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Product Manual 35142
(Revision - 03/2025)
Original Instructions

EPG Electrically Powered Governor
RoHS Compliant

Isochronous Models 512/524 and 1712/1724
Standard, Start Fuel Limit, Dual Dynamics
UL Listed E97763

Installation and Operation Manual

Released

General Precautions

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

Practice all plant and safety instructions and precautions.

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

Revisions

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

www.woodward.com/publications

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

Proper Use

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

Translated Publications

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

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 Out-of-date translations are marked with ⚠.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

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

Manual 35142

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Important Definitions

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

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

⚠WARNING

Start-up

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

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.

Regulatory Compliance

European Compliance

Restriction of Hazardous Substances (RoHS): Declared to 2011/65/EC Council Directive of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Exemption in use: 6(c), 7 (a), 7(c)-I

EMC Directive: Declared to 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC).

EMC Limitations

Cabling

All cabling for this unit is limited to less than 30m (98.4'). See wiring diagrams for specific cable types required.

Power cabling is limited to less than 10m (32.8') in total length from its source; power is intended to be from a local bus structure. The control is NOT intended to have a power bus that is derived from a plant-wide distribution system, remote source, or similar "mains" type distribution systems. The power to the control should also be a dedicated circuit, directly to the battery or source via a power and return wire that are routed together.

See User Manual 36526 for additional regulatory information, limitations, and wiring diagrams with specific, required cable types.

Power Bus

The power bus is intended to be a local bus without power line surges and to have inductive load kickback events suppressed. Therefore, the control's power input is not designed to withstand a charging system load dump, heavy inductive kickbacks, or heavy surge type pulses. If the control is installed outside its intended usage, as described in this manual, centralized voltage pulse suppression must be implemented to help protect the control and other components on the bus. (See Chapter 6: Installation Instructions.)

COMM Port

The COMM port is intended to be a service port, with only temporary connection during service or initial configuration. The COMM port is susceptible to some EMC phenomena and possible unintentional battery return currents.

1. Battery return (B-) is also the communication signal common; typically PCs connect the communication signal's common to protective earth. The PC grounding can provide an unintended return path for B- currents. If B- and the PC are grounded to protective earth, a communication isolator should be used between the PC and the control. Damage to the PC or control, and/or unintended operation may result from a broken battery return wire or the parallel path.
2. The pins inside the COMM port plug are susceptible to damage by ESD discharges, static electricity arcs. Care should be taken not to touch them with tools or put fingers into the port. Always touch your hand or tool to a grounded piece of metal (discharge ESD) prior to coming in contact with the communication port.
3. The input is susceptible to RF noise such as switching transients and transmitter signals coupled into the communication cable. Cable orientation and short cable length may be used to eliminate these issues, depending on the severity of the environment.

Chapter 1.
General Information

Introduction

This manual covers Electrically Power Governor (EPG) models 512/524 and 1712/1724. Refer to the appropriate manual or contact Woodward for information about other versions of the EPG.

Application

The EPG is used to control the speed of diesel, gas, and gasoline engines. It can also control the speed of gas turbines. Installation of EPG actuators is simple because they require neither mechanical drive nor hydraulic supply.

The EPG handles prime movers with mechanical loads and generator loads equally well. Generator sets which will be paralleled, however, require additional appropriate switch gear, current and potential transformers, and the Woodward Generator Load Sensor.

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

A battery charger must be used to keep the battery charged. Maximum steady state current consumption is 4 A for the 12-volt models (512/1712), and 3 A for the 24-volt models (524/1724).

Part Number Selection

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

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

Speed controls and actuators must be compatible. Use the Part Number Selection Table below to choose compatible EPG speed controls and actuators.

The optional Start Fuel Limit feature allows setting a maximum actuator position during start-up. The maximum position remains in effect until the engine reaches the selected idle or rated speed. The limit may be adjusted out of the way by turning the adjustment potentiometer fully clockwise.

The Dual Dynamics feature allows tailoring a special set of responses for unloaded and loaded operating conditions. This type of control is often needed for gas engines and other systems with non-linear fuel systems. A switch is used to change between slow and fast dynamics.
8256-032

Table 1-1. Part Number Selection

	Isochronous Speed Control				Actuator P/N
For use with engine type (system battery voltage)	Speed Range (Hz) Required				
	750 to 1500	1500 to 3000	3000 to 6000	6000 to 12 000	
Diesel w/ Start Fuel Limit (24 V)			8290-215*		8256-032

