip jumpered to Terminal 15 may be used. Failure to observe this precaution can damage the control.



Installation Checks

Checks for all Applications

The following steps check only the speed control and actuator. They must work correctly before paralleling the generator. Since most faults appear when the prime mover is first run, this step by step approach eliminates most problems before they occur. Also, the main part of Chapter 5, Troubleshooting, is doing these checks.

If a 2500 Load Sensor is used, temporarily remove the wires at speed control terminals 11 and 12. Temporarily jumper terminals 11 to 12. The generator must not be paralleled during these tests. If a 2500 Ramp Generator is used temporarily remove the wire at speed control terminal 10 that goes to the ramp generator. Leave the idle-rated switch wiring connected. Perform the checks in the order indicated. Terminal numbers in this chapter refer to the speed control.

1. Check that all electrical connections are correctly made and terminal screws tightened; the magnetic pickup is properly installed and jam nut tightened; the actuator and linkage are securely fastened.

2. Do not start the prime mover now. Turn on governor power. If the fuse or breaker opens as soon as power is applied, the battery polarity (terminals 14 and 15) is probably reversed. The actuator shaft can jump when power is turned on but must quickly come back to the minimum fuel position. Check the battery voltage at terminal 15(+) and 14(–). It must be from 10 to 16 Vdc for 12 volt EPGs and from 18 to 32 Vdc for 24 V EPGs.

3. Do the following checks only if a wide range pot is connected to terminals 1, 2, and 3. Otherwise skip to check 4. Measure voltage from terminal 3(–) to terminal 2(+). Turn wide range pot fully ccw, voltage must be zero. Slowly turn wide range pot cw, voltage must smoothly increase when pot is fully cw to 6.75 ±0.4 V for 24 V EPGs or 3.35 ±0.25 V for 12 V EPGs. If voltages are incorrect, remove wires to 1, 2, and 3. Check for correct wiring to wide range pot and measure resistance of wide range pot which must be 1 kΩ ±100 Ω. If pot and wiring check are OK, proceed to step 4.

4. For speed controls having no connections to terminals 1, 2, and 3, measure voltage from 3(–) to 1(+) and 3(–) to 2(+). In each case voltage must be 12 ± 1 V for 24 V EPGs or 8 ± 0.5 V for 12 V EPGs.

   If it is not correct, the speed control is defective. If it is correct check for voltage on the wires which were removed.

5. Set the idle pot fully ccw. Put the idle-rated switch in the rated position or jumper terminal 9 to 10. Measure the voltage from terminal 7(+) to 5(–). Put the idle-rated switch in the idle position or remove the jumper. The voltage must increase. If it does not increase, check the speed trim pot, if used, and idle-rated switch wiring.

6. If a signal generator with an isolated output is available, the failsafe and actuator travel can be checked. Rated and idle speeds can be preset. If a signal generator is not available, skip to step 7.

   Turn governor power off. Remove the magnetic pickup wires from terminals 5 and 6. Connect the signal generator to terminals 5 and 6. Set the output between 2 and 10 Vrms. The waveform can be sine, square, or triangular. Calculate the MPU frequency for idle and rated speeds. See part number selection in Chapter 1.

6.1 Check Failsafe And Actuator Travel.

Set the signal generator frequency to about half idle speed. Set the idle-rated switch to rated. Turn the signal generator and governor power on. The linkage must be at the maximum fuel position. Except for Detroit Diesel engines, verify linkage travel is limited by the prime mover fuel control, not by the actuator stop. Turn the signal generator off and remove the connections at terminals 5 and 6. The linkage should move to the minimum fuel position. Verify linkage travel is limited by the prime mover's fuel control, not by the actuator stop.

6.2 Preset Rated Speed.

Set the signal generator for MPU frequency at rated speed and connect it to terminals 5 and 6. Put the idle-rated switch in the rated position. Set the speed trim pot, if connected, to mid position. Observe the linkage position.

- If the linkage is at the maximum fuel position:
  Slowly turn the rated speed pot ccw until the linkage just begins to move to the minimum fuel position.

- If the linkage is at the minimum fuel position:
  Slowly turn the rated speed pot cw until the linkage just begins to move to the maximum fuel position.

Continue to very slowly adjust the rated speed pot in the appropriate direction, trying to stop the linkage between the minimum and maximum fuel -stops. Because it is not possible to stop the motion, cease adjusting when the linkage moves slowly. The rated speed reference is now set very close to desired speed. A slight adjustment when the engine is running will achieve the exact speed.

6.3 Preset Idle Speed.

Preset idle speed only after presetting rated speed. Set the signal generator for MPU frequency at idle speed. Put the idle-rated switch in the idle position. Observe the linkage position.

- If the linkage is at the maximum fuel position:

Slowly turn the idle speed pot ccw until the linkage just begins to move to the minimum fuel position.

- If the linkage is at the minimum fuel position:

Slowly turn the idle speed pot cw until the linkage just begins to move to the maximum fuel position.

Continue to very slowly adjust the idle speed pot in the appropriate direction, trying to stop the linkage between the minimum and maximum fuel stops. Because it is not possible to stop the motion, cease adjusting when the linkage moves slowly. The idle speed reference is now set very close to desired speed. A slight adjustment when the engine is running will achieve the exact speed.

7. If the idle and rated speed pots were not preset with a signal generator, set the rated speed pot fully ccw.

8. Remove the MPU wires from speed control terminals 5 and 6. Measure the resistance of the MPU at the wire ends. It should be between 100 and 300 Ω. Reconnect the MPU wires.

9. Set the idle-rated switch for rated speed. Turn governor power on.

10. Gain & Stability.

Set the gain and stability pots to mid position. Connect an ac voltmeter to speed control terminals 5 and 6 to measure the MPU voltage. Start the prime mover and check the MPU voltage. It must be at least 1.5 Vrms while cranking.

- If the prime mover does not start, check the linkage while cranking. If it is at the maximum fuel position, the EPG is operating correctly. Check the fuel supply, ignition, etc.

- If the linkage is not at the maximum fuel position, cranking speed can be greater than the speed reference. Measure the resistance from speed control terminal 9 to 10. It must be a short circuit (0 Ω). If not, the idle-rated switch is in the idle position or the switch or wiring is defective. Place in rated position or repair. If the resistance is 0 Ω the rated speed reference can be lower than cranking speed. Turn the rated speed pot cw four turns and try to restart. Be prepared to quickly adjust rated speed ccw to minimize overspeed if the prime mover starts. If it still doesn't start turn the rated speed pot fully ccw to minimize overspeed when it does start. Refer to Chapter 5, Troubleshooting.

When the prime mover, starts, slowly turn the gain pot back and forth to observe high and low frequency oscillation. Eliminate oscillation by slowly turning the gain pot for the stable region between high and low frequency oscillation. If the oscillation does not stop at the high-low crossover, turn the stability pot slightly ccw and slowly readjust the gain pot. Continue adjusting the stability pot slightly ccw followed by readjusting gain until the prime mover runs at a steady speed.

10.1Set Transient Response.

By turning gain slightly cw and stability slightly ccw, or vice-versa, it is possible to maintain stable speed and vary transient response. See Figure 2-6. Its four curves are examples of a naturally aspirated (not turbocharged) diesel engine. Note that increasing the gain and decreasing the stability causes shorter settling times at the expense of ringing. The use of chart recorder makes it easier to observe transient response.

