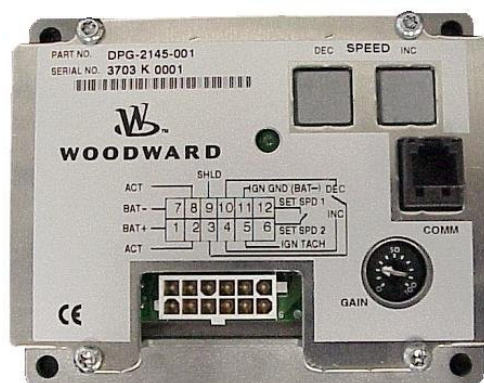




## User Manual



DPG-2101-001



DPG-2145-001

## DPG-21XX-00X Digital Controllers

**APECS<sup>®</sup> Programmable Controllers for  
Isochronous Generators**

**Manual 36526C**



## **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.

In systems where large inductive loads are switched on the DC power buss, surge impulse energy will be present due to the switching. To address surge energy affects on the control, appropriate suppression devices must be installed in the DC power buss prior to the control's power connection.

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.



## **IMPORTANT DEFINITIONS**

**WARNING**—indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



**CAUTION**—indicates a potentially hazardous situation which, if not avoided, could result in damage to equipment.



**NOTE**—provides other helpful information that does not fall under the warning or caution categories.

**Revisions**—Text changes are indicated by a black line alongside the text.

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# Regulatory Compliance

## Declaration of Conformity

**DECLARATION OF CONFORMITY**

According to EN 45014

**Manufacturer's Name:** WOODWARD GOVERNOR COMPANY (WGC)  
Industrial Controls Group

**Manufacturer's Address:** 1000 E. Drake Rd.  
Fort Collins, CO, USA, 80525

**Model Name(s)/Number(s):** DPG-2133-002, DPG-2101-002, DPG-2146-002, DPG-2133-001, DPG-2101-001, DPG-2146-001

**Conformance to Directive(s):** Declared to 89/336/EEC COUNCIL DIRECTIVE of 03 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility, with applicable amendments.

**Applicable Standards:** EN61000-6-4, (2001): EMC Part 6-4: Generic Standards - Emissions for Industrial Environments

EN61000-6-2, (2001): EMC Part 6-2: Generic Standards - Immunity for Industrial Environments

We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

**MANUFACTURER**

Signature

Douglas W. Salter

Full Name

Engineering Manager

Position

WGC, Fort Collins, CO, USA

Place

Date

6/23/05

## EMC Limitations

### Cabling

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

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

See wiring diagrams for specific cable types required.

### Power Bus

The power bus is intended to be a local bus and to have inductive load kickback events suppressed. Therefore, the control's power input is not designed to withstand a charging system load dump, heavy inductive kickbacks, or heavy surge type pulses. If the control is installed outside its intended usage, as described in this manual, centralized voltage pulse suppression should be implemented to protect the control and other components on the bus. (See Chapter 6: Installation Instructions.)

### COMM Port

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

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

# 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 anti-static 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 anti-static 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

This manual provides information on the following DPG controllers:

DPG-2101-001 and  
DPG-2101-002

DPG-2145-001 and  
DPG-2145-002

DPG-2155-001 and  
DPG-2155-002

DPG-2146-001 and  
DPG-2146-002

The DPG-21XX-00X digital controller 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 controller settings, allowing adaptation to each application during service and initial configuration.

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

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

The controller'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	APECS 0150
DYNA 2500	DYNA 70025	DYNA 8200	APECS 0250
DYNA 10141		DYNA 8400	APECS 0300

Power Flow Series Gas Valves  
APECS Linkage Free Integral Type

Other Models Available:

DPG-2100 Series – for Genset Applications  
DPG-2300 Series – for Off-Road Vehicles  
DPG-2400 Series – for EFC Valve Applications



## Chapter 2.

# Controller Specifications

The controller's main electrical and mechanical specifications are listed here along with several performance characteristics. DPG-21XX-00X Series controllers 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-2101-00X	*		*		1 + idle	
DPG-2145-00X		*		*	2 + idle	*
DPG-2146-00X	*			*	1 + idle	
DPG-2155-00X		*	*		2 + idle	*

### Electrical

<b>Operating Voltage Range:</b>	9–30 Vdc *
<b>Rated Output Current:</b>	7 A Maximum (continuous)
<b>Maximum Surge Current:</b>	14 A (not to exceed ten seconds)
<b>Connections:</b>	Terminal strip with 7 Euro style terminals or a quick connector with 12 pins
<b>Input Signal from Magnetic Pickup:</b>	2.0 VAC RMS minimum during cranking
<b>Input Signal from Engine's Ignition System:</b>	40 V minimum during cranking

(\*) All cabling for these controllers is limited to less than 30m (98.4').  
Power cabling is limited to less than 10m (32.8') in total length.  
See wiring diagrams for specific cable types required.

### Mechanical

<b>Ambient Operating Temperature:</b>	-40 °F to +185 °F (-40 °C to +85 °C)
<b>Sealing:</b>	Oil, water, and dust resistant via conformal coating and die cast enclosure
<b>Weight:</b>	10 oz. (284 g)

## Performance

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

## Suggested Mating Connectors for DPG-2145-00X and DPG-2155-00X Models

<b>AMP 770581-1</b>	Mini universal Mate-N-Lock
<b>AMP 171637-3 or 794407-3</b>	Duplex finish socket
<b>AMP 90707-1</b>	Crimping hand tool for 18 gauge wire
<b>AMP 408-4137</b>	Crimping documentation
<b>AMP 189727-1</b>	Socket extraction tool

## User Interface Operation

### Keypad

The DPG-21XX-00X 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-00X series controllers provide a potentiometer (labeled GAIN) to adjust the OVG @ Set Speed A. This is one of the controller's tuning parameters.

The gain potentiometer's 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 =  $\frac{1}{2}$  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 adjustments require that the controller be connected, via the COMM port, to a computer running the Universal PST application. Remote access via the COMM port is intended for connection only while programming, tuning and troubleshooting the control. **It is a service port and not intended for permanent connection.**

The Universal PST is an MS Windows based application available from the Software Products page at [www.woodward.com/IC/Software](http://www.woodward.com/IC/Software). See Chapter 4 for a description of this tool.

## Chapter 3.

# Parameter Reference

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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 OVG @ 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.

The parameter list provides information regarding each of the parameters that can be adjusted when a computer is connected to the controller via the COMM port and the Universal PST software. The COMM port is intended only for configuration and periodic service. **Do not leave a computer and/or COMM cable connected to the COMM port.**

## DPG-2101-00X & DPG-2146-00X Parameter List

PARAMETER LIST FOR DPG-2101-00X (MPU) & DPG-2146-00X (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	-001	0	0	0
		-002	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. OVG @ Set Speed A		Use the controller's built-in GAIN potentiometer		
	9. Not Available				
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. Over Speed Limit	-001	100	0	100
		-002	15000 (450)	0	15000 (450)
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 Limit		95	10	95
Req.	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-2146-00X controller					

Note: All *Speed* and *Rate* values are shown as Hertz values (parameters 2, 4, 14-16, 20-22, 25-26). Changing the value of parameter 1 will cause different default values to be displayed based on the Hertz to RPM formula.

## DPG-2155-00X & DPG-2145-00X Parameter List

PARAMETER LIST FOR DPG-2155-00X (MPU) & DPG-2145-00X (IGNITION)					
(These controllers use the 12-terminal quick connect.)					
	PARAMETER NAME		DEFAULT	MINIMUM	MAXIMUM
Opt.	1. No. of Flywheel Teeth or Pulses per Revolution	-001	0	0	0
		-002	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. OVG @ 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. Over Speed Limit	-001	100	0	100
		-002	15000 (450)	0	15000 (450)
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 Limit		95	10	95
Req.	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-2145-00X controller.					

Note: All *Speed* and *Rate* values are shown as Hertz values (parameters 2-4, 14-16, 20-26). 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.



**NOTE—FOR DPG-21XX-002 MODELS: Adjusting the No. of Flywheel Teeth parameter is prohibited while the engine is running.**

Adjust this parameter to a value equal to the exact number of pulses seen by the controller 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:

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

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

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

#### **DPG-2101-00X and DPG-2155-00X Models**

To use this parameter correctly on controllers 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-2145-00X and DPG-2146-00X Models**

To use this parameter correctly on controllers 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 controller'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.

