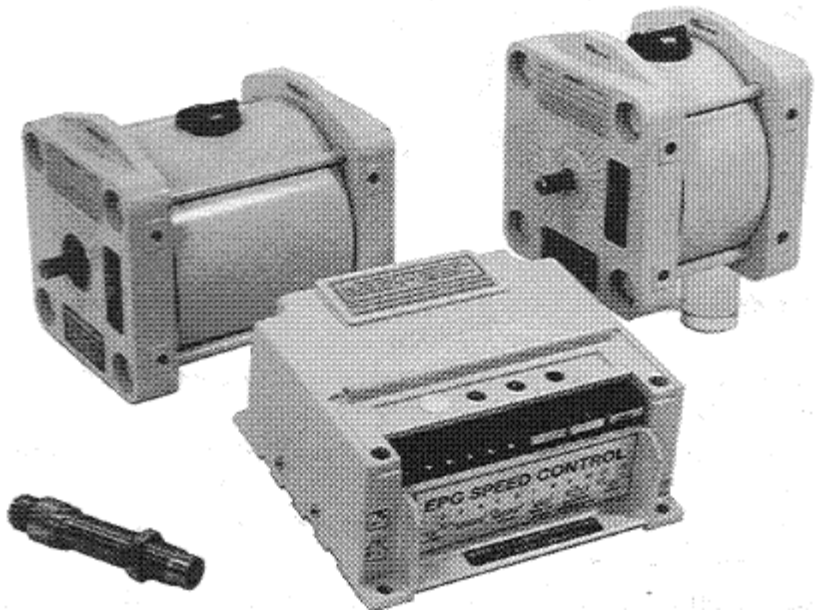
WOODWARD

Product Manual 82327
(Revision F, 10/2013)
Original Instructions



EPG Electrically Powered Governors with Single Phase Droop

Models 512/524 and 1712/1724
UL Listed E97763

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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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 Out-of-date translations are marked with ⚠.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.

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

Manual 82327

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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

IMPORTANT

This manual covers only the part numbers of the system components that are listed in the Part Number Selection Chart. Contact Woodward or your authorized dealer or distributor for information about other part numbers or applications.

The Model 1712/1724 and Model 512/524 Electrically Powered Governors (EPGs) are used to control the speed of diesel, gas, and gasoline engines. They also can control the speed of gas turbines. Installation of EPG actuators is simple because they require neither mechanical drive nor hydraulic supply.

These controls are intended for prime mover with generator loads. The advantage of these units is that the DROOP circuitry is in the speed control.

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

A battery charger must be used to keep the battery charged. Maximum steady-state-current consumption is 4 amps for the 12-volt model, and 3 amps for the 24-volt model.

Part Number Selection

Use EPG Model 1712/512 for operation in 12-volt systems. Use the Model 1724/524 for use in 24-volt systems.

Additionally, speed controls are available for four ranges of magnetic pickup frequencies. These speed controls are available for diesel engines and gas turbines or for gasoline and gas engines. Actuators have a double ended output shaft for either clockwise (cw) or counterclockwise (ccw) rotation to increase fuel.

Part Number Selection Chart

		Single Phase Droop Control Speed Range (Hz) Required				Actuator Part Number
For Use with Prime Mover Type	**System Battery Voltage**	**750 to 1500**	**1500 to 3000**	**3000 to 6000**	**6000 to 12 000**	
Diesel and Gas Turbine	12	8290-067	8290-071	8290-046 8290~192*	8290-075	(512) 8256-022*
Gasoline or Gas	12	8290-068	8290-072	8290-047	8290-076	(1712) 8256~017*
Diesel and Gas Turbine	24	8290-069	8290-073	8290-044 8290~191*	8290-077	(524) 8256-021*
Gasoline and Gas	24	8290-070	8290-074	8290-045	8290-078	(1724) 8256~016*

*—These Part Numbers Are EU Directive Compliant.

Speed controls and actuators must be compatible. Selection of compatible EPG Speed Controls and Actuators is made from the Part Number Selection Chart.

To Adjust Acceleration and Deceleration

An optional Ramp Generator or External Capacitor can be used to adjust the time it takes the prime mover to go from idle to rated speeds and vice versa. The 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 8271-909 Ramp Generator with 24-volt batteries and the 8271-910 Ramp Generator for 12-volt batteries. The capacitor provides an exponential ramp with times up to 4 seconds. Exponential means it changes (speed in this case) rapidly at first but slows as it reaches its final value. See the typical wiring diagram for capacitor requirements.

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.

Reference

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

Catalog 52122, Woodward Product Line Catalog
Product Specification 04106, EPG Electrically Powered Governors
Manual 25070, Electronic Control Installation Guide
Manual 82510, Magnetic Pickups and Proximity Switches for Electronic Controls

