

EDG6000

Electronic Digital Governor

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www.governors-america.com

1 INTRODUCTION

GAC's EDG6000 digital governor is designed to regulate engine speed on diesel and gaseous fueled engines. When paired with a GAC actuator the EDG is a suitable upgrade for any mechanical governor system that needs flexibility, precision, or accurate control of governed speed.

The EDG is designed for industrial engine applications from generator sets, and mechanical drives, to pumps or compressors.

- Wide operating temperature range
- Immune to analog drift
- IP67 sealed case and connector
- RS-232 and SAE J1939 (CAN) communications
- Multiple PID control for full tuning of operation range
- 4 selectable speeds: 3 fixed speeds with idle, 1 variable speed
- Includes standard GAC AUX input for synchronizing and load sharing
- User tamper-resistant; no external adjustable pots or switches



Computer



Internet Connection
www.governors-america.com



GAC SmartVU Software

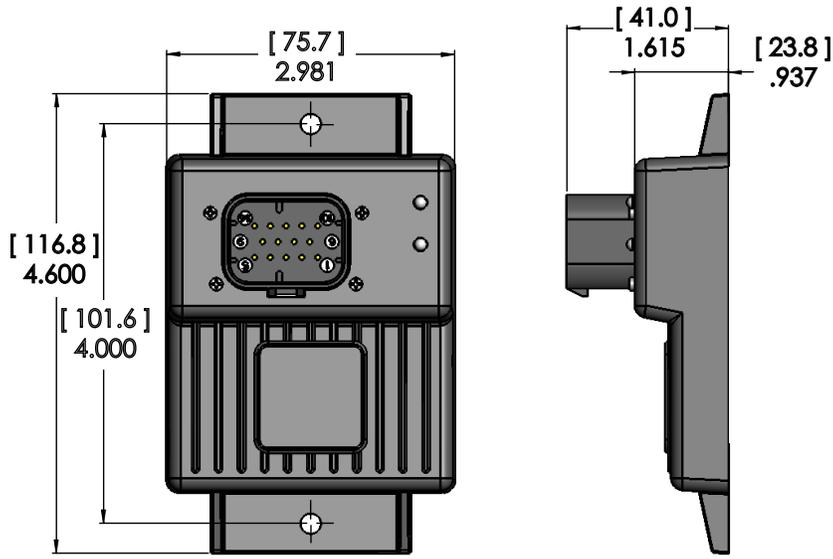
A computer with an internet connection and USB or serial ports is required to download and run GAC's SmartVU software.

2 SPECIFICATIONS

PERFORMANCE	
Isochronous Operation	± 0.25 %
Speed Range / Governor	400 - 10 KHz
Idle Adjust	Full Range
Droop Range	1 - 5 % regulation
Speed Trim	Programmable 0-100 %, (default = 5 %)
INPUT / OUTPUT	
Supply	12-24 V DC Battery Systems (6.5 to 33 V DC)
Polarity	Negative Ground (Case Isolated)
Power Consumption	70 mA MAX Continuous Plus Actuator Current
Speed Sensor Signal	1.0 -120 V RMS
Actuator	MAX 6 A Continuous
Load Share / Synchronizer Input	0 - 10 V DC (5 V nominal, reversed, 107 Hz / V MAX)
Reverse Power Protection	Yes
Transient Voltage Protection	60 V
Overspeed	Rated to 2 A DC

ENVIRONMENTAL	
Ambient Temperature	-40 to 85 °C [-40 to 180 °F]
Relative Humidity	up to 95 %
All Surface Finishes	Fungus Proof and Corrosion Resistant
RELIABILITY	
Vibration	7 g, 20 - 100 Hz
Shock	20 g Peak
Testing	100 % Functional Testing
COMPLIANCE / STANDARDS	
Agency	CE and RoHS Requirements
Communications	RS-232-C, SAE J1939
PHYSICAL	
Dimension	See Section 3, Installation
Weight	6 ozf (170 gf)
Mounting	Any position, Vertical Preferred

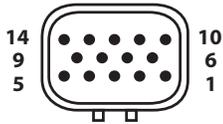
3 INSTALLATION



Dimensions: [mm] in

-   Vertical orientation allows for the draining of fluids in moist environments.
-   Mount in a cabinet, engine enclosure, or sealed metal box.
-  Avoid Extreme Heat