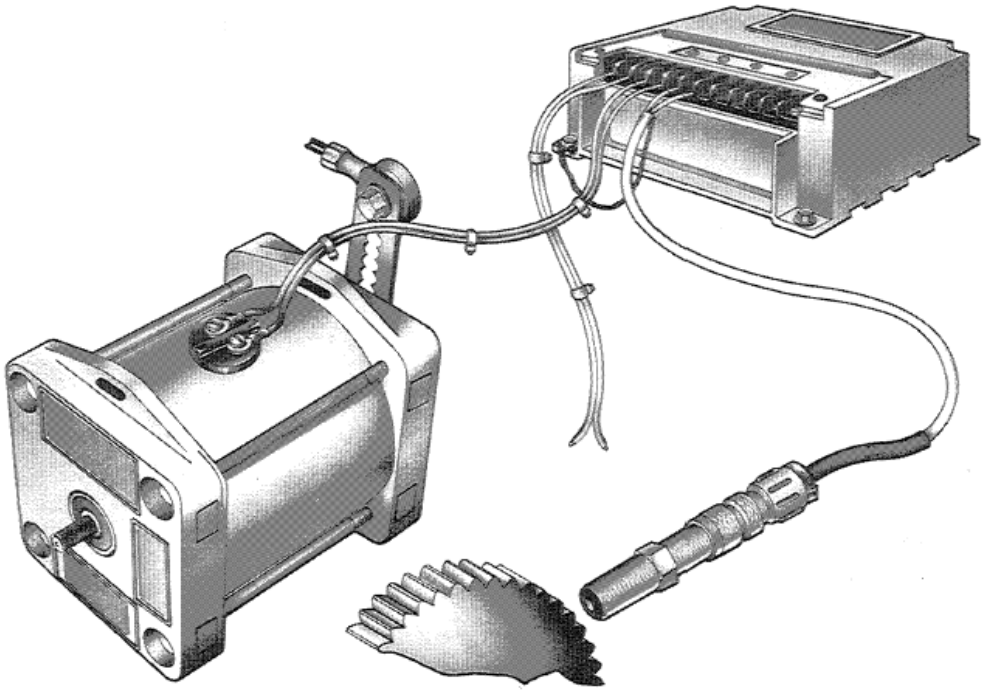
(*) EU Directive compliant and UL/cUL Listed

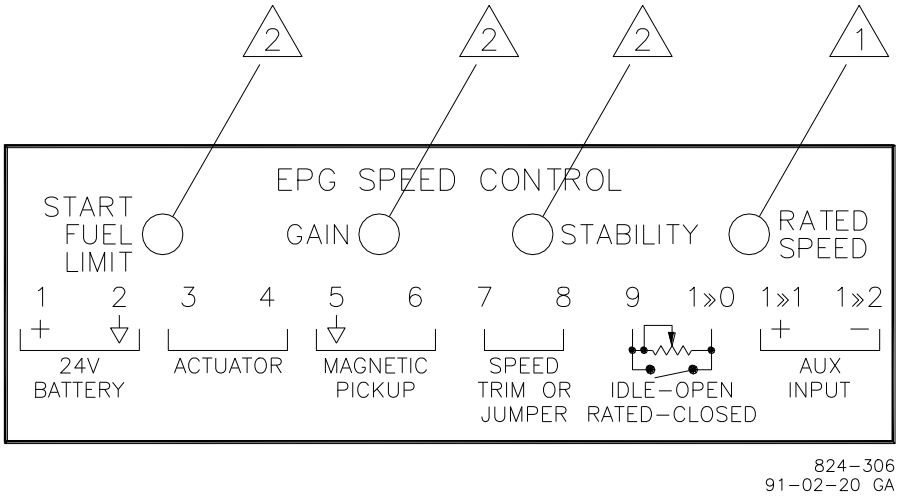
References

These publications can be obtained from your Woodward authorized Distributor or AISF (Authorized Independent Service Facility). All are also available on the Woodward website (**www.woodward.com**).

Product Specification	Title
04106	Model 512/1712 & 524/1724 Electrically Powered Governors

Manual	Title
25070	Electric Governor Installation Guide
82510	Magnetic Pickups for Electric Governors





1 25–TURN POTENTIOMETER. RATCHET–TYPE CLUTCHES AT BOTH ENDS OF TRAVEL.

2 ONE–TURN POTENTIOMETER. SOLID STOPS AT BOTH ENDS OF TRAVEL.

MOST MODELS DO NOT HAVE THE START FUEL LIMIT OR DUAL DYNAMICS.

Figure 1-1. Basic Electrically Powered Governor System

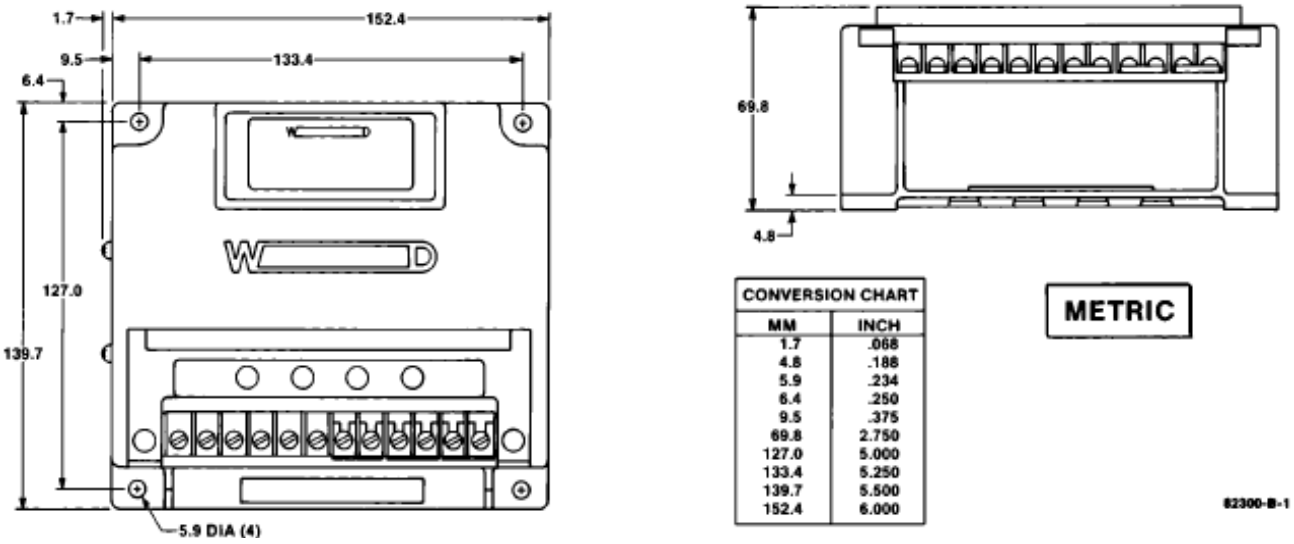


Figure 1-2. Outline Drawing for EPG 512/1712 and 524/1724 Speed Controls
(Do not use for construction.)