All the following adjustments to gain and stability pots should be very slight. Check response after each adjustment by momentarily changing speed. Repeat the following tuning procedure until the prime mover responds as desired. Note that settings with high gain and low stability can result in stable operation at normal temperatures and oscillation when the prime mover is cold.

- To decrease settling time turn the gain pot cw. Turn the stability pot ccw as required to eliminate oscillation and obtain desired response.

- To decrease ringing turn the gain pot ccw. Turn the stability pot cw as required to eliminate oscillation and obtain desired response.

- Check response by applying and removing load, manually hitting the linkage, or quickly switching to idle speed and back to rated.

11. Setting Speed References.

The prime mover should not be oscillating. Make sure the idle-rated switch is in the rated speed position. If speeds were not preset with a signal generator, adjust the rated speed pot for exactly rated speed. Set the idle-rated switch for idle speed. Adjust the idle speed pot for desired idle speed. Set the idle-rated switch back to rated.

Checks for Applications with the 2500 Ramp Generator

Reconnect the ramp generator output to terminal 10 of the speed control. Turn the accel time and decel time pots ccw four turns. Switch from rated speed to idle and back, noting the time it takes each way. Turn accel and decel pots two turns cw. Check that it now takes longer to go from rated to idle and from idle to rated. Set each pot for the desired time.

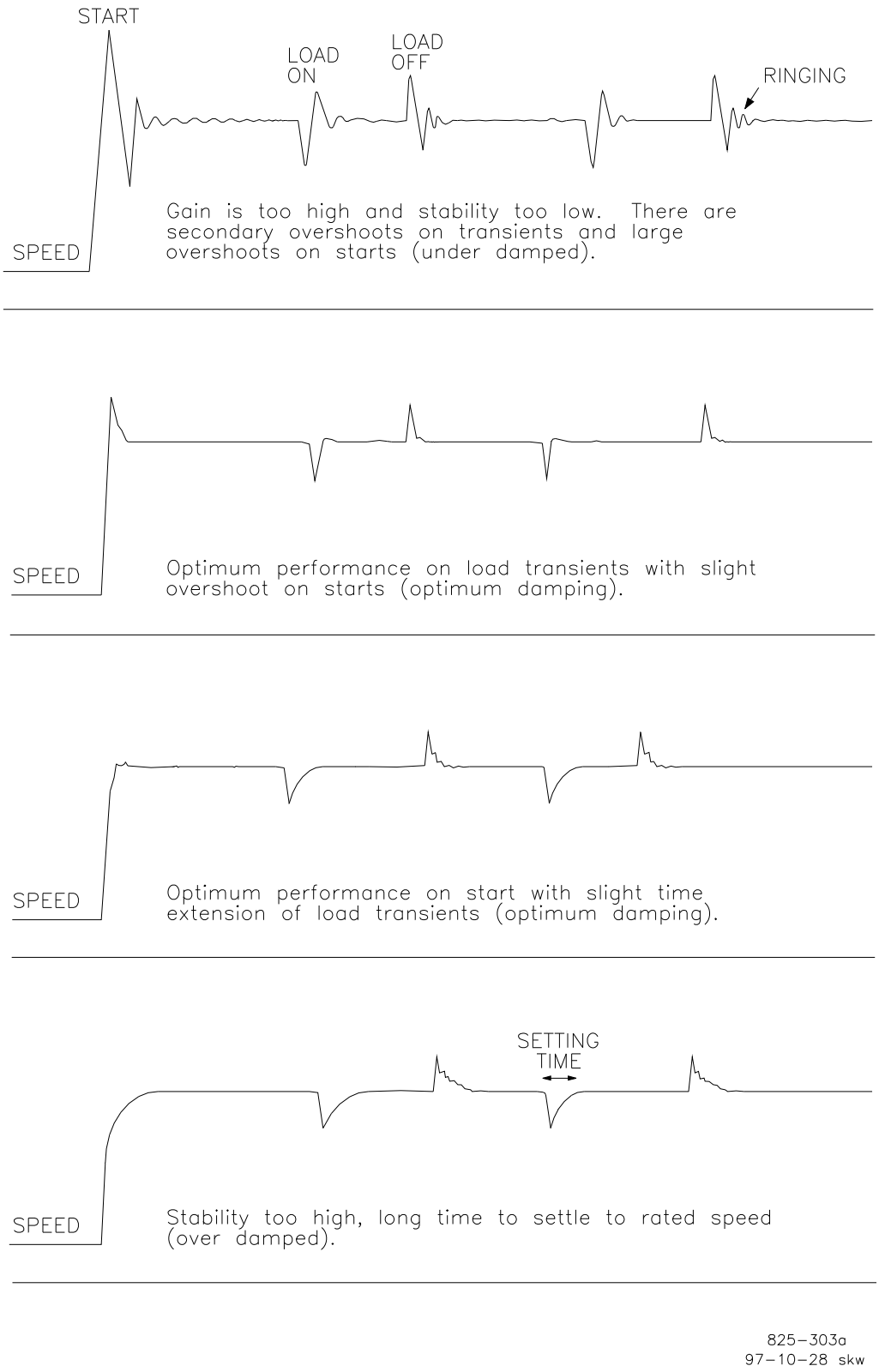


Figure 2-6. Starting and Transient Response Curves

Checks for Paralleled Generator Applications with the 2500 Load Sensor

Make these checks only after the above checks have been completed. Stop the prime mover. Remove the jumper from speed control terminal 11 to 12. Connect the 2500 Load Sensor terminal 12 to speed control terminal 11. Connect 2500 Load Sensor terminal 13 to speed control terminal 12. Make sure the other wiring conforms to Figure 2-12. Terminal numbers in the rest of this chapter refer to the 2500 Load Sensor.

⚠WARNING

Always be prepared to make an emergency shutdown when starting a prime mover after working on the governor.

1. **Pre-Start Setup**
   Set the 2500 Load Sensor droop pot fully ccw. Set the load gain pot fully cw. Select isochronous operation by closing the droop-isoch switch or jumpering terminal 23 to 24. Remove the wires from terminals 10, 11, 14, 15, and 16.

2. **Preliminary Load Gain Adjustment**
   Start the prime mover and apply load. Load the generator as close to full load as possible. If the voltage at the load signal test points is less than six, either the current or voltage transformers are incorrectly connected or the current transformer ratio is not correct and does not provide 5 amps secondary current at full load.

⚠WARNING

HIGH VOLTAGE—Never disconnect any wire attached to the 2500 Load Sensor terminals 4 through 9 (never disconnect the internal burden resistor from the current transformers) when the prime mover is running. The current transformers can develop dangerously high voltages when open circuited if the prime mover is running.

To measure current transformer secondary current, use an ac voltmeter accurate in the one volt range. Phase A current is four times the voltage across terminals 4 and 5. Phase B current is four times the voltage across terminals 6 and 7. Phase C current is four times the current across terminals 8 and 9.

3. **Current Transformer Phasing Check**
   Verify voltage and current transformer connections are correct by making this check. The check assumes unity, power factor.