**The default value for SET SPEED A is 1000 MPU Hertz (25 Hertz ignition). The SET SPEED A parameter's adjustable range extends from SET SPEED A MIN to SET SPEED A MAX.**

**DPG-2145-00X and DPG-2155-00X Models**

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 controller's target speed. If the controller'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 using the speed select feature.

### 3.3 Set Speed B (optional)

**DPG-2145-00X and DPG-2155-00X Models**

SET SPEED B becomes the controller's target speed 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 controller's target speed.

**The default value for SET SPEED B is 1000 MPU Hertz (25 Hertz ignition). The SET SPEED B parameter's adjustable range extends from SET SPEED B MIN to SET SPEED B MAX.**

See the Installation Instructions chapter for details about using the speed select feature.

### 3.4 Idle Speed (optional)

**DPG-2101-00X and DPG-2146-00X Models**

The IDLE SPEED is the controller's target speed for the IDLE HOLD TIME when the engine is started. When the idle hold timer reaches zero, the target speed will become SET SPEED A.

**DPG-2145-00X and DPG-2155-00X Models**

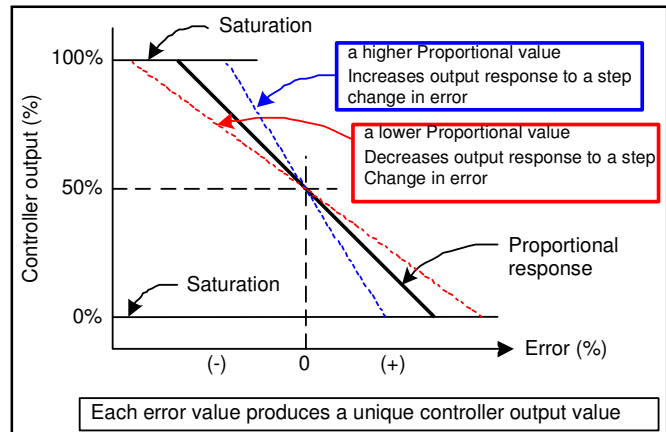
The IDLE SPEED is the controller's target speed for the IDLE HOLD TIME when the engine is started. When the idle hold timer reaches zero, the target speed will be either SET SPEED A or SET SPEED B depending on the state of the SPEED SEL input terminal.

**The default value for IDLE SPEED is 500 MPU Hertz (20 Hertz ignition). The IDLE SPEED parameter's adjustable range extends from IDLE SPEED MIN to IDLE SPEED MAX.**



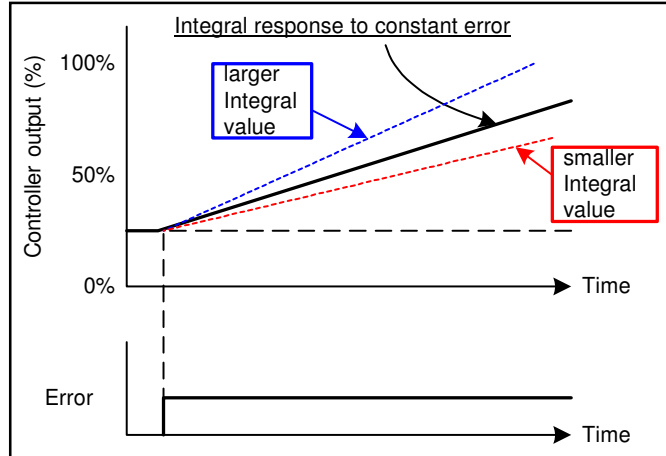
### 3.5 Proportional (required)

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 controller output response to a step change in the speed error.



### 3.6 Integral (required)

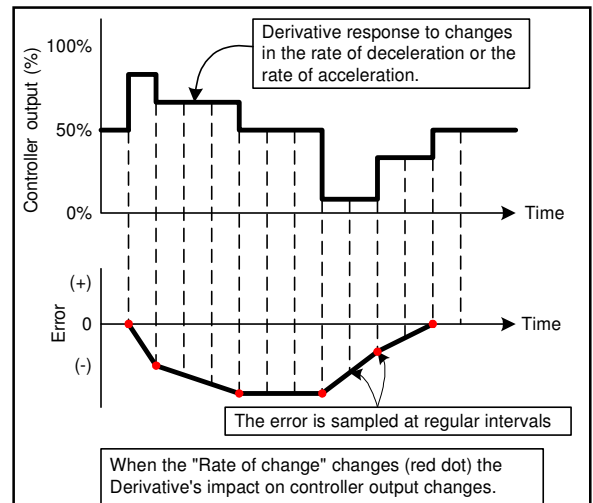
The integral term is one of the interrelated PID terms that determine how well a DPG controller governs the engine's speed. The integral term acts to drive speed error to zero. In a proportional only control with constant load, there will be a constant speed error that inversely relates to the proportional 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 OVG @ Set Speed A (required)

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

### 3.9 OVG @ Set Speed B (optional)

#### **DPG-2145-00X and DPG-2155-00X Models**

This overall 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 overall gain term is adjustable from 01 to 99.

### 3.10 OVG @ Idle Speed (optional)

This overall 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 overall 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 overall gain terms reach their adjustment limits then this value can be modified to provide for more range of adjustment in the PID and OVG 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 controller'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 flywheel teeth 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 controller's response to speed changes.
- Too little filtering can make the controller 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.

$$[(\text{No. of flywheel\_teeth}) / (\text{No. of engine cylinders})] * 0.75 = \text{speed\_filter\_value}$$

#### **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.

$$[(\text{pulses\_per\_rev}) * (2)] = \text{speed\_filter\_value}$$

### **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 controller 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.

$$[(\text{higher\_speed\_in\_Hertz}) - (\text{lower\_speed\_in\_Hertz})] / (\text{ramp\_time\_in\_seconds}) = \text{accel\_rate\_value}$$

For example, suppose Set Speed A is 3300 Hertz and Set Speed B is at 3960 Hertz. The controller 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.

$$[(\text{Set Speed B}) - (\text{Set Speed A})] / (\text{N seconds}) = \text{accel\_rate\_value in Hertz per second}$$

$$[3960 - 3300] / 2 = 330 \text{ Hertz per second}$$

### **3.15 Decel Rate (optional)**

The Decel Rate specifies how fast the controller 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.

$$[(\text{higher\_speed\_in\_Hertz}) - (\text{lower\_speed\_in\_Hertz})] / (\text{ramp\_time\_in\_seconds}) = \text{decel\_rate\_value}$$

For example, suppose Set Speed A is 4170 Hertz and Set Speed B is 3475 Hertz. The controller 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 to Set Speed B in 1.5 seconds.

$$[(\text{Set Speed A}) - (\text{Set Speed B})] / (\text{N seconds}) = \text{decel\_rate\_value in Hertz per second}$$

$$[4170 - 3475] / 1.5 = 463 \text{ Hertz per second}$$

### 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 controller 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.

$$[(\text{final\_target\_speed\_in\_Hertz}) - (\text{crank\_speed\_in\_Hertz})] / (\text{ramp\_time\_in\_seconds}) = \text{startup\_rate\_value}$$

The ramp up will pause at the STARTUP SPEED until the controller senses an MPU signal greater than the STARTUP SPEED. This prevents the startup ramp from reaching completion before the engine has even started. The controller 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 controller 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 under speed duration after a long or sustained over speed condition was present. The low limit helps reduce the duration and amount of engine under speed 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 under speed 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 controller from ever reaching the target speed. The first line of defense in reducing over speed or under speed errors is a well-tuned controller 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 under speed 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 over speed 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 over speed 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 controller from ever reaching the target speed. The first line of defense in reducing over speed or under speed errors is a well-tuned controller via the PID terms.**

### **3.19 Password**

The Password parameter is not available on the DPG-21XX-00X Series models.