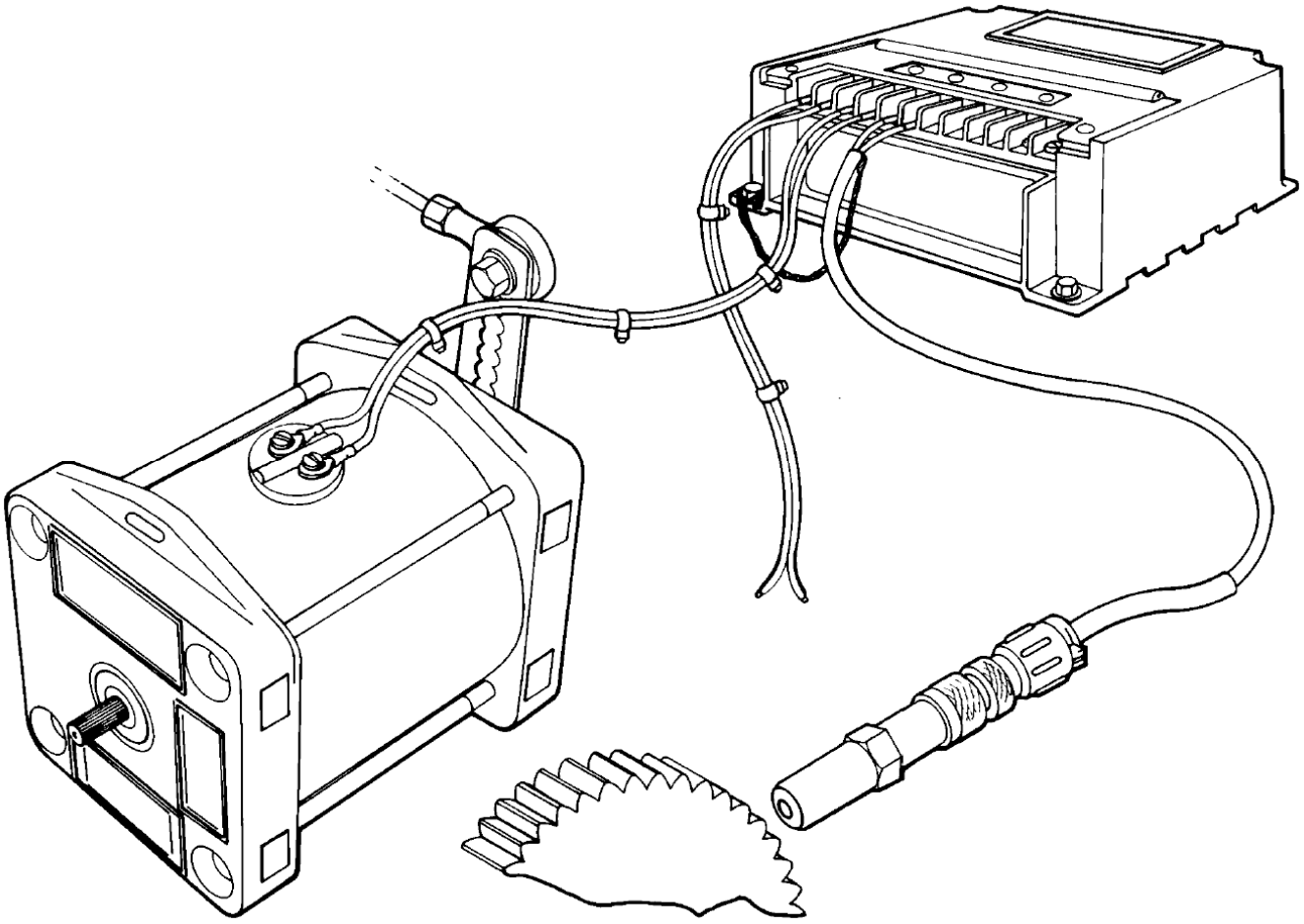

Figure 1-1. Basic EPG System

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 or your authorized dealer or distributor 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 the control won't be damaged when moving the prime mover or when equipment is moving nearby. Mount the control close to the actuator and battery to meet the wire length requirements. Allow for adequate ventilation.

Actuator Mounting and Linkage

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 excessive heat.

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.

If you are using a Woodward-supplied installation kit, follow its instructions and skip over Linkage Compatibility. Begin again with Installing the Magnetic Pickup.

Sealed bearings should not be pressure-washed. If the actuator is exposed to weather, mount it with the clockwise end higher, if your installation allows it.

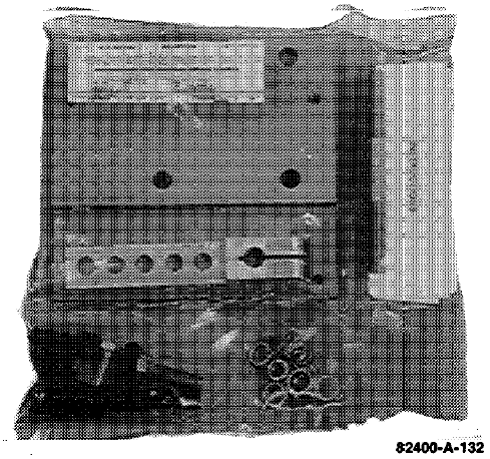

Figure 2-1. Typical Installation Kit

Linkage Compatibility

Also match linkage to the fuel control. Use a linear linkage as shown in Figure 2-4 unless the prime mover has a carburetor or other nonlinear fuel control. See Figures 2-5 and 2-6 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.

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. Woodward recommends minimizing the external return force. (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, just below maximum when the fuel control is at its maximum stop. It is recommended that Woodward installation kits be used.

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

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

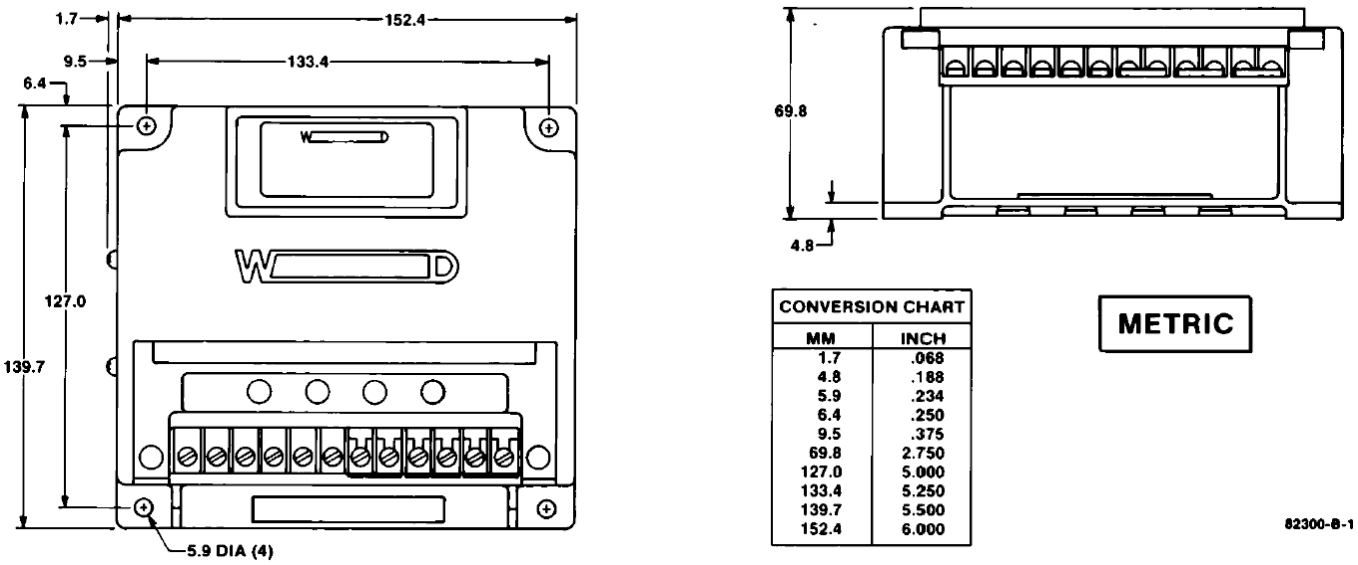

Figure 2-2. Outline Drawing of EPG Speed Control
(Do not use for construction.)

