



**Electrically
Powered
Governor**

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

Installation, Operation, and Troubleshooting Manual

WOODWARD GOVERNOR COMPANY

WARNING

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.

NOTE

The electronic control contains parts that are static sensitive. To prevent damage to these parts observe the following precautions.

- *Discharge personal static before handling. (Touch a grounded surface and maintain contact while handling.)*
- *Do not touch the PCB inside the control with your hands or with conductive devices.*
- *Avoid all plastic, vinyl, and styrofoam around the controls (except antistatic plastics).*

The letter designation following the manual number is changed to the next letter in alphabetical order when an important revision is made to the manual.

TEXT CHANGES ARE INDICATED BY A BLACK LINE ALONGSIDE THE TEXT.

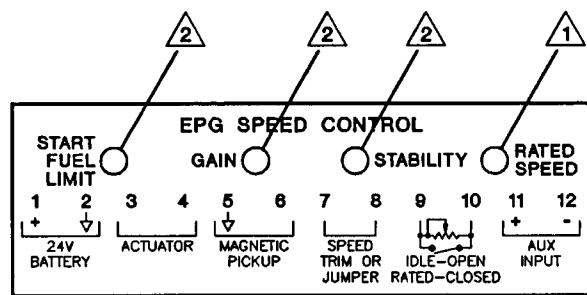
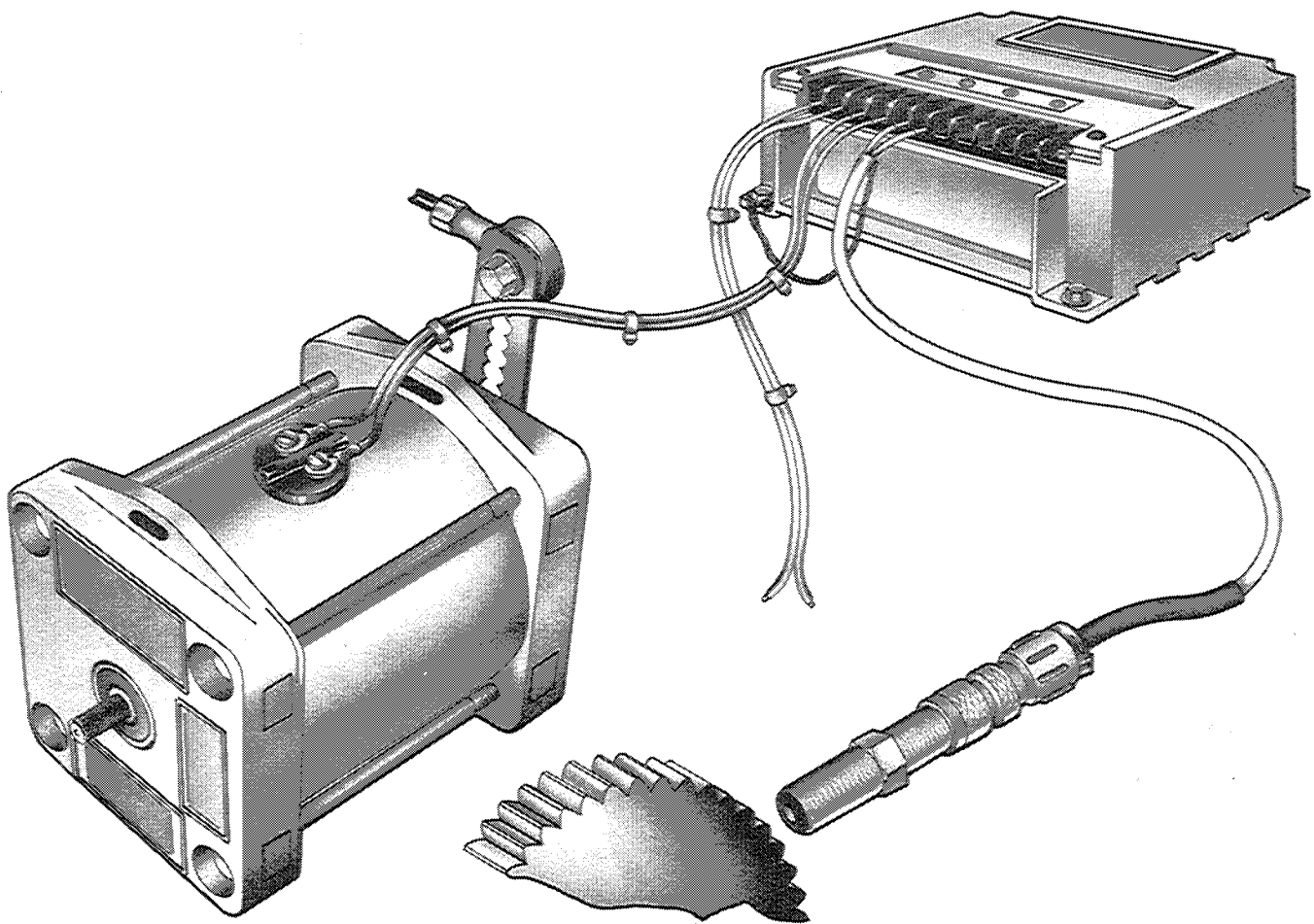
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- 1 TWENTY FIVE POTENTIOMETER. RATCHET-TYPE CLUTCHES AT BOTH ENDS OF TRAVEL.
- 2 ONE-TURN POTENTIOMETER. SOLID STOPS AT BOTH ENDS OF TRAVEL.

MOST MODELS DO NOT HAVE THE START FUEL LIMIT.

82500-C-83

Figure 1-1. Basic Electrically powered Governor System

SECTION 1 GENERAL INFORMATION

INTRODUCTION

The Model 1712/1724 and Model 512/524 Electrically Powered Governors (EPG's) are designed and manufactured by the Woodward Governor Company, Engine and Turbine Controls Division, P.O. Box 1519, Fort Collins, Colorado 80522. The telephone number is 303-482-5811 and the telex number is 4-5691.

NOTE

This manual covers only the part numbers of the system components that are listed in the Part Number Selection Chart. Contact the Woodward Governor Company for information about other part numbers.

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 Governor 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.