IMPORTANT

Before starting the phasing check, be sure potential connections ØA, ØB, and ØC correspond to load sensor terminals 1, 2, and 3.

a. Apply full load with unity power factor. Load must be equal on all three phases. Run isochronously and not paralleled.

b. Use a dc voltmeter to measure the load signal at the test jacks.

⚠WARNING

HIGH VOLTAGE—Never disconnect any wire attached to 2500 Load Sensor terminals 4 through 9 (never disconnect the internal burden resistors from the current transformers) when the prime mover is running. The current transformers can develop dangerously high voltages If open circuited and the prime mover is running.

c. Check the phase wiring by momentarily shorting the phase A current transformer secondary (terminal 4 to 5). Use 0.8 mm² (18 AWG) or larger, short wire. The load signal should drop by one third if the load is evenly divided among the three phases. Repeat this procedure for phases B (terminal 6 to 7) and C (terminal 8 to 9), one phase at a time.

If the load signal drops by one third for each phase the phasing is correct.

If the load signal does not drop by one third for each phase the phasing is wrong. The following phasing procedure will eliminate the problem.

4. Phasing Procedure

Do this procedure only if the Current Transformer Phasing Check, above, indicates the phasing is wrong. This procedure assumes unity power factor.

a. Turn the load gain potentiometer to mid position.

b. Apply a constant load. If it is not possible to use a load bank for applying a constant load, or if load varies, use two voltmeters to make simultaneous measurements of load gain voltage and CT input voltage.

c. Short out ØB and ØC CT inputs. It is important that the jumpers be no longer than 100 mm (4 inches) and 0.8 mm² (18 AWG) or larger. .Jumper terminal connections must be low resistance and should be made with spade lugs.

d. Read ØA CT input in Vrms.

e. Read the load signal voltage at the test jacks.

f. Find the ratio 'R' where

$$R = \frac{\text{Load signal (+ Vdc)}}{\text{ØA CT signal (Vrms)}}$$

If R = +0.95, ØA is correctly wired.
If R = –0.95, ØA CT polarity is reversed.

If R = –0.5, ØA CT is interchanged with ØB or ØC.*
If R = +0.5, ØA CT is interchanged with ØB or ØC, and ØB or ØC CT polarity is reversed.*

*—It cannot be determined which phase is interchanged with ØA by testing only ØA. Repeating the above tests using ØB and ØC should indicate which phase is interchanged with ØA. If all phases yield the same result (i.e., R= + or –0.5 above), then the system should be shut down and CT inputs rotated one position (i.e., ØA to ØB, ØB to ØC, and ØC to ØA). If the same results are again observed, shut the system down and again rotate the CT inputs.

EXAMPLE 1: ØA CT connection reversed

a. With unit loaded, turn load gain potentiometer to mid position.

b. Short out ØB and ØC CT inputs. (Attach a jumper between terminals 6 and 7, and. 8 and 9.)

c. Read ØA CT input in Vrms. (Measuring between terminals 4 and 5 we get V = 1.25 Vac.)

d. Read the load signal voltage at the test jacks; observe the polarity markings (V = –1.19 Vdc).

e.

$$R = \frac{\text{Load signal (+ Vdc)} \quad -1.19}{\text{ØA CT signal (Vrms)} \quad 1.25} = -0.95$$

f. Since R = –0.95, we know that the CT connections to terminals 4 and 5 are reversed. After shutting the prime mover down, simply disconnect and interchange them.

EXAMPLE 2: ØA interchanged with ØC, ØC reversed

a. With unit loaded, turn load gain potentiometer to mid position.

b. Short out ØB and ØC CT inputs, (attach a jumper between terminals 6 and 7, and between 8 and 9).

c. Read ØA CT input in Vrms. (Measuring between terminals 4 and 5 we get V = 1.25 Vac.)

d. Read the load signal voltage at the test jacks (V = +0.62 Vdc).

e.

$$R = \frac{\text{Load signal (+ Vdc)} \quad 0.62}{\text{ØA CT signal (Vrms)} \quad 1.25} = 0.5$$

f. ØA CT is interchanged with ØB or ØC. Also ØB or ØC is reversed.

g. Short out ØA and ØC CT inputs, (attach a jumper between terminals 4 and 5, and between 8 and 9). Open jumper between terminals 6 and 7.

h. Read ØB CT input in Vrms, measuring between terminals 6 and 7 (V = +1.25 V)

i. Read the load signal voltage at the test jack (V = +1.18 Vdc).

j.

$$R = \frac{\text{Load signal (+ Vdc)} \quad +1.18}{\text{ØB CT signal (Vrms)} \quad 1.25} = -0.94$$

This indicates ØB is properly connected. We are now assured ØA and ØC are interchanged. We also know that ØC phasing is reversed because ØB was found to be correct.

k. After shutting down the engine, reverse the polarity of ØC CT (Terminals 8 and 9). Then interchange ØA and ØC CT connections. Take care to maintain correct polarity once this phasing procedure is complete.

5. Run the prime mover with full load. Measure the voltage at terminals 12(+) and 13(–). If necessary, adjust the de-droop pot for 0.0 ±0.1 Vdc. Remove the load. If the voltage is not 0.0 ± 0.1 Vdc, the 2500 Load Sensor is defective.

6. **Load Gain Adjustment**
With engine operating in single unit configuration, set LOAD GAIN control for 6.0 V measured at the LOAD S1GNAL jacks during full load. If the CT ratio does not provide 5 A at full load, it will be necessary to select a lower voltage. Set all other units in the system for the same voltage. When paralleled, adjustment of the load gain potentiometer cw will cause that unit to carry less load. If stability problems occur when paralleled at this setting, reduce the setting and set all other units for the same voltage. It may be necessary to reduce this setting to as low as 3 V in cases of extremely poor system dynamics. Consult Woodward in such cases.

IMPORTANT **Reducing the load gain voltage of all units will reduce the load sharing gain. This will result in some loss of load sharing sensitivity.**

7. **De-Droop Adjustment**
The DE-DROOP adjustment counteracts droop resulting from component tolerances. Set the system for isochronous operation at rated speed, unloaded. Load the unit to 100% (single unit operation) and adjust DE-DROOP to return to unloaded speed.

8. **Droop Adjustment**
Adjustment of the droop potentiometer is necessary when droop mode operation of the control is required. Droop can be set with either of the following methods.

Droop is usually expressed as a percentage and calculated by:

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

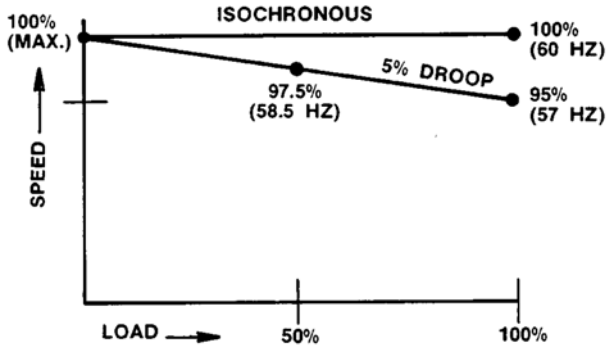


Figure 2-7. Droop Definition

For setting DROOP on an isolated load:

1. Set Mode Switch to droop position. Adjust the control for rated speed with no load.

2. Apply load, 100% load if possible.

3. Adjust DROOP potentiometer to give the desired speed. Operating at 60 Hz, 57 Hz at full load indicates 50/0 droop. If only 50% loading is possible. 58.5 Hz would indicate 5% droop. See figure 3-2, Droop Adjustment.