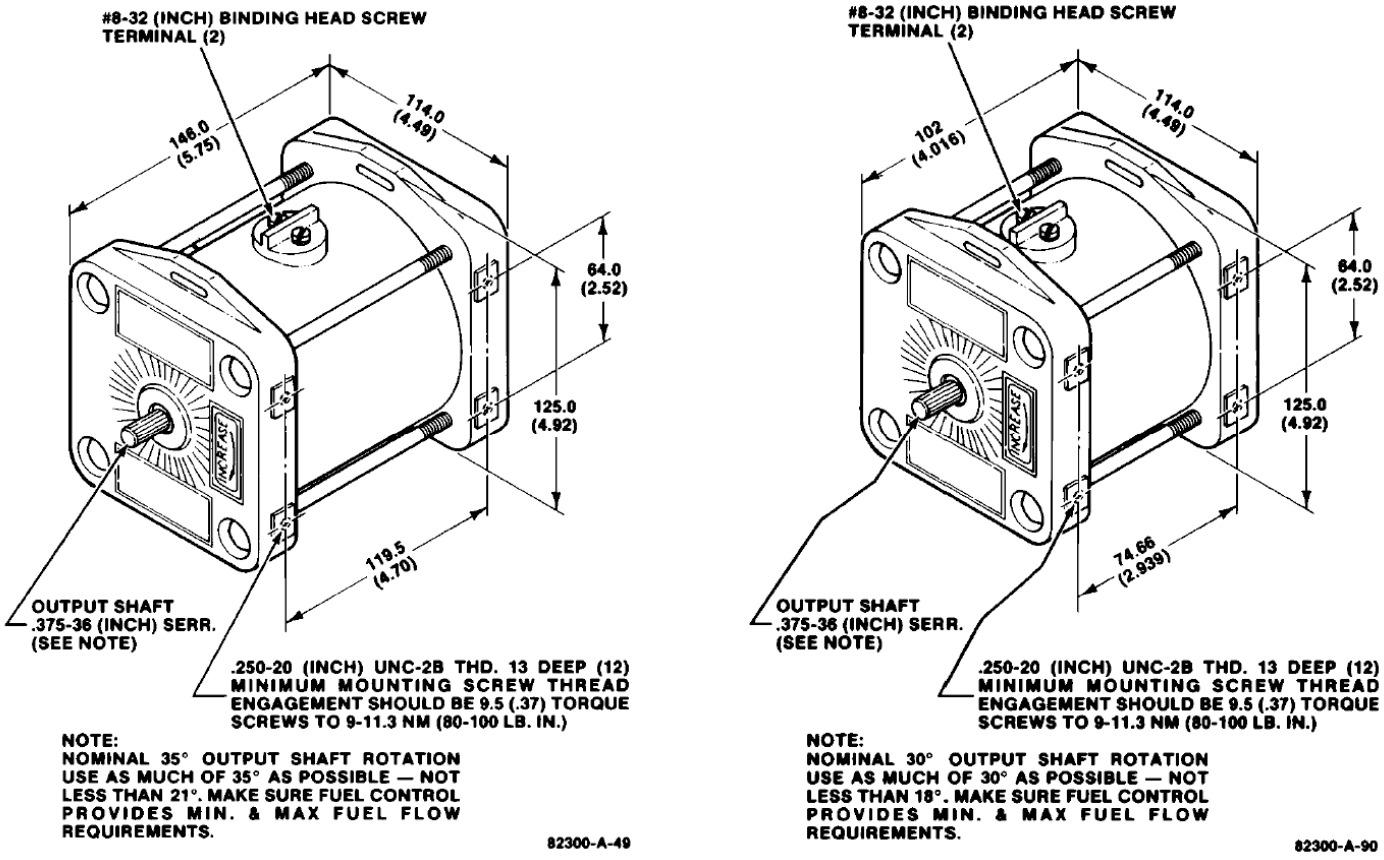

Figure 2-3. Outline Drawing of EPG Actuators
(EPG Models 1712/1724 left, Models 512/524 right)
(Do not use for construction.)

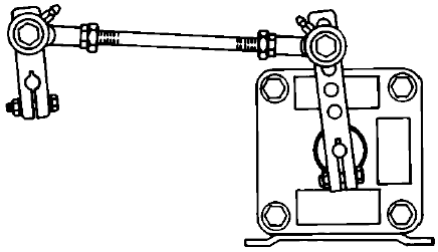

Figure 2-4. Linear Linkage

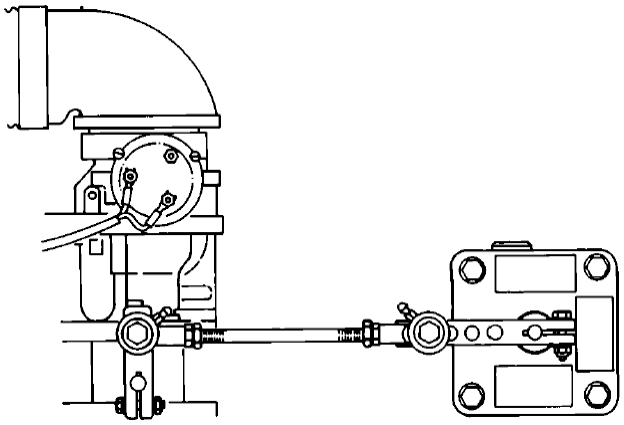

Figure 2-5. Carburetor Compensating Linkage at Minimum Fuel

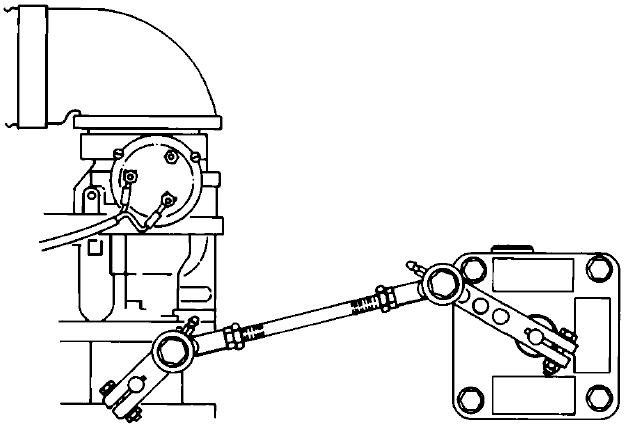

Figure 2-6. Carburetor Compensating Linkage at Maximum Fuel

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 the gear slowly through 360 degrees of 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 may be ordered from Woodward or your authorized dealer or distributor if desired. More information is contained in Woodward manual 82510, *Magnetic Pickups and Proximity Switches for Electronic Controls*.

