36526

DPG-21XX-001
Digital Governor

APECS® Programmable Governor for Isochronous Generators

User Manual

Manual 36526

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.

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.

CAUTION

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.

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.**

Contents

Electrostatic Discharge Awareness

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

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

CAUTION

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

Chapter 1.
General Information

Introduction

The DPG-21XX-001digital governor is used primarily to govern diesel or gas fueled engines of generator sets. This microprocessor based, digital controller performs across a wide speed range and allows adjustment of set speed and gain parameters with the built-in user interface. The COMM port provides access to all other governor settings to allow adaptation to each application.

Separately programmable Proportional, Integral, and Derivative gains are provided for tailoring governor response to many engine applications. Other adjustments include acceleration and deceleration ramp rates, idle speed set, hold time, and more.

Properly tuned, this governor delivers fast engine response to speed or load change while providing precise stable isochronous operation.

The governor's internal FAILSAFE reacts instantly to loss of the engine speed signal, allowing the actuator to return to minimum fuel.

Features include:

- Isochronous speed control
- User friendly / operator adjustable
- Precision frequency control
- Superior temperature stability
- Reverse battery protection
- Input voltage range: 9-30 Vdc
- Remote setup
- Serial communication port

Actuator Compatibility:

DYNA 2000	DYNA 7000	DYNA 8000
DYNA 2500	DYNA 70025	DYNA 8200
Power Flow Gas Valves		DYNA 8400
DYNA 10141		

Other Models Available:

DPG-2200 Series – for Genset Applications
DPG-2300 Series – for Off-Road Vehicles
DPG-2401 Series – for EFC Valve Applications

Chapter 2.
Governor Specifications

The governor's main electrical and mechanical specifications are listed here along with several performance characteristics. The DPG-21XX-001 Series governors are available in five hardware configurations.

Configurations

Model No.	Connector Style Options		Speed Sensing Options		Adj. Set Speeds	Remote Speed INC and DEC
	7-wire Euro	12-pin Molex	Magnetic Pickup	Ignition Sense		
DPG-2101-001	*		*		1 + idle	
DPG-2111-001	*		*		1 + idle	
DPG-2146-001	*			*	1 + idle	
DPG-2145-001		*		*	2 + idle	*
DPG-2155-001		*	*		2 + idle	*

Electrical

Operating Voltages:	9 Vdc minimum to 30 Vdc maximum
Maximum Controlled Output Current:	7 A
Maximum Surge Current:	14 A for ten seconds
Connections:	Terminal strip with 7 terminals or a quick connector with 12 pins
Input Signal from Magnetic Pickup:	2.0 VAC RMS minimum during cranking
Input Signal from the Engine's Ignition System	40 V minimum during cranking

Mechanical

Ambient Operating Temperature:	-40°F to +185°F (-40°C to +85°C)
Sealing:	Oil, water, and dust resistant via conformal coating and die cast enclosure
Weight:	.6 lbs (.28 kg)

Performance

Steady State Speed Band:	± .25% over ambient operating temperature range
Engine Speed MPU Measurement Range:	10 MPU Hertz to 14,000 MPU Hertz
Governing Speed Range with MPU:	500 MPU Hertz to 11,000 MPU Hertz
Engine Speed Ignition Measurement Range:	2 Hertz to 350 Hertz
Governing Speed Range with Ignition:	25 Hertz to 300 Hertz

User Interface Operation

Keypad

(Not available on DPG-2111-001)

The DPG-21XX-001 provides two buttons for adjusting the engine set speed.

- INC – increases the *selected* Set Speed (A or B)
- DEC – decreases the *selected* Set Speed (A or B)

Gain Potentiometer

The DPG-21XX-001 provides a potentiometer (labeled GAIN) to adjust the Overall Gain at Set Speed A. This is one of the governor's tuning parameters. On the DPG-2111-001, the gain potentiometer adjustment range is +/-20% on the nominal value entered for the Gain at Set Speed A parameter. For all other models, the gain potentiometer adjustment range is 1 to 99.

LED

The LED (Light Emitting Diode) is used as a status indicator. When the LED is off, it indicates that one of the following is true:

- The unit is not being powered.
- The unit is reverse powered (check polarity of supplied power).

If a voltage between 9 Vdc and 30 Vdc is being properly supplied across the BAT+ and BAT- connector pins of the controller and the LED is off, then refer to the troubleshooting chapter.

A slow blinking LED indicates all of the following:

1. The unit is powered.
2. The controller is not seeing a speed signal.

This means the engine is not running. If the engine is running or cranking and the LED is blinking slow, then refer to the troubleshooting chapter for help in diagnosing why the speed signal to the controller is missing.

A fast blinking LED indicates all of the following:

1. The unit is powered.
2. There is an engine speed signal at the controller's tachometer inputs.

When the LED is on and not blinking it indicates the following:

1. The unit is powered.
2. There is a controller fault.

NOTE: The slow blink rate = ½ Hertz (the LED is turned on for 1 second followed by off for 1 second then on again and so on). The fast blink rate is 3 times faster than the slow blink rate.

COMM Port

All governor adjustments require that the controller be connected, via the COMM port, to a computer running the Universal PST application. The Universal PST is an MS Windows based application available from the Software Products page at www.woodward.com/IC/Software. See Chapter 6 for a description of this tool.

Chapter 3.
Parameter Reference

This chapter provides information regarding each of the parameters that can be adjusted when a computer is connected to the controller via the COMM port. Universal PST (described in the following chapter) is required to make adjustments to the parameters described in this chapter, with the exception of Set Speed A, Set Speed B, and Gain at Set Speed A. It contains 29 subsections. Each subsection provides information about a single parameter.

The following tables list each of the parameters and their default, minimum, and maximum values. Several of the parameters have minimum and maximum values set by other parameters. *Speed* and *Rate* values are shown as Hertz values.

PARAMETER LIST FOR DPG-2101-001 & DPG-2146-001 (IGNITION)
(These controllers use the 7-terminal Euro style screw terminal connector.)

	PARAMETER NAME	DEFAULT	MINIMUM	MAXIMUM
Opt.	1. No. of Flywheel Teeth or (Pulses per revolution)	0	0	572
Req.	**2. Set Speed A**	**1000 (25)**	**Set Speed A Min**	**Set Speed A Max**
	3. Not Available			
Opt.	4. Idle Speed	50 (20)	Idle Speed Min	Idle Speed Max
Req.	**5. Proportional**	**25**	**1**	**99**
Req.	**6. Integral**	**50**	**0**	**99**
Req.	**7. Derivative**	**25**	**0**	**99**
Req.	**8. Gain at Set Speed A**	**Use the controller's built-in GAIN potentiometer**		
	9. Not Available			
Opt.	10. Gain at Idle Speed	20	1	99
Req.	**11. Gain Factor**	**20 (40)**	**1**	**99**
Req.	**12. Speed Filter**	**16 (4)**	**1**	**24**
Opt.	13. Idle Hold Time	0	0	9999
Opt.	14. Accel Rate	1000 (3000)	1	9999
Opt.	15. Decel Rate	1000 (3000)	1	9999
Opt.	16. Startup Rate	1000 (3000)	1	9999
Opt.	17. Integral Low Limit	0	0	Integral High Limit
Opt.	18. Integral High Limit	99	Integral Low Limit	99
Opt.	19. Password	0	0	99
Opt.	20. Overspeed Limit	100	0	100
Opt.	21. Set Speed A Min	10 (2)	10 (2)	Set Speed A
Opt.	22. Set Speed A Max	11000 (300)	Set Speed A	11000 (300)
	23. Not Available			
	24. Not Available			
Opt.	25. Idle Speed Min	10 (2)	10 (2)	Idle Speed
Opt.	26. Idle Speed Max	11000 (300)	Idle Speed	11000 (300)
Opt.	27. Duty Cycle Max	95	10	95
Opt.	28. Startup Speed	1000 (25)	10 (2)	11000 (300)
Opt.	29. Startup Duty Cycle	30	5	95

Req. = Parameter adjustment required to achieve Basic Governing
Opt. = Parameter use is optional

Default, Minimum and Maximum values in parenthesis apply when the controller uses ignition pulses to sense engine speed, which would be the case for a DPG-2146-001 controller

PARAMETER LIST FOR DPG-2155-001 & DPG-2145-001 (IGNITION)
(These controllers use the 12-terminal quick connect.)

	PARAMETER NAME	DEFAULT	MINIMUM	MAXIMUM
Opt.	1. No. of Flywheel Teeth or (Pulses per Revolution)	0	0	572
Req.	**2. Set Speed A**	**1000 (25)**	**Set Speed A Min**	**Set Speed A Max**
Opt.	3. Set Speed B	1000 (25)	Set Speed B Min	Set Speed B Max
Opt.	4. Idle Speed	50 (20)	Idle Speed Min	Idle Speed Max
Req.	**5. Proportional**	**25**	**1**	**99**
Req.	**6. Integral**	**50**	**0**	**99**
Req.	**7. Derivative**	**25**	**0**	**99**
Req.	**8 GAIN @ Set Speed A**	**Use the controller's built-in GAIN potentiometer**		
Opt.	9. OVG @ Set Speed B	20	1	99
Opt.	10. OVG @ Idle Speed	20	1	99
Req.	**11. Gain Factor**	**20 (40)**	**1**	**99**
Req.	**12. Speed Filter**	**16 (4)**	**1**	**24**
Opt.	13. Idle Hold Time	0	0	9999
Opt.	14. Accel Rate	1000 (3000)	1	9999
Opt.	15. Decel Rate	1000 (3000)	1	9999
Opt.	16. Startup Rate	1000 (3000)	1	9999
Opt.	17. Integral Low Limit	0	0	Integral High Limit
Opt.	18. Integral High Limit	99	Integral Low Limit	99
Opt.	19. Password	0	0	99
Opt.	20. Overspeed Limit	100	0	100
Opt.	21. Set Speed A Min	10 (2)	10 (2)	Set Speed A
Opt.	22. Set Speed A Max	11000 (300)	Set Speed A	11000 (300)
Opt.	23. Set Speed B Min	10 (2)	10 (2)	Set Speed A
Opt.	24. Set Speed B Max	11000 (300)	Set Speed B	11000 (300)
Opt.	25. Idle Speed Min	10 (2)	10 (2)	Idle Speed
Opt.	26. Idle Speed Max	11000 (300)	Idle Speed	11000 (300)
Opt.	27. Duty Cycle Max	95	10	95
Opt.	28. Startup Speed	1000 (25)	10 (2)	11000 (300)
Opt.	29. Startup Duty Cycle	30	5	95

Req. = Parameter adjustment required to achieve Basic Governing
Opt. = Parameter use is optional

Default, Minimum and Maximum values in parenthesis apply when the controller uses ignition pulses to sense engine speed, which would be the case for a DPG-2145-001 controller.

