



USER MANUAL

PRODUCT: DPG-2201-001

DYNA Programmable Governor for Isochronous Generators With Load Sharing Capability

GOVERNOR OVERVIEW

The DPG-2201-001 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 all governor features through the built-in user interface.

Separately programmable Proportional, Integral, and Derivative gains are provided for tailoring governor response to many engine applications.

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

Other adjustments include Acceleration and Deceleration Ramp Rates, Startup and Torque Limits, Idle Speed Set and Hold Time, and more.

This governor can also provide droop speed control with 100 user selectable droop levels.

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



Isochronous Speed Control

Load Sharing & Droop Operation

User Friendly/Operator Adjustable

.25% Precision Frequency Control

Superior Temperature Stability

Reverse Battery Protection

9 - 30 VDC Input Voltage Range

Smoke Control on Start Up

Remote Setup

Serial Communication Port

**Actuator
Compatibility:**

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

**Other Models
Available:**

- DPG-2100 Series – for Genset Applications
- DPG-2300 Series – for Off-road Vehicles
- DPG-2401 Series – for EFC Valve Applications
- DPG-2420 Series – for Pneumatic Actuators

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WARNING: Always disconnect power before making external connections to the control unit, to protect against electrical shock.



WARNING: As a safety measure, the engine should be equipped with an independent over speed shutdown device in the event of a failure that may render the governor inoperative.

NOTE: Barber-Colman DYNA Products believes that all information provided herein is correct and reliable but reserves the right to update at any time. Barber-Colman does not assume any responsibility for its use unless otherwise expressly undertaken.

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1 Governor Specifications

The governor's main electrical and mechanical specifications are listed here along with several performance characteristics.

1.1 Electrical

Operating Voltages:	9 VDC minimum to 30 VDC maximum
Maximum Controlled Output Current:	7 amps
Maximum Surge Current:	14 amps for ten seconds
Connections:	Terminal Strip with 13 terminals
Input Signal from the Magnetic Pickup:	2.0 VAC RMS minimum during cranking

1.2 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:	.75lbs, .34kilograms
Connection	13-terminal Euro-style connector
Mechanical Vibration	Suitable for mounting per SAE J1455; 1 to 500 Hz, 5G amplitude

1.3 Performance

Temperature Stability	0.007 Hz @ 70°C
Steady State Speed Band:	± .25% over Ambient Operating Temperature range
Engine Speed Measurement Range:	10 MPU Hertz to 14,000 MPU Hertz
Governing Speed Range:	500 MPU Hertz to 11,000 MPU Hertz
ILS Input Voltage Measurement Range:	2.4 VDC to 2.6 VDC
ILS Input Speed Adjust Range:	±3% around the set speed
Droop Adjustment Range:	0 to 10 percent of the set speed
Droop Setting Resolution:	Tenths of a percent

2 User Interface Operation

The user interface has two distinct behaviors that you should familiarize yourself with in order to select parameters and make adjustments to them. These behaviors are described in the Operating Modes section below.

A 4-pushbutton keypad and a 2-digit LED display make up the built-in user interface. The pushbuttons, also called keys, are described in the section named Keypad. The LED display is described in the section named LED Display.

Remote access to the governor's parameter settings is available when the governor's COMM port is connected to a computer running our Universal PST application. The DPG-2201-001 Technical Manual, available from the website www.dynaproducts.com, provides more information regarding the COMM Port and the Universal PST application.

2.1 Operating Modes

The user interface operates in two modes: PARAMETER SELECT MODE and PARAMETER EDIT MODE. For each of these modes, the keypad and the display have a unique way of operating.

The following table provides a quick reference to the behavior of the display and the function of each key when a particular operating mode is active.

PARAMETER SELECT MODE		PARAMETER EDIT MODE	
LED Display	The ID number of a parameter listed on the governor's label is blinking on and off	LED Display	The value of the selected parameter is displayed. A blinking decimal point means the value can be modified, otherwise the value is view only.
INC key	Increase the parameter ID number by one	INC key	Increase the selected parameter's value.
DEC key	Decrease the parameter ID number by one	DEC key	Decrease the selected parameter's value.
SELECT key	Activate PARAMETER EDIT MODE on the parameter whose number was blinking	SELECT key	Return to PARAMETER SELECT MODE and ignore changes made to the parameter's value
ENTER	Display the version number of the governor's programming	ENTER	Save the parameter's new value, and return to PARAMETER SELECT MODE
INC & DEC Simultaneously	Turn on all LED segments as a test	INC & DEC Simultaneously	Use to display the upper digits of values larger than 99

PARAMETER SELECT MODE is the mode used to *select* a parameter for viewing and editing. This mode is active when the 2-digit value being displayed is blinking. The value being displayed is a parameter's identification (ID) number. The controller's label lists each user-adjustable parameter and its corresponding ID number.

PARAMETER EDIT MODE is the mode that displays the *selected* parameter's value and allows the value to be modified. This mode is active when the 2-digit value being displayed is on and no longer blinking. The value being displayed is the selected parameter's current value. The display's decimal points have several different meanings while in PARAMETER EDIT MODE. These are described below.

- Decimal point blinking - the selected parameter's value can be modified.
- Decimal point not blinking - the selected parameter's value cannot be modified; parameter editing is locked and values can only be viewed. This is the case when password protection is active and the unlock code has not been entered. Read about the Password parameter in the Parameter Reference chapter for more information about using password protection.

- Right digit's decimal point is blinking or on - the lower two digits (the tens digit and the ones digit) of a parameter's 4-digit value are being displayed.
- Left digit's decimal point is on - the upper two digits (the thousands digit and the hundreds digit) of a parameter's 4-digit value are being displayed. The upper two digits of a parameter are always view only and can never be modified directly. The upper two digits change when the lower digits overflow (transition from 99 to 00) or underflow (transition from 00 to 99).

2.2 Keypad

The keypad consists of four pushbuttons named ENTER, SELECT, INC, and DEC.