For setting DROOP with a system operating into an infinite bus:

1. With the generator not paralleled, adjust the RATED SPEED POTENTIOMETER to give a speed setting above 60 Hz by the percent droop required. (For example, 5% droop would require raising the speed to 63 Hz). Mark the potentiometer position and return to 60 Hz.

2. Turn the DROOP potentiometer fully cw (for maximum droop) and set the Mode Switch to droop position.

3. Synchronize the generator to the bus and parallel it to the line.

4. Return RATED SPEED potentiometer to the mark made in step 1.

5. Adjust the DROOP potentiometer ccw, decreasing droop, until 100% load is achieved.

IMPORTANT **If load other than 100% is desired, the speed pot will have to be set accordingly for desired percent droop. For example; at 5% droop a 50% load speed setting would be for 61.5 Hz.**

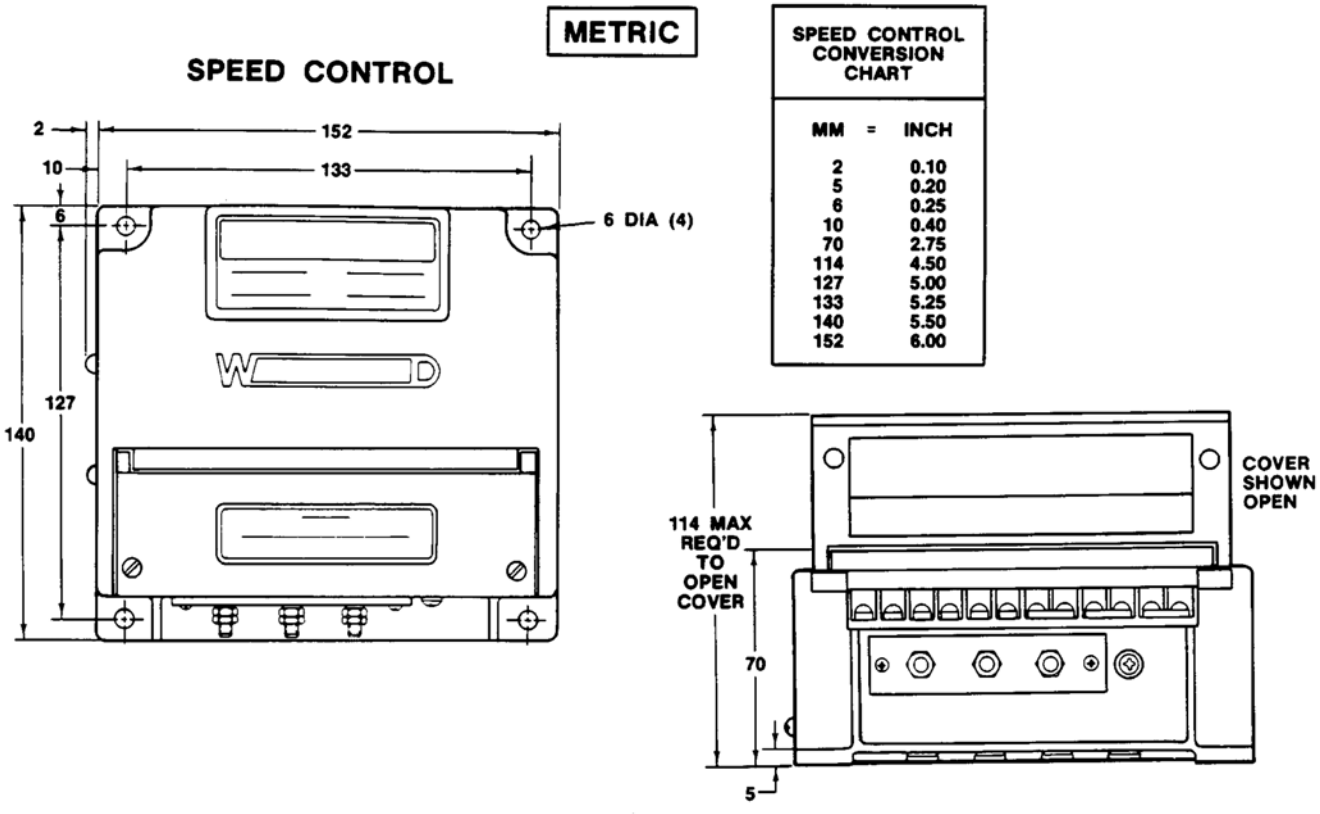


Figure 2-8. Model 501 and Model 1701 Speed Controls Outline Drawing
(Do Not Use for Construction)

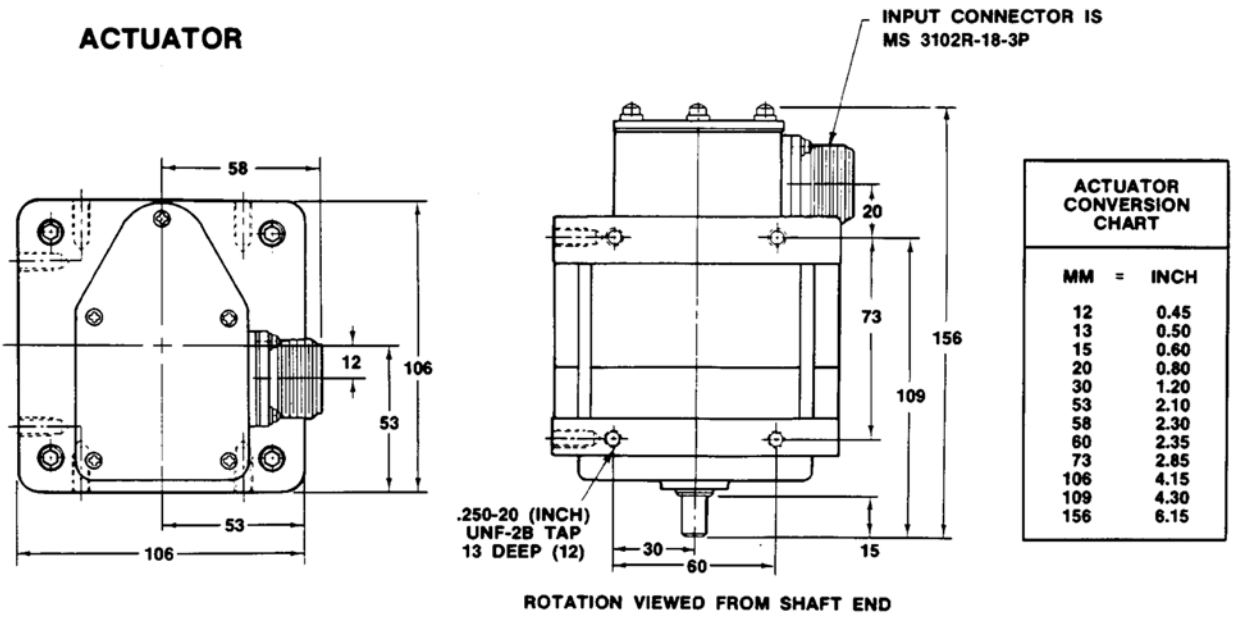


Figure 2-9. Model 501 Actuator Outline Drawing
(Do Not Use for Construction)