Wiring Instructions

Use a wiring diagram for the specific part number of your EPG system to make all wiring connections. Typical wiring is shown in Figure 2-7.

Make all connections using insulated terminals. The wiring from the actuator to the speed control and from the battery to the speed control must be as short as possible. Maximum wiring lengths are listed:

Maximum Wiring Length Chart

EPG Model	Maximum Wire Length	
	14 AWG (2 mm²)	12 AWG (4 mm²)
1712/512	10 ft (3 m)	20 ft (6 m)
1724/524	35 ft (11 m)	75 ft (23 m)

The fuse and switch or circuit breaker must be in the non-grounded battery lead. Use a fuse or circuit breaker as specified in the Switch and Fuse Requirements Chart. Do not use a fuse of higher current rating. Starter relays make good EPG power switches.

Switch and Fuse Requirements Chart

Model	Voltage	Switch Rating	Fuse
1712/512	12	10 A	10 A
1724/524	24	10 A	10 A

Wire Harness Part Number Chart

Harness Part No.	Harness Lengths		
	MPU	Actuator	Battery
8924-621	10 ft (3 m)	15 ft (4.6 m)	15 ft (4.6 m)
8924-620	10 ft (3 m)	25 ft (7.6 m)	25 ft (7.6 m)

The battery connection to speed control terminals 1 and 2 must be directly from the terminals, not through distribution points. See Figure 2-10.

Do not connect any other wire to terminals 1 and 2 except the power for the 2500 Ramp Generator, if used.

NOTICE

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

NOTICE

Connect power wires directly to the battery terminals. The speed control can be damaged If those wires are connected to distribution points. See Figure 2-10.

Shields

Connect shields as shown in your wiring diagram. Terminate shields at a chassis mounting screw. Only one end of each shield, the end nearest the speed control, should be tied to ground. All shields must be tied to the same point.

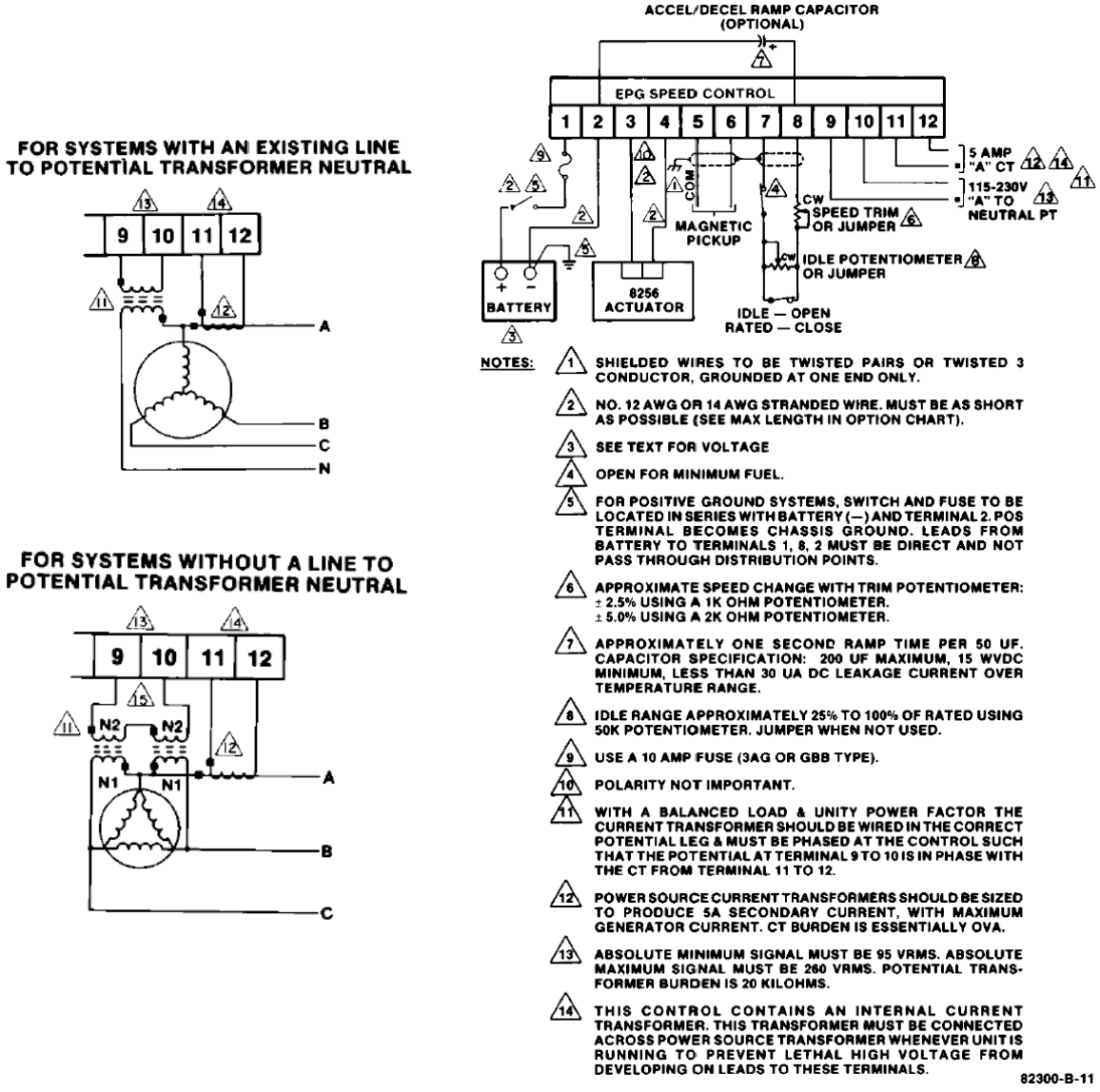

Figure 2-7. Typical EPG (with droop) Wiring Diagram

When passing shields through connectors to terminal blocks, 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 (connect to earth ground).