The ENTER key

The ENTER key is used to exit PARAMETER EDIT MODE and return to PARAMETER SELECT MODE while saving the parameter's new value to nonvolatile memory. Nonvolatile memory is where parameter values are stored so that they are remembered even when the governor is not being powered. In PARAMETER SELECT MODE, pressing ENTER displays the version number of the governor's programming.

The SELECT key

The SELECT key is used to enter PARAMETER EDIT MODE from PARAMETER SELECT MODE once a particular parameter has been selected for editing.

The SELECT key is also used to escape from PARAMETER EDIT MODE and return to PARAMETER SELECT MODE without saving a change in a parameter's value. The value a parameter had when PARAMETER EDIT MODE was entered is restored.

The INC (increase) key

The INC key is used to increase the displayed value.

In PARAMETER SELECT MODE, each press of the INC key will cause the next higher parameter identification number to be displayed. When the maximum parameter identification number is reached, the next INC key press will cause the first parameter ID number to be displayed.

For example: If the controller's label lists 32 parameters, then pressing the INC key when the display is blinking the value 32 will cause the display to wrap around to the first parameter listed and begin blinking the value 01.

In PARAMETER EDIT MODE, each INC key press will increase a parameter's current value. If the INC key is held down, while in PARAMETER EDIT MODE, the value will automatically continue to be increased at gradually faster and faster rates until the INC key is released or the parameter's maximum allowed value is reached. When the lower two digits display a 99, pressing the INC (increase key) will cause the lower two digits to display a 00 and the hundreds digit will have been increased by 1.

The DEC (decrease) key

The DEC (decrease) key is used to decrease the displayed value.

In PARAMETER SELECT MODE, each press of the DEC key will cause the next lower parameter number to be displayed. When the first parameter identification number is reached, the next DEC key press will cause the last parameter ID number to be displayed.

For example: If the controller's label lists 32 parameters, then pressing the DEC key when the display is blinking the value 01 will cause the display to wrap around to the last parameter listed, which in this case is 32, and blink this new value.

In PARAMETER EDIT MODE, each DEC key press will decrease a parameter's current value. If the DEC key is held down, while in PARAMETER EDIT MODE, the value will automatically continue to be decreased at gradually faster and faster rates until the DEC key is released or the parameter's minimum allowed value is reached. When the lower two digits display a 00, pressing the DEC (decrease key) will cause the lower two digits to display a 99 and the hundreds digit will have been decreased by 1.

The INC and DEC keys

In PARAMETER EDIT MODE, the INC and DEC keys are used together to view the value of the upper two digits of a 4-digit number.

Press and hold both INC and DEC simultaneously to view the value of a 4-digit number's upper two digits; note that the left digit's decimal point is turned on to indicate that the thousands and the hundreds digits are being displayed.

Release INC and DEC and now the tens and the ones digits are again being displayed; note that the right digit's decimal point is blinking if editing is allowed or just on if editing is not allowed.

Note – not all parameters are 4-digit numbers, in which case the upper digits will always display 0.0 (zero dot zero).

In PARAMETER SELECT MODE, pressing both the INC and DEC keys at the same time will cause all LED segments to be turned on. This serves as an LED test. Release the keys to resume displaying the parameter ID number.

2.3 LED Display

The two 7-segment LED's along with each digit's corresponding decimal point are used to display values and indicate the operating mode of the user interface.

When the value being displayed by the two 7-segment LED's is blinking, PARAMETER SELECT MODE is active.

When the value being displayed is not blinking, the selected parameter's value is being displayed and the user interface is in PARAMETER EDIT MODE. The decimal points further indicate which half of a 4-digit value is being displayed and whether editing is allowed.

The right digit's decimal point is used to indicate that the lower 2 digits of a value (the tens and the ones digits) are being displayed. When the right decimal point is blinking, it means that the value can be modified using the INC key or the DEC key. Not blinking means that editing is not allowed or password protected.

The left digit's decimal point is used to indicate that the upper 2 digits of a value (the thousands and the hundreds digits) are being displayed. The upper 2 digits are always view only so the right decimal point does not blink. Changes to the upper digits occur when a parameter's lower digits overflow or underflow during editing.

An overflow occurs when the value 99 is being displayed and the INC key is pressed (assuming this is not the parameter's maximum value). This will cause the displayed value to become 00 while the non-displayed value in the parameter's upper 2 digits will be increased by one. You can verify this by pressing both INC and DEC at the same time to view the new value in the upper digits. For example: If the full 4-digit value of the parameter you are editing is currently 1099, then after pressing the INC key the parameter's new value will be 1100.

An underflow occurs when the value 00 is being displayed and the DEC key is pressed (assuming this is not the parameter's minimum value). This will cause the displayed value to become 99 while the non-displayed value in the

parameter's upper 2 digits will be decreased by one. You can verify this by pressing both INC and DEC at the same time to view the new value in the upper digits. For example: If the full 4-digit value of the parameter you are editing is currently 1800, then after pressing the DEC key the parameter's new value will be 1799.

When values exceeding 9,999 are to be displayed, the controller uses the hexadecimal numbering system to represent the value of the thousands position.

Example 1: The desired set speed is 10,069 Hertz. The upper two digits displayed by the controller will be [A.0], and the lower 2 digits displayed will be [69.].

Example 2: The desired set speed is 10,972 Hertz. The upper two digits displayed by the controller will be [A.9] and the lower 2 digits displayed will be [72.].

Decimal Value	Hexadecimal Equivalent
10	A
11	B
12	C
13	D
14	E
15	F

3 Parameter Reference

This chapter provides information regarding each parameter's function. It contains 32 subsections. Each subsection provides information about a single parameter.

Subsection numbering corresponds to the parameter numbering on the governor's label to make it easier to locate information about the parameter of interest. For example: Parameter 5. PROPORTIONAL is described in subsection 3.5 (chapter 3 subsection 5).