Note: All *Speed* and *Rate* values are shown as Hertz values (parameters 2-4, 14-16, 21-26). Changing the value of parameter 1 will cause different default values to be displayed based on the Hertz to RPM formula.

PARAMETER LIST FOR DPG-2111-001 (These controllers use the 7-terminal Euro style screw terminal connector.)				
	PARAMETER NAME	**DEFAULT**	**MINIMUM**	**MAXIMUM**
Opt.	1. No. of Flywheel Teeth or (Pulses per Revolution)	0	0	572
Req.	**2. Set Speed A**	**1000**	**Set Speed A Min**	**Set Speed A Max**
Opt.	3. Not Available			
Opt.	4. Idle Speed	50	Idle Speed Min	Idle Speed Max
Req.	**5. Proportional**	**25**	**1**	**99**
Req.	**6. Integral**	**50**	**0**	**99**
Req.	**7. Derivative**	**25**	**0**	**99**
Req.	**8. GAIN @ Set Speed A**	**20**	**1**	**99**
		The controller's built-in GAIN ADJUST potentiometer provides a +/-20% adjustment range of the nominal gain value entered.		
Opt.	9. Not Available			
Opt.	10. OVG @ Idle Speed	20	1	99
Req.	**11. Gain Factor**	**20**	**1**	**99**
Req.	**12. Speed Filter**	**16**	**1**	**24**
Opt.	13. Idle Hold Time	0	0	9999
Opt.	14. Accel Rate	1000	1	9999
Opt.	15. Decel Rate	1000	1	9999
Opt.	16. Startup Rate	1000	1	9999
Opt.	17. Integral Low Limit	0	0	Integral High Limit
Opt.	18. Integral High Limit	99	Integral Low Limit	99
Opt.	19. Password	0	0	99
Opt.	20. Overspeed Limit	100	0	100
Opt.	21. Set Speed A Min	10	10	Set Speed A
Opt.	22. Set Speed A Max	11000	Set Speed A	11000
Opt.	23. Not Available			
Opt.	24. Not Available			
Opt.	25. Idle Speed Min	10	10	Idle Speed
Opt.	26. Idle Speed Max	11000	Idle Speed	11000
Opt.	27. Duty Cycle Max	95	10	95
Opt.	28. Startup Speed	1000	10	11000
Opt.	29. Startup Duty Cycle	30	5	95
Req. = Parameter adjustment required to achieve Basic Governing Opt. = Parameter use is optional				

Note: All *Speed* and *Rate* values are shown as Hertz values (parameters 2, 4, 14-16, 21-22, 25-26). Changing the value of parameter 1 will cause different default values to be displayed based on the Hertz to RPM formula.

3.1 No. of Flywheel Teeth or Pulses per Revolution (optional)

This parameter provides the conversion factor needed to display speeds as RPM values instead of Hertz values. Adjusting this parameter is optional. The default value of 0 disables Hertz (Hz) to RPM conversions so all set speeds are displayed in Hertz. Setting this parameter to a value other than zero enables Hertz to RPM conversion.

Adjust this parameter to a value equal to the exact number of pulses seen by the governor in one revolution of the engine to display set speeds in RPM. The formula used to convert the speed signal from a Hertz value to a RPM value is:

$$\frac{[(Hertz)\times(60s)]}{[Pulses\_per\_rev]} = [EngineRPM]$$

For example:

$$\frac{[(3960Hz)\times(60s)]}{[132Pulse\_per\_rev]} = [1800RPM]$$

The following derivation of the above formula can be used to convert from RPM to Hertz.

$$\frac{[(EngineRPM)\times(Pulses\_per\_rev)]}{[60s]} = [Hertz]$$

DPG-2101-001, DPG-2111-001 and DPG-2155-001 Controllers
To use this parameter correctly on governors sensing engine speed with a magnetic pickup, you must know the exact number of flywheel teeth that pass by the magnetic pickup in one revolution of the engine.

DPG-2145-001 and DPG-2146-001 Controllers
To use this parameter correctly on governors sensing engine speed via ignition pulses, you must know the exact number of ignition pulses that occur in one revolution of the engine.

3.2 Set Speed A (required)

This parameter is adjustable both from the controller's DEC and INC keys and by using the Universal PST application. However, when the value is changed using the controller's keypad, the value displayed by the Universal PST does not automatically update. To refresh the value displayed on the PC the user must select a different parameter with the mouse pointer then reselect the value of Set Speed A. The Universal PST application also provides a [Read All] button that can be used to perform a complete refresh of all parameter values.

SET SPEED A is the governor's target speed after startup when Set Speed B is not selected. The startup sequence is complete when the target speed and the engine speed reach the set speed.

NOTE: If parameter 1 is used, then the Universal PST will display speeds and ramp rates as RPM values instead of Hertz values.

On DPG-2145-001 and DPG-2155-001 units, when a two-position switch is connected between SET SPD 1 (pin 12) and SET SPD 2 (pin 6) then an open switch selects SET SPEED A as the governor's target speed. If the governor's SET SPD inputs are not used then SET SPEED A is automatically the active target speed after the startup sequence is completed. See the Installation Instructions chapter for details about wiring in a switch to use the speed select feature available on DPG-2145-001 and DPG-2155-001 model controllers.

3.3 Set Speed B (optional)

SET SPEED B becomes the governor's target speed on DPG-2145-001 and DPG-2155-001 units, when SET SPD 1 (pin 12) and SET SPD 2 (pin 6) of the connector are tied together. In other words, when a two-position switch is connected between SET SPD 1 (pin 12) and SET SPD 2 (pin 6) then a closed switch selects SET SPEED B as the governor's target speed.

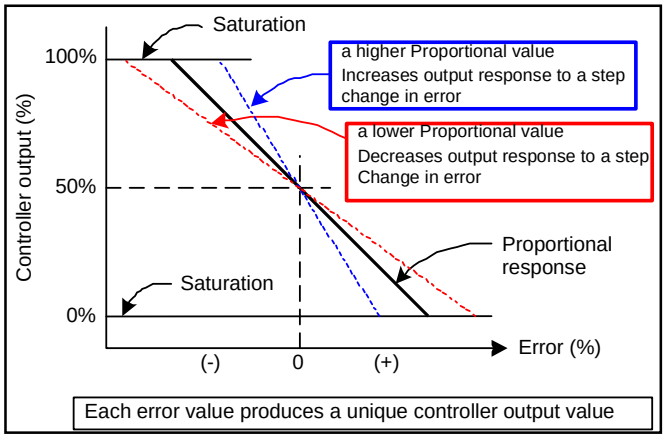
See the Installation Instructions chapter for details about wiring in a switch to use the speed select feature available on DPG-2145-001 and DPG-2155-001 model controllers.

3.4 Idle Speed (optional)

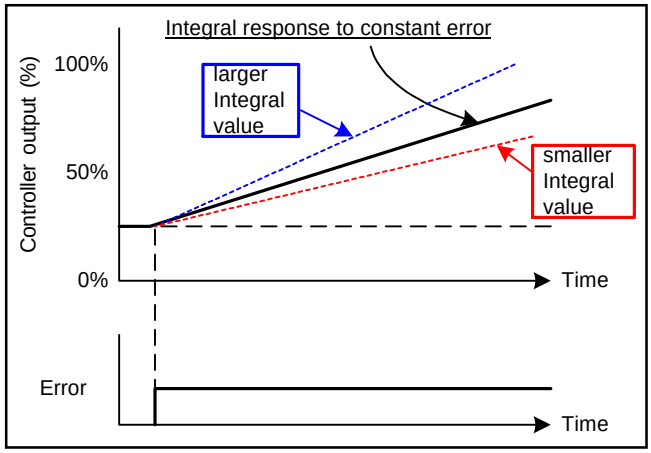
The IDLE SPEED is the governor's target speed for the IDLE HOLD TIME (parameter 13) when the engine is started. When the idle hold timer reaches zero, the target speed will be become either SET SPEED A or SET SPEED B depending on the state of the SPEED SEL input terminal.

3.5 Proportional (required)

The proportional term is one of the interrelated PID terms that determine how well a DPG controller governs the engine's speed. A speed change creates a speed error (the difference between the target speed and the actual speed.) The proportional gain controls the size of the governor output response to a step change in the speed error.