Additional Wiring for 2500 Ramp Generators (optional)

Connect the 2500 Ramp Generator terminals 1 and 2 to speed control terminals 1 and 2, respectively. Connect 2500 Ramp Generator terminal 4 to speed control terminal 8 with a shielded wire. Connect the shield, at the speed control, to a chassis mounting screw for grounding. Do not connect the shield at the ramp generator end.

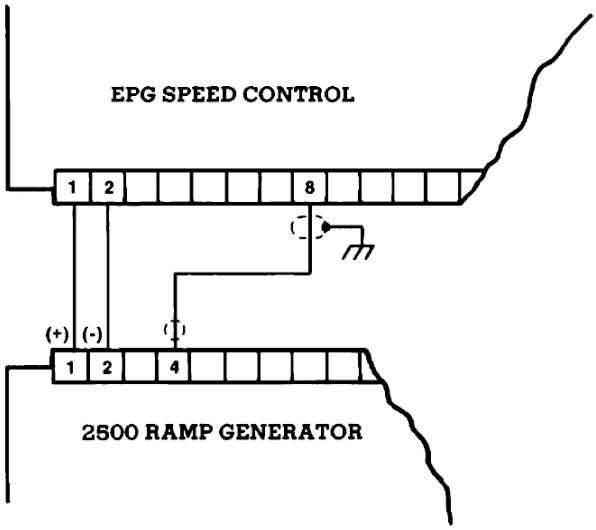

Figure 2-8. Typical Wiring for 2500 Ramp Generator

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, covers these checks.

The generator must not be paralleled during these tests. If a Ramp Generator is used, then temporarily remove the wire at speed control terminal 8, which 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. Make sure 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 1 and 2) 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 1 (+) and 2 (–). It must be from 10 to 16 Vdc for EPG Model 1712 control and from 20 to 32 Vdc for Model 1724.

3. Disconnect any wiring or jumper on terminal 7. Measure voltage from 2 (–) to 7 (+). The voltage must be 7.2 ±1 volt. If voltage is correct, then re-install the wiring to terminal 7.

4. If idle speed is desired, connect a 50 kΩ potentiometer or fixed resistor to terminals 7 and 8 as shown in the typical wiring diagram. To calculate the value of a fixed resistor:

$$R = 17\ k\Omega \left(\frac{\text{Rated Speed}}{\text{Idle Speed}} - 1 \right)$$

5. Put the idle-rated switch in the rated position. Measure the voltage from terminal 7 (+) to 2 (–). Put the idle-rated switch in the idle position. 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 make sure 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. Make sure 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) clockwise 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 S and 6. Measure the resistance of the MPU at the wire ends. It should be between 100 and 300 ohms. Reconnect the MPU wires.

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

⚠WARNING **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.**

10. Gain And 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 following manufacturer's instructions, 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 7 to 8. It must be a short circuit (0 ohms). 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 ohms 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.

10.1 Set 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 response-curve diagram. 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.

Check response after each adjustment by disturbing the engine off and on, step loading the engine, manually bumping the linkage, or quickly switching to idle speed and then back to rated. Repeat the following tuning procedure until the prime mover responds as desired. Note that “tight settings” gain high as possible with given stability setting, 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 stability gain pot cw. Turn the gain pot ccw as required to eliminate oscillation and obtain desired response.

Check response by step loading the engine, disturbing the engine off and on, manually bumping 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. Adjust the rated-speed pot for exact 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.

Applications with the 2500 Ramp Generator

Reconnect the ramp generator output to terminal 8 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. Make sure that it now takes longer to go from rated to idle and from idle to rated. Set each pot for the desired time.

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:

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

For setting DROOP on an isolated load:

1. 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 500/0 loading is possible, 58.5 Hz would indicate 5% droop. See Figure 2-9, Droop Definition.

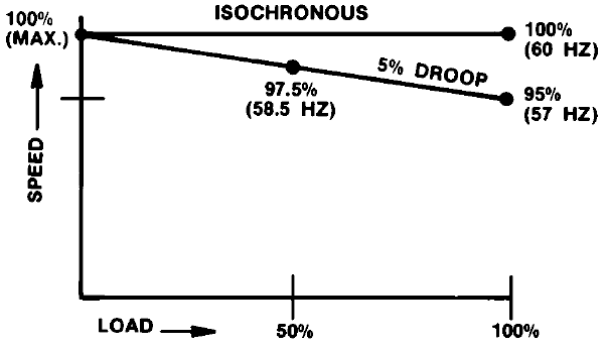

Figure 2-9. Droop Definition

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).

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 1000/0 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.