Part Number Selection Charts

Isochronous Speed Control—

For Use with Engine Type (System Battery Voltage)	Speed Range (Hz) Required				Actuator Part Number
	750 to 1500	1500 to 3000	3000 to 6000	6000 to 12000	
Diesel & Gas Turbine (12 V)	8290-062	8290-050	8290-040	8290-063	8256-022 (512) **
Gasoline or Gas Engine (12 V)	8290-064	8290-059	8290-041	8290-051	
Diesel w/ Start Fuel Limit (12 V)			8290-140 8290-186* **		8256-017 (1712) **
Gas w/ Start Fuel Limit (12 V)			8290-141 8290-187* **		
Gasoline or Gas w/ Dual Dynamics (12 V)			8290-158		
Diesel & Gas Turbine (24 V)	8290-061	8290-054	8290-038	8290-060	8256-021 (524) **
Gasoline or Gas Engines (24 V)	8290-057	8290-058	8290-039	8290-052	
Diesel w/ Start Fuel Limit (24 V)		8290-175	8290-138 8290-184* **	8290-172	8256-016 (1724) **
Gasoline or Gas w/ Start Fuel Limit (24 V)		8290-174	8290-139 8290-185* **		
Gasoline or Gas w/ Dual Dynamics (24 V)			8290-118		

Droop Speed Control—

For Use with Engine Type (System Battery Voltage)	Speed Range (Hz) Required				Actuator Part Number
	750 to 1500	1500 to 3000	3000 to 6000	6000 to 12000	
Diesel & Gas Turbine (12 V)	8290-067	8290-071	8290-046	8290-075	8256-022 (512) **
Gasoline or Gas Engine (12 V)	8290-068	8290-072	8290-047	8290-076	8256-017 (1712) **
Diesel & Gas Turbine (24 V)	8290-069	8290-073	8290-044	8290-077	8256-021 (524) **
Gasoline or Gas Engine (24 V)	8290-070	8290-074	8290-045	8290-078	8256-016 (1724) **
Diesel & Gas Turbines w/ Dual Dynamics (24 V)			8290-142		

*—These part numbers are EU Directive compliant.

** - These part numbers are UL/cUL listed.

APPLICATION

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

Prime movers with mechanical loads and generator loads are handled 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 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 1712/512, and 3 amps for the 24 volt Model 1724/524.

PART NUMBER SELECTION

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

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

Speed controls and actuators must be compatible. Selection of compatible EPG Speed Control and Actuator are made from the Part Number Selection Chart.

Start Fuel Limit EPGs allow setting a maximum actuator position during startup. 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.

Dual Dynamics 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 nonlinear fuel systems. A switch is used to change between slow and fast dynamics.

ACCESSORIES

This manual includes some information about accessories frequently used with EPG's.

TO PARALLEL GENERATORS

Add the Generator Load Sensor to the EPG in paralleled generator applications. Woodward makes many accessories for paralleled generator applications.

TO DECREASE ACCELERATION AND DECELERATION

The Ramp Generator or an optional, external capacitor can be used to increase the time to go from idle to rated speeds and vice versa. The Ramp Generator provides a linear ramp with times adjustable to twenty-five seconds in a typical case. It is useful in smoke limiting applications. Use the 8271-909 with 24 volt batteries and the 8271-910 for 12 volt batteries. The capacitor provides an exponential ramp with times up to four seconds. Exponential means it changes (speed in this case) rapidly at first but slows as it reaches its final value. See the typical wiring diagram for capacitor requirements.

REFERENCE

These publications can be ordered from any Woodward office listed on the back cover.

<i>Catalog</i>	<i>Title</i>
25066	Woodward Controls for Engine Generator Sets
25074	Woodward Controls for Industrial Gas Turbines

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

<i>Manual</i>	<i>Title</i>
25070	Electric Governor Installation Guide
82510	Magnetic Pickups for Electric Governors

SECTION 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 the Woodward Governor Company for more information

WARNING

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown device(s), that operates totally independent of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

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 near by. 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 93°C (-40° to 200°F). Do not expose the actuator to sources of excessive heat.

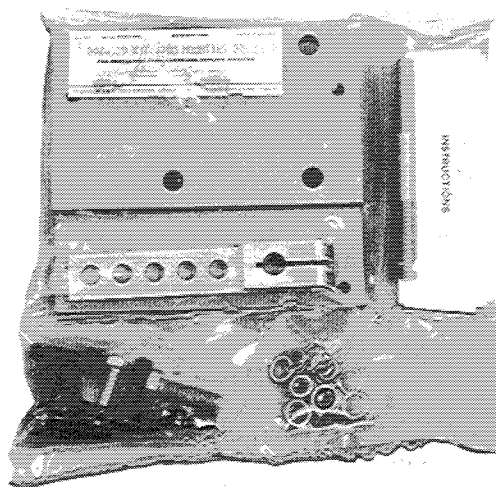
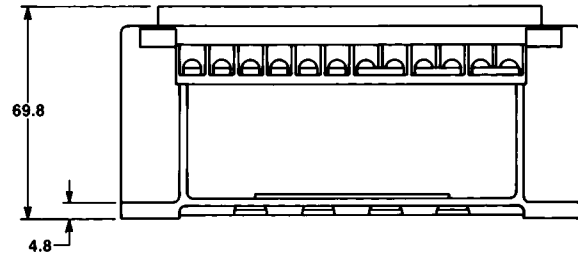
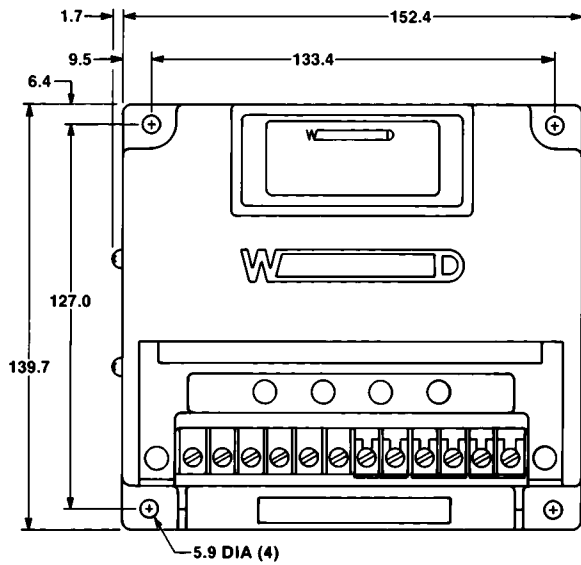