3.6 Integral (required)

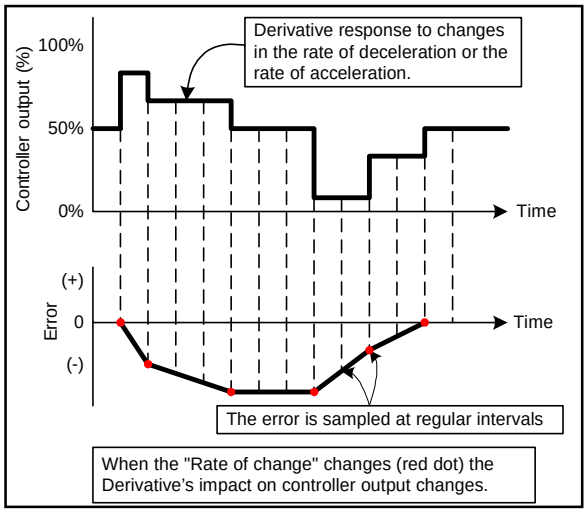


The integral term is one of the interrelated PID terms that determine how well a DPG controller governs the engine's speed. The integral term acts to drive speed error to zero. In a proportional-only control with constant load, there will be a constant speed error that inversely relates to the proportional gain of the system. The integral term is key to isochronous speed control. This term eliminates the difference between the programmed set speed and the actual speed. The integral gain changes the time it takes to drive the error to zero.

Note: Integral is needed to eliminate speed offsets due to proportional gain and should never be left at zero.

3.7 Derivative (required)

The derivative term is one of the interrelated PID terms that determine how well a DPG controller governs the engine's speed. The derivative responds to the rate of change in the speed error. This parameter is primarily used to dampen very rapid oscillations resulting from large speed changes. The derivative responds to engine acceleration or deceleration. If the engine speed approaches the target speed at a fast rate, the derivative acts to minimize or eliminate overshoot. A zero value is allowed but systems typically require some derivative gain to improve overall engine speed control.



3.8 Gain at Set Speed A (required)

This gain acts as the multiplier on the three PID terms (proportional, integral, derivative) when Set Speed A is selected as the active target speed. For all models except DPG-2111-001, the controller's built-in gain potentiometer is adjustable from 1 to 99.

On DPG-2111-001, the controller's built-in gain potentiometers adjustable range is +/-20% of the nominal gain value entered for the Overall Gain at Set Speed A parameter. Universal PST is required to modify the nominal value of the Overall Gain at Set Speed A parameter.

For example, the Overall Gain at Set Speed A has a value of 35. The following equations determine the gain potentiometer range of adjustment.

(Overall Gain at Set Speed A) - [(Overall Gain at Set Speed A) * (0.20)] = Min Gain Pot Setting

(35) - [(35) * (0.20)] = 28

(Overall Gain at Set Speed A) + [(Overall Gain at Set Speed A) * (0.20)] = Max Gain Pot Setting

(35) + [(35) * (0.20)] = 42

3.9 Overall Gain at Set Speed B (optional)

(Available only on DPG-2145-001 & DPG-2155-001)

This gain acts as the multiplier on the three PID terms (proportional, integral, derivative) when Set Speed B is selected as the active target speed. This gain term is adjustable from 01 to 99.

3.10 Overall Gain at Idle Speed (optional)

This gain acts as the multiplier on the three PID terms (proportional, integral, derivative) when the Idle Speed is the active target speed. The idle speed set point is active only during startup when the idle hold timer is running. This gain term is adjustable from 01 to 99.

3.11 Gain Factor (required)

The gain factor parameter is used to obtain more range of adjustment from the PID terms. In other words, if any of the PID terms or the Gain terms reaches their adjustment limits then this value can be modified to provide for more range of adjustment in the PID and Gain terms.

For example, if the PID terms are set to 90, 80, and 50 respectively and the Gain Factor is set to 20, then doubling the Gain Factor by setting it to 40 allows the PID terms to be halved to 45, 40, and 25 respectively. These new settings are equivalent to the previous settings with respect to the governor's tuning response and now allow the PID terms to be adjusted higher if needed.

3.12 Speed Filter (required)

This parameter indicates the number of speed signal pulses to use when computing an average engine speed and is used to dampen out speed measurement variations that can make PID tuning difficult. But, keep in mind the following:

- Too much filtering will slow down the governor's response to speed changes.
- Too little filtering can make the governor overly sensitive and tuning difficult.

There is measurable acceleration and deceleration that occurs between cylinder firings. As a general rule, less filtering is required the more engine cylinders there are. This is because the number of acceleration-deceleration cycles increases and these oscillations will have lower amplitude. With more cylinders, there is less time for the speed to slow down before the next cylinder firing.

Rotational mass also affects the amount of speed signal filtering needed. The more rotational mass, the less filtering is needed. The less rotational mass, the more filtering is needed.

For installations using a magnetic pickup to sense engine speed
Typically, the value 24 works well on small 3- or 4-cylinder engines. A value of 16 is recommended for 6- or 8-cylinder engines. The following formula can also be used to derive a good starting point for the speed filter value for a given engine application. Round the result to the nearest integer. The maximum value allowed is 24.

[(#_of_flywheel_teeth) / (#_of_engine_cylinders)] * 0.75 = speed_filter_value

For installations using ignition pulses to sense engine speed
It is recommended that the Speed Filter be at least equal to the number of ignition pulses per one revolution of the engine. A good starting point would be 2 times the number of ignition pulses per one revolution of the engine.

[(pulses_per_rev) * (2)] = speed_filter_value

3.13 Idle Hold Time (optional)

The idle hold time specifies how long, after starting, the engine is to stay at the idle speed before finishing the ramp to the target speed. The time value has a resolution of one-tenth of a second.

3.14 Accel Rate (optional)

This rate specifies how fast the governor should increase the engine's speed when a new higher target speed is made active. The parameter value is specified in Hertz per second based on the following formula.

[(higher_speed_in_Hertz) – (lower_speed_in_Hertz)] / (ramp_time_in_seconds) = accel_rate_value

For example, suppose Set Speed A is 3300 Hertz and Set Speed B is at 3960 Hertz. The governor is currently controlling the engine at 3300 Hertz (Set Speed A), when Set Speed B becomes the active target speed. It is desired that the new speed of 3960 be reached in precisely 2 seconds. The following formula determines the value needed by Accel Rate to increase the engine speed from Set Speed A to Set Speed B in 2 seconds.

[(Set Speed B) – (Set Speed A)] / (N seconds) = accel_rate_value in Hertz per sec.

[3960 – 3300] / 2 = 330 Hertz per second

3.15 Decel Rate (optional)

The Decel Rate specifies how fast the governor should decrease the engine's speed when a new lower target speed is made active. The parameter value is specified in Hertz per second based on the following formula.

[(higher_speed_in_Hertz) – (lower_speed_in_Hertz)] / (ramp_time_in_seconds) = decel_rate_value

For example, suppose Set Speed A is 4170 Hertz and Set Speed B is 3475 Hertz. The governor is currently controlling the engine at 4170 Hertz (Set Speed A), when Set Speed B becomes the active target speed. It is desired that the new speed of 3475 be reached in precisely 1.5 seconds. The following formula determines the value needed by Decel Rate to decrease the engine speed from Set Speed A Set Speed B in 1.5 seconds.

[(Set Speed A) – (Set Speed B)] / (N seconds) = decel_rate_value in Hertz per sec.

[4170 – 3475] / 1.5 = 463 Hertz per second

3.16 Startup Rate (optional)

This parameter is used to achieve a smooth controlled engine start. On diesel engines, this feature is also useful for minimizing exhaust smoke at startup. When used in combination with the Idle Speed and Idle Hold Time, a brief warm-up cycle can be programmed.

The startup rate specifies how fast the governor should increase the engine speed when the engine is started. The rate value indicates Hertz per second. The formula to use for determining a precise Startup Rate is shown below.

[(final_target_speed_in_Hertz) – (crank_speed_in_Hertz)] /
(ramp_time_in_seconds) = startup_rate_value

The ramp up will pause at the STARTUP SPEED until the governor senses an MPU signal greater than the STARTUP SPEED. This prevents the startup ramp from reaching completion before the engine has even started. The governor considers MPU frequencies below the STARTUP SPEED as indicating that the engine is cranking but has not yet started. MPU frequencies above the STARTUP SPEED are taken to indicate that the engine has started and the governor will increase the engine speed until the selected set speed is reached.

Exception: In cases where the target speed is less the STARTUP SPEED, the startup ramp sequence ends when the target speed is reached.

NOTE:
When the No. of FLYWHEEL TEETH parameter is used, the ACCEL RATE, DECEL RATE, and STARTUP RATE parameters are displayed as a RPM quantity per second instead of Hz/sec values. The given rate formulas can be used to compute rates in terms of RPM values by substituting the Hertz speed values with RPM speed values.

3.17 Integral Low Limit (optional)

The integral low limit prevents "integral windup" in the negative direction. In other words, the integral low limit parameter is used to reduce underspeed duration after a long or sustained overspeed condition was present. The low limit helps reduce the duration and amount of engine underspeed by maintaining a minimum actuator position.

When smaller pulse width modulated (PWM) duty cycle values do not reduce the engine speed any further but an off speed (measured speed greater than the target speed) remains, letting the Integral term grow more negative is not beneficial. Unused negative integration would cause a slower recovery from an underspeed condition.

The integral low limit specifies the PWM duty cycle where the integrator's influence on lowering PID output must stop. The default value is 0%. The value can be adjusted from 0% to 90% in 1% increments.

CAUTION: Use carefully as improper use can prevent the governor from ever reaching the target speed. The first line of defense in reducing overspeed or underspeed errors is a well-tuned governor via the PID terms.

3.18 Integral High Limit (optional)

The integral high limit prevents "integral windup" in the positive direction. In other words, the integral high limit parameter is used to reduce overspeed duration after a long or sustained underspeed condition was present. The high limit helps reduce the duration and amount of engine overspeed by maintaining a maximum actuator position.