The table to the right lists each of the parameters and their default, minimum, and maximum values.

Note that several of the parameters have minimum and maximum values set by other parameters.

Note also that all *Speed* and *Rate* values are shown as magnetic pick-up Hertz values (parameters 2-4, 14-16, 26-31). Changing the # of Flywheel Teeth will cause different default values to be displayed based on the Hertz to RPM formula described in subsection 3.1 below.

Parameter Name	Default	Minimum	Maximum
1. # of Flywheel Teeth	0	0	572
2. <i>Set Speed A</i>	1000	<i>Set Speed A Min</i>	<i>Set Speed A Max</i>
3. Set Speed B	1000	Set Speed B Min	Set Speed B Max
4. Idle Speed	500	Idle Speed Min	Idle Speed Max
5. <i>Proportional</i>	25	1	99
6. <i>Integral</i>	50	0	99
7. <i>Derivative</i>	25	0	99
8. <i>OVG @ Set Speed A</i>	20	1	99
9. OVG @ Set Speed B	20	1	99
10. OVG @ Idle Speed	20	1	99
11. <i>Gain Factor</i>	20	1	99
12. <i>Speed Filter</i>	16	1	24
13. Idle Hold Time	0	0	9999
14. Accel Rate	1000	1	11000
15. Decel Rate	1000	1	11000
16. Startup Rate	1000	1	11000
17. Startup Limit	1000	0	1000
18. Torque Limit	1000	0	1000
19. Integral Low Limit	0	0	Integral High Limit
20. Integral High Limit	99	Integral Low Limit	99
21. % Droop	0	0	100
22. No Load Cal	0	0	1000
23. Full Load Cal	1000	0	1000
24. Password	0	0	99
25. Overspeed Limit	100	0	100
26. Set Speed A Min	10	10	Set Speed A
27. Set Speed A Max	11000	Set Speed A	11000
28. Set Speed B Min	10	10	Set Speed A
29. Set Speed B Max	11000	Set Speed B	11000
30. Idle Speed Min	10	10	Idle Speed
31. Idle Speed Max	11000	Idle Speed	11000
32. Duty Cycle Max	95	10	95

Parameters 2, 5, 6, 7, 8, 11, and 12 require adjustment, while adjustments to the other parameters are optional.

3.1 # of Flywheel Teeth *(optional)*

This parameter provides the conversion factor needed by the governor to display speeds as RPM values instead of Hertz values. Adjusting this parameter is optional. To use this parameter correctly, you must know the exact number of flywheel teeth that pass by the magnetic pickup in one revolution of the engine.

The default value of 0 disables Hz to RPM conversions so all set speeds are displayed in MPU (magnetic pick-up) Hertz. Setting this parameter to a value other than zero enables Hz to RPM conversion.

Adjust this parameter to a value equal to the exact number of pulses that the MPU delivers to the governor in one revolution of the engine to display set speeds in RPM. The formula used to convert the magnetic pickup signal from a Hertz value to a RPM value is:

$\frac{[(MpuHertz) \times (60s)]}{[NumberOfTeeth]} = [EngineRPM]$	<p>For example:</p> $\frac{[(3960Hz) \times (60s)]}{[132Teeth]} = [1800RPM]$
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The following derivation of the above formula can be used to convert from RPM to Hertz.

$$\frac{[(EngineRPM) \times (NumberOfTeeth)]}{[60s]} = [MpuHertz]$$

3.2 Set Speed A *(required)*

SET SPEED A is the governor's target speed when the SPEED SEL input (terminal 8) is open and the startup sequence has completed. The startup sequence is complete when the target speed and the engine speed reach the set speed.

When a two-position switch is connected between SPEED SEL and +5VDC OUT (terminal 13) then an open switch selects SET SPEED A as the governor's target speed. If the governor's SPEED SEL input is not used then SET SPEED A is automatically the active target speed after the startup sequence is completed.

The default value for SET SPEED A is 1000 MPU Hertz. SET SPEED A's adjustable range extends from SET SPEED A MIN (parameter 26) to SET SPEED A MAX (parameter 27).

When SET SPEED A values greater than 9999 are displayed, the left most digit uses the capital letter A to represent 10000 and uses the lower case letter b to represent 11000.

For example: If SET SPEED A is set to 10750, then the upper 2 digits will be displayed by the controller as [A.7] and the lower 2 digits will display [50.]

NOTE: If # of Flywheel Teeth is used then Set Speed A will be displayed as RPM.

3.3 Set Speed B (optional)

SET SPEED B becomes the governor's target speed when the SPEED SEL input (terminal 8) is at 5 volts potential and the startup sequence is complete. See the chapter Installation Instructions for details about wiring in a switch between SPEED SEL and +5VDC OUT (terminal 13) in order to use SET SPEED B.

When a two-position switch is connected between SPEED SEL and +5VDC OUT then a closed switch selects SET SPEED B as the governor's target speed.

The default value for SET SPEED B is 1000 MPU Hertz. SET SPEED B's adjustable range extends from SET SPEED B MIN (parameter 28) to SET SPEED B MAX (parameter 29).

When SET SPEED B values greater than 9999 are displayed, the left most digit uses the capital letter A to represent 10000 and uses the lower case letter b to represent 11000.

For example: If SET SPEED B is set to 11000, then the upper 2 digits will be displayed by the controller as [b.0] and the lower 2 digits will display [00.]

NOTE: If the # of Flywheel Teeth parameter is used then Set Speed B will be displayed as RPM.