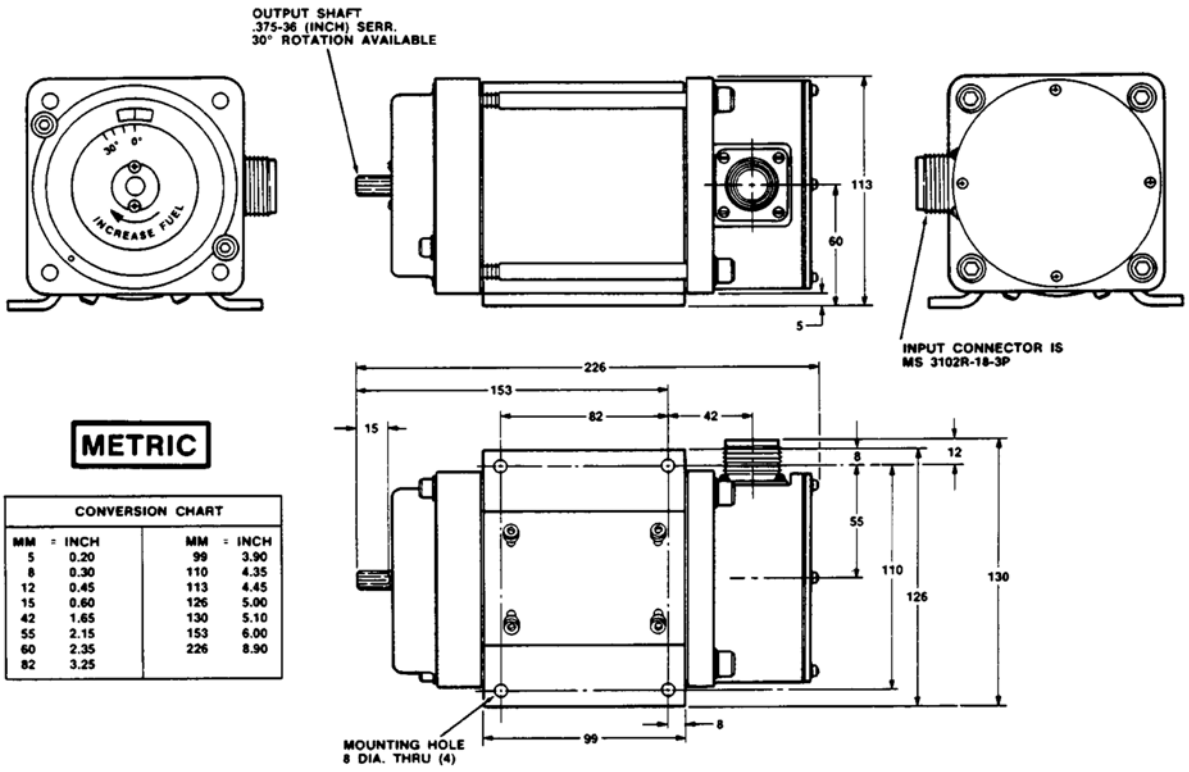
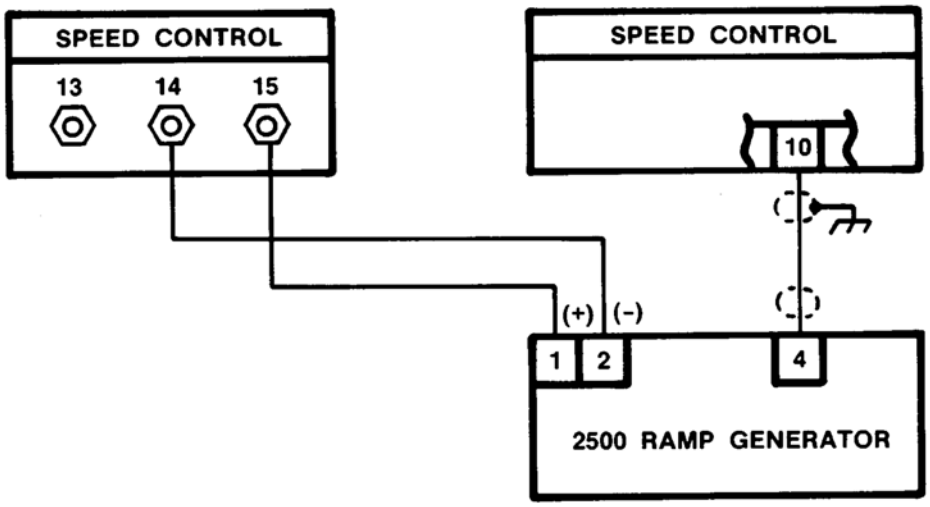
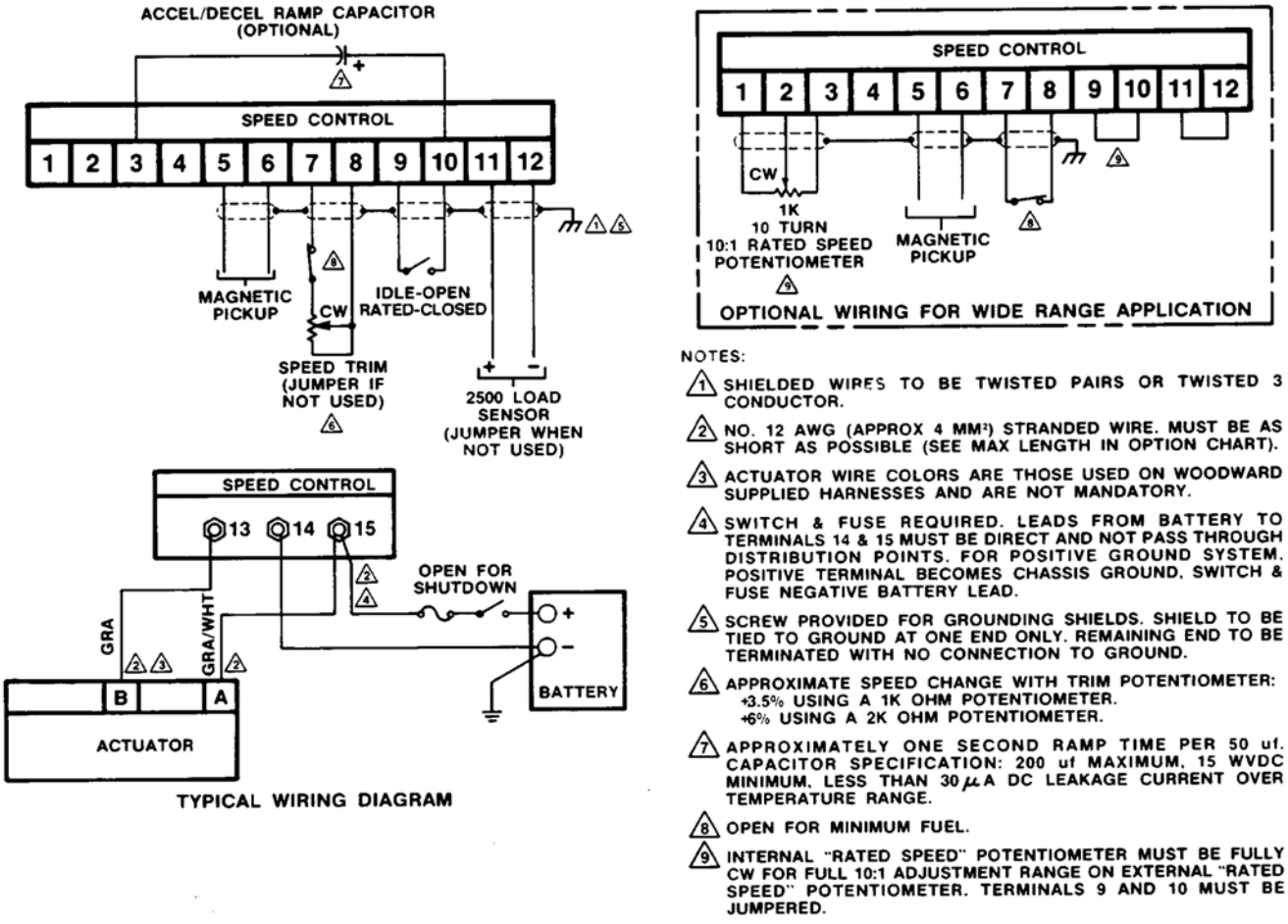