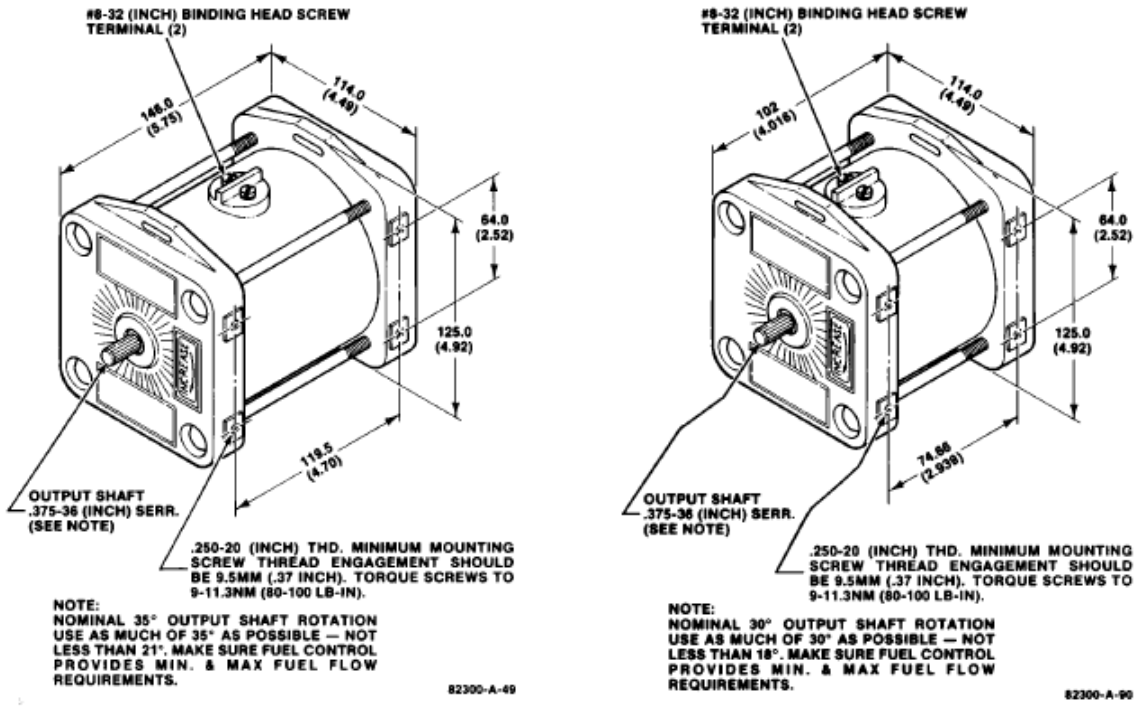


Figure 1-3. Outline Drawing for EPG 1712/1724 and 512/524 Actuators
(Do not use for construction.)

Chapter 2.
Installation, Checkout, 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 that 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.

The EPG speed control must be mounted on a metal plate that is at the same ground potential as the case. The case and mounting plate must be grounded to either the protective earth of the building or, if no protective earth is available, the frame ground of the engine/skid.

Actuator Mounting and Linkage

Mounting Screws
0.250-20 (inch) thread. Minimum mounting screw engagement should be 9.5 mm (0.375 inch). Torque screws to 9–11 N·m (80–100 lb-in). Use star washers between the screw heads and control body to break paint and ground the EPG chassis to the mounting plate.

Actuator location must allow installation of a suitable linkage. The actuators are designed to operate within a temperature range of –40 to +93 °C (–40 to +200 °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.

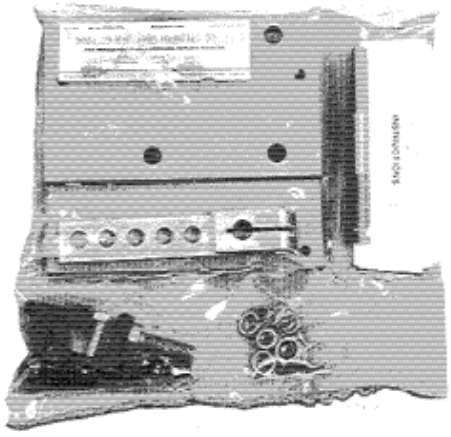


Figure 2-1. Typical Installation Kit

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

Linkage Compatibility

Also match linkage linearity to the fuel control. Use a linear linkage as shown in Figure 2-2 unless the prime mover has a carburetor or other non-linear fuel control. See Figures 2-3 and 2-4 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.