Figure 2-1. Typical Installation Kit

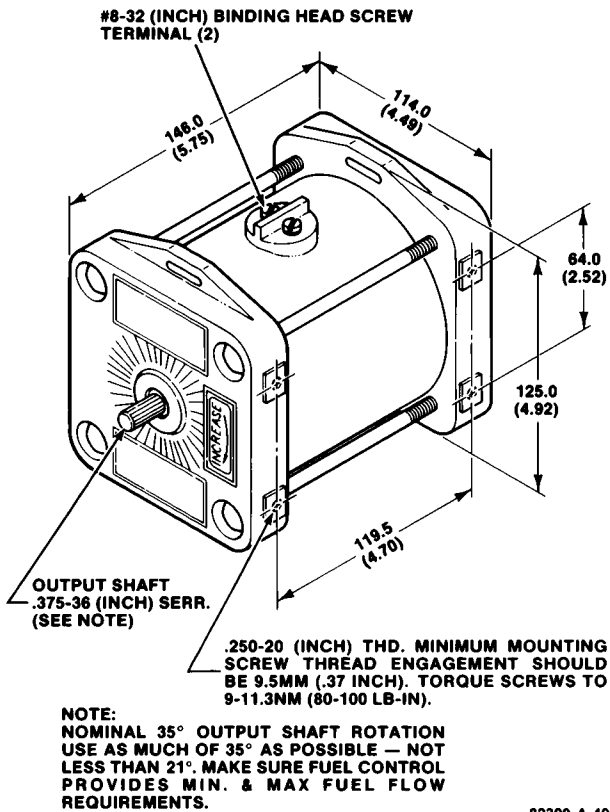


CONVERSION CHART	
MM	INCH
1.7	.068
4.8	.188
5.9	.234
6.4	.250
9.5	.375
69.8	2.750
127.0	5.000
133.4	5.250
139.7	5.500
152.4	6.000

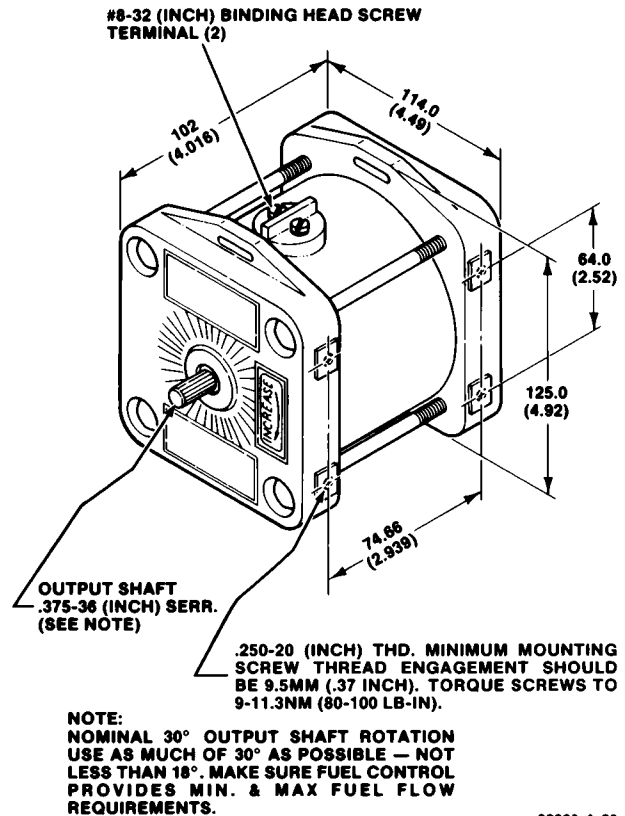
METRIC

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Figure 2-2. Outline Drawing for EPG 1712/512 and 1724/524 Speed Controls
(Do Not Use for Construction)



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82300-A-90

Figure 2-3. EPG Models 1712/1724 and 512/524 Actuator Outline Drawing
(Do Not Use for Construction)

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.

LINKAGE COMPATIBILITY

Also match linkage linearity to the fuel control. Use a linear linkage as shown in figure 2-4 unless the prime mover has a carburetor or other non-linear fuel control. See figures 2-5 and 2-6 for a carburetor compensating linkage. Contact the Woodward Governor Company 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.

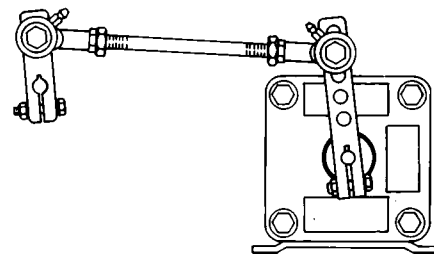
Manually stroke the fuel control linkage from stop to stop as if the actuator were moving it. The linkage must move freely without friction and without backlash. Lubricate or replace linkage or fuel control parts as required.

Mount the actuator and install a suitable linkage.

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

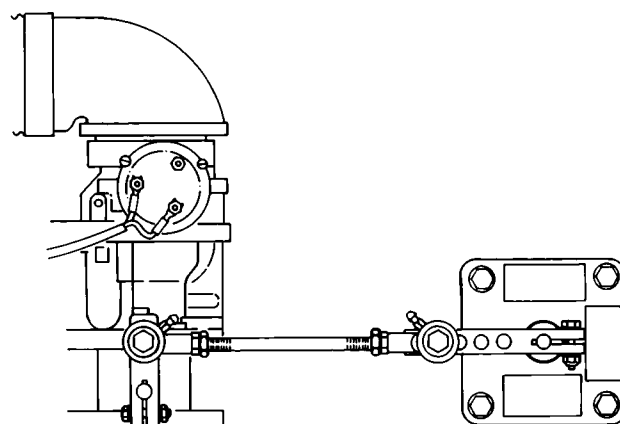
Make sure the actuator is capable of moving the fuel control to maximum and minimum limits. Let the fuel control limit actuator travel. Set the linkage so the actuator is just above minimum when the fuel control is at its minimum stop and, except for Detroit Diesel engines, so the actuator is just below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

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



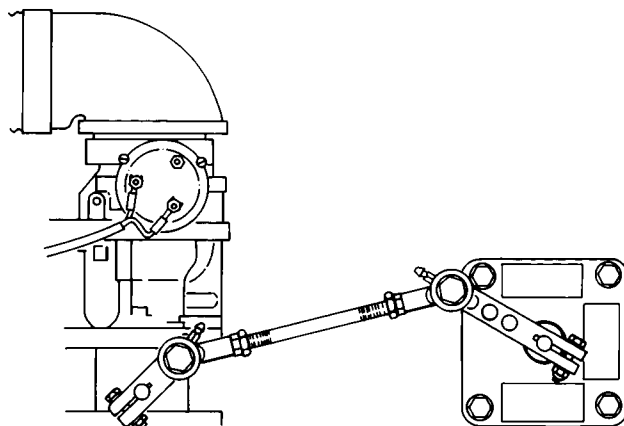
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Figure 2-4. Linear Linkage



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Figure 2-5. Carburetor Compensating Linkage at Minimum Fuel



25000-A-75

Figure 2-6. Carburetor Compensating Linkage at Maximum Fuel

INSTALL MAGNETIC PICKUP

Mount the magnetic pickup through a housing or rigid bracket. Make sure the sensed gear is of magnetic material. The gap between the pickup and the outside diameter of the gear should be set to approximately 1.0 mm (.040") at the closest point (radial runout). Using the pickup with small gears may require spacing as close as 0.2 mm (0.010").