3.4 Idle Speed (optional)

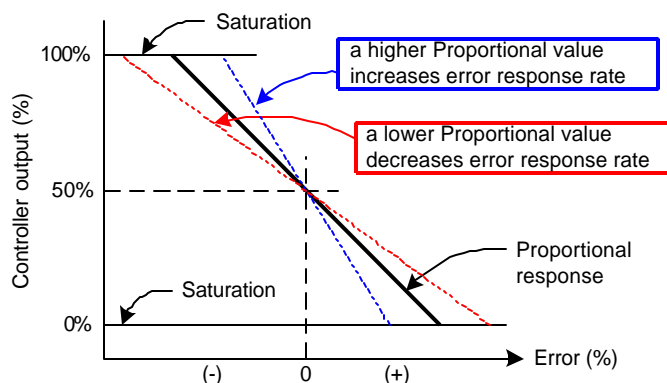
IDLE SPEED is the governor's target speed for the IDLE HOLD TIME (parameter 13) when the engine is started. When the idle hold timer reaches zero, the target speed will become either SET SPEED A or SET SPEED B depending on the state of the SPEED SEL input terminal.

The default value for IDLE SPEED is 500 MPU Hertz. The IDLE SPEED can be set to any value between IDLE SPEED MIN (parameter 30) and IDLE SPEED MAX (parameter 31).

NOTE: If the # of Flywheel Teeth parameter is used then Idle Speed will be displayed as RPM.

3.5 Proportional (required)

The proportional term is one of the interrelated PID terms that determine how well a DPG-2000 series 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 governor output produced for a specific amount of speed error.

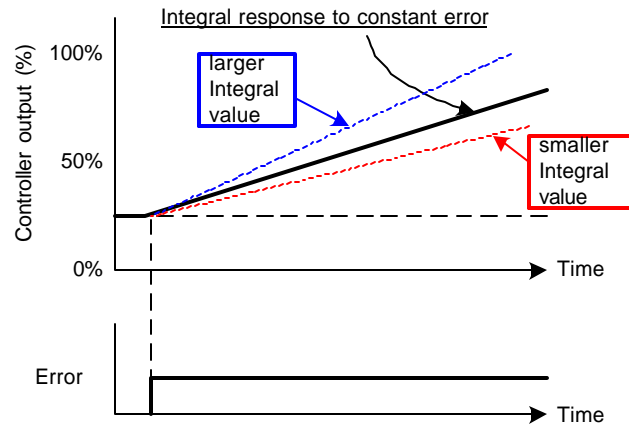


Each error value produces a unique controller output value

3.6 Integral (required)

The integral term is one of the interrelated PID terms that determine how well a DPG-2000 series controller governs the engine's speed. The integral gain sets how fast the governor's output changes in response to how long a speed error exists. In other words: 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 operates to drive this error to zero. The integral gain changes the rate at which the error is driven to zero.

Integral is needed to eliminate speed offsets due to proportional gain and should never be left at zero. A zero value is allowed but should only be used as a test when seeking to find the best proportional and derivative values.

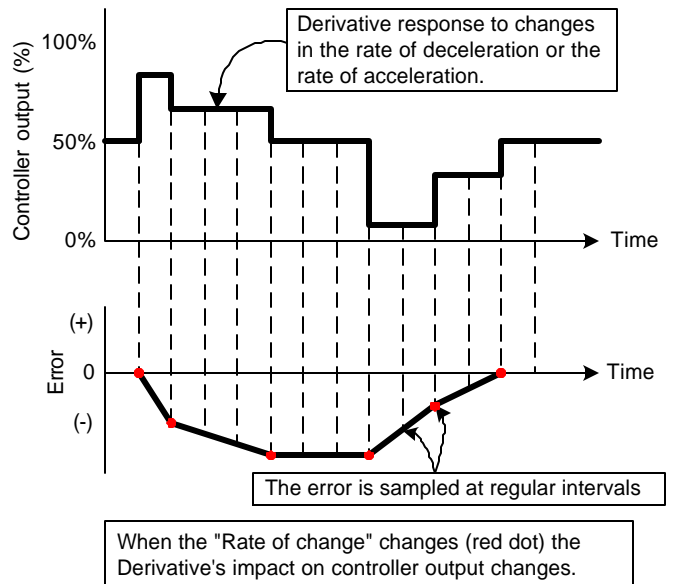


3.7 Derivative (required)

The derivative term is one of the interrelated PID terms that determine how well a DPG-2000 series 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. A critically damped tuning will always require some derivative. A zero value is allowed but should only be used as a test when seeking to find the best proportional and integral values.

3.8 OVG @ Set Speed A (required)

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



3.9 OVG @ Set Speed B (optional)

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

3.10 OVG @ 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 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 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 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 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 engine 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.

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.

$$[(\text{\#_of_flywheel_teeth}) / (\text{\#_of_engine_cylinders})] * 0.75 = \text{speed_filter_value}$$

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 1 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 MPU (magnetic pickup) Hz 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 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.

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

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

3.15 Decel Rate (optional)

The Decel Rate specifies how fast the governor should decrease the engine's speed when a new lower target speed is made active. The parameter value is specified in MPU (magnetic pickup) 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 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 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 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.

$$[(\text{final_target_speed_in_Hertz}) - (\text{crank_speed_in_Hertz})] / (\text{ramp_time_in_seconds}) = \text{startup_rate_value}$$

The governor increases the engine speed from the engine's crank speed to the active target speed at the rate specified. The governor will bring the engine to the Idle Speed for the Idle Hold Time then continue increasing the engine speed at this same ramp rate until the engine reaches the selected target speed (Set Speed A or Set Speed B).

Exception 1 – In cases where the target speed is less than the Idle Speed and the Idle Hold Time is nonzero, the startup ramp sequence ends when the Idle Speed is reached. Then the Decel Rate is used to ramp the engine speed down to the target speed from the Idle Speed.

The ramp up will pause at 1000 MPU Hz until the governor senses an MPU signal greater than 1000 Hertz. This prevents the startup ramp from reaching completion before the engine has even started. The governor considers MPU frequencies below 1000 Hertz as indicating that the engine is cranking but has not yet started. MPU frequencies above 1000 Hertz 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 2 – In cases where the target speed is less than 1000 Hertz, the startup ramp sequence ends when the target speed is reached.