When larger PWM duty cycle values do not increase the engine speed any further but a negative off speed (measured speed less than the target speed) remains, letting the Integral term grow more positive is not beneficial. Unused positive integration would cause a slower recovery from an overspeed condition.

If an engine overload situation causes the engine speed to remain below the target speed for some period of time, then the integral portion of PID output would grow larger than otherwise needed (would windup). Therefore, when the load is removed the engine may overspeed because it takes time for the integral portion of PID output to shrink or "unwind". This is where reducing the Integral Limit High value can help by preventing excessive windup in the PID output's integration term.

The integral high limit specifies the PWM duty cycle where the integrator's influence on raising PID output must stop. The default value is 99%. The value can be adjusted from 99% down to 10% in 1% increments.

CAUTION: Use carefully as improper use can prevent the governor from ever reaching the target speed. The first line of defense in reducing overspeed or underspeed errors is a well-tuned governor via the PID terms.

3.19 Password (optional)

The password protect parameter is provided to protect against inadvertent parameter changes that may occur whenever the keys are pressed and a parameter modification is not intended. The password protect parameter has three possible settings: DISABLED, LOCKED, and UNLOCKED

DISABLED – This setting turns off any password protection. Use this setting if password protection is not desired. This is the default setting as shipped from the factory. Entering a value of [99] sets the password protect parameter to the disabled mode. When the password protect parameter is selected, the LED display will show [Pd] for 2 seconds indicating the password disabled mode, then the value [00.] is displayed. The user can then edit the value.

LOCKED – This setting means that password protection is active and only parameter viewing is allowed (parameter editing is disabled). Enter a value of [22] to set password protect to locked mode. For 2 seconds after selecting the password protect parameter the LED display will show [PE.] for this mode and the

rightmost decimal point will be ON (no blinking), then the value [00.] is displayed. The user can then edit the value.

UNLOCKED – This setting means that password protection is active but parameter editing is allowed. Entering a value of [30] while in LOCKED mode will UNLOCK parameter editing. The user is free to edit parameters. If there is no keypad activity for 5 minutes, the controller returns to LOCKED mode. If not already in the UNLOCKED mode, the user must get into the UNLOCKED mode in order to enter a 99 to disable password protection.

3.20 Overspeed Limit (optional)

This parameter is used to determine the engine speed that will trigger the governor to output minimum fuel. The parameter's value is in terms of a percentage over the highest set speed. In other words, an overspeed condition is detected if the engine speed reaches a speed of [OVERSPEED LIMIT %] greater than the highest set speed.

For example: If the highest set speed is 1800 RPM and this parameter is set to 20, then an overspeed condition will be detected at 2160 RPM (the value that is 20% greater than 1800). Formula: 1.20 * 1800 RPM = 2160 RPM

The default value of 100 is used to disable overspeed detection. Use values less than 100 to enable the overspeed limit function and set the limit speed to [(1 + (overspeed_limit_value/100)) * (highest_set_speed)].

NOTE: The governor must be turned off to clear the overspeed detection before the engine can be restarted.

NOTE:
When the No. of FLYWHEEL TEETH parameter is used, the SET SPEED A MIN, SET SPEED A MAX, SET SPEED B MIN, SET SPEED B MAX, IDLE SPEED MIN, and IDLE SPEED MAX parameters are displayed as RPM values instead of Hertz values.

3.21 Set Speed A Min (optional)

Set Speed A Min is used to set the lowest value allowed for adjustments of Set Speed A. This parameter can be set to any value within the range bordered by 10 Hertz (2 Hertz ignition) and the current value of the Set Speed A parameter.

3.22 Set Speed A Max (optional)

Set Speed A Max is used to set the highest value allowed for adjustments of Set Speed A. This parameter can be set to any value within the range bordered by current Set Speed A setting and 11,000 Hertz (300 Hertz ignition).

3.23 Set Speed B Min (optional)

(Available only on DPG-2145-001 & DPG 2155-001)

Set Speed B Min is used to set the lowest value allowed for adjustments of Set Speed B. This parameter can be set to any value within the range of 10 Hertz (2 Hertz ignition) and the current value of Set Speed B.

3.24 Set Speed B Max (optional)

(Available only on DPG-2145-001 & DPG 2155-001)

Set Speed B Max is used to set the highest value allowed for adjustments of Set Speed B. This parameter can be set to any value within the range bordered by current Set Speed B and 11,000 Hertz (300 Hertz ignition).

3.25 Idle Speed Min (optional)

Idle Speed Min is used to set the lowest value allowed for adjustments of Idle Speed. This parameter can be set to any value within the range of 10 Hertz (2 Hertz ignition) and the current value of Idle Speed.

3.26 Idle Speed Max (optional)

Idle Speed Max is used to set the highest value allowed for adjustments of Idle Speed. This parameter can be set to any value within the range bordered by current Idle Speed and 11,000 Hertz (300 Hertz ignition).

3.27 Duty Cycle Limit (optional)

The Duty Cycle Maximum parameter sets the absolute maximum amount of drive signal that can be output to the actuator and thus serves as a mechanism for fuel limiting. Fuel limiting is achieved by setting the maximum duty cycle or on-time allowed during one cycle of the PWM (pulse-width-modulation) signal controlling the actuator drive circuit. The value assigned to the duty cycle limit parameter is a percentage, and is limited to values in the range 10% to 95%. The default value is 95%.

3.28 Startup Speed (optional)

The Startup Speed parameter should be set to an engine speed at least 10% higher than the fastest engine cranking speed but lower than the engine's idle speed. This allows the governor to determine whether the engine is cranking or running whenever an engine speed signal is present.

If the Startup Speed value is set too low (less than crank speed) the governor's target speed will be ramped to the active set speed (Idle, Set Speed A, or Set Speed B) before the engine has started. Therefore, when the engine does start, it may overspeed or output excessive smoke because the startup ramp, having already completed, no longer controls the rate of engine speed increase.

If the Startup Speed value is set too high (above the active set speed) then the Startup Speed becomes the target speed that the governor must reach before the governor considers the startup sequence complete. Typically, the startup sequence ends when the engine speed reaches the active set speed. The active set speed is the Idle Speed if the Idle Hold Time parameter is a nonzero value or the "selected set speed" (either Set Speed A or Set Speed B).

To determine the proper value for this parameter the crank speed must be known. There are two ways to determine the engine crank speed.

1) Use a meter to measure the frequency across the MPU+ and MPU- terminals of the governor during cranking or . . .
2) Use a PC running the Universal PST application and read the value of the Measured Speed in the View Status panel when the engine is cranking. Note: From the Universal PST startup

screen press the View Status button, then press the Start Monitoring button to begin reading values.

3.29 Startup Duty Cycle (optional)

The Startup Duty Cycle parameter is used to pre-load the PID output with a PWM duty cycle value close to that needed for the actuator to allow enough fuel to idle the engine.

If the value is too low, then the engine crank time may be longer than desired because the governor's actuator output starts from a value much smaller than needed to begin opening the fuel valve.

If the value is too high, then the engine may overspeed because the actuator opens more than needed to start the engine.

There are two ways to determine a good value to use for this parameter.

1) Use a meter to measure the duty cycle across the ACT terminals of the governor while the engine is running. Note: To determine if your meter is reading the correct value:
    a. First, apply power to the governor but do NOT start the engine
    b. Second, measure the duty cycle across the ACT terminals (No. 3 and No. 4). The reading should be 5 for 5%. If the reading is 95, then reverse the leads.
2) Use a PC running the Universal PST application and read the value of the PWM command in the View Status panel when the engine is cranking. Note: from the Universal PST startup screen press the View Status button, then press the Start Monitoring button to begin reading values.

Chapter 4.
Universal PST

Introduction

This chapter provides the information needed to use a computer with your governor. Here you will find instructions for wiring the governor's COMM port to a computer's serial port and instructions for acquiring, installing, and running the Universal Parameter Setup Tool (Universal PST).

The Universal PST is a Microsoft® Windows® application available from Woodward that enables you to adjust parameter settings and monitor governor operation.

The Universal PST also includes a graphical chart recorder that displays engine speed in real-time. This provides a visual representation of the governor's response to changes in speed or load, which can be very helpful in achieving precise tuning.

Features

Universal PST features include:

- Automatic configuration to each DPG when communications established
- Read/write access to all of a DPG's programmable parameters and features
- Display of each parameter's default, minimum, and maximum values
- Diagnostics utilizing automatic refresh of DPG status
- Saving and reloading DPG setup information to and from a file for reuse
- Single button read to get the current values of all parameters
- Single button write to program a DPG with previously saved setup values
- Engine speed monitoring via a chart recorder to aid in tuning the governor
- Saving chart recorder data to a Microsoft Excel compatible file
- Help information on each of the governor's parameters
- Help information on using the Universal PST

Universal PST Requirements

The program requires an Intel Pentium class machine running Microsoft® Windows® 98se (Second Edition), NT4, 2000, or XP. The display resolution needs to be set to SVGA (800x600) or higher.

Acquiring Universal PST

The Universal PST application is available from our website. If you have an Internet connection you can download a copy from www.woodward.com/IC/Software.

What to download: The files *ReadMeFirst.txt*, *Universal_PST.zip*, and *Universal_PST_mdb_Update.zip* are available for download on the Software Products page at the www.woodward.com/IC/Software website.

Requesting the Universal PST on CD-ROM: If you do not have an Internet connection, or have problems downloading the large zip file, contact the Woodward sales department to request a CD-ROM copy of Universal PST for a nominal charge. Telephone: (847) 967-7730.