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

The standard models of pickups require mating connectors, MS 3102R-18-3P. The connectors are not furnished with the pickup, but may be ordered from Woodward if desired. Contact the Woodward Governor Company or order manual 82510, Magnetic Pickups for Electric Governors 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 the Woodward Governor Company. Typical wiring is shown in figure 2-7.

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 listed:

Maximum Wiring Length Chart

EPG model	Maximum Wire Length	
	14 AWG (2mm ²)	12AWG (4mm ²)
1712/512	10 ft. (3m)	20 ft. (6m)
1724/524	35 ft. 10.7m	75 ft. (22.9m)

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 AMPS	10 AMP
1724/524	24	10 AMPS	10 AMP

Wire Harness Part Numbers Chart

Harness Part #	Harness Lengths		
8924-621	MPU 10 ft.	Actuator 15 ft.	Battery 15 ft.
8924-620	MPU 10 ft.	Actuator 25 ft.	Battery 25 ft.

The battery connection to speed control terminals 1 and 2 must be directly from the terminals, not through distribution points. See figure 2-9

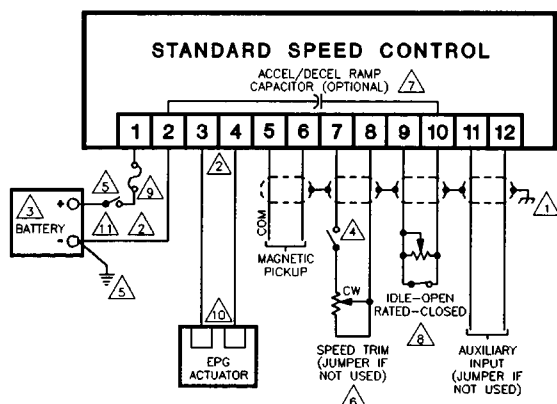
Do not connect any other wires to terminals 1 and 2 except the power for the 2500 Ramp Generator, if used.



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



Connect power wires directly to the battery terminals. The speed control can be damaged if these wires are connected to distribution points. See figure 2-9.



EPG SPEED CONTROL PLANT WIRING

NOTE:

- 1 SHIELDED WIRES TO BE TWISTED PAIRS OR TWISTED 3 CONDUCTOR, GROUNDED AT ONE END ONLY.
- 2 NO. 12 AWG OR 14 AWG STRANDED WIRE. MUST BE AS SHORT AS POSSIBLE (SEE MAX LENGTH IN CHART).
- 3 SEE TEXT FOR VOLTAGE.
- 4 OPEN FOR MINIMUM FUEL, DO NOT USE EITHER THE MINIMUM FUEL OPTION, OR DISCONNECT THE ACTUATOR LEADS, OR DISCONNECT THE POWER TO THE CONTROL AS PART OF ANY EMERGENCY STOP SEQUENCE.
- 5 FOR POSITIVE GROUND SYSTEMS, SWITCH AND FUSE TO BE LOCATED IN SERIES WITH BATTERY (+) AND TERMINAL 2. POS TERMINAL BECOMES CHASSIS GROUND. LEADS FROM BATTERY TO TERMINALS 1 & 2 MUST BE DIRECT AND NOT PASS THROUGH DISTRIBUTION POINTS. USE 10A FUSE AND SWITCH
- 6 APPROXIMATE SPEED CHANGE WITH TRIM POTENTIOMETER.
±2.5% USING A 1K OHM POTENTIOMETER.
±5% USING A 2K OHM POTENTIOMETER.
- 7 APPROXIMATELY ONE SECOND RAMP TIME PER 50 UF. CAPACITOR SPECIFICATION: 200 UF MAXIMUM, 15 WVDC MINIMUM, LESS THAN 30 UA DC LEAKAGE CURRENT OVER TEMPERATURE RANGE.
- 8 IDLE RANGE APPROXIMATELY 25% TO 100% OF RATED USING 150K POTENTIOMETER. FOR FIXED IDLE SPEED, CALCULATE THE VALUE OF THE RESISTOR.
$$R = 17 \text{ K OHM } \left(\frac{\text{RATED SPEED}}{\text{IDLE SPEED}} - 1 \right)$$
- 9 JUMPER IF IDLE SPEED IS NOT USED.
- 10 USE A 10 AMP FUSE (3 AG OR GBB TYPE).
- 11 POLARITY NOT IMPORTANT.
- 12 CONNECT CONTROL WIRES ONLY AT BATTERY POSTS, NOT AT OTHER CONNECTOR POINTS.

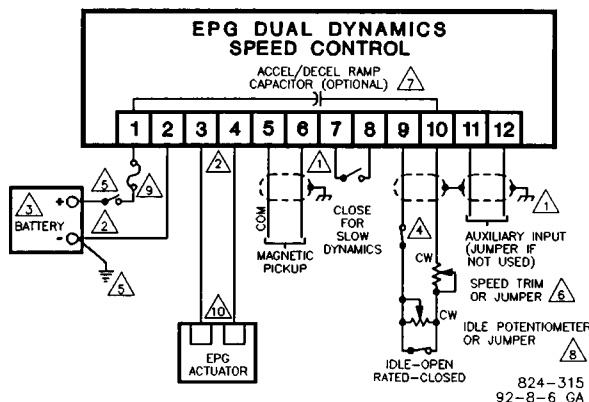


Figure 2-7. Typical EPG (Isochronous) Wiring Diagram (Do Not Use for Construction)

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 ().

ADDITIONAL WIRING FOR 2500 RAMP GENERATORS (OPTIONAL)

Connect the 2500 Ramp Generator terminal 1 and 2 to speed control terminals 1 and 2, respectively. Connect 2500 Ramp Generator terminal 4 to speed control terminal 10 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.