### **3.20 Over Speed Limit (optional)**

#### **DPG-21XX-001 Models:**

This parameter is used to determine the engine speed that will trigger the controller to output minimum fuel. The parameter’s value is in terms of a percentage over the highest set speed. In other words, an over speed condition is detected if the engine speed reaches a speed of [OVER SPEED 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 over speed condition will be detected at 2160 RPM (the value that is 20% greater than 1800). Formula:  $1.20 * 1800 \text{ RPM} = 2160 \text{ RPM}$

The default value of 100 is used to disable over speed detection. Use values less than 100 to enable the over speed limit function and set the limit speed to  $[(1 + (\text{over\_speed\_limit\_value}/100)) * (\text{highest\_set\_speed})]$ .

#### **DPG-21XX-002 Models:**

This parameter is used to determine the engine speed that will trigger the controller to output minimum fuel. The parameter’s value is set as a frequency in Hertz or as a RPM value depending on whether the No. of Flywheel Teeth parameter is zero or nonzero respectively. The default value of 15,000 Hertz (450 Hertz ignition) is used to disable over speed detection.

The controller detects an over speed condition when it measures an engine speed that exceeds the OVER SPEED LIMIT value. When an over speed is detected the controller’s actuator output signal is set to minimum.



**NOTE—The controller must be turned off to clear the over speed detection before the engine can be restarted.**

### 3.21 Set Speed A Min (optional)

Set Speed A Min is used to set the lowest value allowed for Set Speed A adjustments. The adjustable range for Set Speed A Min extends from 10 Hertz (2 Hertz ignition) to the current value of Set Speed A.

### 3.22 Set Speed A Max (optional)

Set Speed A Max is used to set the highest value allowed for Set Speed A adjustments. The adjustable range for Set Speed A Max extends from the current value of Set Speed A to 11000 Hertz (300 Hertz ignition).

### 3.23 Set Speed B Min (optional)

#### DPG-2145-00X and DPG 2155-00X Models

Set Speed B Min is used to set the lowest value allowed for Set Speed B adjustments. The adjustable range for Set Speed B Min extends from 10 Hertz (2 Hertz ignition) to the current value of Set Speed B.

### 3.24 Set Speed B Max (optional)

#### DPG-2145-00X and DPG 2155-00X Models

Set Speed B Max is used to set the highest value allowed for Set Speed B adjustments. The adjustable range for Set Speed B Max extends from the current value of Set Speed B to 11000 Hertz (300Hertz ignition).

### 3.25 Idle Speed Min (optional)

Idle Speed Min is used to set the lowest value allowed for Idle Speed adjustments. The adjustable range for Idle Speed Min extends from 10 Hertz (2 Hertz ignition) to the current value of Idle Speed.

### 3.26 Idle Speed Max (optional)

Idle Speed Max is used to set the highest value allowed for Idle Speed adjustments. The adjustable range for Idle Speed Max extends from the current value of Idle Speed to 11000 Hertz (300Hertz ignition).

### 3.27 Duty Cycle Limit (optional)

The Duty Cycle Limit 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 (required)

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 controller to determine whether the engine is cranking or running whenever an engine speed signal is present. See the "Startup Sequence" example in Chapter 5.

If the Startup Speed value is set too low (less than crank speed) the controller'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 controller must reach before the it 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 controller 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 controller'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 controller while the engine is running. Note: To determine if your meter is reading the correct value:
  - a. First, apply power to the controller 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

The Universal Parameter Setup Tool (Universal PST) is a Microsoft® Windows® application available from Woodward that enables you to adjust controller parameter settings and monitor controller operation. Universal PST also includes a graphical chart recorder that displays engine speed in real-time. This provides a visual representation of how the engine speed changes in response to changes in load, which can be very helpful when tuning the controller.

This chapter provides the information needed to use a computer with your controller. Here you will find instructions for acquiring, installing, and running the Universal PST on your PC. Also described is information for obtaining or constructing the communications cable needed to connect the controller's COMM port to your computer's serial port.

### Features

Universal PST features include:

- Automatic configuration to each DPG when communications are established
- Read/write access to all DPG programmable parameters and features
- View each parameter's default, minimum, and maximum values
- Diagnostics utilizing automatic refresh of DPG status
- Save and open DPG setup data 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 controller
- Saving chart recorder data to a Microsoft Excel compatible file
- Help information on each of the controller's parameters
- Help information on using the Universal PST

### System Requirements

Universal PST minimum system requirements:

- Pentium® 133 MHz PC
- 50 MB of hard disk space
- 64 MB of RAM
- Display resolution set to SVGA (800x600) or higher
- Windows® 98se, NT 4.0, 2000, and XP or greater
- Windows® 95 or ME not supported

**CAUTION**

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.



## Acquiring Universal PST

There are two ways to acquire a copy of the Universal PST application:

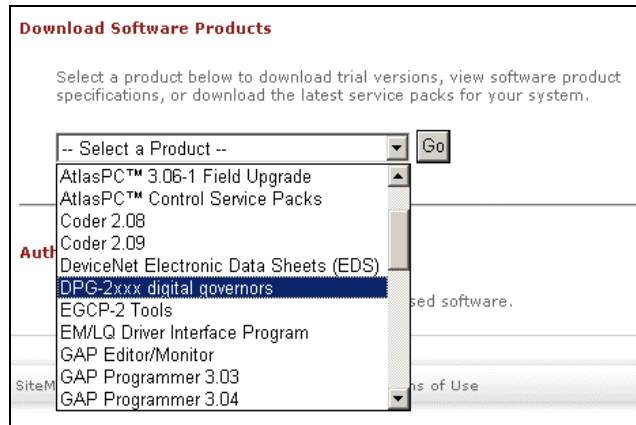
- Obtain the DPG Software Calibration Kit
- Download the application from the Woodward website

### Obtaining the DPG Software Calibration Kit:

The DPG Software Calibration Kit (Woodward P/N 8447-1003) contains the latest version of Universal PST on CD-ROM, a DB-9 Modular Adapter and modular cable. Contact the Woodward sales department to request a DPG Software Calibration Kit for a nominal charge. Telephone: (847) 967-7730.

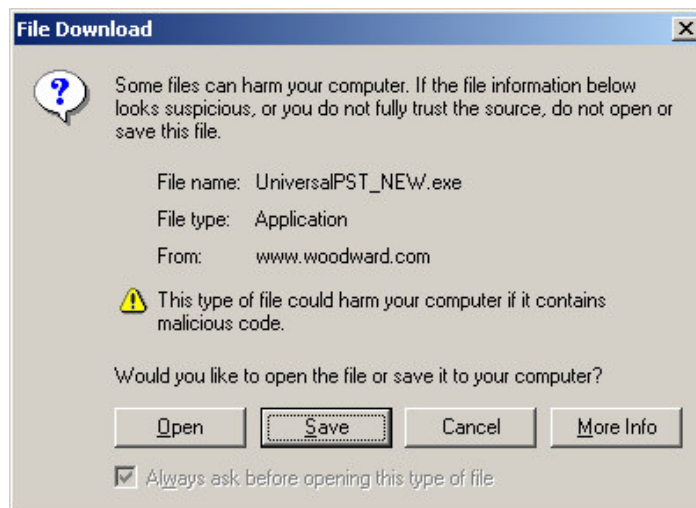
### Downloading Universal PST:

The Universal PST application is also available to download from the Woodward Software Products page at [www.woodward.com/IC/Software](http://www.woodward.com/IC/Software). Use the "Select a Product" drop down menu in the center of the web page to select "DPG-2xxx digital governors" then press the [Go] button.



This will automatically redirect you to the Universal PST download page where you can click on the word **Download** to begin the download process.

Once you are logged into the Woodward download site you are presented with the File Download dialog box shown below, or one similar. Click the [Save] button and choose a folder to save the download to.



**NOTE:** Due to the large file size, it is recommended that the [Open] button not be used because this would try to run the self-extracting executable from the web site.

## Installing Universal PST

### Instructions to Install from CD-ROM:

When you insert the DPG Software Calibration Kit's CD-ROM into your computer, the "autorun" file on the CD will attempt to launch the "setup.exe" program. If the "autorun" feature is disabled on your computer or does not start the setup program you can launch the program manually. To start the installation manually, explore the contents of the CD then double click on the "setup.exe" file.

### Instructions to Install from the Downloaded File:

The file downloaded from the Woodward web site contains two files: "ReadMeFirst.txt" and "setup.exe". Run the downloaded file to extract its contents to a folder you choose on your computer's hard drive. Then run the "setup.exe" program from the folder you extracted it to.