Figure 2-10. Model 1701 Actuator Outline Drawing
(Do Not Use for Construction)



Additional Wiring for 2500 Ramp Generator



NOTES:

1. SHIELDED WIRES TO BE TWISTED PAIRS OR TWISTED 3 CONDUCTOR.
2. NO. 12 AWG (APPROX 4 MM²) STRANDED WIRE. MUST BE AS SHORT AS POSSIBLE (SEE MAX LENGTH IN OPTION CHART).
3. ACTUATOR WIRE COLORS ARE THOSE USED ON WOODWARD SUPPLIED HARNESSES AND ARE NOT MANDATORY.
4. SWITCH & FUSE REQUIRED. LEADS FROM BATTERY TO TERMINALS 14 & 15 MUST BE DIRECT AND NOT PASS THROUGH DISTRIBUTION POINTS. FOR POSITIVE GROUND SYSTEM. POSITIVE TERMINAL BECOMES CHASSIS GROUND. SWITCH & FUSE NEGATIVE BATTERY LEAD.
5. SCREW PROVIDED FOR GROUNDING SHIELDS. SHIELD TO BE TIED TO GROUND AT ONE END ONLY. REMAINING END TO BE TERMINATED WITH NO CONNECTION TO GROUND.
6. APPROXIMATE SPEED CHANGE WITH TRIM POTENTIOMETER:
   +3.5% USING A 1K OHM POTENTIOMETER.
   +6% USING A 2K OHM POTENTIOMETER.
7. APPROXIMATELY ONE SECOND RAMP TIME PER 50 uf. CAPACITOR SPECIFICATION: 200 uf MAXIMUM, 15 WVDC MINIMUM. LESS THAN 30 μA DC LEAKAGE CURRENT OVER TEMPERATURE RANGE.
8. OPEN FOR MINIMUM FUEL.
9. INTERNAL "RATED SPEED" POTENTIOMETER MUST BE FULLY CW FOR FULL 10:1 ADJUSTMENT RANGE ON EXTERNAL "RATED SPEED" POTENTIOMETER. TERMINALS 9 AND 10 MUST BE JUMPERED.

Figure 2-11. Typical EPG Wiring Diagram

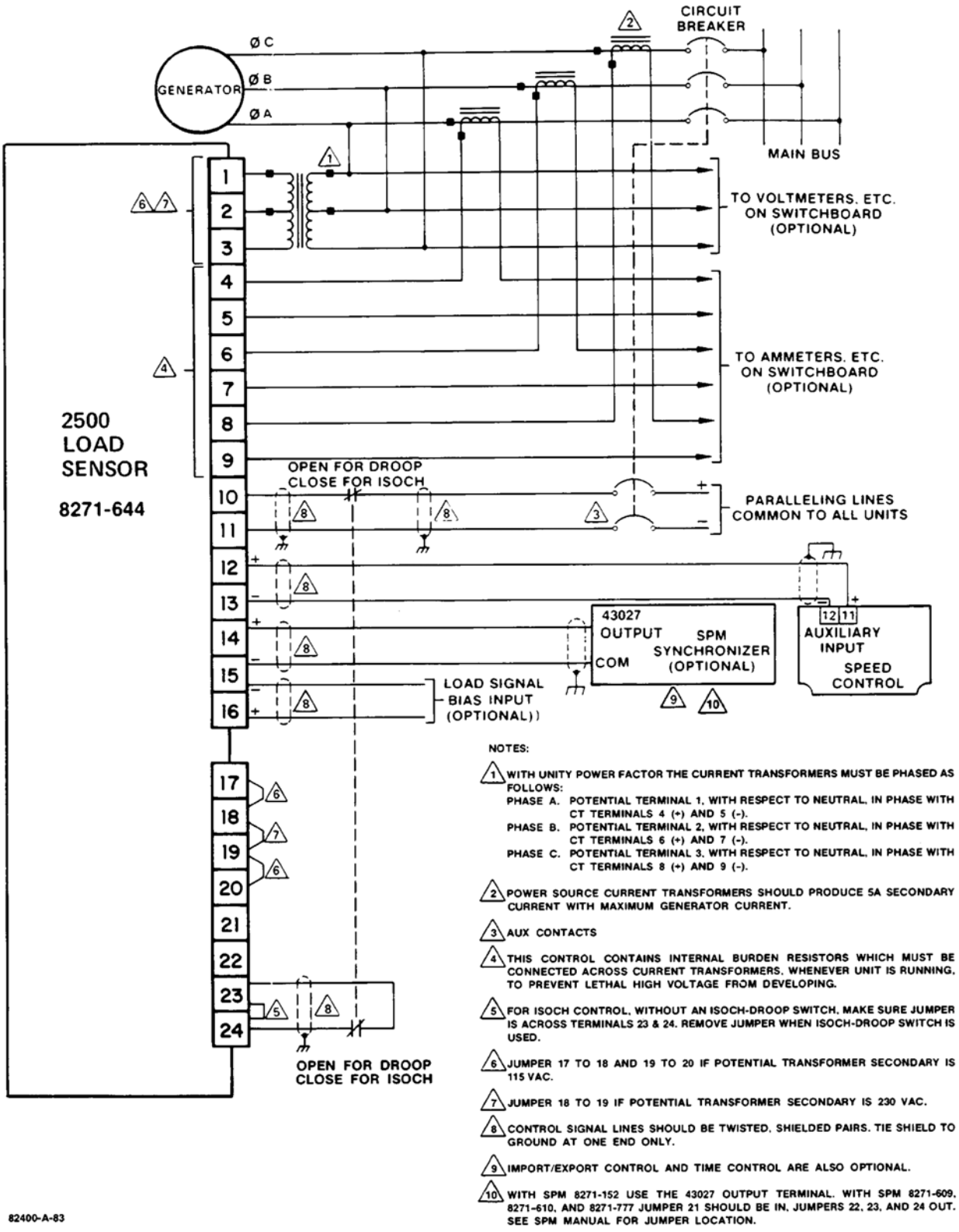


Figure 2-12. Additional Wiring for Paralleled Generator Applications

Chapter 3.
Operation

The speed control requires power on when starting, power off when stopping (power off causes shutdown if fuel flow is stopped when the fuel control is at the minimum fuel position), and idle-rated speed switching. Paralleled generator applications require synchronizing and paralleling. If paralleling in droop mode, a rated speed pot adjustment is required to set the amount of power generated.