NOTE:

When the # 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 Startup Limit *(optional)*

The startup limit parameter is used to limit the fuel supplied to the engine during startup. The default value of 1000 means that the actuator drive signal is allowed to use 100.0% of available current. Decreasing the value limits the available drive signal thereby limiting how far open the actuator can go. Increasing the value allows the actuator to open further.

The value assigned to the startup limit parameter is in units of 1 tenth of a percent of the actuator's maximum current feedback reading. The governor measures actuator drive signal feedback to obtain an approximation of the amperes of current flowing through the actuator. Fuel limiting is achieved by setting the maximum level of electrical current allowed to flow through the actuator during engine startup. This feature is useful in reducing smoke when starting diesel engines.

Note – If the value is set too low the engine may not start.

3.18 Torque Limit *(optional)*

The torque limit parameter is used to limit the fuel supplied to the engine during heavy generator loads or generator overloads. The default value of 1000 means that the actuator drive signal is allowed to use 100.0% of available current. Decreasing the value limits the available drive signal thereby limiting how far open the actuator can go. Increasing the value allows the actuator to open further.

The value assigned to the torque limit parameter is in units of 1 tenth of a percent of the actuator's maximum current feedback reading. The governor measures actuator drive signal feedback to obtain an approximation of the amperes of current flowing through the actuator. Fuel limiting is achieved by setting the maximum level of electrical current allowed to flow through the actuator during normal operation.

Note – If the value is set too low the engine will not be able to carry its rated load.

3.19 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 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, improper use can prevent the governor from ever reaching the target speed. The first line of defense in reducing over speed or under speed errors is a well-tuned governor via the PID terms.

3.20 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 over speed duration after a long or sustained under speed condition was present. The high limit helps reduce the duration and amount of engine over speed 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). So 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, improper use can prevent the governor from ever reaching the target speed. The first line of defense in reducing over speed or under speed errors is a well-tuned governor via the PID terms.

3.21 Percent Droop *(optional)*

The percent droop parameter is used to select droop mode operation and specify the percentage of droop required. When the percent droop parameter is set to zero (the default setting) then droop mode is not active. Droop mode is active when this parameter is set to any value from 1 to 100 which corresponds to 0.1% to 10.0% droop.

The following formula determines the no load droop speed.

$$[(\text{selected_set_speed}) / ((1000 - \text{value_of_}\% _ \text{DROOP}) / 1000)] = \text{no_load_droop_speed}$$

For example: If 5% droop is desired, set the percent droop value to 50. Now if the selected set speed is 1800 RPM then the no load droop speed will be:

$$[(1800\text{RPM}) / ((1000 - 50) / 1000)] = 1800\text{RPM} / 0.95 = 1895\text{RPM}$$

NOTE: This parameter can only be modified during the Droop Calibration Procedure. See the Calibration Instructions chapter for more information.

Droop mode relies on knowing the actuator position. The actuator’s position corresponds to the amount of fuel being delivered to the engine. The DPG-2201-001 controller senses electrical current flow through the actuator to determine its position. This method of position sensing does not work with all actuators.

3.22 No Load Calibration *(optional)*

The No Load Calibration value is learned during the Droop Calibration Procedure and should not be set manually. Once calibrated, the no load calibration value indicates the percentage of electrical current, relative to the measurable maximum, that must flow through the actuator to run the engine at the no load droop speed.

The factory default value is zero, so if droop mode is to be used, this parameter must be calibrated. The no load calibration value must be less than then the full load calibration value for proper droop operation. If after performing the Droop Calibration Procedure the no load calibration value is greater than the full load calibration then the droop function can not be used. Some actuators may have a current verses position curve that is incompatible with this controller’s method of determining actuator position.

NOTE: This parameter is only modified during the Droop Calibration Procedure. See the Calibration Instructions chapter for more information.

3.23 Full Load Calibration *(optional)*

The Full Load Calibration value is learned during the droop calibration procedure and should not be set manually. Once calibrated, the full load calibration value indicates the percentage of electrical current, relative to the measurable maximum, that must flow through the actuator to run the engine at the selected set speed when a full load is being applied to the generator.

The factory default value is 1000, so if droop mode is to be used, this parameter must be calibrated. The full load calibration value must be greater than the no load calibration value for proper droop operation. If after performing the Droop Calibration Procedure the full load calibration value is less than the no load calibration value then the droop function can not be used. Some actuators may have a current verses position curve that is incompatible with this controller's method of determining actuator position.

NOTE: This parameter is only modified during the Droop Calibration Procedure. See the Calibration Instructions chapter for more information.

3.24 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.

3.25 Over Speed 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 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 $[(1 + (\text{overspeed_limit_value}/100)) * (\text{highest_set_speed})]$.

NOTE: The governor must be turned off to clear the over speed detection before the engine can be re-started.

NOTE:

When the # 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.

3.26 Set Speed A Min *(optional)*

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

3.27 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 (or its RPM equivalent).

3.28 Set Speed B Min *(optional)*

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 bordered by 10 Hertz (or its RPM equivalent) and the current value of Set Speed B.

3.29 Set Speed B Max *(optional)*

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 setting and 11,000 Hertz (or its RPM equivalent).

3.30 Idle Speed Min *(optional)*

This parameter sets the minimum value that the Idle Speed parameter is allowed to have. This parameter can be set to any value within the range bordered by current Idle Speed setting and 11,000 Hertz (or its RPM equivalent).

3.31 Idle Speed Max *(optional)*

This parameter sets the maximum value allowed for Set Speed A Max, Set Speed B Max, and Idle Speed.

3.32 DutyCycle Maximum *(optional)*

The DutyCycle 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 dutycycle or ontime allowed during one cycle of the PWM (pulse-width-modulation) signal controlling the actuator drive circuit. The value assigned to the dutycycle limit parameter is a percentage, and is limited to values in the range 10% to 95%. The default value is 95%.