### IMPORTANT:

The installation program will detect operating system components older than those required by the "Universal PST" application. In this case the installation program will ask if you want to update Windows. If you do not want "setup" to update your system then you can not use the "Universal PST" application on this computer.

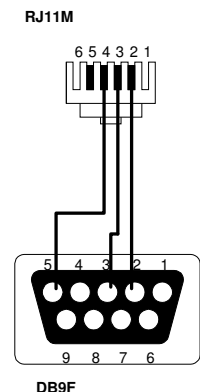
Read the setup program's instructions carefully as they appear and respond as needed. The installation may take as long as 7 minutes depending on your computer's power and operating system. Do not interrupt the installation program even though it may appear as though it is not running.

NOTE: Administrator rights may be needed to install on some Microsoft Windows operating systems (such as Windows XP Professional) for the setup program to properly register application resources.

## Wiring the COMM Port to a PC

To construct a communications cable to use between the DPG's COMM port and your PC's RS-232 serial port refer to the table and wiring diagram below.

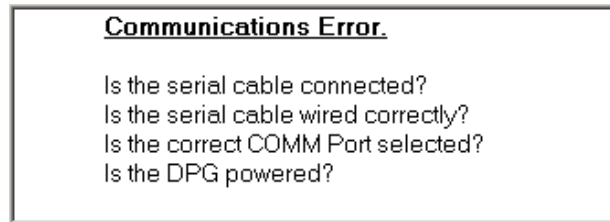
RJ11 OR RJ12 POSITION	DPG-21XX SIGNAL	CONNECTS TO:
1	No connection	N/C
2	Transmit data to PC	PC receive (RxD) DB9 pin 2
3	Receive data from PC	PC transmit (TxD) DB9 pin 3
4	COMMON	PC common DB9 pin 5
5	+5 Vdc (Do NOT connect at the PC end)	N/C
6	No connection	N/C



**NOTE—Remote access via the COMM port is intended for connection only while programming, tuning and troubleshooting the control/engine. It is a service port and not intended for permanent connection of a PC and/or cable.**

## Communications Error

The following message window appears when Universal PST is running and unable to communicate with a DPG.



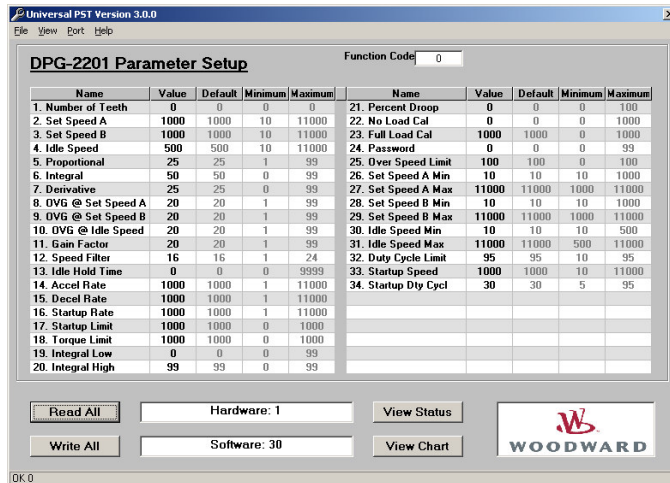
After the problem is found and corrected, you can either restart Universal PST or press the <Read All> button to clear the error message. The <Read All> button is near the lower left corner of Universal PST's main startup screen.

## Universal PST User Interface Overview

Universal PST has two main display modes.

- Table View (the main startup screen)
- Chart View

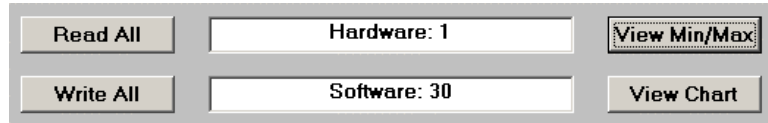
### TABLE VIEW



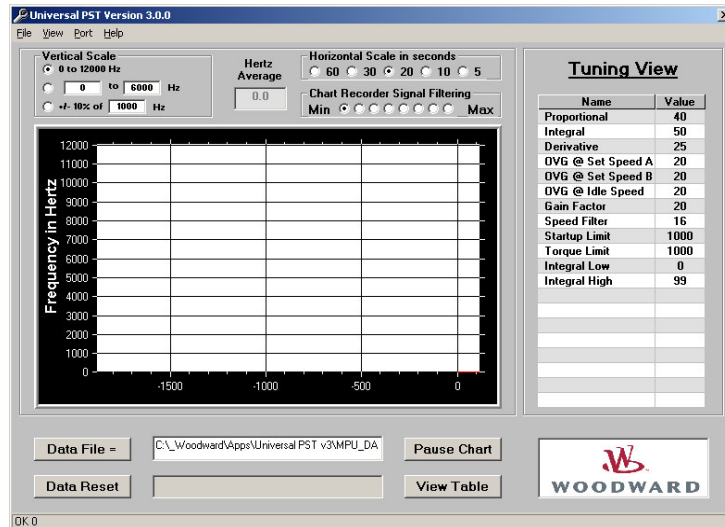
In Table View the user can:

- View the current values for all user programmable parameters in the Parameter Setup panel.
- 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 displayed in the Parameter Setup panel.
- Press the <Write All> button to transmit setup values to the controller.
- 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.

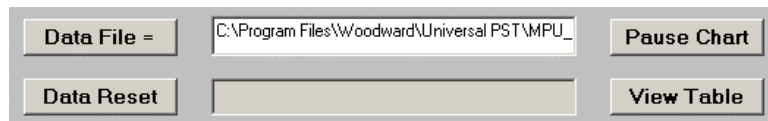


## CHART VIEW



In Chart View the user can:

- Monitor engine speed in real-time.
- Adjust the horizontal and vertical scale settings of the chart recorder.
- Edit parameter values related to controller 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.
- Press the <View Table> button to set the display mode back to Table View.
- Select items from the menu.

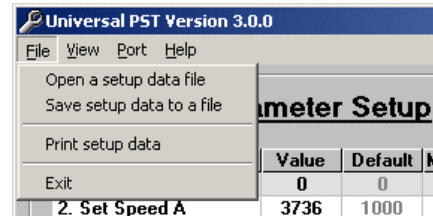


NOTE: Pressing a button means positioning the mouse pointer over the button and clicking the left mouse button.

## Universal PST Menu Items

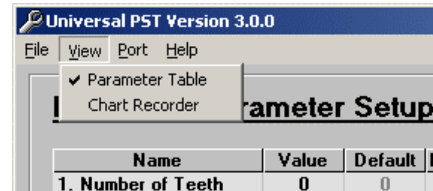
### Use the File menu to:

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



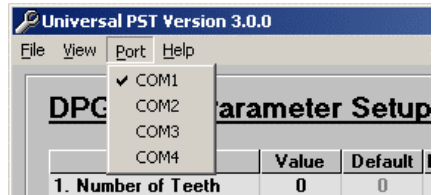
### Use the View menu to:

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



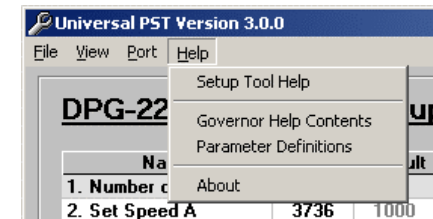
### Use the Port menu to:

- 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.

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 controller.

In the figure shown below, the Set Speed A value has been selected for editing.

DPG-2201 Parameter Setup				
Name	Value	Default	Minimum	Maximum
1. Number of Teeth	0	0	0	0
2. Set Speed A	3736	1000	10	11000
3. Set Speed B	1000	1000	10	11000
4. Idle Speed	477	500	10	11000
5. Proportional	40	25	1	99
6. Integral	50	50	0	99
7. Derivative	25	25	0	99

## Parameter Help

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. This opens the DPG online help file and automatically jumps to the selected parameter's help page.

NOTE: Complete online help for each DPG controller is also accessible by selecting either *"Governor Help Contents"* or *"Parameter Definitions"* from the Universal PST *Help* menu.

## Synchronizing Universal PST with a DPG

Pressing the <Read All> button will load the current values for all of a DPG-2XXX-00X's parameters into Universal PST. The <Read All> button is part of the Table View.