4 WIRING



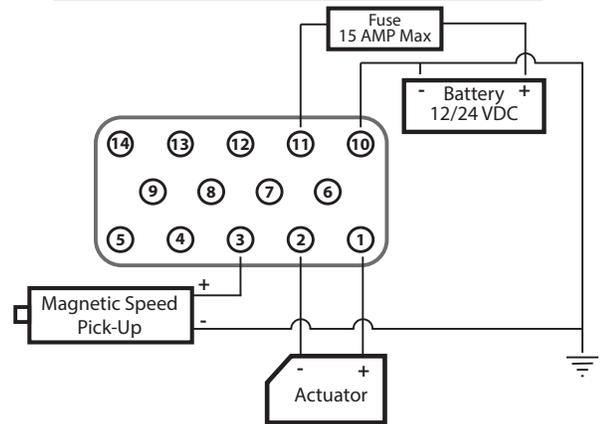
14 pin AMPSEAL requires GAC mating connector EC1502 or cable harness CH1520

PIN	DEFINITION	WIRE	NOTES
1	Actuator (+)	16 AWG	Polarity not required for actuator
2	Actuator (-)	16 AWG	
3	Magnetic Pickup (+)	20 AWG	* Ground to Pin 10
4	Aux Input	20 AWG	* 0 - 10 V DC Range, 5 V DC Nominal, Reverse Polarity
5	Speed Select A	20 AWG	* Ground to Enable
6	Speed Select B	20 AWG	* Ground to Enable
7	RS-232 Enable	20 AWG	* Connect to ground to enable RS-232
8	Overspeed Output	16 AWG	* 2 A MAX
9	Variable Speed Input	20 AWG	* 5 K Ω Resistive or 0 - 5 V DC selectable in software
10	Ground / Battery Pwr (-) / Magnetic Pickup (-)	16 AWG	Battery Twisted Pair to Magnetic Speed Pickup
11	Battery Power (+)	16 AWG	A 15 amp fuse must be installed in the positive battery lead to protect against any overload or short circuit
12	CAN Termination	20 AWG	* 120 Ω Resistor Built-In, Jumper to CAN L 14
13	(CAN H / RS232 RX)	20 AWG	* Twist Wires 14 turns per foot.
14	(CAN L / RS232 TX)	20 AWG	

RECOMMENDATIONS

- * Shielded cable should be used for all external connections to the EDG control. One end of each shield, including the speed sensor shield, should be grounded to a single point on the EDG case.

EDG MATING CONNECTOR BASIC WIRING



PIN 3 MAGNETIC SPEED PICKUP

- Wires must be twisted and/or shielded for their entire length (14 turns per foot)
- Gap between speed sensor and gear teeth should not be smaller than 0.02 in (.51 mm)
- Speed sensor voltage should be at least 1 V AC RMS during crank

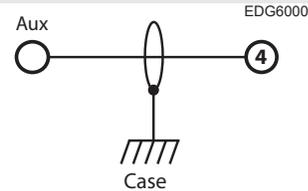
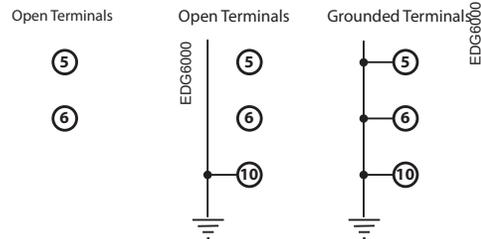


If the EDG6000 detects no input from the magnetic pickup, the EDG will set the actuator to 0 V and the speed to 0 RPM. After the EDG has detected loss of magnetic pickup, the LED 1 will flash red and the system must be reset. To reset the EDG, DC power must be cycled.

PIN 4 ACCESSORY INPUT

The Auxiliary input accepts signals from:

- GAC Accessories connect directly to this pin
- Auto Synchronizers
- Load Sharing Units
- Other Governing Accessories

**PINs 5 and 6 SPEED SELECT**

WIRING COMBINATIONS		
PIN 5	PIN 6	Speed Mode
Open	Open	Variable Speed (or Fixed Speed)
Ground	Open	Fixed Speed 1
Open	Ground	Fixed Speed 2
Ground	Ground	Fixed Speed 3 - Idle

NOTE

Setup of these speed modes as detailed in Section 10, Main Menu Parameters.