Installing Universal PST

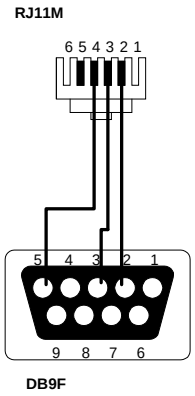
The installation procedures are slightly different depending on whether you downloaded the zip file or have the CD-ROM version. The instructions provided here assume you know how to user your computer.

The ReadMeFirst.txt file provides instructions regarding application installation using the downloaded zip file. Basically, the program installation files must first be extracted from the zip file into a temporary folder on your computer's hard drive. Then you run the setup.exe program and follow the instructions the setup program gives you.

NOTE: the zip file format is WinZip® compatible. The WinZip® application is not provided. If you are running Microsoft Windows XP, it has built-in resources to extract the files from Universal_PST.zip. Refer to your computer's documentation or online help files for instructions regarding creating folders, installing, and running applications.

Wiring the COMM Port to a PC

RJ11 OR RJ12 POSITION	DPG-21XX SIGNAL	CONNECTS TO:
1	No connection	N/C
2	Transmit data to PC	PC receive (RxD) DB9 pin 2
3	Receive data from PC	PC transmit (TxD) DB9 pin 3
4	COMMON	PC common DB9 pin 5
5	+5 Vdc (Do NOT connect at the PC end)	N/C
6	No connection	N/C



Universal PST User Interface Overview

Universal PST for DPG has two main display modes.

- Table View
- Chart View

NOTE: The program starts in Table View

Table View

In Table View the user can:

- View the current values for all user programmable parameters in the Parameter Setup panel's table.
- Edit a parameter's value by double-clicking on a cell in the "Value" column of the table.
- Press the <Read All> button to refresh the values in table shown on the Parameter Setup panel.
- Press the <Write All> button to transmit setup values to the governor.
- Press the <View Status> button to display read only parameters in the Status View panel.
- Press the <View Chart> button to set the display mode to Chart View.
- Select items from the menu.

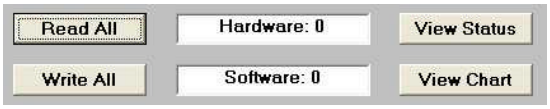
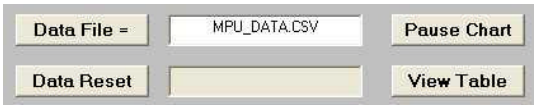


Chart View

In Chart View the user can:

- View the current values for all user programmable parameters in the Parameter Setup panel's table.
- Edit parameter values related to governor tuning. These same parameters are also on the main parameter setup table.
- Press the <Data File => button to open a file for saving chart recorder data.
- Press the <Data Reset> button to start data collection to the open file at the beginning.
- Press the <Pause Chart> button to stop the chart recorder, which also stops writing data to the file. Press the <Continue> button to turn the chart recorder back on.
- Adjust the horizontal and vertical scale settings of the chart recorder.
- Press the <View Table> button to set the display mode back to Table View.
- Select items from the menu.

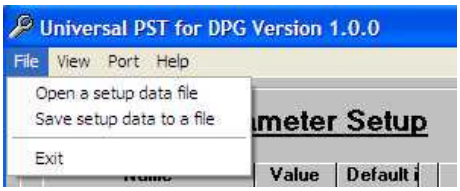


NOTE: Pressing a button means positioning the mouse pointer over the button and clicking the left mouse button. Parameter EDITING requires positioning the mouse pointer over a parameter's "Value" and double-clicking the left mouse button to highlight the particular value.

Universal PST for DPG Menu Items

Use the File menu to:

- Open a previously saved setup data file
- Save setup data to a file
- Exit the program

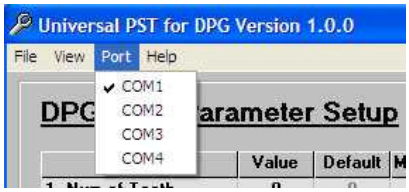


Use the View menu to:

- Select Parameter Table view (Table View)
- Select Chart Recorder view (Chart View)

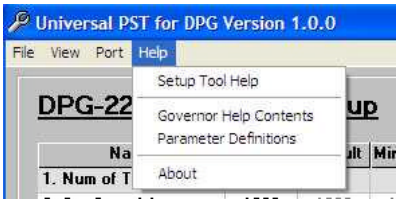
Use the Port menu to:

- Select the PC's serial port that is connected to the DPG-2000



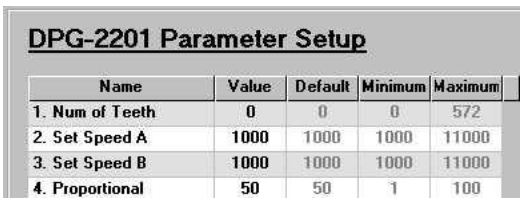
Use the Help menu to access:

- Help on the Universal PST for DPG
- Help on the DPG-2000 product that is currently in communication with the PC
- Information about the Universal PST for DPG application



Parameter Setup

The Parameter Setup panel displays a table where each row shows the Name of a user programmable parameter, its current Value, and the parameter's Default, Minimum, and Maximum values.



DPG-2201 Parameter Setup

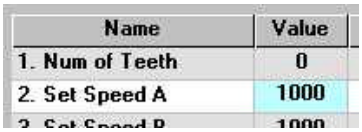
Name	Value	Default	Minimum	Maximum
1. Num of Teeth	0	0	0	572
2. Set Speed A	1000	1000	1000	11000
3. Set Speed B	1000	1000	1000	11000
4. Proportional	50	50	1	100

To modify a parameter's current value, it must first be selected.

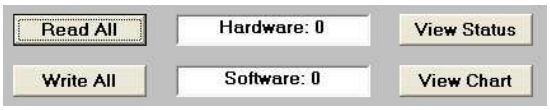
Do this by double-clicking the left mouse button on a cell in the table that is at the intersection of the parameter's row and the Value column. The selected cell will be highlighted and the value can now be modified. When done modifying the value, press the computer keyboard's <Enter> key to transmit the new value to the governor.

NOTE: Pressing a button means positioning the mouse pointer over the button and clicking the left mouse button. Parameter EDITING requires positioning the mouse pointer over a parameter's "Value" and double-clicking the left mouse button to highlight the particular value.

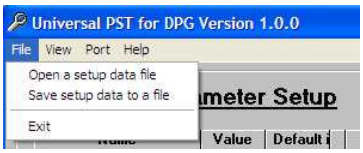
To get help on a particular parameter, single click the left mouse button on a parameter's Value, then press <Ctrl><F1> on the computer's keyboard. <Ctrl><F1> means press and hold the <Ctrl> key while the <F1> key is pressed and released.



To get the current values for all of a DPG-2XXX's parameters, press the <Read All> button.



Use the <Write All> button to transmit all parameter values to the governor automatically.



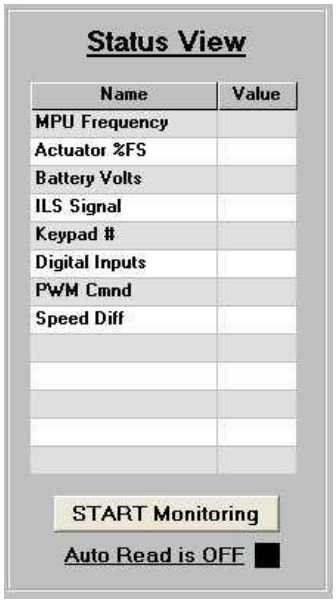
The <Write All> button is very useful when reusing saved setup data to configure a new system the same as a previous one. Simply load an existing set of previously saved parameter values into the Parameter Setup table using *Open a setup data file* from the *File* menu then press the <Write All> button.

Status View

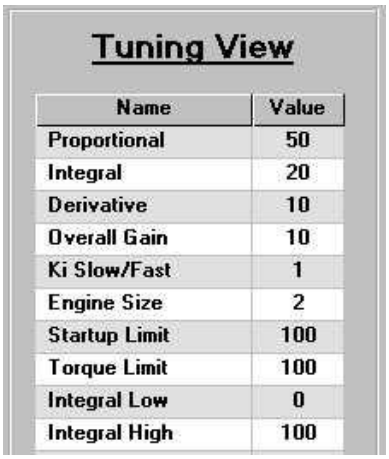
The Status View panel is displayed only after pressing the <View Status> button. The Status View panel is part of the Table View display mode.

The Status View panel displays a table where each row shows the Name of a read only parameter and its current Value (when "Auto Read is ON")

Press (left mouse click) the <START Monitoring> button to have the Universal PST program automatically refresh the Values. Press the <STOP Monitoring> button to disable automatic refresh.



Tuning View



The Tuning View panel is displayed only after pressing the <View Chart> button. The Tuning View panel is part of the Chart View display mode.

To modify a tuning parameter's current value, it must first be selected. Do this by double-clicking the left mouse button on a cell in the table that is at the intersection of the parameter's row and the Value column.

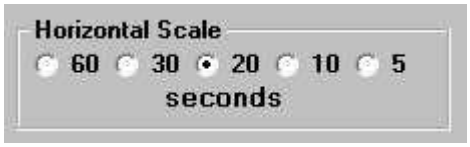
The selected cell will be highlighted and the value can now be modified. When done modifying the value, press the computer keyboard's <Enter> key to transmit the new value to the governor.

Chart Recorder

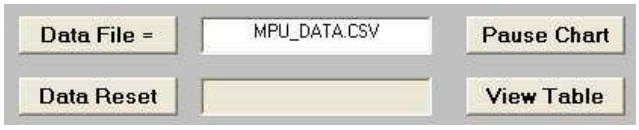
The chart recorder is part of the Chart View display mode. Each time Chart View is entered the last used Data File is reset, the Vertical Scale defaults to [0 Hz to 12000 Hz], and the Horizontal scale defaults to 20 seconds.