IMPORTANT: If the communication cable is unplugged from a DPG and plugged into a different DPG while the Universal PST application is still running, then the <Read All> button must be pressed in order for Universal PST to synchronize with the new DPG.

The <Write All> button is very useful when reusing saved setup data to configure a new system with the same data 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.

Status View	
Name	Value
MPU Frequency	
Actuator %FS	
Battery Volts	
ILS Signal	
Keypad #	
Digital Inputs	
PWM Cmnd	
Speed Diff	
START Monitoring	
Auto Read is OFF <input type="checkbox"/>	

## 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 controller.

Tuning View	
Name	Value
Proportional	50
Integral	20
Derivative	10
Overall Gain	10
Ki Slow/Fast	1
Engine Size	2
Startup Limit	100
Torque Limit	100
Integral Low	0
Integral High	100

## 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 chart recorder's display characteristics are configured using the Vertical Scale options, the Horizontal Scale options, and the Chart Recorder Signal Filtering options.

The screenshot shows a configuration panel with four main sections:

- Vertical Scale:** Three radio button options: "0 to 12000 Hz" (selected), "[ ] to [ ] Hz", and "+/- 10% of [ ] Hz".
- Hertz Average:** A numeric input field showing "0.0".
- Horizontal Scale in seconds:** Five radio button options: "60", "30", "20" (selected), "10", and "5".
- Chart Recorder Signal Filtering:** A row of 11 circular indicators between "Min" and "Max" labels, with the first indicator selected.

The Vertical Scale options provide three different ways to view engine speed data.

- The [0 to 12000 Hz] option is the default and sets the vertical axis range to its absolute minimum and maximum measurable values.
- The [ ] to [ ] Hz option allows you to enter the minimum and maximum speed values to zoom in on a viewing range of interest.
- The +/- 10% of [ ] Hz option is primarily used to zoom in on the target speed and center it in the chart recorder. This is most useful during controller tuning to see if the engine speed stays within +/- 10% of the target speed during load on/off cycling.

The Horizontal Scale options allow you to set how much data is displayed in the chart recorder window. Larger values compress the display and show more data. Smaller numbers expand the display and show less data. 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.

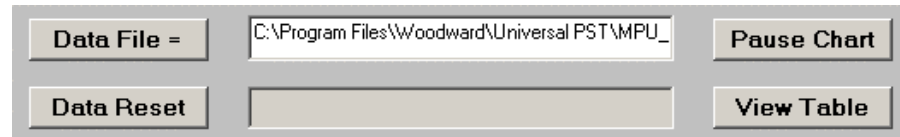
The Chart Recorder Signal Filtering options can be used to smooth out noisy signals. The default setting is Min, which is no filtering. Note that filtering will round out peaks and give a less accurate display of the speeds actually measured by the DPG.



## Engine Speed Data Collection

The engine speed data measured by the DPG and displayed in the Universal PST chart recorder window is also recorded to a computer file. MPU\_DATA00.csv is the default file name used to save engine speed information. You can change the file name by using the <Data File => button. The “.csv” data files created to collect engine speed data can be viewed with either a text editor or with Microsoft Excel. If you load an engine speed data file into Microsoft Excel, then you can highlight the column of data and use Excel's quick graph button to create a line chart of the data.

**IMPORTANT:** Do not open data files in another program that are currently being used by Universal PST. Also be sure to close any open data files needed by Universal PST before starting it.



The <Data File => button opens a dialog box allowing you to set the base file name where chart recorder data will be saved. A two-digit suffix is automatically appended to the file name that is given and serves the following purpose. Each engine speed data file is considered full after recording 60,000 data points which is approximately 10-12 minutes of data. The two-digit suffix is used to automatically continue collecting data to new files with the same base file name but with increasing numeric suffixes. The first 60,000 data points are saved in *filename00.csv* and the next 60,000 data point are saved in *filename01.csv*, and so on until a million data points are collected. This is to prevent each speed data file from exceeding the 65,536-row limit of Microsoft Excel.

The <Data Reset> button is used to clear out the data collection buffer and overwrite the zero suffixed data collection file. Data collection starts from the beginning of *filename00.txt* where *filename* is the base file name previously used.

The progress bar shown to the right of the <Data Reset> button indicates how full the complete set of data files is. A total of one million data points (approximately 3.5 hours of data) can be collected before the progress bar displays the message "The Data File is FULL". In order to start recording data again without overwriting previously collected data, use the <Data File => button to create a new base file name in which to receive additional engine speed information.

The <Pause Chart> button stops chart recorder and Data File updates. After pressing this button the <Continue> button is displayed. Press the <Continue> button to turn the chart recorder back on and continue recording engine speed data to the current target file.

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 the 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 probably need to adjust the parameters shown in the table below.

The parameters listed are the primary ones to modify to get the controller 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
12	SPEED FILTER (note 2)	16
28	STARTUP SPEED	1000

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

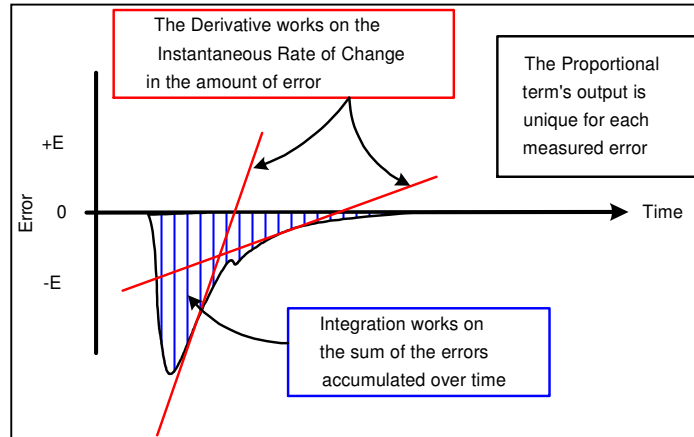
Once the engine is running, the following procedure may be used to discover more optimum values for PID and the overall gain parameters (OVG). The goal would be to find PID values that allow the controller to govern the engine well at a variety of different speeds and loads while only requiring gain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

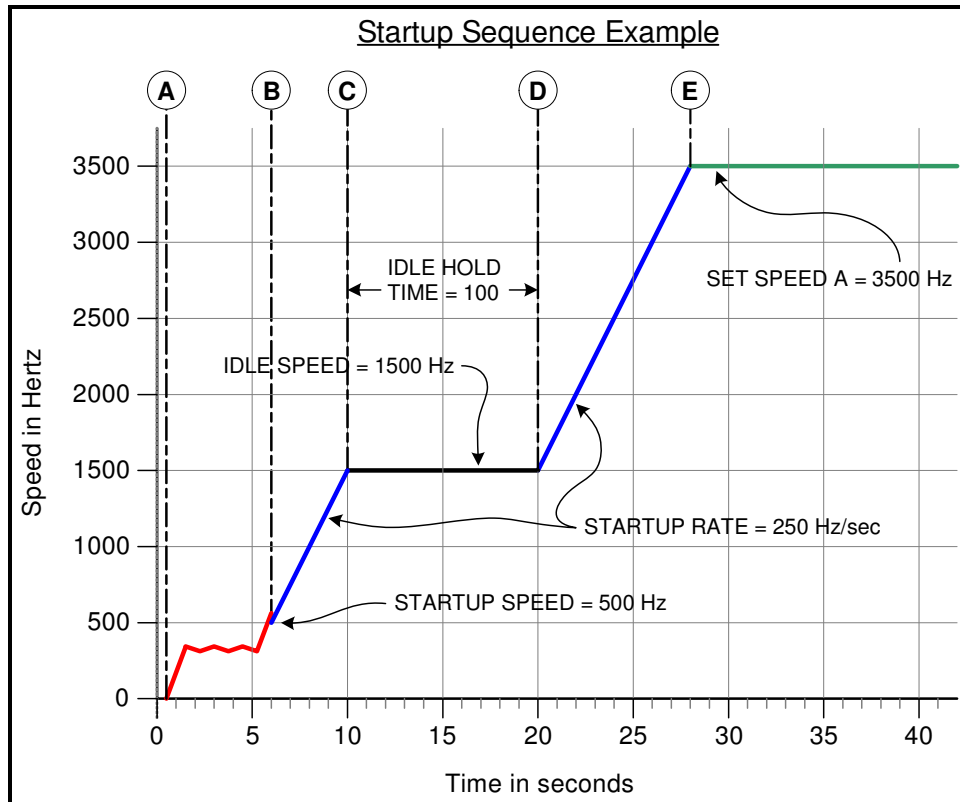
During each of the steps 3 through 6, you need to disturb the system by adding and removing a load from the engine to check the controller's response to the load transition. **START WITH SMALL LOADS.**

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.