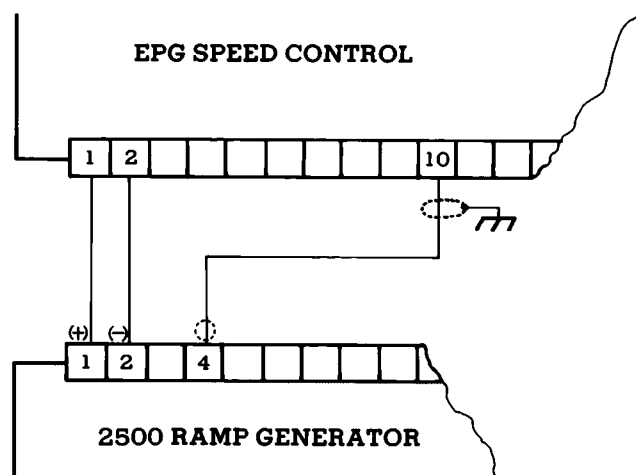
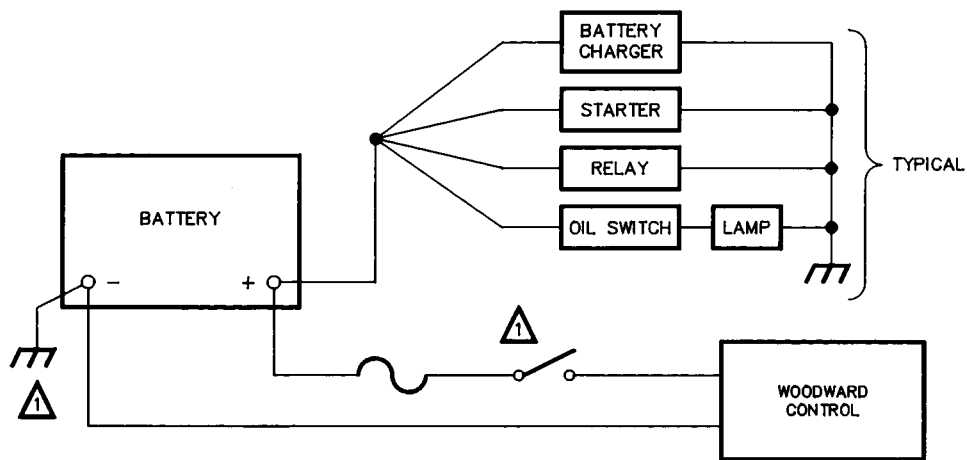


Figure 2-8. Typical Wiring for 2500 Ramp Generator

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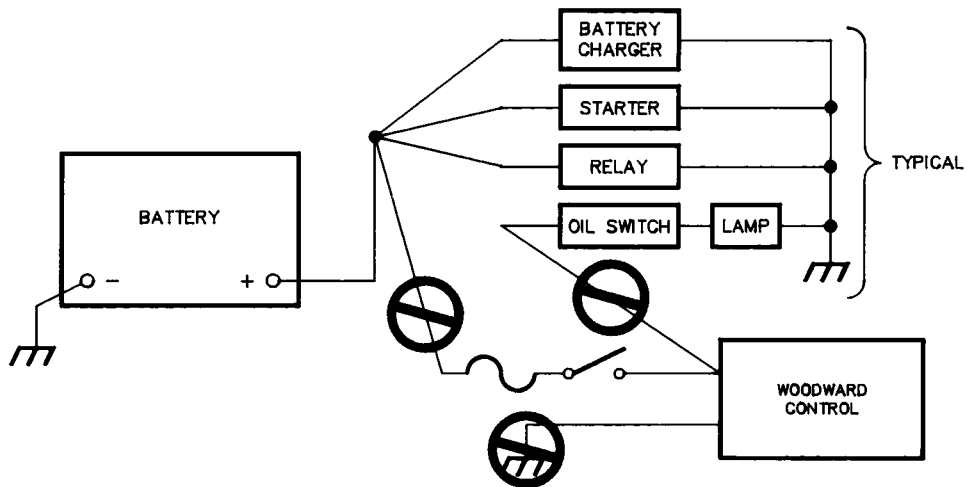


NOTE:

RIGHT



A NEGATIVE GROUND SYSTEM IS SHOWN. IF A POSITIVE GROUND SYSTEM IS USED, THE SWITCH AND FUSE MUST BE LOCATED IN SERIES WITH BATTERY (-) AND TERMINAL (2) ON THE WOODWARD CONTROL. THE POSITIVE TERMINAL BECOMES CHASSIS GROUND.



WRONG

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Figure 2-9. Correct and Incorrect Wiring to Battery

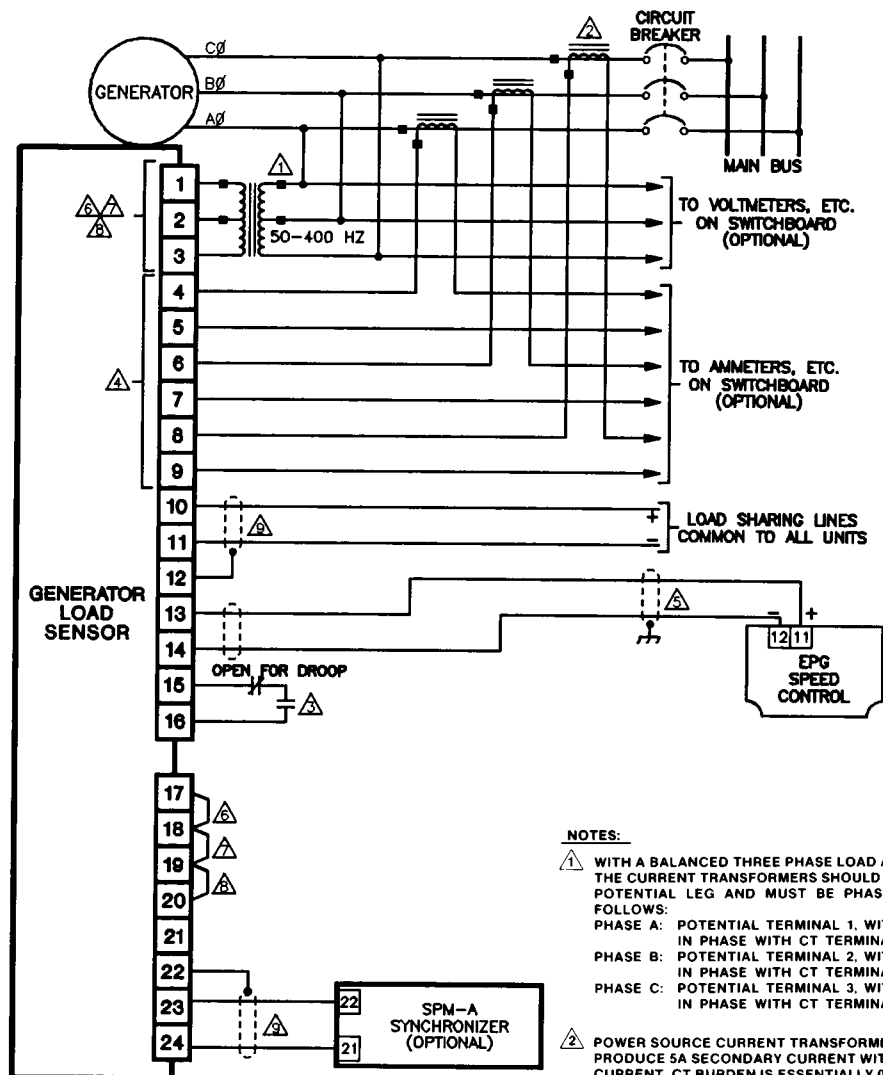
ADDITIONAL WIRING FOR EPG LOAD SENSOR (OPTIONAL)