The Vertical Scale options and the Horizontal Scale options control the chart recorder's display characteristics.

On the Vertical Scale, use the [+/- 10% of ____ Hz] option to zoom in on the current Hertz Average.



Use the Horizontal Scale to have the chart recorder display 60, 30, 20, 10, or 5 seconds of collected engine speed data. Larger values compress the display while smaller numbers expand the display. A Horizontal Scale setting of 20 seconds is approximately the same as a 5 millimeter per second paper travel speed of a conventional paper tape chart recorder.



The <Data File => button opens a dialog box to name the file and path where chart recorder data will get saved.

The <Data Reset> button is used to start data collection over using the current Data File. The progress bar shown to the right of this button indicates how full the Data File is. Each data file can hold approximately 10 minutes of data. The progress bar will display the message “The Data File is FULL” when no longer accepting chart recorder data.

The <Pause Chart> button stops chart recorder and Data File updates. Press this button, which is now named <Continue> to turns the chart recorder back on.

Use the <View Table> button to return to the Table View display mode. Be sure to open a new Data File before returning to Table View if the data already collected needs to be saved. The active Data File is automatically reset each time Chart View display mode becomes active.

Chapter 5
Calibration Instructions

Basic Adjustments

The controller is programmed at the factory with default parameter settings. These settings allow the controller to operate but usually require some further adjustments to obtain the best system performance. In order to bring the engine up to a single speed for the first time, the installer will need to adjust the parameters shown in the table.

The parameters listed are the primary ones to modify to get the governor tuned and the engine running smoothly. It is recommended that you work with them first and leave all the other parameters at their default values until you are satisfied with the basic engine tuning.

No.	Parameter Name	Default Value
2	SET SPEED A	1000
5	PROPORTIONAL	25
6	INTEGRAL	50
7	DERIVATIVE	25
8	OVG @ SET SPEED A	20
11	GAIN FACTOR (note 1)	20 or 40
12	SPEED FILTER (note 2)	16 or 4

NOTE 1: Modify Gain Factor only if you run out of adjustment in a PID or OVG term.

NOTE 2: For the Speed Filter, typically the value 24 works well on small 3- or 4-cylinder engines. A value of 16 is recommended for 6- or 8-cylinder engines.

Tuning Methodology

Once the engine is running, the following procedure may be used to discover more optimum values for PID and the overall gain parameters (OVG). The goal would be to find PID values that allow the controller to govern the engine well at a variety of different speeds and loads while only requiring gain adjustment at those different speeds.

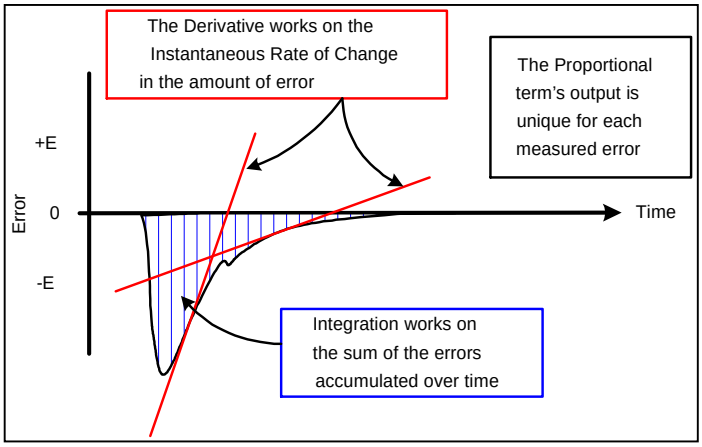
Follow these steps:

1. Set the integral and derivative terms to 0.
2. Set the overall gain low (<20).
3. Increase the proportional term until you get continuous oscillations greater than 2 Hz.
4. Reduce the proportional term by 25% to 50%.
5. Now experiment with small value changes in the derivative to dampen out “ringing” in response to load transients.
6. Add some integral to eliminate any steady-state error in the engine’s speed and help decrease error recovery time.

7. The overall gain can be increased to improve response time while keeping the ratios of the PID terms relative to each other constant.

During each of the steps 3 through 6, you need to disturb the system by adding and removing a load from the engine to check the governor's response to the load transition. **START WITH SMALL LOADS.**

Note that without integral, a speed error may persist after a load-on load-off transition. Therefore, during steps 3-5 you should temporarily increase the integral to get the engine speed back to the set speed, and then reset the integral to a lower value again while working to find good proportional and derivative values. Repeat steps 3-7 as needed to find a Proportional value, Integral value, and a Derivative value that work well with a variety of overall gain values and different load transients.



Chapter 6.
Installation Instructions

Recommended Mounting

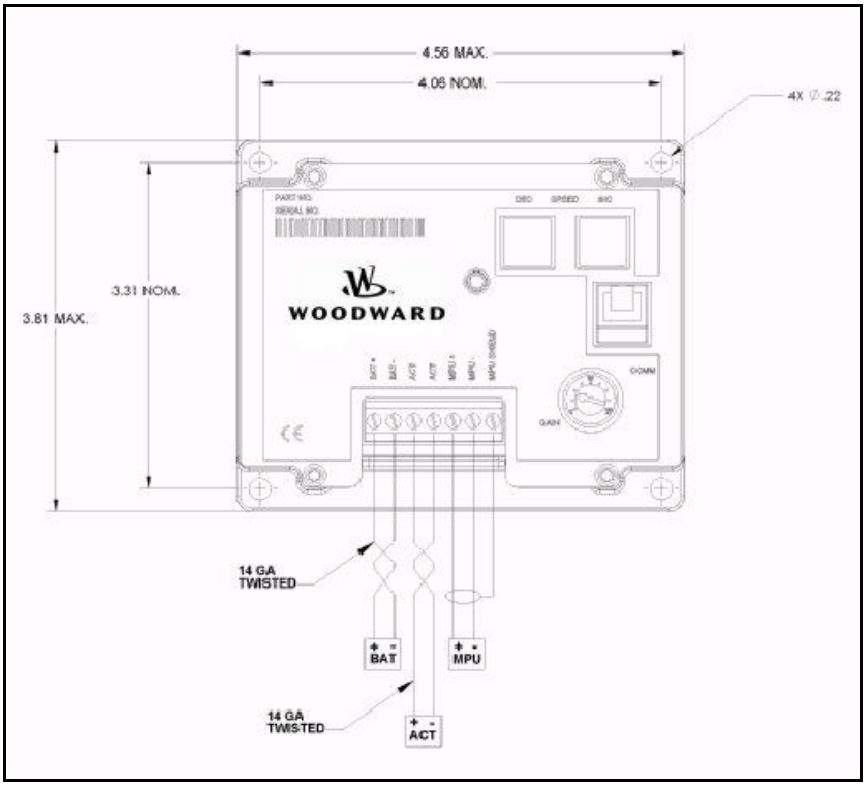
The governor controller is designed to be panel mounted. The mounting should protect the controller from exposure to rain, weather, and direct sunlight. The controller should not be mounted on the engine or in an environment that exceeds the mechanical specifications outlined in Chapter 1 of this manual. The controller should be mounted in a position to allow access to the user interface, the COMM port and the terminal strip.

DPG-2101-001

Terminal Descriptions

NO.	NAME	FUNCTION
1	BAT+	Battery positive (Supply voltage range is 9 Vdc–30 Vdc)
2	BAT-	Battery negative
3	ACT	Actuator drive output
4	ACT	Actuator drive return
5	MPU+	Magnetic pickup signal input
6	MPU-	Magnetic pickup ground
7	SHIELD	Ground connection for cable shielding