## Startup Sequence

The following example describes the DPG-21XX-00X startup sequence.



Engine cranking begins at point A. After a short time, the engine starts and at point B the engine speed exceeds the STARTUP SPEED (the initial target speed) and the controller now considers the engine to be running.

The controller's startup sequence begins at point B by ramping the target speed up from the STARTUP SPEED at the STARTUP RATE. In this example, the STARTUP SPEED is set to 500 Hertz, the STARTUP RATE is set equal to 250 Hertz per second, and the IDLE SPEED is set to 1500 Hertz. It will take 4 seconds for the target speed to ramp up 1000 Hertz (IDLE SPEED minus STARTUP SPEED) and reach point C.

This example uses the IDLE HOLD TIME and has it set to 100 tenths of a second so the target speed will be held at the IDLE SPEED (1500 Hertz in this example) for 10 seconds. At point D, the IDLE HOLD TIME has elapsed and the target speed is again ramped up at the STARTUP RATE.

The example also has SET SPEED A set at 3500 Hertz so it will take 8 seconds for the target speed to ramp up 2000 Hertz from the IDLE SPEED. Ramping stops at point E when the target speed reaches SET SPEED A. The startup sequence also ends at point E assuming the engine speed has been tracking the target speed and has reached SET SPEED A.

## Chapter 6.

# Installation Instructions

### Recommended Mounting

The DPG-21XX-00X controller is designed to be panel mounted and its chassis electrically bonded to the same protective reference as the engine structure. The mounting location 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.

### Terminal Descriptions

#### DPG-2101-00X

NO.	NAME	FUNCTION
1	BAT+	Battery positive (9–30 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

#### DPG-2145-00X

NO.	NAME	FUNCTION
1	BAT+	Battery positive (9–30 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

**DPG-2146-00X**

NO.	NAME	FUNCTION
1	BAT+	Battery positive (9–30 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

**DPG-2155-00X**

NO.	NAME	FUNCTION
1	BAT+	Battery positive (9–30 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

**CAUTION**

To prevent damage to the controller, make sure that it is wired in accordance with the wiring instructions and diagrams in this manual.

## Wiring Diagrams

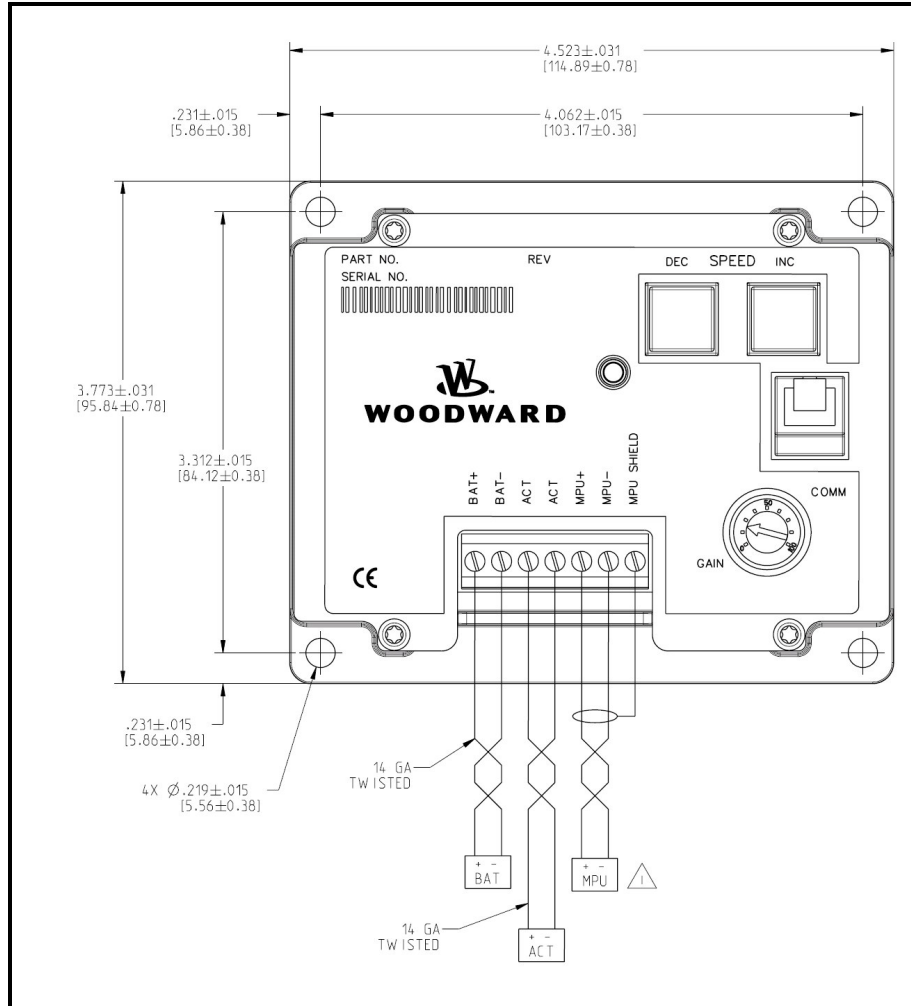


## NOTE

**Cabling for DPG 21XX-00X controllers is limited to less than 30m (98.4'). Power cabling is limited to less than 10m (32.8') in total length. The wiring diagrams below show specific cable types required.**

**DPG-2101-00X**

Dimensions are in inches. [Dimensions in brackets are millimeters.]



**Figure 1. Wiring Diagram for DPG-2101-001 and DPG-2101-002 Controllers**



Connect the MPU shield at the controller end only. Connecting the shield at the MPU source end could introduce noise due to ground loops and also disable the reverse battery protection feature.



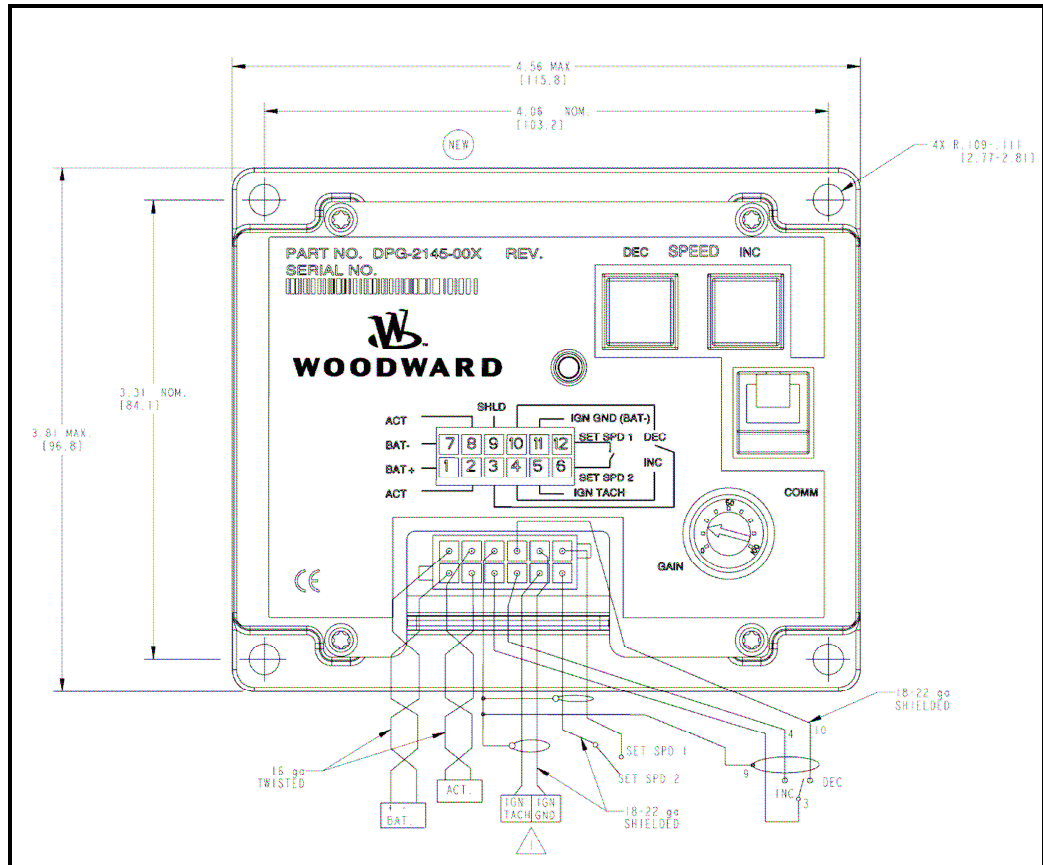
## CAUTION

**To prevent damage to the controller, make sure that it is wired in accordance with the wiring instructions and diagrams in this manual.**

- Do not tin the leads before placing them into the terminals.
- Ensure the terminals are tightened properly to secure wires.