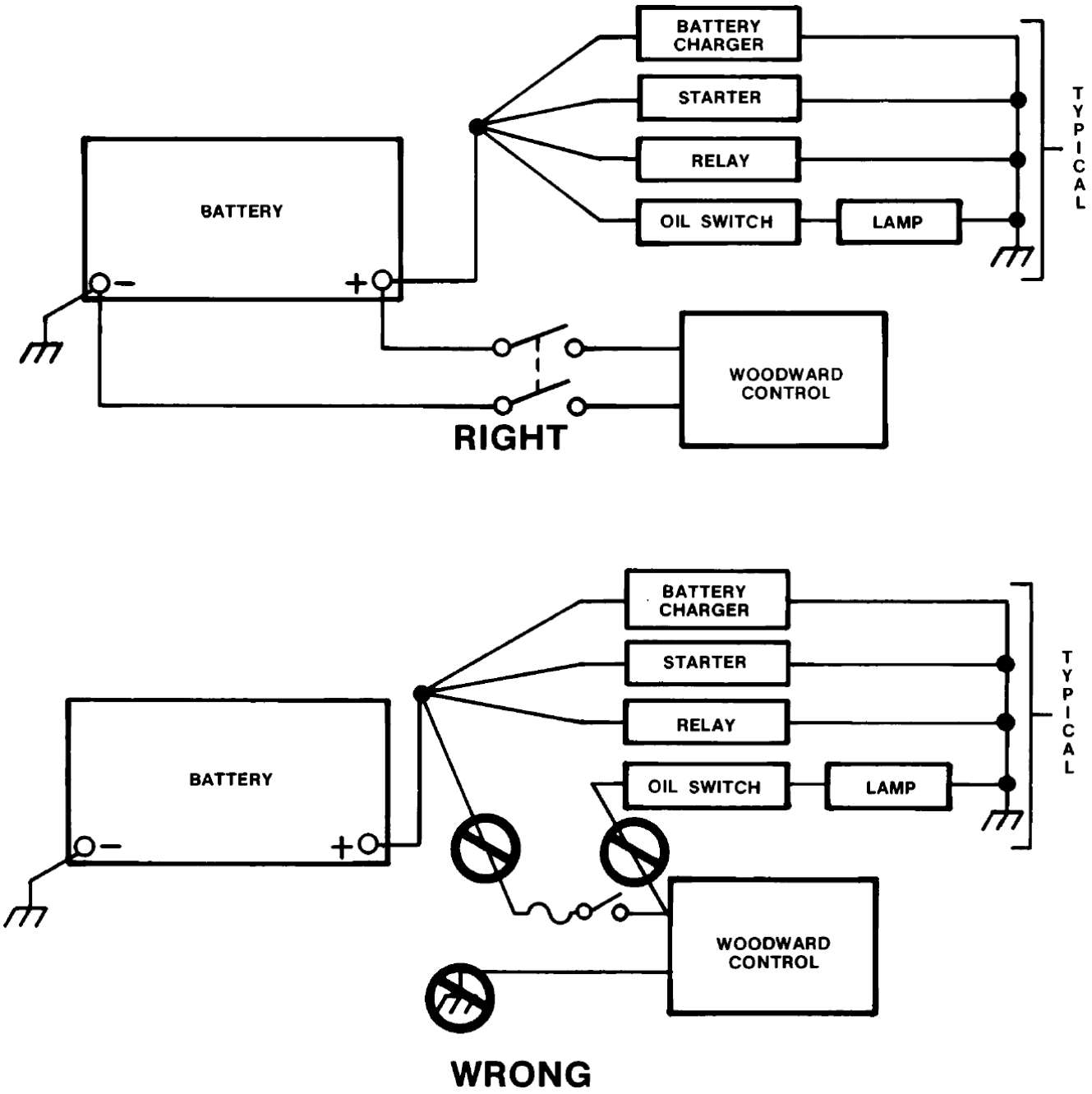

Figure 2-10. Correct and Incorrect Wiring to Battery

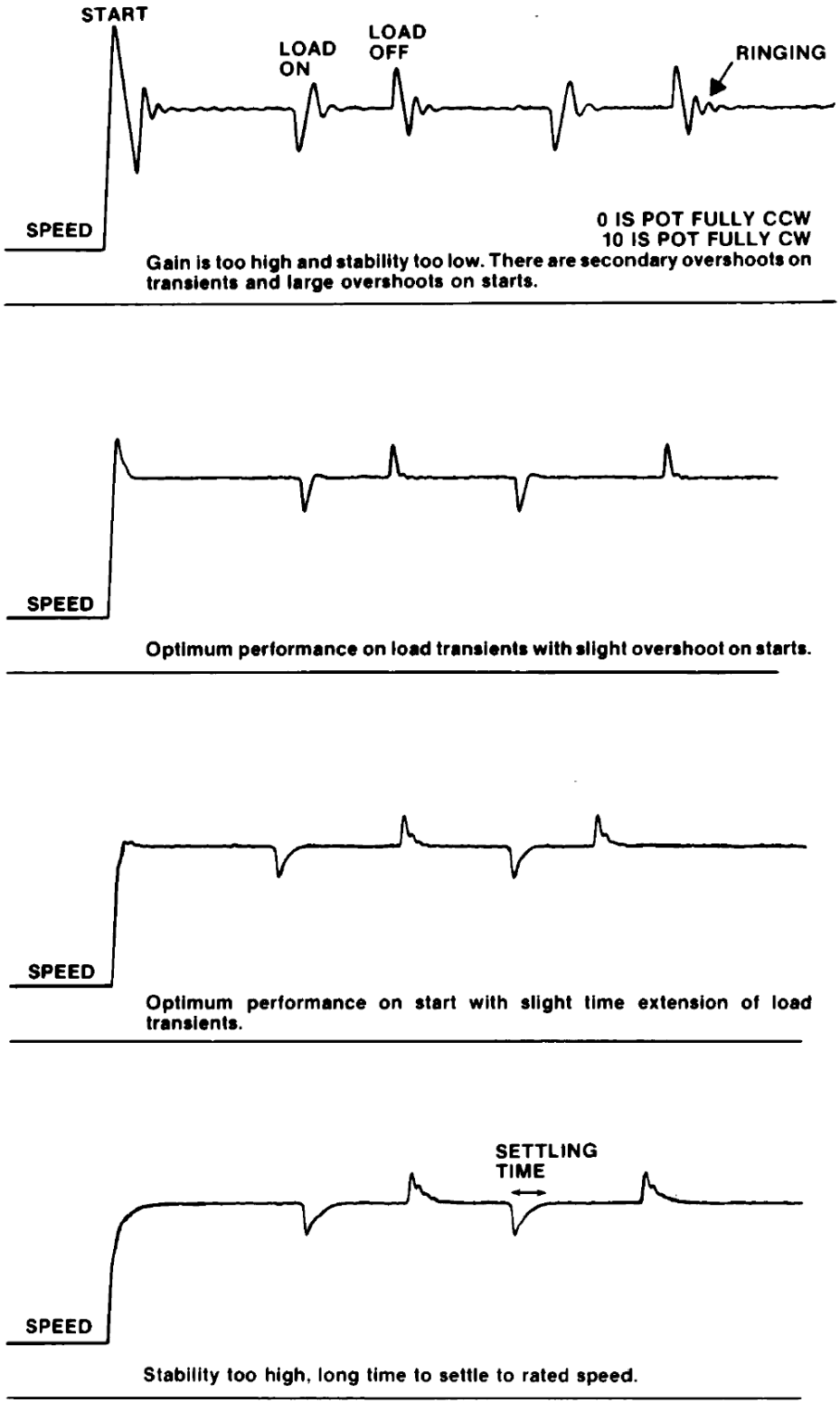

Figure 2-11. Starting and Transient Response Curves

Chapter 3.
Operation

The speed control requires power on when starting, and power off when stopping (power off causes shutdown if fuel flow is stopped when the fuel control is at the minimum-fuel position). Paralleled generator applications require synchronizing and paralleling. If paralleling in droop mode to an infinite bus, a speed-trim 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 or a time switch. Alternatively, the prime mover can run to rated speed upon starting (refer to the curves of Figure 2-11). Paralleled generator applications can be equally automatic when a Woodward SPM Synchronizer is used.