PIN 8 OVERSPEED OUTPUT

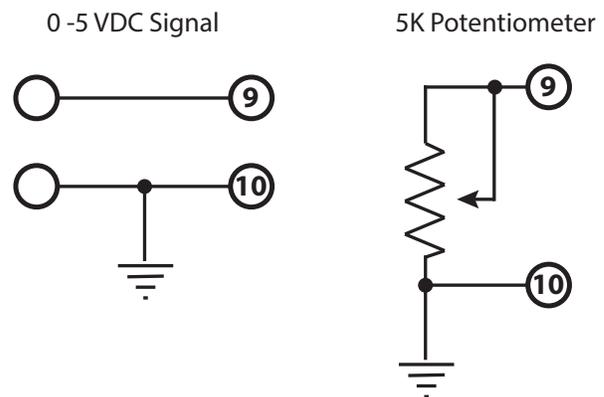
If the EDG6000 detects the engine speed has reached the value specified by OVERSPEED parameter (Main Menu), the EDG6000 will command the engine speed to 0 RPM and the actuator output to 0 V. After the EDG has detected an overspeed, LED 1 will flash and the system must be reset. To reset the EDG, DC power must be cycled.

PIN 9 VARIABLE SPEED

Variable speed is enabled when Pins 5 and 6 are not grounded. A 5 K Ω potentiometer or a 0 - 5 V DC signal can be connected to Pin 9.

NOTE

Variable Speed can be used as a fixed speed setting if both Speed min and Speed max parameters are set to the same RPM and no potentiometer is connected. See Section 10, Main Menu Parameters for Variable Speed Setup procedures.



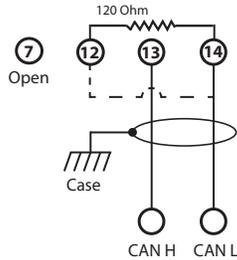
4

WIRING (CONTINUED)

PINs 7, 12, 13 and 14 CAN or RS-232

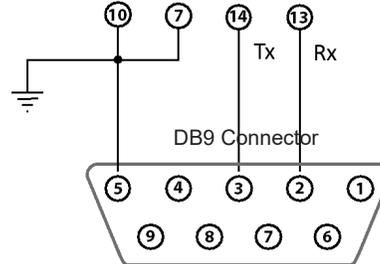
If CAN termination is required, tie Pin 12 to Pin 14. An RS-232 port connection is required, since many computers do not have this port use a USB-to-RS-232 converter will be required. Order GAC part number EAM204 or see your GAC representative for more details.

CAN WIRING



- - - - - = optional CAN termination

RS-232 WIRING



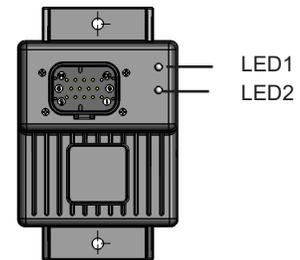
IMPORTANT

1. RS-232 Enable to ground in order to communicate (Pin 7).
2. CANbus has only one engine speed output; it cannot take speed requests. The ECU ID is 26 on the CAN bus with message EEC1.
3. Serial cable must be a straight-through type (common), NOT of null modem/crossover type (uncommon).

5

LED DEFINITIONS

LED	COLOR	DEFINITION
1	FLASHING GREEN	Controller is powered and the microprocessor is initialized.
1	FLASHING RED	Controller has tripped overspeed.
1	SOLID GREEN	Controller has achieved the chosen running speed.
2	FLASHING RED	Flashes when the controller has not reached running speed.
2	ALTERNATING RED & GREEN	Variable speed enabled and controller has achieved the chosen running speed.
2	SOLID GREEN	SPEED Select 1 is enabled and controller has achieved the chosen running speed.
2	SOLID RED	SPEED Select 2 is enabled and controller has achieved the chosen running speed.
2	SOLID AMBER	SPEED Select 1 and 2 are enabled and controller has achieved the chosen running speed.



6 SMARTVU

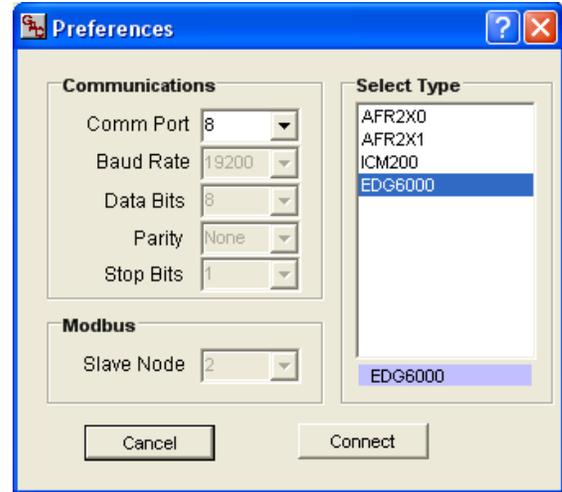
The EDG6000 is programmed using GAC's SmartVU software. The SmartVU installation file and instructions can be found at: www.governors-america.com software page.