4 Universal PST (Parameter Setup Tool)

The Universal PST is a Microsoft® Windows® application available from Barber-Colman DYNA Products that enables you to adjust parameter settings and monitor governor operation when a PC is connected to the governor through the built-in COMM port.

4.1 *Universal PST Features*

Universal PST for DPG 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

4.2 *Universal PST Requirements*

The program requires an Intel Pentium class machine running Microsoft® Windows® 98se, NT4, 2000, or XP. The display resolution needs to be set to SVGA (800x600) or higher. The Universal PST program is not supported on Microsoft® Windows® 95. The program may work on Microsoft® Windows® ME (Millennium Edition), but this has not been tested.

4.3 *Acquiring Universal PST*

The Universal PST application is available to you at no additional cost for use with any COMM port equipped DPG.

Downloading software via the internet

The files *ReadMeFirst.txt* and *Universal_PST.zip* are available for download on the software download page at the www.dynaproducts.com website.

Requesting the Universal PST on CD-ROM

Contact the Barber-Colman DYNA Products sales department to request a CD-ROM copy of Universal PST. Telephone: (815) 637-3000

4.4 *Wiring the COMM Port to a PC*

Wiring instructions are described in document number DYNA 316 available from the software download page at www.dynaproducts.com

5 Calibration Instructions

5.1 Basic Adjustments

The controller is programmed at the factory with default parameter settings. These settings allow the controller to operate but will 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 make adjustments to the parameters shown in the table.

The parameters listed in the table are the primary ones to modify to get the governor tuned and the engine running smooth. 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.

ID#	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

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

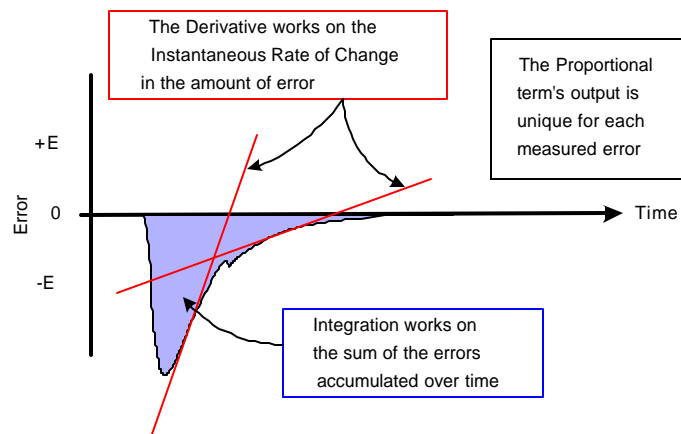
Note 2: For the Speed Filter, typically the value 24 works well on small 3 or 4 cylinder engines. A value of 16 is recommended for 6 or 8 cylinder engines.

5.2 Tuning Methodology

Once the engine is running, the following procedure may be used to discover more optimum values for PID and the overall gain (OVG) parameters. 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.

Step:

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 2Hz.
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. So during steps 3-5 you should temporarily increase the integral to get the engine speed back to the set speed, 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.

5.3 Droop Calibration Procedure

To use Droop, a calibration sequence <i>must</i> be done first. The calibration sequence is as follows.	
Step 1	Make sure the engine is running at the selected set speed and the governor is tuned.
Step 2	Enter a value of 41 into the Password parameter (#24) to allow editing of the droop related parameters.
Step 3	Select the “% DROOP” parameter (#21) and adjust its value while the engine is running with no load applied. The engine speed will increase to: [(selected_set_speed) / ((1000 – value_of_%_DROOP) / 1000)].
Step 4	Allow the engine to stabilize at the <i>no load</i> droop speed then press the controller’s ENTER key to set the percent droop. No Load Calibration is now complete.
Step 5	Select the “FULL LOAD CAL” parameter (#23). The engine speed will return to the selected set speed.
Step 6	Now apply full load to the engine and allow the speed to stabilize. Assumes the governor was previously tuned.
Step 7	Wait 5 seconds then press the controller’s ENTER key to record the calibration value. Full Load Calibration is now complete.
Step 8	Remove the load from the engine. The engine speed will increase to the <i>no load</i> droop speed. Droop Calibration is complete.

After droop calibration, the difference between the No Load Cal and Full Load Cal parameter value should be greater than 100 for best operation of droop. The droop function may still work for smaller differences but with less accuracy. You may be able to get some improvement by modifying or adjusting actuator linkage or adding springs. The goal is to achieve a wider range of measured current change through the actuator from no load to full load.

If the calibrated range is too small then droop may not work at all. The actuator position sensing method used by this controller does not work with all actuators. A different actuator may be required or a different system solution altogether may be needed by your application, such as an actuator with a position feedback potentiometer and a supporting controller.