The Electrically Powered Governors are designed for unattended operation. Governor power can be controlled by the prime mover's start-stop control. The idle-rated switch can be controlled by devices such as an oil pressure switch or a timer. Alternatively, the prime mover can run to rated speed upon starting (refer to the curves of Figure 2-6). Paralleled generator applications can be equally automatic when a Woodward SPM Synchronizer is used.

In both automatically and manually controlled applications a 2500 Ramp Generator can be used to provide adjustable time to go from rated to idle speeds.

Chapter 4. Description

Speed Control Applications

Speed Control

The basic speed control components and connections are shown in Figure 1-1. There are no mechanical drive or hydraulic connections. All input power comes from the battery. The speed control compares the actual speed with the desired speed. It then calculates an error signal and drives the actuator in the increase or decrease fuel direction to correct prime mover speed.

Figure 4-2 shows a block diagram of the Electrically Powered Governor functions. The speed control is shown as two boards. Physically, the speed control consists of a speed board mounted above a current driver board. Both are mounted in a die cast aluminum enclosure.

The EPG has two control loops. The speed loop ensures prime mover speed remains constant. The current loop ensures proper drive to the actuator.

Speed Loop

The speed loop controller has two inputs: the desired speed (speed reference signal) and the actual speed (the speed sensor signal). It compares the two and calculates an error signal which includes dynamic response considerations. Gain and stability adjustments tailor the governor s response to the requirements of the specific prime mover. There are two speed references—idle and rated. Rated speed is set by the rated speed pot and, if attached, a speed trim pot. The idle reference is controlled by the idle speed pot. Rated speed should be set before idle speed. Speed sensor output is a voltage proportional to magnetic pickup frequency. One jumper is installed to match the MPU frequency range for rated speed. Each jumper corresponds to a part number letter prefix.

Current Loop

The current loop error signal can be considered a command for the correct amount of actuator current.

The actuator’s controller circuit compares actual current (from the current sensor circuit) to the desired current level (from the speed loop controller) and generates a current loop error signal. To make the current driver efficient it is operated as a switch. Actuator current is changed by changing the duty cycle. The pulse width modulator converts the current loop error signal from a dc voltage to a switching signal. For this reason measurements of speed control output (15[+] and 13[–]) indicate only general conditions. Excessive currents are prevented from flowing through the actuator coil for long time periods by the energy limiter. It prevents the actuator from overheating but allows enough current to keep the actuator at the maximum fuel position.

The auxiliary input is jumpered except when a 2500 Load Sensor is added for paralleled generator applications. There is a failsafe circuit which senses MPU frequency and forces the speed loop error signal to zero if the MPU frequency or voltage are below acceptable limits, as they would be if an MPU wire broke. This circuit then moves the actuator to the minimum fuel position and stops the prime mover, preventing overspeed.

Actuator

As shown in Figure 4-1, the actuator is mechanically simple. It has specially designed rotor and stator shapes which provide reliable effective performance. The rotary design gives 300 shaft rotation to row mass, low friction fuel controls. The magnetic circuit, when powered by the speed control, applies torque in the increase fuel direction. A preloaded, internal return spring supplies shaft torque in the decrease fuel direction. The preload can be factory reduced to compensate for some external linkage forces acting in the decrease fuel direction.

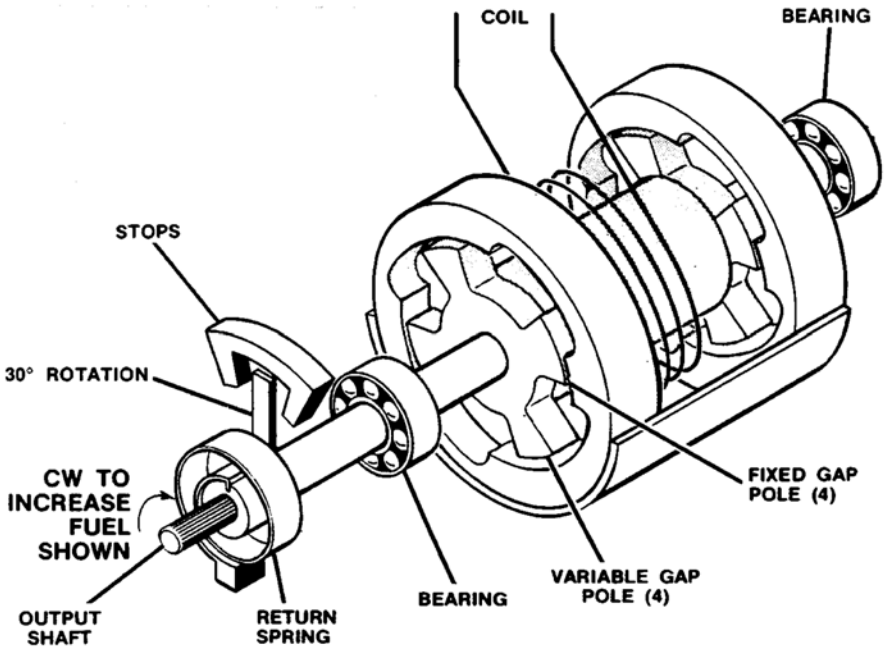


Figure 4-1. Actuator Schematic

Applications Using a Ramp Generator

The 2500 Ramp Generator slows the speed change between idle and rated speeds. It has no effect on steady state speeds. Once set it provides a constant speed change per second by biasing the speed reference when changing from idle to rated and vice versa. The accel and decel pots control the rate of change. Acceleration and deceleration times depend on accel and decel pot settings and the difference between idle and rated speeds.

Paralleled Generator Applications

A 2500 Load Sensor is used with the EPG for isochronous or droop paralleling.

With an isolated bus, isochronous load sharing is usually chosen. In an isochronous load sharing system, the load gain signal voltage is shared with all other controls through paralleling lines and provides an average load gain signal used by the controller circuits.

By comparing the paralleling line voltage to its own load gain voltage, the controller calculates an output to raise or lower, as necessary, the generator output to make the load gain voltage of its unit equal to the paralleling line. Load sensor output directly biases the speed loop controller circuit of the speed control to affect the actuator fuel level setting and precisely maintain its proportional share of system load while maintaining a fixed frequency. See Figure 2-12, Additional Wiring for Paralleled Generator Applications.

Droop operation is required when paralleling with an infinite bus or units not having compatible electric governors. The 2500 Load Sensor and Speed Control can be in isochronous when used against an infinite bus with a Generator Loading Control or Import/Export Control. The Droop signal then comes from either the Generator Loading Control or the Import/Export Control.