SETUP CONNECTION

IMPORTANT

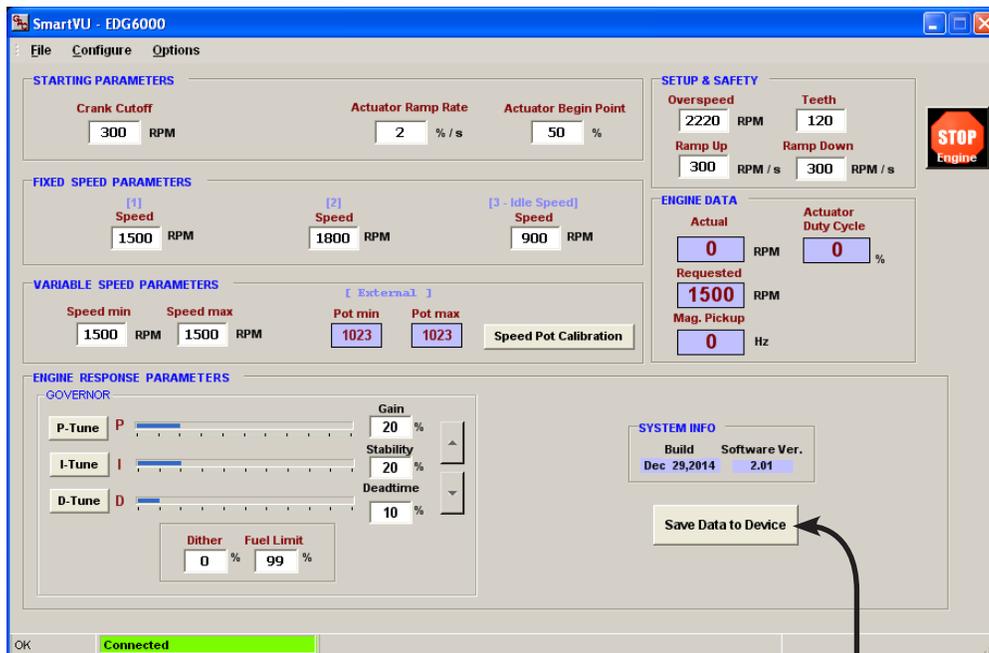
If your PC only has a USB and no serial port, you need a USB adapter. An RS-232 port connection is required, since many computers do not have this port use a USB-to-RS-232 converter will be required. See your GAC representative or order GAC part number EAM204.

1. On the main menu click the Configure and then select Setup Connection from the drop down list. The Preferences menu displays.
2. Select EDG6000 from the Select Type list. When SmartVU recognizes the device the Connect button will become available. Click Connect.
3. Parameters can then be adjusted from the Main menu and the Governor Advanced Settings menu.



Pin 7 on the EDG must be grounded for communication to happen between the EDG and the SmartVU software. EDG6000 will not display on the list if not connected.

1. The Main menu displays once the EDG is selected and connection is complete.



IMPORTANT

1. Press the **Enter** key after changing a parameter to save that individual change.
2. Click **Save Data to Device** to update speed controllers memory.
3. The device does not auto-save settings changes.

7 PRE-START

The following parameters must be set before starting the engine. For more details on these parameters, see Section 10, Main menu Parameters.

SETUP & SAFETY

- Overspeed
- Teeth
- Ramp Up
- Ramp Down



STARTING PARAMETERS

- Crank Cutoff
- Actuator Ramp Rate
- Actuator Begin Point



IMPORTANT

1. Press the **Enter** key after changing a parameter to save that individual change.
2. Click **Save Data to Device** to update speed controllers memory.
3. The device does not auto-save settings changes.

8 STARTING THE ENGINE

Crank the engine with DC power applied to the governor system. The initial amount of power to the actuator is determined by the Actuator Begin Point parameter (default is 100 % open). Actuator Ram Rate controls the rate fuel is increased to start the engine.

9 ADJUSTING FOR STABILITY

Once the engine is running at operating speed with no load, the PID - Gain, Stability, Deadtime performance adjustments can be made to increase engine stability.

P, I, & D parameter adjustments may require minor changes after engine load is applied. Normally, adjustments made at no load achieve satisfactory performance.

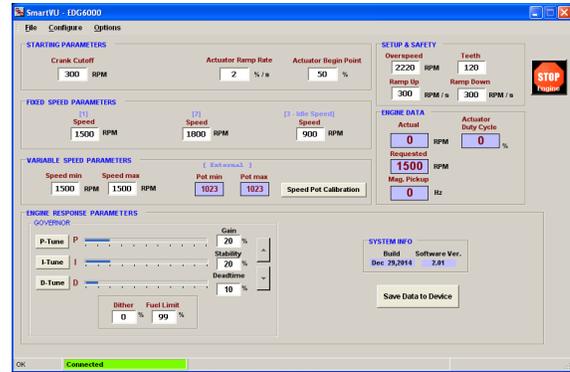
If further performance improvements are required, see Section 11, Advanced Settings or Section 12, System Troubleshooting.