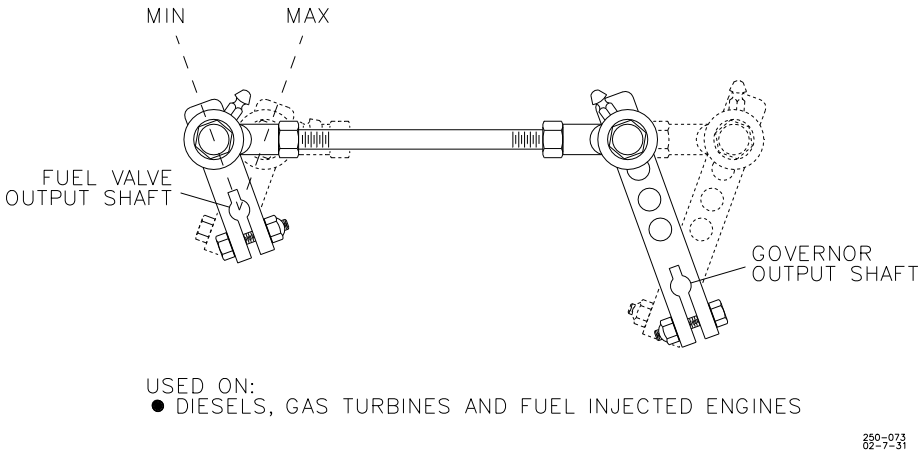


Figure 2-2. Linear Linkage

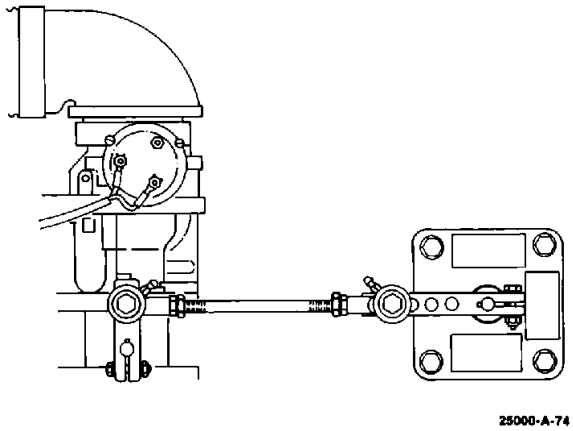


Figure 2-3. Carburetor Compensating Linkage at Minimum Fuel

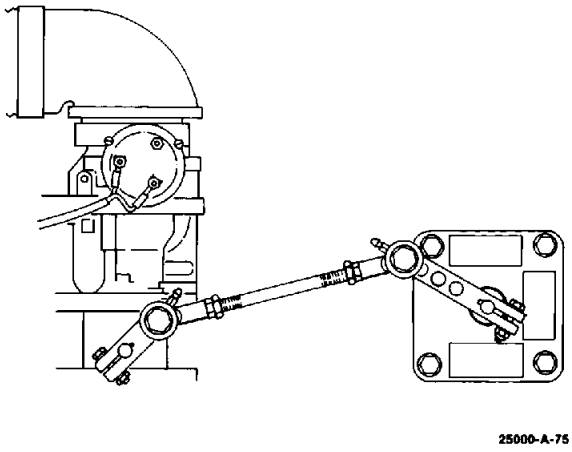


Figure 2-4. Carburetor Compensating Linkage at Maximum Fuel

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 that the actuator is capable of moving the fuel control to the maximum and minimum limits. Let the fuel control limit actuator travel. Set the linkage so that the actuator is just above minimum when the fuel control is at its minimum stop and (except for Detroit Diesel engines) so that the actuator is just below maximum when the fuel control is at its maximum stop. We recommend 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.

Installing the Magnetic Pickup

Mount the magnetic pickup through a housing or rigid bracket. Make sure that the sensed gear is of magnetic material. The gap between the pickup and the outside diameter of the gear should be set to approximately 1.0 mm (0.04") 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 (clockwise) until it touches the outside diameter of a tooth. Then back out the pickup (counterclockwise) approximately three-quarters of a turn. Run the gear slowly through 360 degree rotation to check the clearance of the pickup. When the gap is set, tighten the jam nut securely against the housing or bracket.