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

Start Fuel Limit (8290-191, 8290-192)—The START FUEL LIMIT potentiometer provides a means of limiting the fuel-rack position when starting diesel engines. Adjustment of the pot 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 pot full clockwise will raise-the limit above the maximum fuel position, making the limit non-effective.

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 and load. It then calculates an error signal and drives the actuator in the increase- or decrease-fuel direction to correct prime mover speed and load.

Figure 4-1 shows the Electrically Powered Governor in more detail. The speed control is housed in a die cast aluminum enclosure.

The Electrically Powered Governor 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). The controller compares the two inputs and changes the actuator position if an error exists. Gain and stability adjustments in the controller tailor the governor's response to the requirements of the specific prime mover. Rated speed is set by the rated speed pot and, if attached, a speed trim pot. The idle reference is controlled by an external idle speed pot. Rated speed must be set before idle speed. Speed sensor output is a voltage proportional to magnetic pickup frequency. The frequency range of the control pickup is set by an internal resistor. The specific frequency range of a specific EPG Speed Control is indicated by the part number of the speed control.

Current Loop

The current loop error signal can be considered a command for the correct actuator current or position.

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 droop possible one phase of the PTs (potential transformers) and CTs (current transformers) are used. 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 (3 [+] and 4 [–]) indicate only general conditions. Excessive currents are prevented from flowing through the actuator coil by the energy limiter. It prevents the actuator from overheating but allows enough current to keep the actuator at the maximum-fuel position.

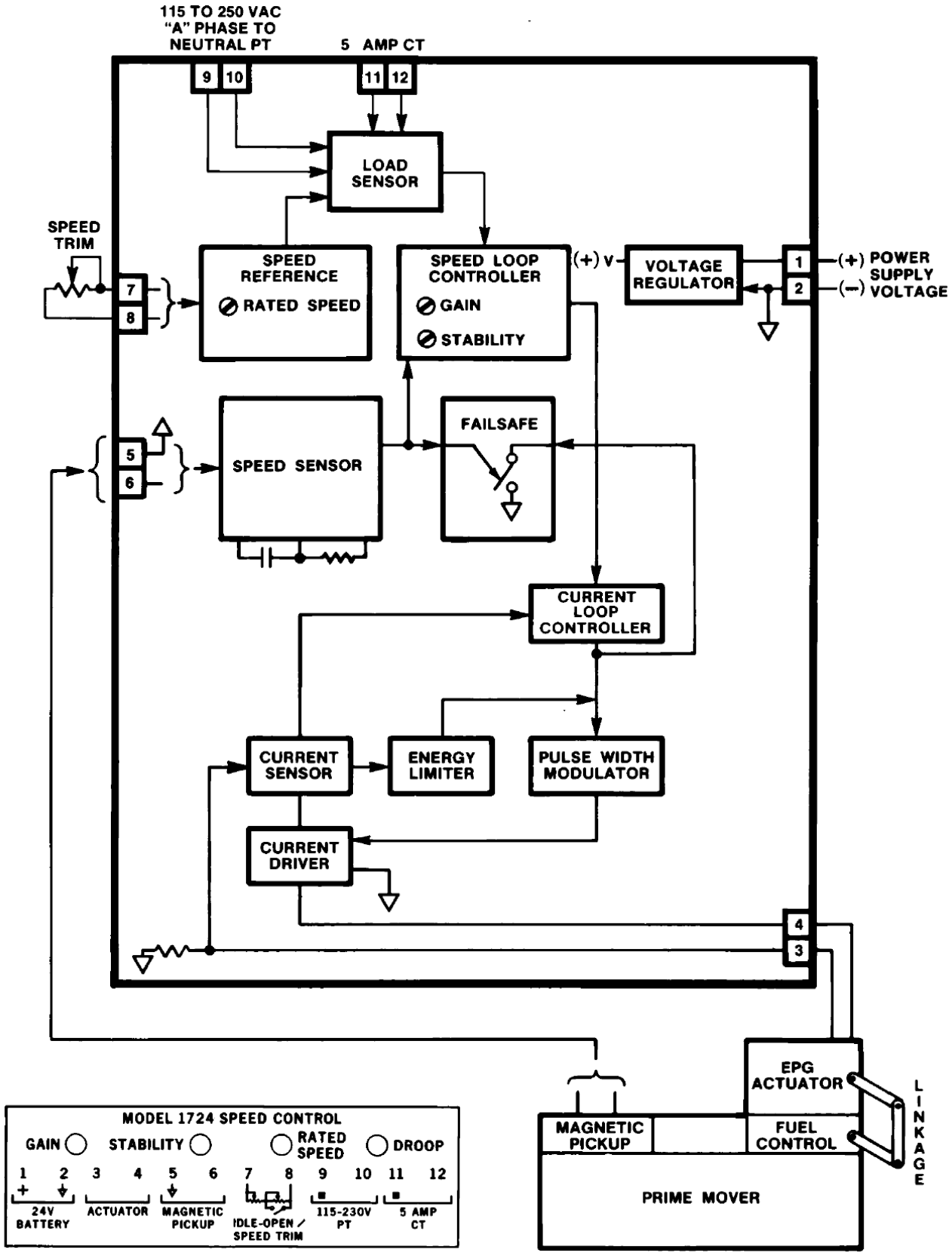

Figure 4-1a. EPG Block Schematic Diagram (standard)