## DPG-2145-00X

Dimensions are in inches. [Dimensions in brackets are millimeters.]



**Figure 3. Wiring Diagram for DPG-2145-001 and DPG 2145-002 Controllers**

- 1 Connect the MPU shield at the controller end only. Connecting the shield at the MPU source end could introduce noise due to ground loops and also disable the reverse battery protection feature.



### CAUTION

To prevent damage to the controller, make sure that it is wired in accordance with the wiring instructions and diagrams in this manual.

- Do not tin the leads before placing them into the terminals.
- Ensure the terminals are tightened properly to secure wires.

## DPG-2146-00X

Dimensions are in inches.

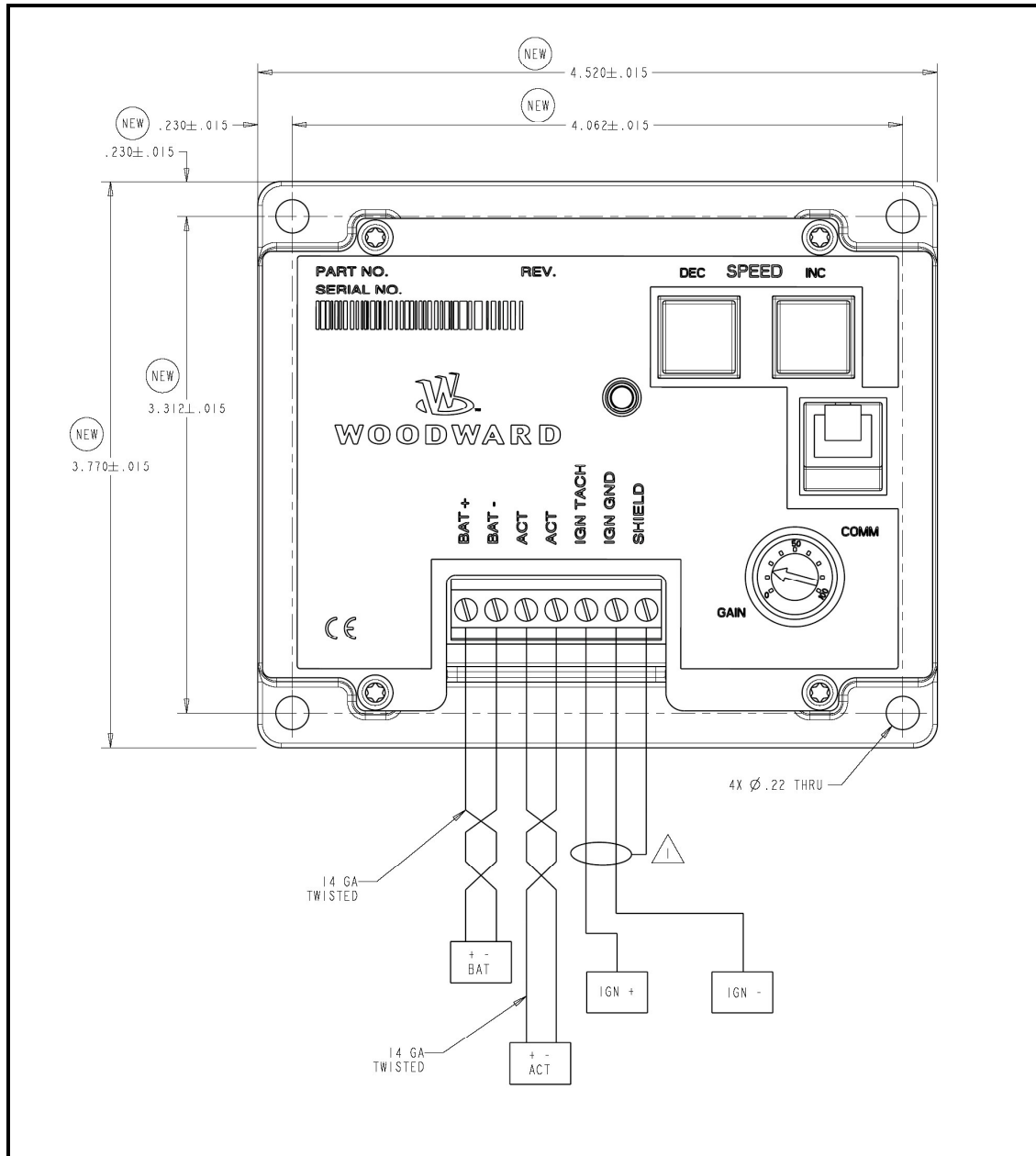


Figure 4. Wiring Diagram for DPG-2146-001 and DPG-2146-002 Controllers

**1** Connect the MPU shield at the controller end only. Connecting the shield at the MPU source end could introduce noise due to ground loops and also disable the reverse battery protection feature.



### CAUTION

To prevent damage to the controller, make sure that it is wired in accordance with the wiring instructions and diagrams in this manual.

- Do not tin the leads before placing them into the terminals.
- Ensure the terminals are tightened properly to secure wires.



## DPG-2155-00X

Dimensions are in inches. [Dimensions in brackets are millimeters.]