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

Wiring Instructions

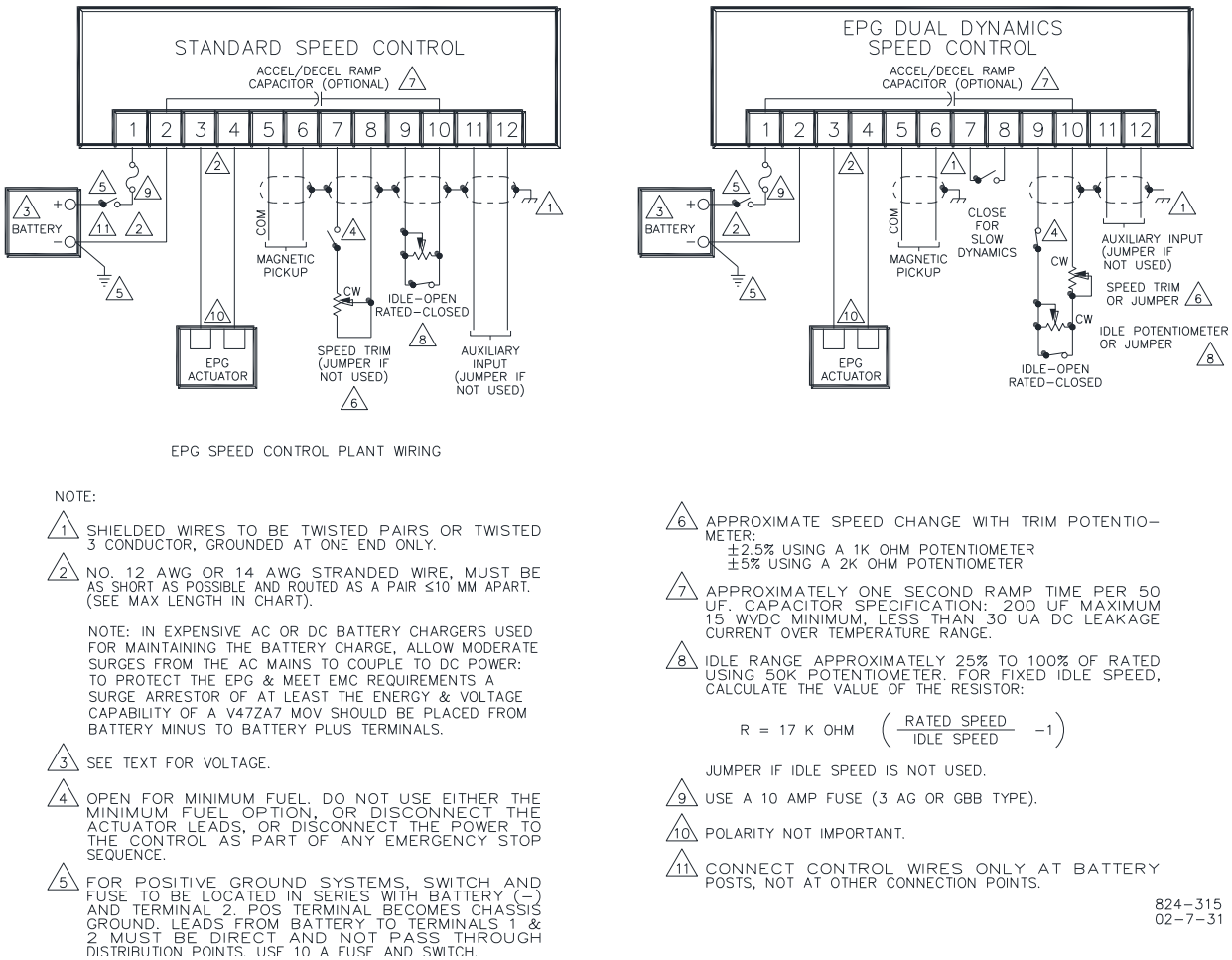
Use a wiring diagram for the specific part number of your EPG system to make all wiring connections. The wiring diagram is available from Woodward. Typical wiring is shown in Figure 2-5.

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

Table 2-1. Maximum Wiring Length

EPG Model	Maximum Wire Length	
	14 AWG (2 mm²)	12 AWG (3 mm²)
512/1712	10 ft (3 m)	20 ft (6 m)
524/1724	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 Table 2-2. Do not use a fuse of higher current rating. Starter relays make good EPG power switches.



EPG SPEED CONTROL PLANT WIRING

Figure 2-5. Typical EPG (Isochronous) Wiring Diagram
(Do not use for construction.)

Table 2-2. Switch and Fuse Requirements

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

The battery connection to speed control terminals 1 and 2 must be directly from the terminals, not through distribution points (see Figure 2-6).

Do not connect any other wires to terminals 1 and 2 except the power for the 2500 ramp generator, if used.

NOTICE **To prevent damage to the control, never disconnect the battery while the engine is running.**

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 2-6.**

NOTICE

Inexpensive AC to DC battery chargers used for maintaining the battery charge allow moderate surges from the AC mains to couple to DC power: To protect the EPG, a surge arrestor of at least the energy and voltage capability of a V47ZA7 MOV should be placed from battery minus to battery plus terminals.

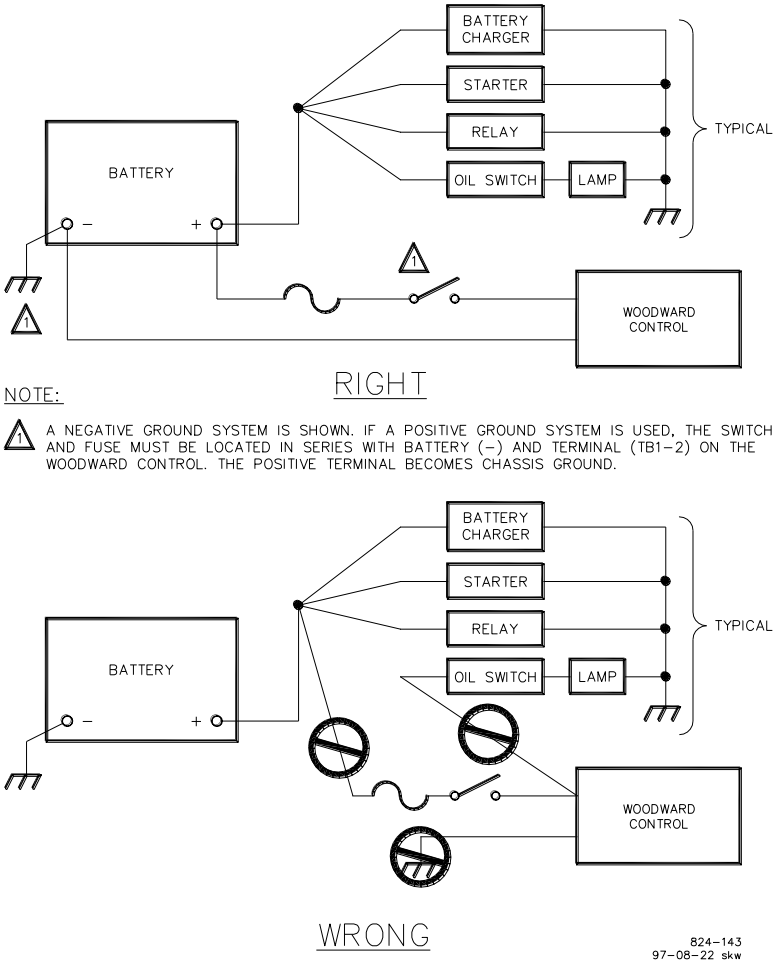


Figure 2-6. Correct and Incorrect Wiring to Battery

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.