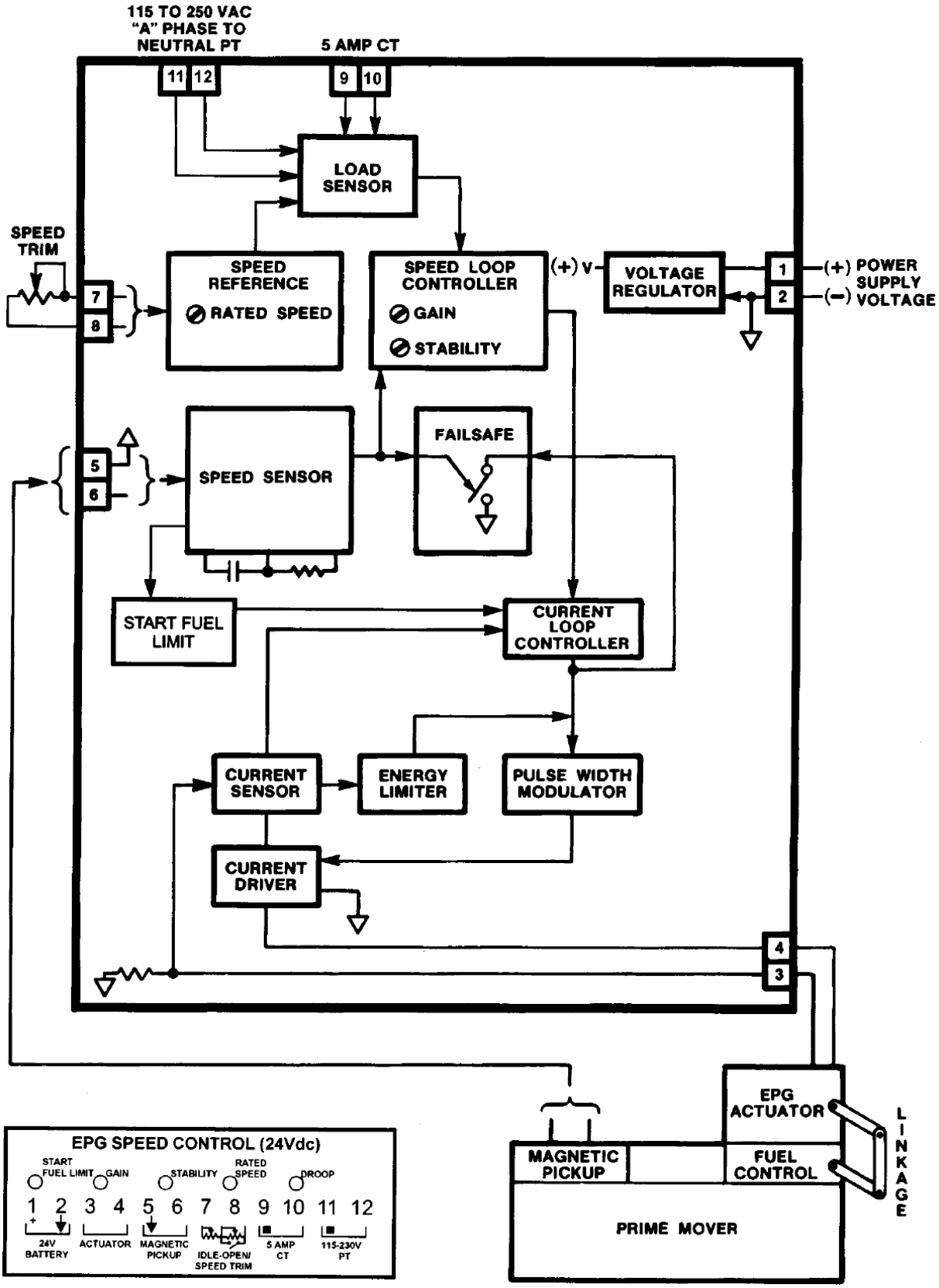

Figure 4-1b. EPG Block Schematic Diagram (start fuel limit)

There is a failed speed sensor detector circuit which senses MPU frequency and forces the pulse width modulator input 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 4-2, the actuator is mechanically simple. It has specially designed rotor and stator shapes which provide reliable effective performance. The rotary design gives 35 degrees shaft rotation to low mass, low friction fuel controls. The magnetic circuit, when powered by the speed control, applies torque in the increase-fuel direction. Two preloaded internal return springs supply 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.

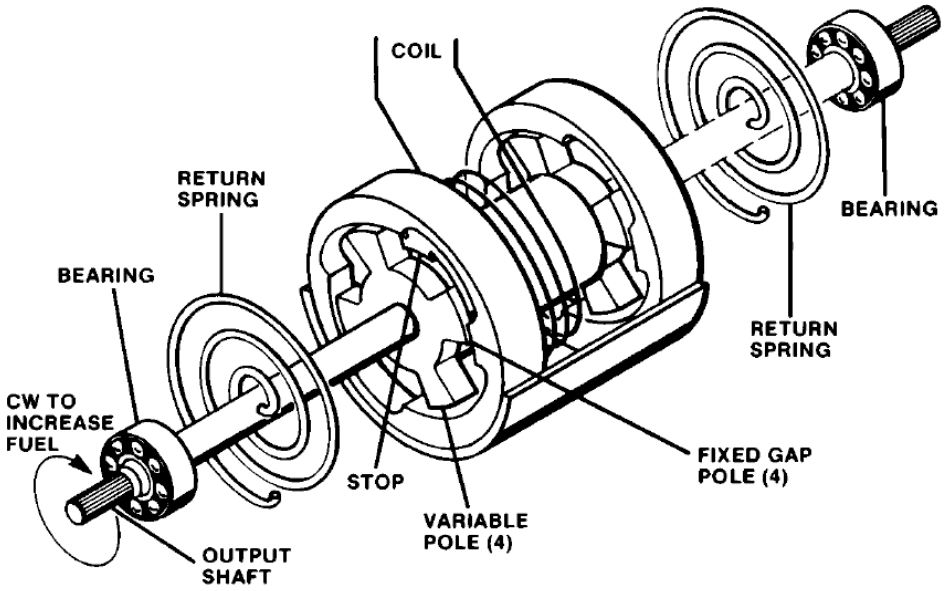

Figure 4-2. Actuator Schematic

Applications Using a Ramp Generator

The 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

These single phase droop EPGs have droop paralleling capabilities using one phase of the PT's and CT's. These controls droop off of current cosine phase (current amplitude times the cosine of the phase difference of the PT and CT). Droop operation is required when paralleling with an infinite bus or units not having compatible electric governors.

Chapter 5. Troubleshooting

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 check. 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.

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 and Stability Adjustments, Chapter 2, are correct, then friction in the linkage may be the cause.

   Disconnect the actuator from the fuel control.

   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.
3. If the prime mover is unstable only when load sharing make sure:

   The current and potential transformers are connected correctly.

   The voltage regulator is not intermittent or otherwise faulty.
4. If the fuse or breaker opens after the prime mover has been running, the speed control may have been damaged. Turn governor power off and remove all wires from terminals 1, 2, 3, and 4. Measure the resistance from terminal 1 to 2 and from 3 to 4, if either is less than 100 ohms the speed control must be replaced. If the control is not damaged, then high voltage spikes from the battery or battery charger may be the problem. Verify that the battery connections are correct. Provide separate wires from the speed control to the battery terminals as shown in the top of Figure 2-10.
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.

Revision History

Changes in Revision F—

- Removed Class I, Division 2 information (not applicable)

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 82327F.

B82327:F

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