Wiring Diagram

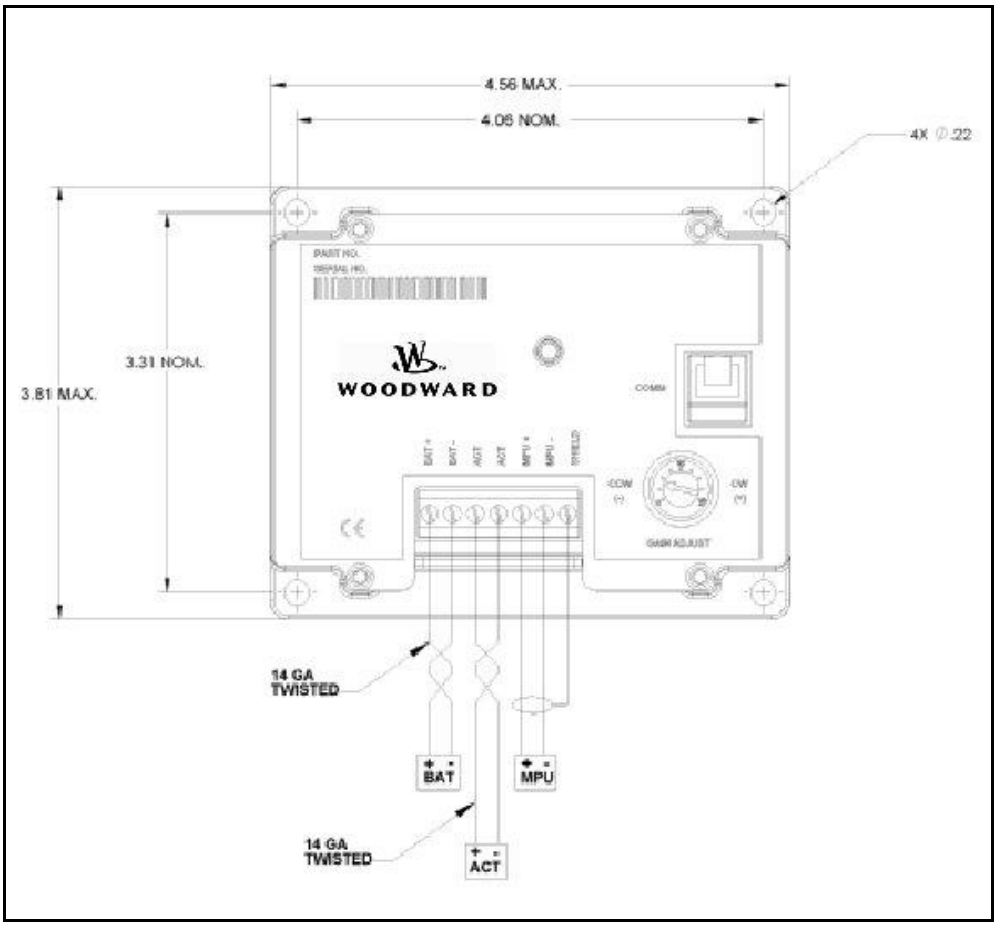


DPG-2111-001

Terminal Descriptions

NO.	NAME	FUNCTION
1	BAT+	Battery positive (Supply voltage range is 9 Vdc–30 Vdc)
2	BAT-	Battery negative
3	ACT	Actuator drive output
4	ACT	Actuator drive return
5	MPU+	Magnetic pickup signal input
6	MPU-	Magnetic pickup ground
7	SHIELD	Ground connection for cable shielding

Wiring Diagram

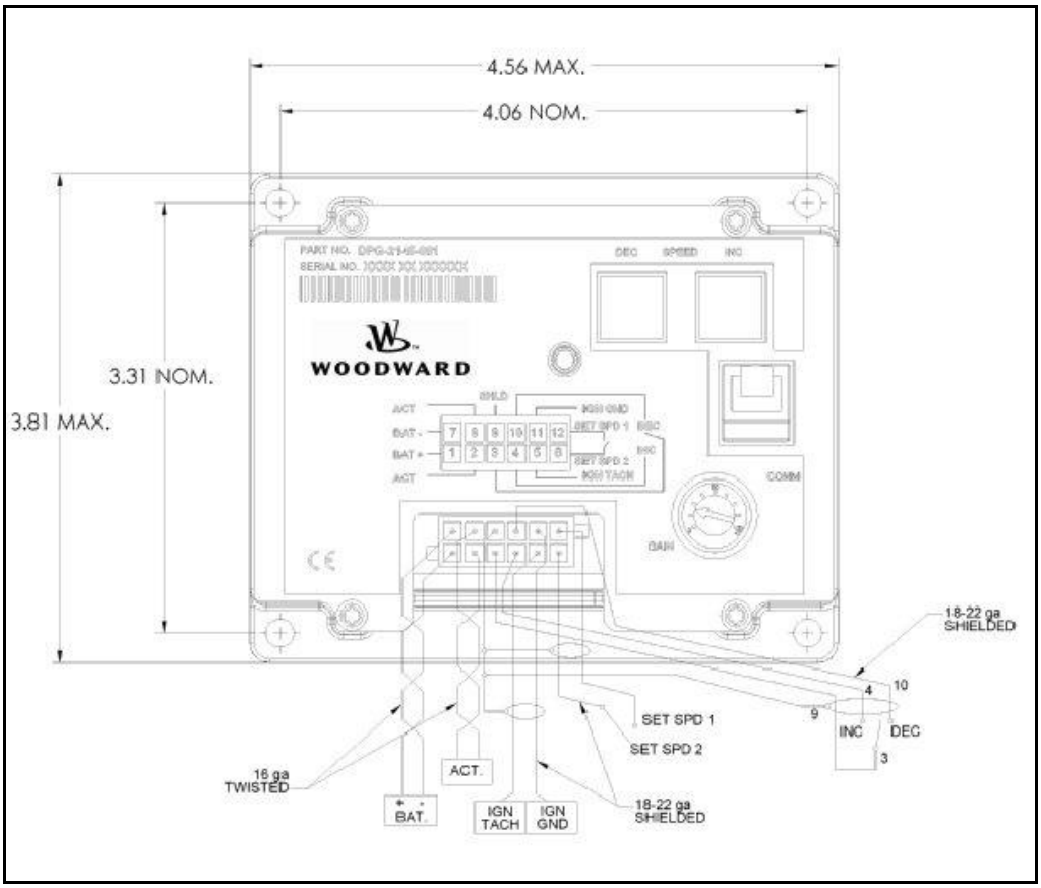


DPG-2145-001

Terminal Descriptions

NO.	NAME	FUNCTION
1	BAT+	Battery positive (Supply voltage range is 9 Vdc–30 Vdc)
2	ACT	Actuator drive output
3	Not Labeled	Digital input common
4	INC	Digital input to increase selected set speed (Active when tied to Pin 3)
5	IGN TACH	Ignition tachometer signal input
6	SET SPD 2	Set Speed B selected when this pin tied to Pin 12
7	BAT-	Battery negative
8	ACT	Actuator drive return
9	SHIELD	Ground connection for cable shielding
10	DEC	Digital input to decrease selected set speed (Active when tied to Pin 3)
11	IGN GND	Ignition ground signal
12	SET SPD 1	Set Speed A selected when this pin is open

Wiring Diagram

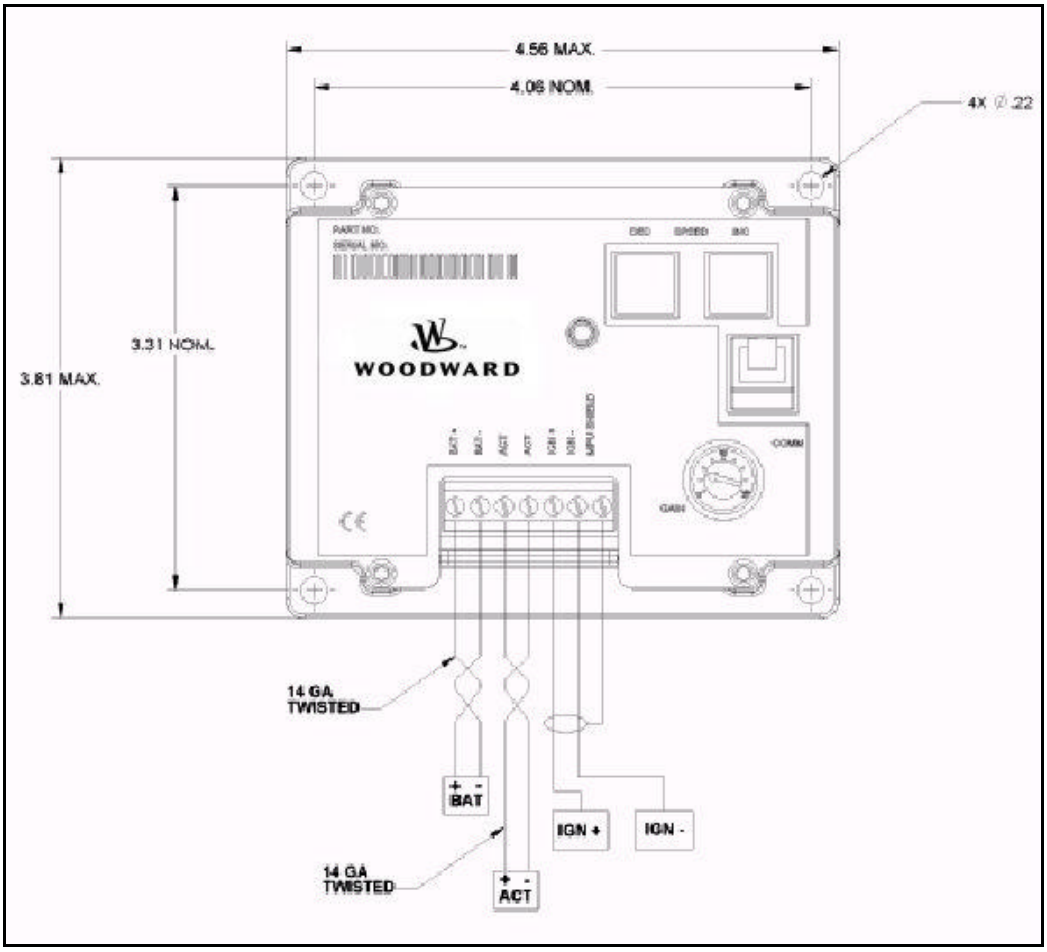


DPG-2146-001

Terminal Descriptions

NO.	NAME	FUNCTION
1	BAT+	Battery positive (Supply voltage range is 9 Vdc–30 Vdc)
2	BAT-	Battery negative
3	ACT	Actuator drive output
4	ACT	Actuator drive return
5	IGN TACH	Ignition tachometer signal input
6	IGN GND	Ignition ground signal
7	SHIELD	Ground connection for cable shielding