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 (⏚).

Installation Checks

Checks for all Applications

The following steps check only the speed control and actuator, which 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. The main part of Chapter 5 (Troubleshooting) is doing these checks.

If a load sensor is used, temporarily remove the wires at speed control terminals 11 and 12 and temporarily jumper terminals 11 to 12. The generator must not be paralleled during these tests. If a Ramp Generator is used, temporarily remove the wire at speed control terminal 10. If a capacitor is connected to terminal 10 to provide a ramp between unloaded and loaded, it must be removed during this test or calibration. Leave the idle-rated switch wiring connected. Do the checks in the order indicated. Terminal numbers in this section refer to the speed control.

1. Check that all electrical connections are correctly made and terminal screws are tight; the magnetic pickup is properly installed and the jam nut is tight; the actuator and linkage are securely fastened. If start-fuel limit is present, turn the adjustment fully clockwise during these tests. If dual dynamics are present, set the switch closed for slow dynamics.

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 1 (+) and 2 (–). It must be from 10 to 16 Vdc for 512/1712 controls, and from 20 to 32 Vdc for 524/1724 controls.

3. Disconnect any wiring or jumper on terminal 7. Measure 7.2 ±1.0 V from terminal 2 (–) to 7 (+) [terminals 2 (–) to 9 (+) for dual-dynamics control]. Reinstall the wiring to terminal 7 if voltage is correct. Do not use the control if voltage is incorrect.

4. If idle speed is desired, connect a 50 kΩ potentiometer or fixed resistor to terminals 9 and 10 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 or jumper terminals 9 and 10. Measure the voltage from terminal 7 (+) to 2 (–). 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 the 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 speed can be preset. If a signal generator is not available, skip to step 7.

   Turn off governor power. 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 wave form can be sine, square, or triangular. Calculate the MPU frequency for idle and rated speeds (see part number selection in Chapter 1).

Check Failsafe and Actuator Travel
Set the signal-generator frequency to about half of 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 that 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 that linkage travel is limited by the prime mover's fuel control, not by the actuator stop.

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 counterclockwise until the linkage just begins to move to the minimum fuel position. Start Fuel (if present) must be adjusted to the maximum clockwise position or the actuator will not move to maximum.

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

Continue to adjust the rated speed pot very slowly 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.

Preset Idle Speed
Preset idle speed only after presetting rated speed. Set the signal generator for the 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 counterclockwise until the linkage just begins to move to the minimum fuel position. Start Fuel (if present) must be adjusted to the maximum clockwise position or the actuator will not move to maximum.

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

Continue to adjust the idle speed pot very slowly 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 counterclockwise.

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.

⚠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. (Units with dual dynamics should select Slow Dynamics if the goal is to have separate dynamics for loaded and unloaded conditions. If the dual dynamics are being used for dual-fuel engines, select and set the dynamics that fit the starting fuel.)

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. (The Start Fuel Limit must be fully clockwise on controls with Start Fuel Limit.) 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 clockwise four turns and try to restart. Be prepared to quickly adjust rated speed counterclockwise to minimize overspeed if the prime mover starts. If it still doesn't start, turn the rated-speed pot fully counterclockwise 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. (Be sure to select the correct low-speed or high-speed dynamics pot on units with dual dynamics.) Eliminate oscillation by slowly turning the gain pot for the stable region between high and low frequency oscillation. If oscillation does not stop at the high-low crossover, turn the stability pot slightly counterclockwise and slowly readjust the gain pot. Continue adjusting the stability pot slightly counterclockwise followed by readjusting gain until the prime mover runs at a steady speed. (The stability pot adjusted must be for the same dynamics as the gain pot on dual dynamics units.)

By turning gain slightly clockwise and stability slightly counterclockwise, or vice-versa, it is possible to maintain stable speed and vary transient response. The four curves on the response curve diagram are examples of a naturally aspirated (not turbocharged) diesel engine. Note that increasing gain and decreasing stability causes shorter settling times at the expense of ringing. A chart recorder makes it easier to observe transient response.

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 clockwise. Turn the stability pot counterclockwise as required to eliminate oscillation and obtain the desired response.

To decrease ringing, turn the stability pot clockwise. Turn the gain pot counterclockwise as required to eliminate oscillation and obtain the desired response.

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

(Units with Dual Dynamics will require setting of the second dynamics under the operating conditions where they will be used—such as engine loaded or a different fuel being used. Repeat step 10 in its entirety to set the second set of dynamics.)

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 exactly rated speed, Set the idle-rated switch for idle speed. Adjust the idle speed pot for the desired idle speed. Set the idle-rated switch back to rated.

12. Set the Start Fuel Limit on units so equipped at mid-position. Attempt to start the engine. If the actuator moves to a position higher than desired, adjust slightly counterclockwise. To increase the start fuel position, turn the potentiometer clockwise. In most diesel applications the ideal setting will be where the engine starts with a minimum amount of ejected smoke. Start Fuel Limit is adjusted on gas fueled engines to prevent flooding while allowing the engine to start. The Start Fuel Limit will be overridden should the cranking speed of the engine exceed the selected idle or rated speed.