MAIN MENU	
PARAMETER	ADJUSTMENT PROCEDURE
P (GAIN)	<ol style="list-style-type: none"> 1. Increase this parameter until instability develops. 2. Then, gradually decrease this parameter until stability returns. 3. Finally, decrease this parameter one increment further to ensure stable performance. 4. If instability persists, adjust the stability parameter.
I (STABILITY)	<ol style="list-style-type: none"> 1. Follow the same adjustment procedure as the P parameter. 2. If instability persists, adjust the deadtime parameter.
D (DEADTIME)	Follow the same adjustment procedure as the P parameter.

10 MAIN MENU PARAMETERS

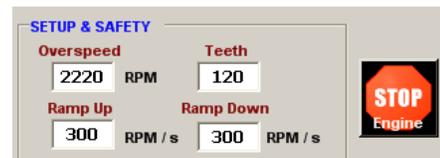
STARTING PARAMETERS

Name	Range	Default	Definition
Crank Cutoff	100 - 500	480	RPM at which EDG switches from starting to governing
Actuator Ramp Rate	0 - 100	2	Throttle position's rate of change from the throttle begin point to 100 %, during the start/crank cycle (% / s)
Actuator Begin Point	0 - 100	100	Starting position of the actuator during the start/crank cycle (%)



SETUP & SAFETY

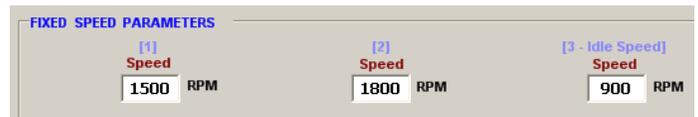
Name	Range	Default	Definition
Overspeed	Cust. Dep.	2220	RPM at which to automatically shut off the actuator
Teeth	50-250	120	Number of teeth on flywheel [freq(Hz) = (RPM / 60) x (# of gear teeth)]
Ramp Up	0 - 9999	300	Allows for rapid engine speed response with minimal overshoot during engine start and acceleration (RPM / s)
Ramp Down	0 - 9999	300	Allows for rapid engine speed response with minimal undershoot during engine deceleration (RPM / s)



Remember to save. Click **Save Data to Device** to update governor's memory.

FIXED SPEED PARAMETERS

Name	Range	Default	Definition
Speed 1,2,3	0 - 9999	1500,1800,900	EDG selects one of three fixed speeds. Fixed Speed 3 is Idle Speed (RPM)



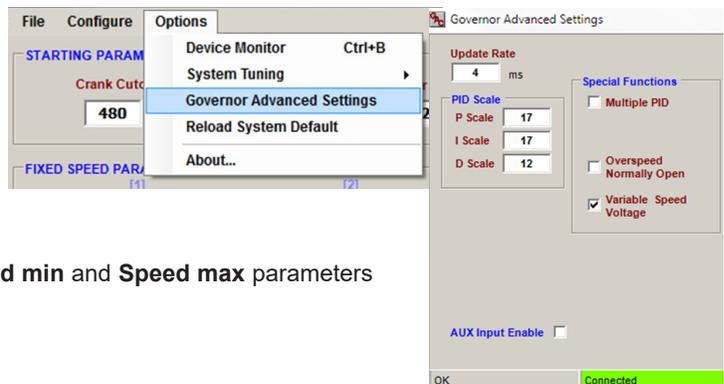
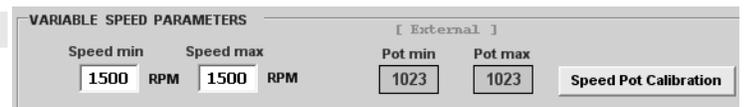
NOTE Idle speed must be set below operation speed but above crank termination (600 - 1200) even if it is not being used.



Setup variable speed with the unit powered but the engine not running to set the variable speed limits. The potentiometers must be calibrated to these set limits afterwards.

VARIABLE SPEED SETUP PROCEDURE

1. In **FIXED SPEED PARAMETERS** menu in the **Speed** parameter **3 - Idle Speed** parameter input a value 50 RPM below the desired idle speed setting.
2. From the Main menu, select Options and choose **Governor Advanced Settings** menu from the drop-down menu.
3. In the Special Functions box, enable the Variable Speed Voltage check box.