Wiring Diagram

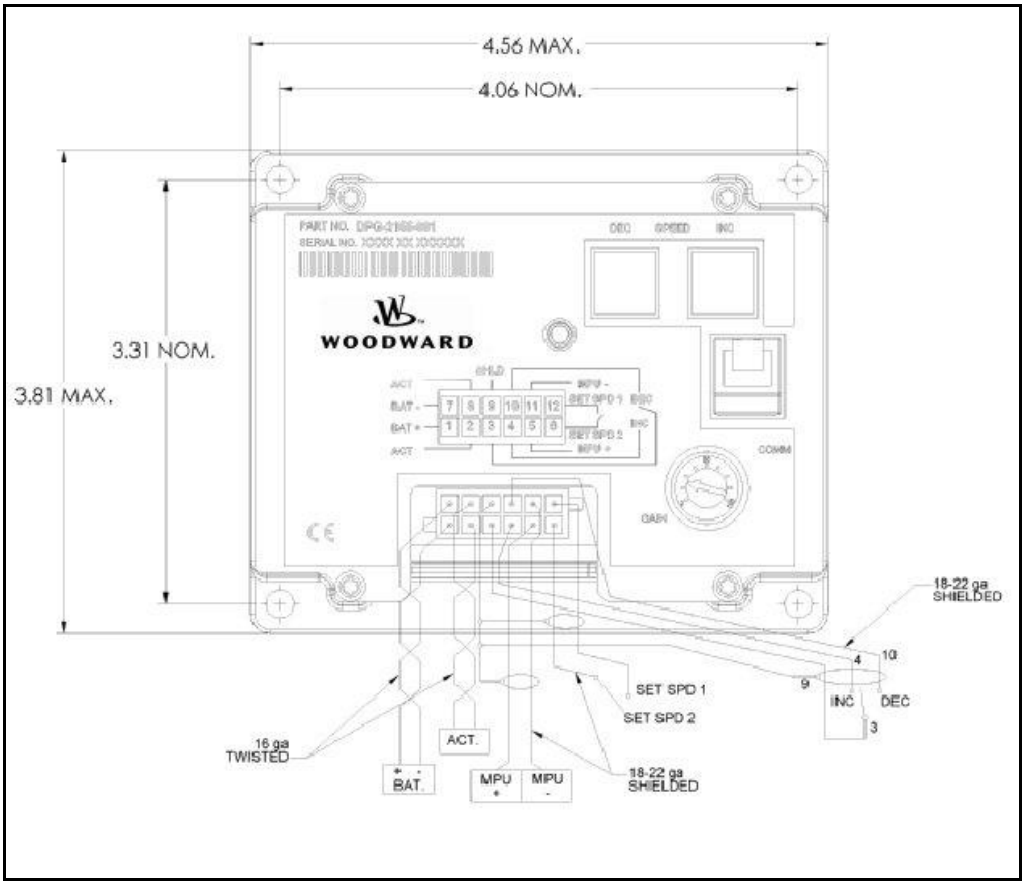


DPG-2155-001

Terminal Descriptions

NO.	NAME	FUNCTION
1	BAT+	Battery positive (Supply voltage range is 9 Vdc–30 Vdc)
2	ACT	Actuator drive output
3	Not Labeled	Digital input common
4	INC	Digital input to increase selected set speed (Active when tied to Pin 3)
5	MPU+	Magnetic pickup signal inputs
6	SET SPD 2	Set Speed B selected when this pin tied to Pin 12
7	BAT-	Battery negative
8	ACT	Actuator drive return
9	SHIELD	Ground connection for cable shielding
10	DEC	Digital input to decrease selected set speed (Active when tied to Pin 3)
11	MPU-	Magnetic pickup ground
12	SET SPD 1	Set Speed A selected when this pin is open

Wiring Diagram



Chapter 7
Diagnostics & Troubleshooting

LED Indications

LED STATE	MEANING
Off	Controller is either not currently powered, or is being reverse powered. (Check polarity of supplied power.) If correctly powered, then controller is malfunctioning.
Blinking Slow (1/2 Hz)	Controller is powered, but not sensing a speed signal. OK if engine is not running. If the engine is running, then this indicates a fault with the speed signal.
Blinking Fast (1½ Hz)	Controller is powered and an engine speed signal is being detected. If the engine is not running, then this indicates electrical noise on the speed signal wires.
ON and Not Blinking	Controller is powered and is malfunctioning. Replace controller.

Troubleshooting Table

SYMPTOM	REMEDY
LED Display Does Not Light Up When Governor Is Powered	BAT + and BAT – leads are reversed. Check wiring. Battery voltage too low. Should measure between 9 and 30 VDC Controller is defective. Replace it.
Unable to Modify Parameters	The parameter's value is the maximum value allowed. The parameter's value is the minimum value allowed. Universal PST not communicating with the controller. Keypad failure, replace unit.
Engine Does Not Start	Actuator leads not connected or shorted. No fuel source. Turn on fuel source. Battery voltage is low. Charge or replace the battery. Set speed is lower than crank speed. Increase the set speed. Startup Rate setting is too low. The target speed ramps up too slow. Startup Limit is too low, limiting the actuator drive signal too much. Is the MPU speed signal present? It should read 2.0 VRMS minimum. Adjust magnetic pickup (MPU) gap. Try reversing the MPU leads. If a speed signal is present, measure actuator output duty cycle. If not greater than 5%, then restore all parameter values to factory default settings and crank the engine again. Final target speed must be greater than crank speed before the governor will attempt to drive the actuator open.
Engine Overspeeds at Startup	Increase the Proportional value. Increase the appropriate Gain value. Decrease the Startup Ramp Rate.
Engine Does Not Reach Set Speed	Improve PID tuning. Integral too low or zero PID values are too low. A tuning that is too soft can prevent the governor from delivering the needed actuator drive signal to reach the set speed.

Engine Does Not Reach Set Speed (cont'd.)	PID values are too high. Tuning is too hot or oversensitive to small speed errors, which causes the governor to make large, rapid changes in actuator drive signal, creating an average signal that is inadequate. The Integral Low Limit setting is too high. Return the value to the default setting of zero. The Integral High Limit setting is too low. Return the value to the default setting of 99.
Engine Takes Too Long to Reach the Set Speed	Improve PID tuning. Integral setting is too low. Startup Rate setting is too low. Accel Rate setting is too low. Speed Filter setting is too high.
Engine Does Not Track Speed Setting Changes	Is the LED blinking fast (3 Hz)? No = not sensing speed. Is the selected set speed parameter being modified? A PID value or a Gain value is too high. A PID value is too low or zero. Accel Rate is set too low. Decel Rate is set too low.
Sluggish Response to Load Changes	Gain too low. Improve PID tuning. Speed filter setting is too high.
Engine Instability With No Load	Improve PID tuning. Speed filter setting is too low. Fuel is restricted. Check actuator linkage. Battery voltage is too low.
Engine Instability With Load	Improve PID tuning. Fuel is restricted. Check actuator linkage. Battery voltage is too low.
Engine Unable to Carry Rated Load	PID values may be too high, causing the governor to overreact and make large, rapid changes in PWM duty cycle output to the actuator. Improve PID tuning. Fuel is restricted. Check actuator linkage.

Chapter 8.
Service Options

Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed:

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

If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

Replacement/Exchange

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

This option allows you to call 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 Woodward facility as explained below (see "Returning Equipment for Repair" later in this chapter).

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned to Woodward within 60 days, Woodward will issue a credit for the core charge. [The core charge is the average difference between the flat rate replacement/exchange charge and the current list price of a new unit.]

Return Shipment Authorization Label. To ensure prompt receipt of the core, and avoid additional charges, the package must be properly marked. A return authorization label is included with every Replacement/Exchange unit that leaves Woodward. The core should be repackaged and the return authorization label affixed to the outside of the package. Without the authorization label, receipt of the returned core could be delayed and cause additional charges to be applied.

Flat Rate Repair

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

Flat Rate Remanufacture

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

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the item(s), attach a tag with the following information:

- 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.

CAUTION

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*.

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 4 inches (100 mm) 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.

Return Authorization Number

When returning equipment to Woodward, please telephone and ask for the Customer Service Department [1 (800) 523-2831 in North America or +1 (970) 482-5811]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the item(s) to be repaired. No work can be started until a purchase order is received.

NOTE

We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at 1 (800) 523-2831 in North America or +1 (970) 482-5811 for instructions and for a Return Authorization Number.

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.

How to Contact Woodward

In North America use the following address when shipping or corresponding:

Woodward Governor Company
PO Box 1519
1000 East Drake Rd
Fort Collins CO 80522-1519, USA

Telephone—+1 (970) 482-5811 (24 hours a day)
Toll-free Phone (in North America)—1 (800) 523-2831
Fax—+1 (970) 498-3058

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

Facility	Phone Number
Brazil	+55 (19) 3708 4800
India	+91 (129) 230 7111
Japan	+81 (476) 93-4661
The Netherlands	+31 (23) 5661111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com**) for the name of your nearest Woodward distributor or service facility. [For worldwide directory information, go to **www.woodward.com/ic/locations**.]

Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Contact information:

Telephone—+1 (970) 482-5811
Toll-free Phone (in North America)—1 (800) 523-2831
Email—icinfo@woodward.com
Website—**www.woodward.com/ic**

Technical Support is available through our many worldwide locations or our authorized distributors, depending upon the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical support, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Technical Support***.

Product Training is available at many of our worldwide locations (standard classes). We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Product Training***.

Field Service engineering on-site support is available, depending on the product and location, from one of our many worldwide locations or from one of our authorized 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 field service engineering assistance, please contact us via telephone, email us, or use our website and reference ***Customer Services*** and then ***Technical Support***.

Technical Assistance

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

General

Your Name_____
Site Location_____
Phone Number_____
Fax Number_____

Prime Mover Information

Engine/Turbine Model Number_____
Manufacturer_____
Number of Cylinders (if applicable)_____
Type of Fuel (gas, gaseous, steam, etc)_____
Rating_____
Application_____

Control/Governor Information

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

Woodward Part Number and Revision Letter

_____

Control Description or Governor Type

_____

Serial Number _____

Woodward Part Number and Revision Letter

_____

Control Description or Governor Type

_____

Serial Number _____

Woodward Part Number and Revision Letter

_____

Control Description or Governor Type

_____

Serial Number _____

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

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

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

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Email and Website—www.woodward.com

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6 March 2001

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

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

04/4/M