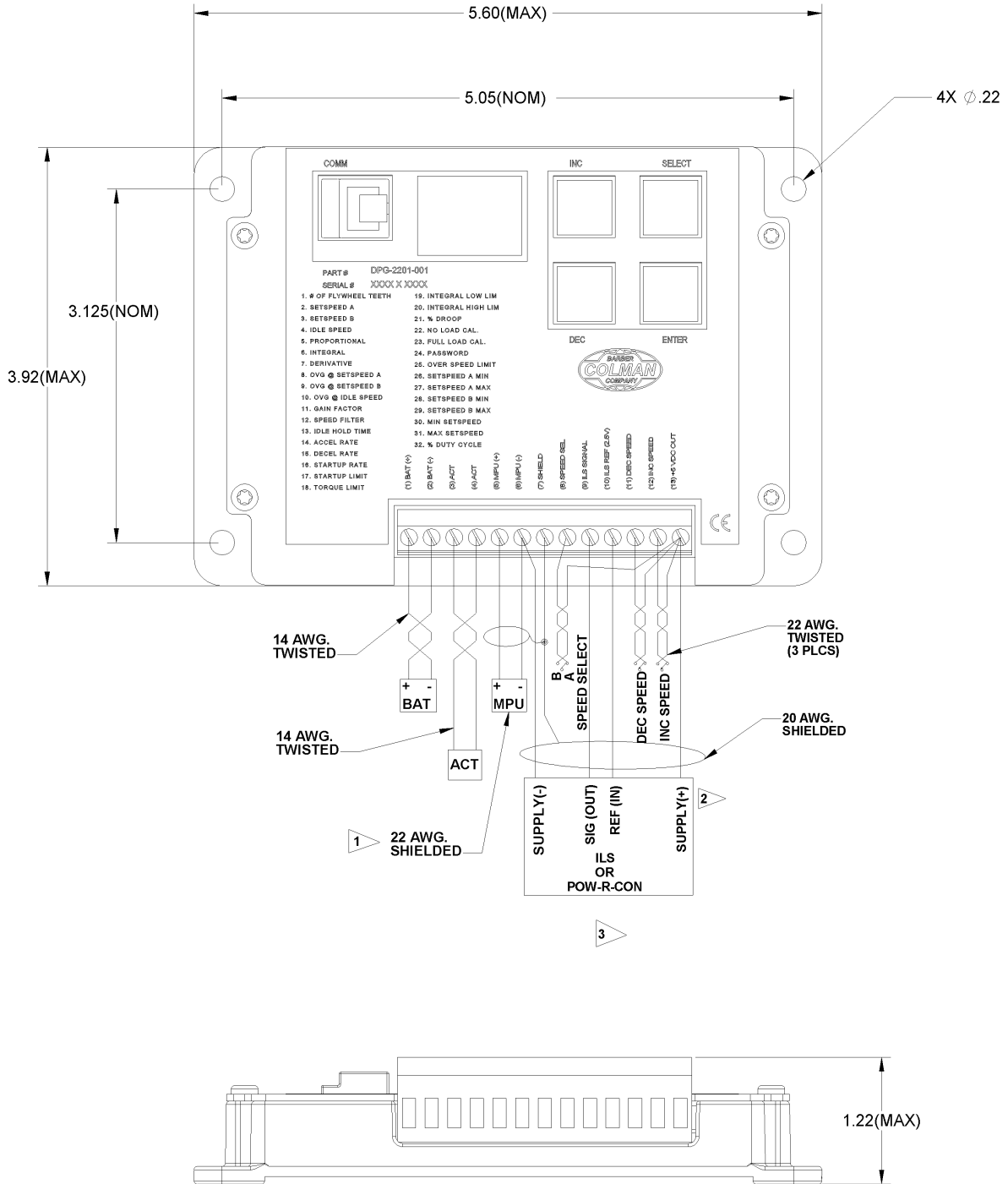
6 Installation Instructions

6.1 Terminal Descriptions

#	Name	Function
1	BAT+	Battery positive (Supply voltage range is 9VDC-30VDC)
2	BAT-	Battery negative
3	ACT	Actuator Drive output
4	ACT	Actuator Drive return
5	MPU+	Magnetic Pickup Signal Inputs
6	MPU-	Magnetic Pickup ground
7	SHIELD	Ground connection for cable shielding
8	SPEED SEL	Digital Input used to select the target set speed
9	ILS SIGNAL	ILS input used to adjust speed +/- 3%
10	ILS REF (2.5V)	Supply voltage around which ILS operates
11	DEC SPEED	Digital Input used to decrease the selected set speed remotely
12	INC SPEED	Digital Input used to increase the selected set speed remotely
13	+5VDC OUT	Supply voltage for the digital inputs

6.2 Wiring Diagram

For Terminal Descriptions, see the table on the previous page.



7 Diagnostics & Troubleshooting

7.1 Display Codes

Code	Meaning
E0	Controller memory failure. Replace controller.
E1	Loss of remote speed potentiometer signal (applies only to DPG-2302-001s and DPG-2401-001s).
E2	Overspeed detected. Controller must be turned off to reset the controller to allow an engine restart.
E3	Actuator drive overcurrent detected. Check wiring. Check actuator loading.

7.2 Troubleshooting Table

SYMPTOM	REMEDY
LED Display Does Not Light Up When Governor Is Powered	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> The parameter's value is at the maximum value allowed. The parameter's value is at the minimum value allowed. A display code is active. Refer to the Display Codes section above Password protection is enabled. Enter Password Keypad Failure, replace unit.
Engine Does Not Start	<ul style="list-style-type: none"> 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 2.0VRMS 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.
Engine Over Speeds at Startup	<ul style="list-style-type: none"> Increase the Proportional value. Increase the appropriate OVG (overall gain) value. Use the Startup Limit. Decrease the Startup Ramp Rate.
Engine Does Not Reach the Set Speed	<ul style="list-style-type: none"> Improve PID tuning. Integral too low or zero Derivative 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. 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 which creates 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.

Troubleshooting Table continued

SYMPTOM	REMEDY
Engine takes too long to reach the set speed.	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Is the LED decimal point blinking? If not enter password. • Is the selected set speed parameter being modified? • A PID value or an OVG value is too high. • A PID value is too low or zero. • Accel Rate is set too low. • Decel Rate is set too low.
Excessive Smoke at Startup	<ul style="list-style-type: none"> • Improve PID tuning. • Use a lower Startup Rate setting. • Use a lower Startup Limit setting. • Low MPU signal voltage. It should read 2.0VRMS minimum.
Sluggish Response to load changes	<ul style="list-style-type: none"> • Gain too low. • Improve PID tuning. • Speed Filter setting is too high.
Engine Instability With No-load	<ul style="list-style-type: none"> • Improve PID tuning. • Speed Filter setting is too low. • Fuel is restricted. Check actuator linkage. • Battery voltage is too low.
Engine Instability With Load	<ul style="list-style-type: none"> • Improve PID tuning. • Fuel is restricted. Check actuator linkage. • Battery voltage is too low.
Engine Unable to Carry Rated Load	<ul style="list-style-type: none"> • PID values may be too high causing the governor to over react and make large rapid changes in PWM duty cycle output to the actuator. • Improve PID tuning. • Torque Limit is set too low. Increase the Torque limit. • Fuel is restricted. Check actuator linkage.
Load Sharing Does Not Work	<ul style="list-style-type: none"> • Measure the ILS input signal to see if the measurement is between 2.375 and 2.625 volts DC. • Use shielded wiring • If the application requires more than $\pm 3\%$ of speed change around the set speed then use a DPG-2401-001 controller instead.
Droop Does Not Work	<ul style="list-style-type: none"> • The No Load and Full Load values are not calibrated. Perform the Droop Calibration Procedure. • Difference between No Load and Full Load calibration values is too small. Should be > 100 for best performance. • Modify or adjust actuator linkage to increase range of actuator loading. • If finer droop control is required, then use a DPG-2401-001 controller instead.