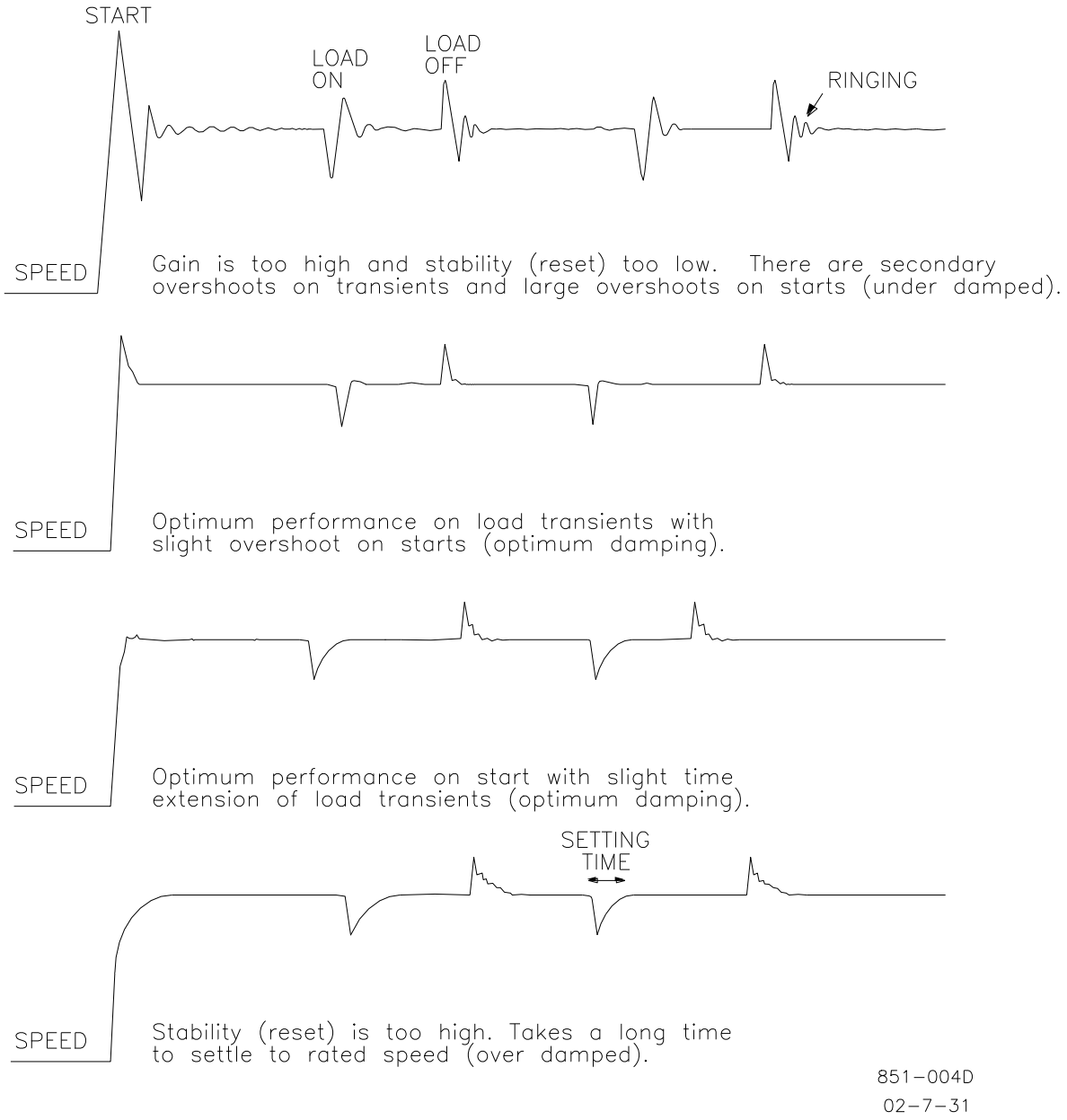


Figure 2-7. Starting and Transient Response Curves

Chapter 3.
Operation

The speed control requires that power be on when starting, and that power be 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, a speed trim pot adjustment is required to set the amount of power generated.

The EPG is 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 time switch. Alternatively, the prime mover can run to rated speed on starting (refer to the curves in Figure 2-7). 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.

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 4-1 shows the EPG Electrically Powered Governor in more detail. The speed control is housed 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. 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 should be set before idle speed. Speed sensor output is a voltage proportional to magnetic pickup frequency. The frequency range of the magnetic 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 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 [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.

The auxiliary input is jumpered except when a Load Sensor is added for paralleled generator applications. There is a failsafe 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.