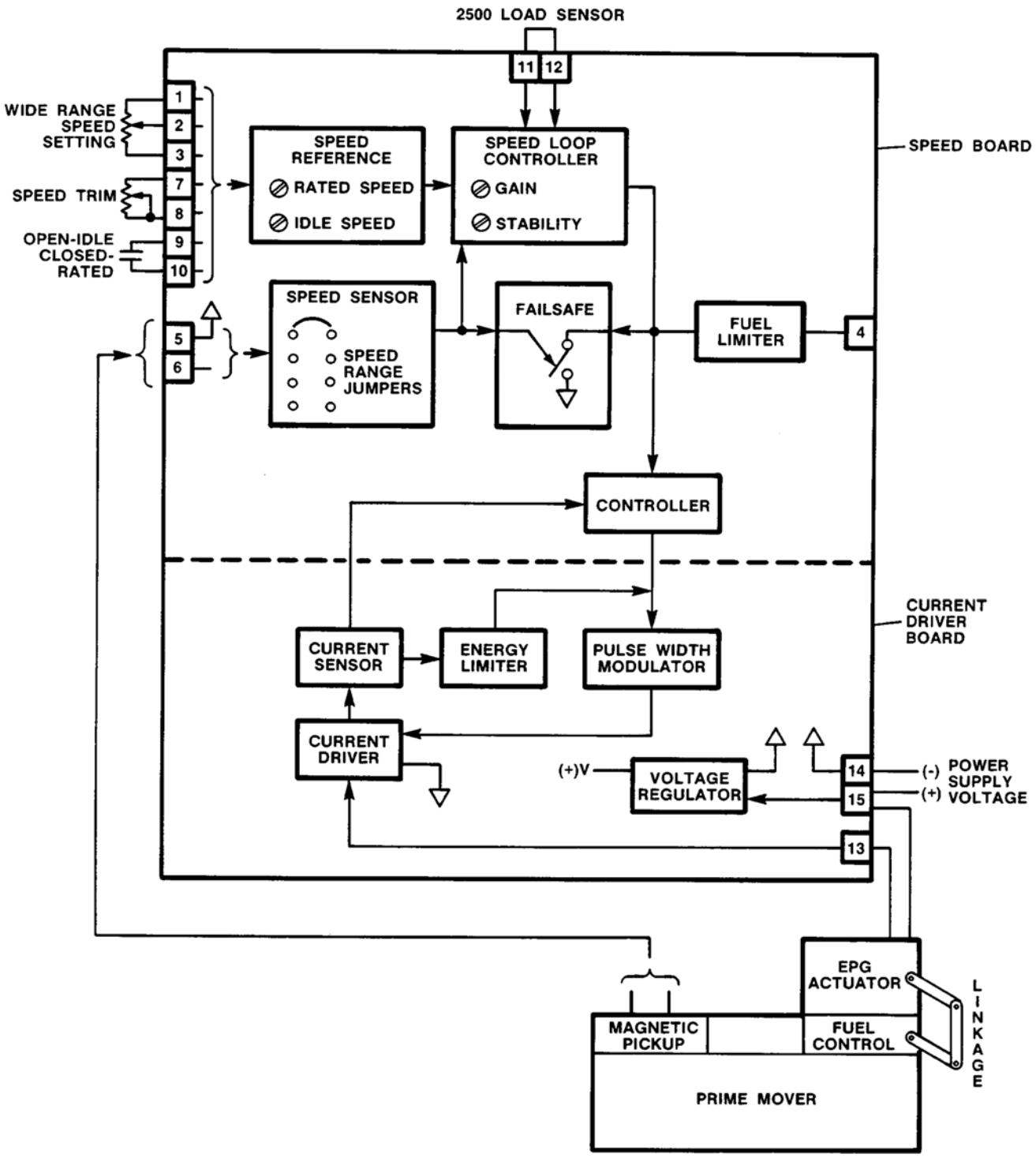


Figure 4-2. EPG Block Schematic Diagram

Chapter 5. Troubleshooting

Troubleshooting Procedure

Even though governor faults cause improper prime mover operation, improper prime mover operation can be also caused by other items, such as low fuel pressure. When the prime mover stops working properly find out which part is defective. Do this by:

1. Substituting, if available, a part that works for the one suspected of causing the problem.

2. Simplifying the system. Remove options and observe performance after each removal.

3. Testing the parts suspected of causing the problem. Follow the manufacturer's instructions or set up input and operating conditions which produce known outputs.

To test the EPG, use Chapter 2 to verify the installation is correct and perform the installation checks. Those checks are the best way to test the EPG. Step 6.2 of Chapter 2, Preset Rated Speed, is the best test of the EPG's ability to control speed. It requires the use of a signal generator with an isolated output. If appropriate, do the Checks for Paralleled Generator Applications, also in Chapter 2.

Other Checks

Do the installation checks described in the previous paragraph first. Then check the following:

1. If the prime mover is stable at some speeds or power outputs but oscillates at others. The linkage may not be compatible with the fuel control. Refer to Linkage Compatibility under Actuator Mounting and Linkage in Chapter 2.

2. If the prime mover oscillates at low frequency (about 1 Hz) and Gain & Stability Adjustments page 16, are correct, then friction in the linkage may be the cause.

   Make the Linkage and Fuel Control Friction Check under Actuator Mounting and Linkage in Chapter 2.

3. If the prime mover is unstable only when load sharing make sure:
   - Load sensor CTs and PTs are wired correctly by doing the Current Transformer Phasing Check in Chapter 2.
   - Paralleling lines are switched by relay contacts intended for low level signals.
   - Voltage regulator droop or cross current compensation is set correctly.
   - The voltage regulator is not intermittent or otherwise faulty.
   - For more information refer to Chapter 9, Wiring for Load Sharing Controls, in manual 25070, *Electronic Control Installation Guide*.

If the problem is still there, reduce the load gain a little and set the load gain pot on all other load sensors in the system for the same load signal at full load. It may be necessary to reduce the load signal to three volts in extreme cases. Woodward should be consulted in such cases.

4. If the fuse or breaker opens after the prime mover has been running, the speed control has probably been damaged. Turn governor power off and remove all wires from terminals 13, 14, and 15. Measure the resistance from terminal 13 to 14 and from 14 to 15. If either is less than 100 Ω, the speed control must be replaced. Verify that the battery connections are correct as shown in Figure 2-4. Provide separate wires from the speed control to the battery terminals as shown in the top of Figure 2-4.

5. If the prime mover oscillates when cold and stabilizes when warm, turn the gain pot slightly ccw. Turn the stability pot slightly cw if required to maintain stability.

Chapter 6.
Product Support and Service Options

Product Support Options

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

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

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

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

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

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

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

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

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

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

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in "like-new" condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

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

When shipping the item(s), attach a tag with the following information:
- return number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:
- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

NOTICE

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

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- Technical Support
- Product Training
- Field Service

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

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

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

For information on these services, please contact one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at **www.woodward.com/directory**.

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

Products Used In Electrical Power Systems

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

Products Used In Engine Systems

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

Products Used In Industrial Turbomachinery Systems

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

For the most current product support and contact information, please visit our website directory at **www.woodward.com/directory**.

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Symptoms

Description _____

_____

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

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 82448B.

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Email and Website—www.woodward.com

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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.