Mount the Load Sensor where it will be between -40° and 71°C (-40° and 160°F). Do not mount it on the prime mover. The best location is usually the switchgear cabinet which has the CT's and PT's.

Wire the Load Sensor as shown in the diagram for additional wiring. Careful attention to correct CT

and PT wiring can save time during the phasing checks later on. Install appropriate voltage selection jumpers at terminals 17 through 20. Refer to Manual 82313 for load sensor information.

Contact the Woodward Governor Company before connecting anything other than the 8290-048 Load Sensor to terminals 11 and 12 of the EPG Speed Control.



NOTES:

1. WITH A BALANCED THREE PHASE LOAD AND UNITY POWER FACTOR THE CURRENT TRANSFORMERS SHOULD BE WIRED IN THE CORRECT POTENTIAL LEG AND MUST BE PHASED AT THE CONTROL AS FOLLOWS:
 PHASE A: POTENTIAL TERMINAL 1, WITH RESPECT TO NEUTRAL, IN PHASE WITH CT TERMINALS 4 TO 5
 PHASE B: POTENTIAL TERMINAL 2, WITH RESPECT TO NEUTRAL, IN PHASE WITH CT TERMINALS 6 TO 7
 PHASE C: POTENTIAL TERMINAL 3, WITH RESPECT TO NEUTRAL, IN PHASE WITH CT TERMINALS 8 TO 9
2. POWER SOURCE CURRENT TRANSFORMERS SHOULD BE SIZED TO PRODUCE 5A SECONDARY CURRENT WITH MAXIMUM GENERATOR CURRENT. CT BURDEN IS ESSENTIALLY 0VA.
3. CONTACTS CUSTOMER OPTION
4. THIS CONTROL CONTAINS INTERNAL BURDEN RESISTORS. THESE BURDEN RESISTORS MUST BE CONNECTED ACROSS POWER SOURCE CURRENT TRANSFORMERS WHENEVER UNIT IS RUNNING TO PREVENT LETHAL HIGH VOLTAGE FROM DEVELOPING ON LEADS TO THESE TERMINALS.
5. OUTPUT LINES SHOULD BE TWISTED SHIELDED PAIRS. SHIELD IS TO BE TIED TO GROUND AT SPEED CONTROL ONLY.
6. JUMPER 17 TO 18 AND 19 TO 20 WHEN POTENTIAL INPUT AT TERMINALS 1 THRU 3 IS 95 TO 130VAC PHASE TO PHASE (50-400 HZ).
7. JUMPER 18 TO 19 WHEN POTENTIAL INPUT AT TERMINALS 1 THRU 3 IS 190 TO 260 VAC PHASE TO PHASE (50-400 HZ).
8. POTENTIAL TRANSFORMER BURDEN IS 5VA PER PHASE WITH 230VAC INPUT AND 2.5VA PER PHASE WITH 115 VAC INPUT.
9. CONTROL SIGNAL LINES SHOULD BE TWISTED SHIELDED PAIRS. SHIELD IS TO BE TIED TO GROUND AT ONE END ONLY.

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Figure 2-10. Additional Wiring to Install the EPG Load Sensor
(For Paralleled Generator Applications)



Class I, Division 2, Group A, B, C, D Hazardous Locations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D, or non-hazardous locations only.



WARNING

Explosion Hazard—Substitution of components may impair suitability for Class I, Division 2.



AVERTISSEMENT

Risque d'explosion—La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe 1, Division 2.



WARNING

Explosion Hazard—Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.



AVERTISSEMENT

Risque d'explosion—Avant de déconnecter l'équipement, coupler le courant ou s'assurer que l'emplacement est désigné non dangereux.



NOTE

Installation wiring must be in accordance with Class I, Division 2 wiring methods in Article 501-4(b) of the NEC, and in accordance with the authority having jurisdiction.

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. The main part of Section 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. Perform 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 1712/512 controls and from 20 to 32 Vdc for 1724-/524 controls.
3. Disconnect any wiring or jumper on terminal 7. Measure 7.2 ± 1 volt from terminal 2 (-) to 7 (+) [terminals 2(-) to 9 (+) for dual-dynamic 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 K Ω potentiometer or fixed resistor to terminals 9 and 10 as shown in the typical wiring diagram. To calculate the value of a fixed resistor:

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

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 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 wave form can be sine, square, or triangular. Calculate the MPU frequency for idle and rated speeds. (See part number selection in Section 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 linkage travel is limited by the prime-mover fuel control, not by the actuator stop. Turn the signal generator off and remove the connections at terminals 5 and 6. The linkage should move to the minimum fuel position. Verify linkage travel is limited by the prime mover's fuel control, not by the actuator stop.

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. Start Fuel (if present) must be adjusted to maximum cw position or the actuator will not move to maximum.

If the linkage is at the minimum fuel position:

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

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

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

If the linkage is at the minimum fuel position:

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

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

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

8. Remove the MPU wires from speed control terminals 5 and 6. Measure the resistance of the MPU at the wire ends. It should be between 100 and 300 ohms. Reconnect the MPU wires.
9. Set the idle-rated switch for rated speed. Turn governor power on.

WARNING

TO PROTECT AGAINST POSSIBLE PERSONAL INJURY, LOSS OF LIFE, and/or PROPERTY DAMAGE WHEN STARTING the engine, turbine, or other type of prime mover, BE PREPARED TO MAKE AN EMERGENCY SHUTDOWN to protect against runaway or overspeed should the mechanical-hydraulic governor(s), or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the control devices fail.