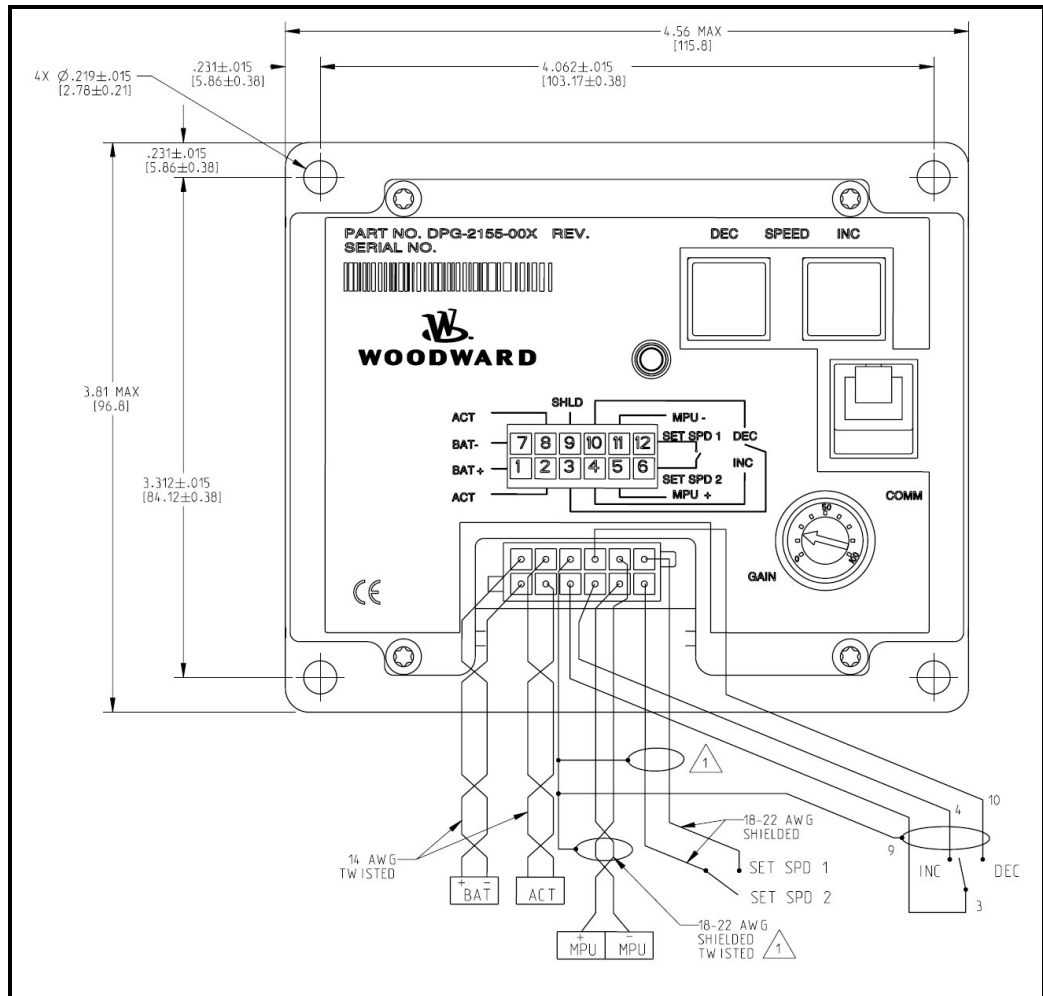


Figure 5. Wiring Diagram for DPG-2155-001 and DPG-2155-002 Controllers

- 1 Connect the MPU shield at the controller end only. Connecting the shield at the MPU source end could introduce noise due to ground loops and also disable the reverse battery protection feature.



### CAUTION

To prevent damage to the controller, make sure that it is wired in accordance with the wiring instructions and diagrams in this manual.

- Do not tin the leads before placing them into the terminals.
- Ensure the terminals are tightened properly to secure wires.

## Centralized Suppression

The control meets the regulatory requirements for its intended installations, and when installed correctly, the input power bus can handle some level of surge pulses.

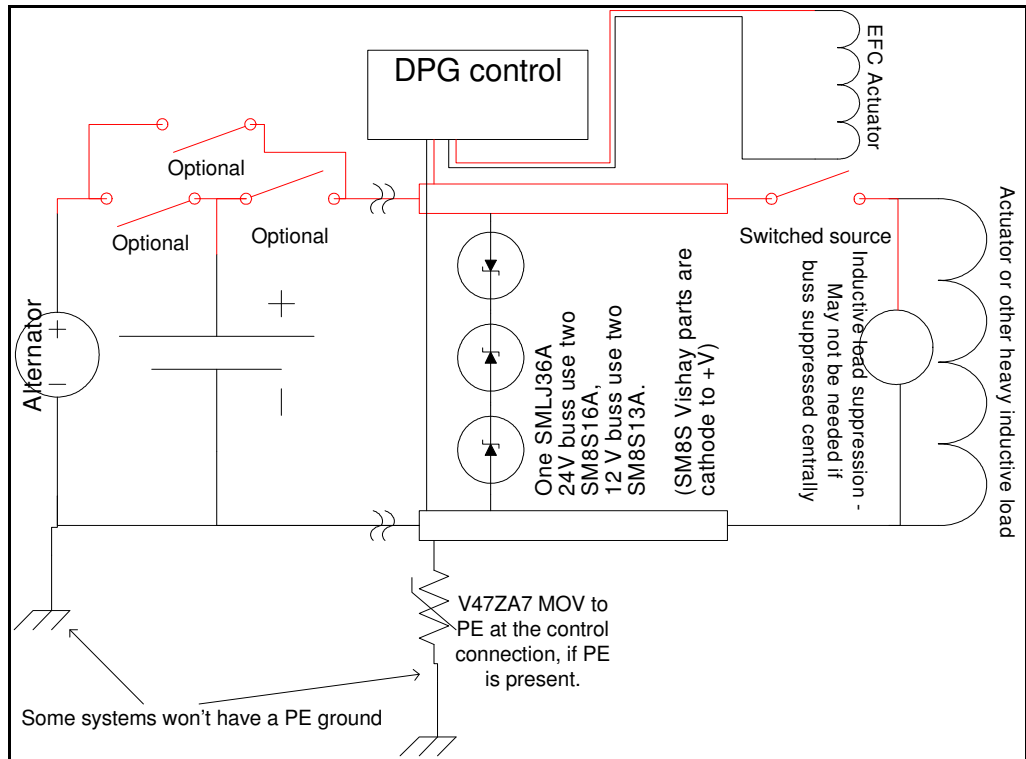
Because the control power input is designed to be connected to a local bus and to have inductive load kickbacks suppressed, it cannot withstand a charging system load dump, heavy inductive kickbacks, or heavy surge pulses.

1. Charging system load dump is a pulse created when a heavily charging battery that is being charged by an alternator or generator (or similar), is disconnected from the bus.
2. Inductive kickbacks are due to switched, unsuppressed, inductive loads on the bus.
3. Large surge pulses are typically due to indirect lightning strikes. Some surge pulses may also be present due to series inductances with switched currents.

The EMC environment into which the control is installed may have the above conditions if the control is installed outside its intended usage. If the stated conditions exist, centralized pulse suppression should be implemented to protect the components on the bus, including the control.

**Figure 6** is an example of centralized suppression that should be implemented at the system level when any of the following are present:

1. The battery can be disconnected and a high current battery charging system is in use.
2. Unsuppressed, switched inductive loads are in parallel or series with the control power.
3. The input power is derived from a distribution system or it is more than 32.8' (10m) from the control to the main power source.



**Figure 6. Centralized Suppression Implemented at the System Level**

**NOTES:**

1. Power and return cables to the control and from the control to the actuator are routed together for minimizing noise pick up and emission.
2. MOV and TVS suppression devices are recommended based on the typical pulse levels that might be seen in Group 1 or Group 2 engine applications and the internal circuitry of the control.
3. Other suppression devices may be used, but clamping voltages are important, as energy handling capability requirements are dependant on the full system implementation. Examples:
  - (a) The SMLJ36A and two SM8S16A parts can be replaced with two 15KP17CA through-hole parts.
  - (b) The SMLJ36A and two SM8S13A parts can be replaced with two 15KP13CA through-hole parts.

## 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 Controller Is Powered	BAT + and BAT – leads are reversed. Check wiring. Battery voltage too low. Should measure between 9–30 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 controller 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.

## Troubleshooting Table (Cont'd.)

SYMPTOM	REMEDY
Engine Does Not Reach Set Speed	<p>Improve PID tuning. Integral too low or zero PID values are too low. A tuning that is too soft can prevent the controller from delivering the needed actuator drive signal to reach the set speed.</p> <p>PID values are too high. Tuning is too hot or oversensitive to small speed errors, which causes the controller to make large, rapid changes in actuator drive signal, creating an average signal that is inadequate.</p> <p>The Integral Low Limit setting is too high. Return the value to the default setting of zero.</p> <p>The Integral High Limit setting is too low. Return the value to the default setting of 99.</p>
Engine Takes Too Long to Reach the Set Speed	<p>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.</p>
Engine Does Not Track Speed Setting Changes	<p>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.</p>
Sluggish Response to Load Changes	<p>Gain too low. Improve PID tuning. Speed filter setting is too high.</p>
Engine Instability With No Load	<p>Improve PID tuning. Speed filter setting is too low. Fuel is restricted. Check actuator linkage. Battery voltage is too low.</p>
Engine Instability With Load	<p>Improve PID tuning. Fuel is restricted. Check actuator linkage. Battery voltage is too low.</p>
Engine Unable to Carry Rated Load	<p>PID values may be too high, causing the controller to overreact and make large, rapid changes in PWM duty cycle output to the actuator.</p> <p>Improve PID tuning. Fuel is restricted. Check actuator linkage.</p>

## 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;
- anti-static 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.

<u>Facility</u>	<u>Phone Number</u>
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](http://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](http://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](mailto:icinfo@woodward.com)

Website—[www.woodward.com/ic](http://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](mailto:icinfo@woodward.com)**

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



PO Box 1519, Fort Collins CO 80522-1519, USA  
1000 East Drake Road, Fort Collins CO 80525, USA  
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

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as well as authorized distributors and other authorized service and sales facilities throughout the world.**

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