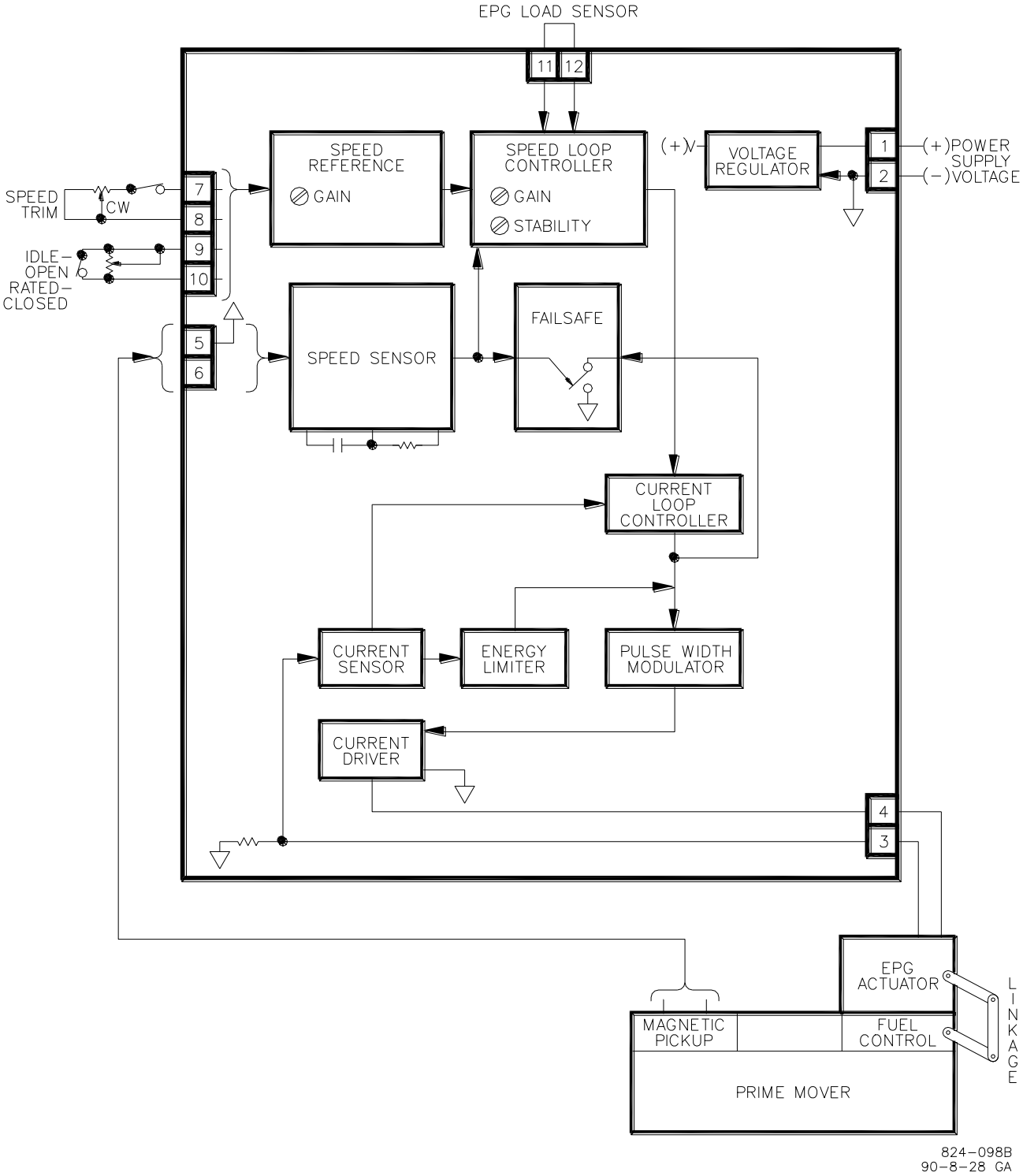


Figure 4-1. EPG Block Schematic Diagram

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°* 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.

(*) 35° for 1712/1724 actuators; 30° for 512/524 actuators

(**) Two springs for 1712/1724 actuators; one spring for 512/524 actuators

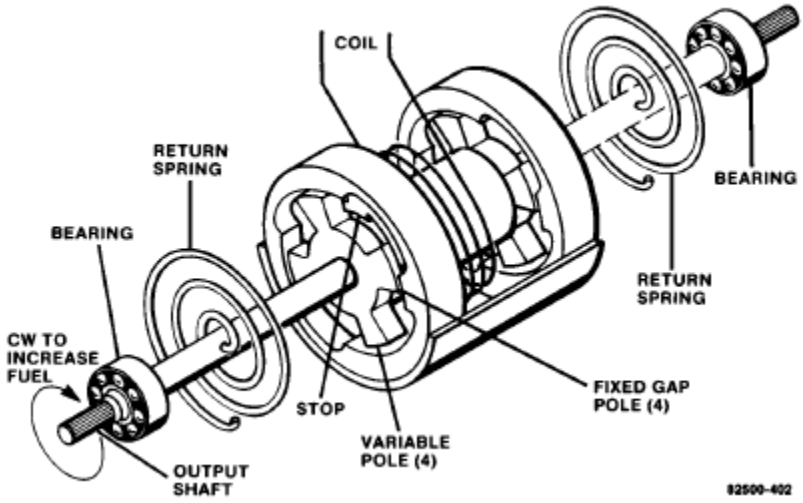


Figure 4-2. Actuator Schematic

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 information in Chapter 2 to verify that the installation is correct and perform the installation check. Those checks are the best way to test the EPG. The Preset Rated Speed section (under Step 6 of the Installation Checks in Chapter 2) 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 with the Load Sensor (referenced in Chapter 2, manual 82313).

Other Checks

Perform 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 the Gain and Stability adjustments (see 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, verify that:
   - Load sensor CTs and PTs are wired correctly.
   - Voltage regulator droop or cross current compensation is set correctly.
   - The voltage regulator is not intermittent or otherwise faulty.

   If the problem still persists, 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 3 volts in extreme cases. Consult with your authorized distributor or with Woodward in such cases.

4. If the fuse or breaker opens after the prime mover has been running, high voltage spikes from the battery or battery charger may be the problem. Provide separate wires from the speed control to the battery terminals as shown in the top of figure 2-6.

5. If the fuse or breaker opens upon initial start-up, the battery connections may be incorrect. Verify that the battery connections are correct. Remove the wires to terminals 1 through 4. Check for a short to ground on each wire.

6. If the prime mover oscillates when cold and stabilizes when warm, turn the gain pot slightly counterclockwise. Turn the stability pot slightly clockwise if required to maintain stability.