10. GAIN & 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 (0Ω). If not, the idle-rated switch is in the idle position or the switch or wiring is defective. Place in rated

position or repair. If the resistance is 0 Ω the rated speed reference can be lower than cranking speed. Turn the rated-speed pot cw four turns and try to restart. Be prepared to quickly adjust rated speed ccw to minimize over speed 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 Section 5, Troubleshooting.

When the prime mover starts, slowly turn the gain pot back and forth to observe high and low frequency oscillation. (Be sure and select the correct low- 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 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. (The stability pot adjusted must be for the same dynamics as the gain pot on dual dynamics units.)

By turning gain slightly cw and stability slightly ccw, 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 turbo-charged) 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 setting 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 pot cw. Turn the gain pot ccw as required to eliminate oscillation and obtain desired response.

Check response by applying and removing load, manually hitting the linkage, or quickly switching to idle 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, i.e. 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.

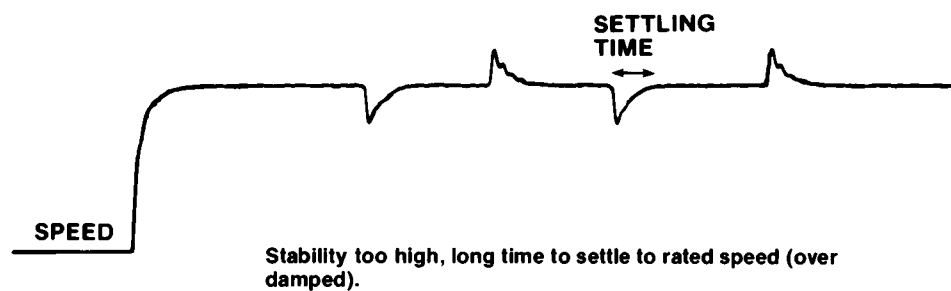
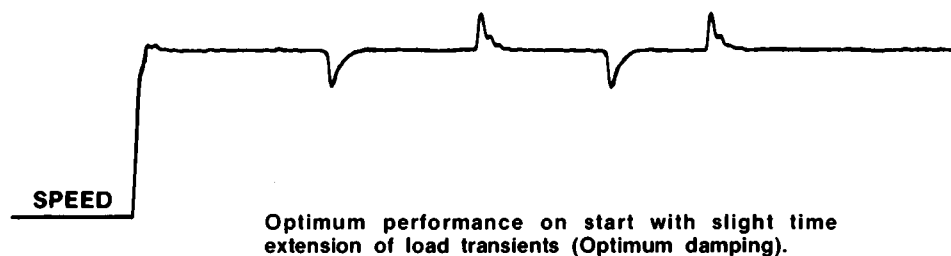
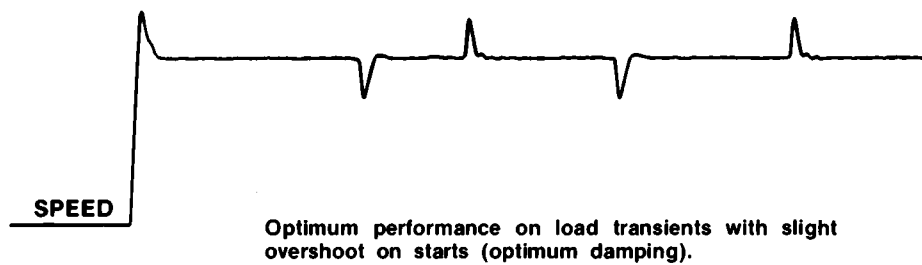
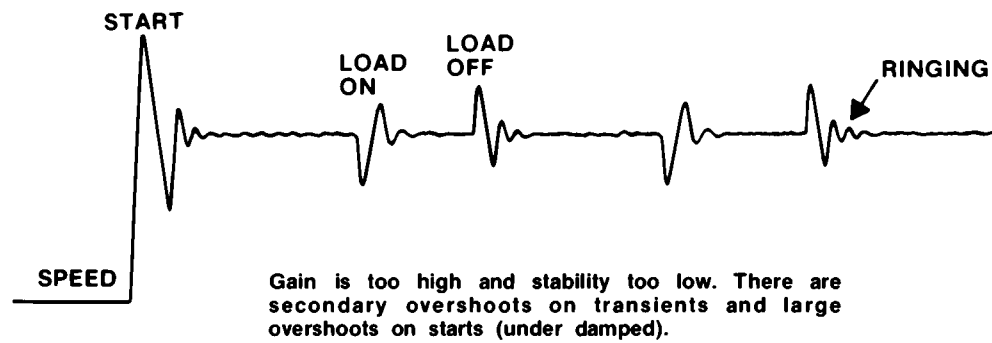
12. Set the Start Fuel Limit on units so equipped at mid-position. Attempt to start the engine. If the actuator moves to a position higher than desired adjust ccw slightly. To increase the start fuel position turn the potentiometer cw. In most diesel applications the ideal setting will be where the engine 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.

CHECKS FOR APPLICATIONS WITH THE 2500 RAMP GENERATOR

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

PARALLELED GENERATOR APPLICATIONS WITH THE LOAD SENSOR.

See Manual 82313 for information concerning load sensor.



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Figure 2-11. Starting and Transient Response Curves

SECTION 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, 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 switch or a time. 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.

SECTION 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 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). 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.