IMPORTANT

For an additional fixed speed setting, set **Speed min** and **Speed max** parameters to the same value with no input on Pin 9.

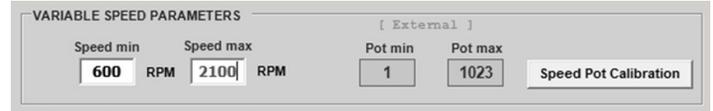
10 MAIN MENU PARAMETERS (CONTINUED)

VARIABLE SPEED SETUP PROCEDURE (CONTINUED)

- At the Main menu, at **VARIABLE SPEED PARAMETERS**, input the desired idle RPM in the box labeled **Speed min** and press **Enter**.
- Input the desired maximum RPM in the box labeled **Speed max** and press **Enter**.

VARIABLE SPEED PARAMETERS

Name	Range	Default	Definition
Speed Min	0 - 9999	1500	Minimum allowed RPM desired
Speed Max	0 - 9999	1500	Maximum allowed RPM desired



VARIABLE SPEED POT CALIBRATION

- After setting Speed min and max, set the speed input to its minimum; either 0 V DC or turn the potentiometer full counter clockwise.
- Click the Speed Pot Calibration and press **Enter** or press the **Save Data to Device**.
- Set the speed input to its maximum; either 5 V DC or turn the potentiometer full clockwise.
- Click **Speed Pot Calibration** and press **Enter** or click the Save Data to Device.

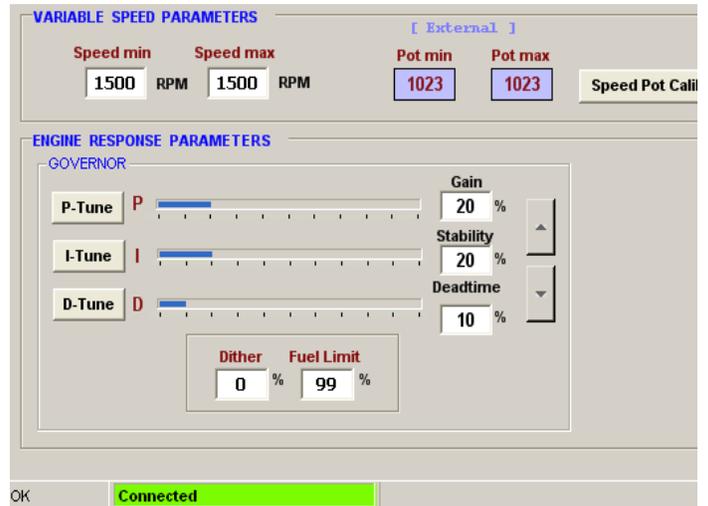


NOTE

The displayed values for **Pot min** and **Pot max** are in counts. When a 5 k Ω potentiometer is used as a variable speed input, the total speed range will be 0 to 2.5 V DC, equivalent to 0 to 512 counts displayed. When a 0 to 5 V DC input is used, the full range of 0 to 1023 counts are displayed and the unit operates at its best resolution.

ENGINE RESPONSE PARAMETERS

Name	Range	Default	Definition
P	0 - 100, 100 = Max Gain	20	Proportional (P) set point of the PID control
I	0 - 100, 100 = Longest Time	36	Integral (I) set point of the PID control
D	0 - 100	21	Derivative (D) set point of the PID control
Dither	0 - 100%. 0 = No Dither	0	Adds a high-frequency, low amplitude signal to the actuator to prevent the butterfly valve from sticking in harsh environment
Fuel Limit	0 - 100%	99	Maximum allowable throttle % the system can command

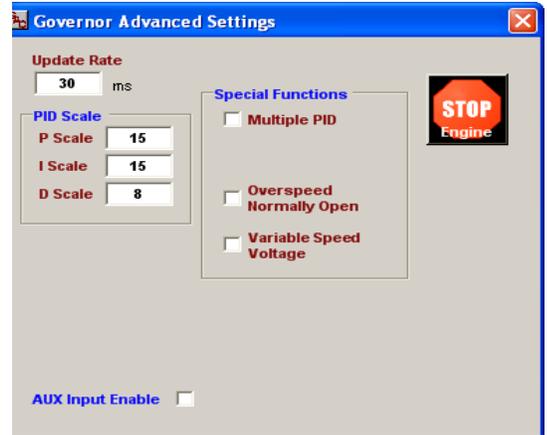


IMPORTANT

- Press the **Enter** key after changing a parameter to save that individual change.
- Click **Save Data to Device** to update speed controllers memory.
- The device does not auto-save settings changes.