DPG-2201-001 INSTALLATION RECORD & PARAMETER QUICK REFERENCE

Customer: _____ Phone #: _____
 Distributor: _____ Phone #: _____
 Installation Site: _____ Installation Date: _____
 Engine Information: _____ Actuator Model #: _____
 # of Cylinders: _____ Fuel Type: _____ Actuator Serial #: _____
 Magnetic Pickup: _____ DPG-2201-001 Serial #: _____
 DPG-2201-001 Software Version: _____

NOTES: _____

Record an installation's DPG-2201-001 Setup Information in the User Setting column of the following table.

ID#	PARAMETER NAME – parameter definition	Default Value	User Setting
1.	# OF FLYWHEEL TEETH - is a factor used to display speed as RPM instead of MPU Hertz values.	0	
2.	SET SPEED A - is the governor's target speed when the controller's SPEED SEL terminal is open.	1000	
3.	SET SPEED B - is the governor's target speed when the SPEED SEL terminal is at 5 volts DC.	1000	
4.	IDLE SPEED - is the governor's target speed for the IDLE HOLD TIME when the engine first starts. If the value of the IDLE HOLD TIME parameter is zero the IDLE SPEED is not used.	500	
5.	PROPORTIONAL - is the gain applied to the speed error.	25	
6.	INTEGRAL - is the gain on the reset time and is used to eliminate the speed offset due to proportional gain.	50	
7.	DERIVATIVE - is the gain on the response to the rate of speed change.	25	
8.	OVG @ SET SPEED A - is a multiplier used on the three PID terms when Set Speed A is the target speed.	20	
9.	OVG @ SET SPEED B - is a multiplier used on the three PID terms above when Set Speed B is the target.	20	
10.	OVG @ IDLE SPEED - is a multiplier used on the three PID terms above when Idle Speed is the target.	20	
11.	GAIN FACTOR - is a multiplier applied to the PID terms that can be used to give those terms more range.	20	
12.	SPEED FILTER - is the number of flywheel teeth to use when computing an average engine speed.	16	
13.	IDLE HOLD TIME - is the period of time that the engine will remain at the Idle Speed during the startup sequence before ramping to either Set Speed A or Set Speed B.	0	
14.	ACCEL RATE - is the rate, in MPU Hertz (or RPM) per second, used to ramp to a new higher target speed.	1000	
15.	DECEL RATE - is the rate, in MPU Hertz (or RPM) per second, used to ramp to a new lower target speed.	1000	
16.	STARTUP RATE - is the rate in MPU Hertz (or RPM) per second at which the governor will ramp to the selected target speed when the engine is started. Useful in limiting smoke at engine startup.	1000	
17.	STARTUP LIMIT - is the maximum actuator current output allowed when starting the engine. Resolution is 0.1%, so a value of 1000 means 100%. Use to limit smoke at engine startup.	1000	
18.	TORQUE LIMIT - is the maximum actuator current output allowed during heavy generator load. The resolution is 0.1%, so a value of 1000 means 100%.	1000	
19.	INTEGRAL LOW LIM - is the duty cycle percentage where integration stops when the governor is trying to decrease engine speed. It limits integral wind-down. Use with caution.	0	
20.	INTEGRAL HIGH LIM - is the duty cycle percentage used to limit integral windup when the governor is trying to increase engine speed. Use with caution.	99	
21.	% DROOP - is the percentage of droop desired adjustable in steps of 0.1%. This means that a value of 99 represents 9.9% droop. The Droop Calibration Procedure must be used to modify this parameter.	0	
22.	NO LOAD CAL - is the calibrated actuator current needed to maintain the unloaded droop speed. This parameter is set automatically during the Droop Calibration Procedure. The resolution is 0.1%.	0	
23.	FULL LOAD CAL - is the calibrated actuator current needed to maintain the selected target speed when the engine is fully loaded. This parameter is set automatically during the Droop Calibration Procedure.	1000	
24.	PASSWORD - is a key used to lock or unlock the capability to modify the parameter values. It is also used to activate the droop calibration procedure.	0	
25.	OVERSPEED LIMIT - is the percent over the higher of Set Speed A or Set Speed B that will cause the governor to output the minimum signal to the actuator.	100	
26.	SET SPEED A MIN - sets the lowest value allowed for Set Speed A's adjustable range.	10	
27.	SET SPEED A MAX - sets the highest value allowed for Set Speed A's adjustable range.	11000	
28.	SET SPEED B MIN - sets the lowest value allowed for Set Speed B's adjustable range.	10	
29.	SET SPEED B MAX - sets the highest value allowed for Set Speed B's adjustable range.	11000	
30.	IDLE SPEED MIN - is the lowest value allowed for the Idle Speed parameter.	10	
31.	IDLE SPEED MAX - is the highest value allowed for the Idle Speed parameter.	11000	
32.	DUTYCYCLE MAX - sets the absolute maximum amount of drive signal that can be output to the actuator and thus serves as a mechanism for fuel limiting. Adjustable in 1% steps.	95	