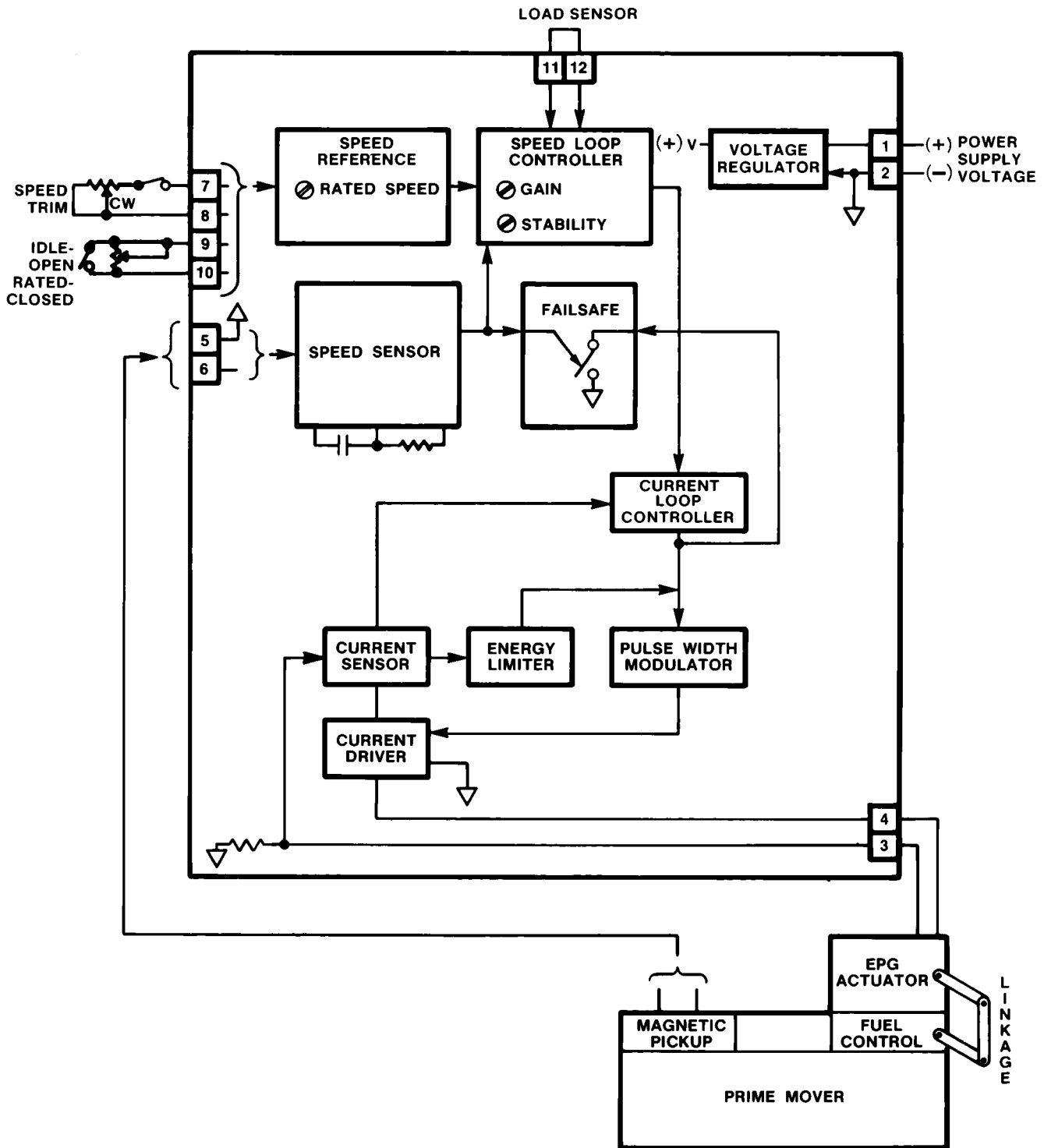
The auxiliary input is jumpered except when a Load Sensor is added for paralleled generator applications. There is a failsafe circuit which senses MPU frequency and forces the pulse width modulator input to zero if the MPU frequency or voltage are below acceptable limits, as they would be if an MPU wire broke. 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°* 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.

* For 1712/1724 Actuators and 30° for 512/524 Actuators.

Two springs for 1712/1724 Actuators. One spring for 512/524 Actuators.



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Figure 4-1. EPG Block Schematic Diagram

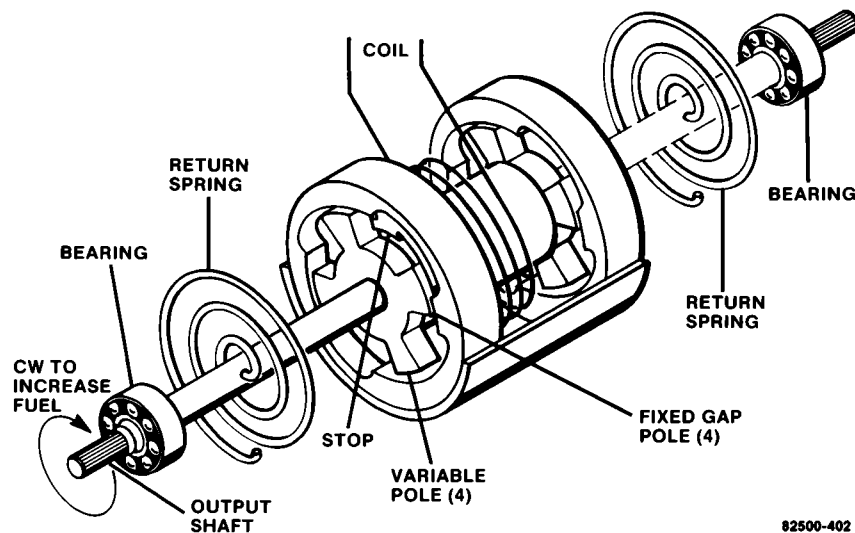


Figure 4-2. Actuator Schematic

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

A Load Sensor is used with the Electrically Powered Governor for isochronous or droop paralleling.

With an isolated bus, isochronous load sharing is usually chosen. In an isochronous load sharing system, the load gain signal voltage is shared with

all other controls through paralleling lines and provides an average load gain signal used by the controller circuits.

By comparing the paralleling line voltage to its own load gain voltage, the controller calculates an output to raise or lower, as necessary, the generator output to make the load gain voltage of its unit equal to the paralleling line. Load Sensor output directly biases the speed loop controller circuit of the speed control to affect the actuator fuel level setting and precisely maintain its proportional share of system load while maintaining a fixed frequency. See figure 2-10, Additional Wiring for Paralleled Generator Applications.

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

SECTION 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 Section 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 Section 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 Section 2.

OTHER CHECKS

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

1. If the prime mover is stable at some speeds or power outputs but oscillates at others. The linkage may not be compatible with the fuel control. Refer to Linkage Compatibility under Actuator Mounting and Linkage in Section 2.
2. If the prime mover oscillates at low frequency (about 1 Hz) and Gain & Stability Adjustments page 16, are correct, then friction in the linkage may be the cause.

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:
 - Load sensor CT's and PT's are wired correctly by doing the Current Transformer Phasing Check in Section 2.
 - Voltage regulator droop or cross current compensation is set correctly.
 - The voltage regulator is not intermittent or otherwise faulty.

If the problem is still there, reduce the load gain a little and set the load gain pot on all other load sensors in the system for the same load signal at full load. It may be necessary to reduce the load signal to three volts in extreme cases. The Woodward Governor Company should be consulted 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 2-9.
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 ccw. Turn the stability pot slightly cw if required to maintain stability.

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