11 GOVERNOR ADVANCED SETTINGS

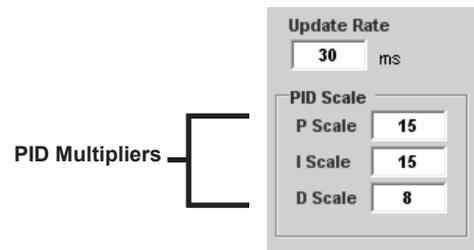
Governor Advanced Settings will further adjust engine stability and is accessed through the **Options** menu on SmartVU's Main Menu.



UPDATE RATE & PID SCALE			
Name	Range	Default	Definition
Update Rate	4 - 250	4	Changes the rate in ms at which the PID routine is called
P Scale	0 - 20	17	If a PID Scale multiplier is changed (e.g. P Scale), the corresponding parameter (e.g. P) will be affected in following two ways:
I Scale	0 - 20	17	
D Scale	0 - 20	12	

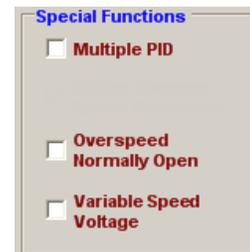
1. If the multiplier is decreased by 1, the corresponding parameter will double.
2. If the multiplier is increased by 1, the corresponding parameter will halve.

If Multiple PID (described in SPECIAL FUNCTIONS) is enabled, you cannot change the PID scale. Simply disable and re-enable.

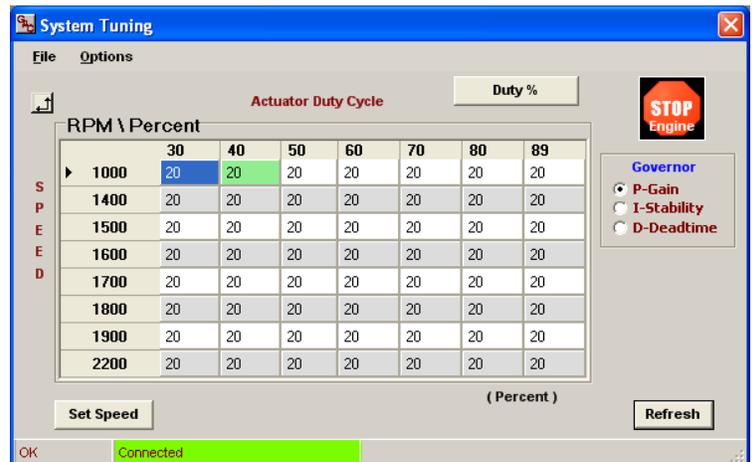


SPECIAL FUNCTIONS

SPECIAL FUNCTIONS			
Name	Range	Default	Definition
Multiple PID	Off, On	OFF	Enables or disables the multi-PID tables which displays a variable map over full engine speed and actuator duty cycle range.
Overspeed Normally Open	Off, On	On	Overspeed normally open (Box Checked), output voltage (Pin 8) is a "0" until the overspeed threshold is exceeded, at which point output (Pin 8) goes to battery Voltage. Off : Overspeed normally open (box Unchecked) output voltage (Pin 8) is at battery voltage until the overspeed threshold is exceeded, at which point output goes to 0 V.
Variable Speed Voltage	Off, On	Off	Selects type of input for variable speed signal. Checked = 0 - 5 V DC, Unchecked = 5 K Ω Potentiometer



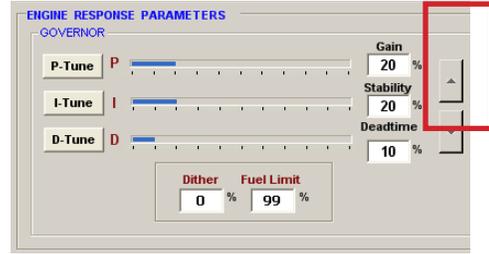
1. When multiple PID is enabled, the user has the ability to set the gain, stability, and Deadtime at each RPM and commanded actuator duty cycle in a 56-position (8 speeds by 7 positions with customizable axis values) table using the **System Tuning** menu.
2. The System Tuning menu is accessed from the Main menu the Options drop-down.



11 GOVERNOR ADVANCED SETTINGS



Use caution when adjusting the up/down arrows on the Engine Response Parameters on the Main menu when multiple PID is enabled. Changes made will be reflected for the specific cell (speed vs. position) on the table but not the entire table itself.



IMPORTANT

When using a 5 k Ω potentiometer you have a range of 0 - 2.5 V DC which is 0 - 512 A DC. With 0 - 5 V DC input enabled, you can use the full range of 0 - 1023 A DC.

AUX			
Name	Range	Default	Definition
Aux Input Enable	Off, On	Off	Enables or disables load sync input.

12 SYSTEM TROUBLESHOOTING

SYSTEM INOPERATIVE

If the engine governing system does not function, the fault may be determined by performing the voltage tests described in Steps 1 through 3. Positive (+) and negative (-) refer to meter polarity. Should normal values be indicated during troubleshooting steps, then the fault may be with the actuator or the wiring to the actuator. Tests are performed with battery power on and the engine off, except where noted. See your actuator installation manual for testing procedures for that actuator.

STEP	WIRES	NORMAL READING	PROBABLE CAUSE
1	Power 10(-) & 11(+)	Battery Supply Voltage (12 or 24 V DC)	<ol style="list-style-type: none"> DC battery power not connected. Check for blown fuse Low battery voltage Wiring error
2	Pick-Up 3 & Ground	1.0 V AC RMS min while cranking	<ol style="list-style-type: none"> Gap between speed sensor and gear teeth too great Check Gap Improper or defective wiring to the speed sensor. Resistance between 3 and Ground should be 30 to 1200 Ω. See your specific mag pickup data for resistance. Defective speed sensor.
3	Actuator & Battery 1(-) & 11(+)	1.0 - 2.0 V DC while cranking	<ol style="list-style-type: none"> SPEED parameter set too low Short/open in actuator wiring Defective speed control Defective actuator, see your actuator troubleshooting guide

INSTABILITY

INSTABILITY	SYMPTOM	PROBABLE CAUSE
Slow Periodic	An irregularity of speed below 3 Hz. (Sometimes severe)	<ol style="list-style-type: none"> Decrease the update rate of the controller by decreasing the UPDATE Advanced parameter. (Each time UPDATE is changed, P, I, and D must be re-adjusted.) Check fuel system linkage during engine operation for: <ol style="list-style-type: none"> binding high friction poor linkage Add a small amount of droop.
Non-Periodic	Erratic Engine Behavior	<ol style="list-style-type: none"> Increasing the P parameter should reduce the instability but not totally correct it. If this is the case, there is most likely a problem with the engine itself. Check for: <ol style="list-style-type: none"> engine mis-firings an erratic fuel system load changes on the generator set voltage regulator.

UNSATISFACTORY PERFORMANCE

SYMPTOM	CHECK	PROBABLE CAUSE
Engine Overspeed	1. Do Not Crank. Apply DC power to the governor system.	1. After the actuator goes to full fuel, disconnect the speed sensor at Pin 3. If the actuator is still at full fuel-speed then the control unit is defective. 2. If the actuator is at minimum fuel position and there exists an erroneous position signal, then check speed sensor
	2. Manually hold the engine at the desired running speed. Measure the DC voltage between Pins 1(-) and 11(+) on the speed control unit.	1. If the voltage reading is 1.0 to 2.0 V DC: a. SPEED parameter set above desired speed b. Defective speed control unit 2. If voltage reading is > 2.0 V DC then check for: a. actuator binding b. linkage binding 3. If the voltage reading is below 1.0 V DC: a. Defective speed control unit
	3. Check #TEETH parameter.	1. Incorrect number of teeth entered.
Overspeed shuts down engine after running speed is reached	1. Examine the SPEED and OVERSPEED operating parameters for the engine	1. SPEED parameter set too high. 2. OVERSPEED set too close to SPEED. 3. Actuator or linkage binding. 4. Speed Control unit defective.
Overspeed shuts down engine before running speed is reached	1. Check resistance between Pins 3 and Ground. Should be 30 to 1200 Ω. See your specific Magnetic Pick-up data for resistance.	1. OVERSPEED set too low 2. If the speed sensor signal is erroneous, then check the wiring.
Actuator does not energize fully	1. Measure the voltage at the battery while cranking.	1. If the voltage is less than: a. 7 V DC for a 12 V DC system, or b. 14 V DC for a 24 V DC system, Then: Check or replace battery.
	2. Momentarily connect Pins 1 and 11. The actuator should move to the full fuel position.	1. Actuator or battery wiring in error 2. Actuator or linkage binding 3. Defective actuator 4. Fuse opens. Check for short in actuator or harness.
Engine remains below desired governed speed	1. Measure the actuator output, Pins 1 and 2, while running under governor control.	1. If voltage measurement is within 2 V DC of the battery supply voltage level, then fuel control is restricted from reaching full fuel position, possibly due to mechanical governor, carburetor spring, or linkage interference. 2. SPEED parameter set too low

If unsuccessful in solving instability, contact GAC for assistance.
GAC@governors-america.com or call: 1-413-233-1888