IGA225
Integrated Governor & Actuator

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1 INTRODUCTION

GAC's IGA225 integrated digital governor and actuator is designed to regulate engine speed on diesel and gaseous fueled engines. The IGA is a suitable upgrade for any mechanical governor system that needs flexibility, precision, or accurate control of governed speed. The IGA is designed for industrial engine applications from generator sets, and mechanical drives, to pumps or compressors.

- ◊ 12 or 24 V DC
- ◊ Combined ADC225S with integrated EDG6000
- ◊ Provides all the EDG Series Electronic Speed Control
  - No Analog Drift
  - Selectable Isochronous or Droop Governing
  - Overspeed Sensing
  - Adjustable Starting Fuel Strategy
  - Black Smoke Reduction
  - Variable Speed Governing
  - GAC AUX/Load Sharing

A computer with an internet connection, an RS-232 port, and an DB-9 F/M cable are required to download and run GAC's SmartVU configuration software. SmartVU is GAC's configuration software for the EDG series controllers. It incorporates a simple user interface for initial configuration as well as added functionality for diagnostic and troubleshooting purposes.

2 SPECIFICATIONS

PERFORMANCE	
Available Torque (Without Return Spring)	2.2 ft-lb MAX (2.7 N m)
Max Angular Travel	25 ° ±1 ° CW/CCW
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 - 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
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

RELIABILITY	
Vibration	7 g, 20 - 100 Hz
Shock	20 g Peak
Testing	100% Functional Testing

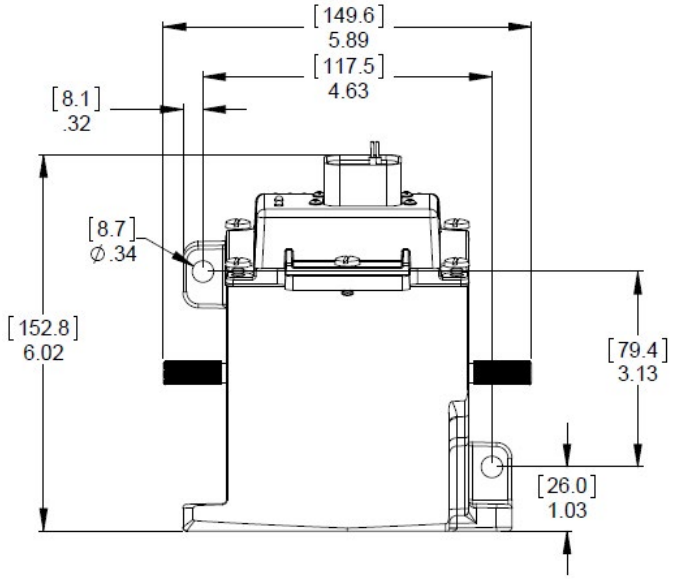
ENVIRONMENTAL	
Ambient Temperature	-40 to 85 °C (-40 to 180 °F)
Relative Humidity	Up to 95f%
All Surface Finishes	Fungus Proof and Corrosion Resistant

COMPLIANCE / STANDARDS	
Agency	CE and RoHS Requirements
Communications	RS-232-C, SAE J1939

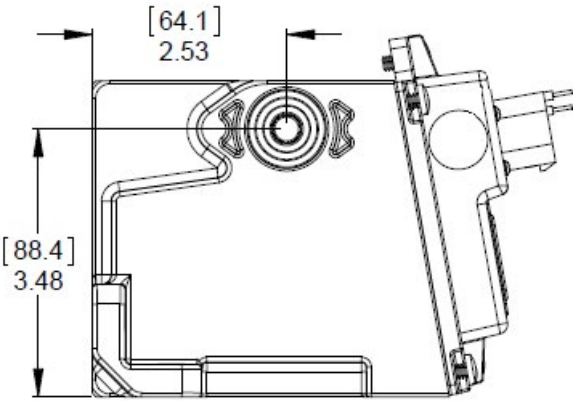
PHYSICAL	
Dimension	See Section 3, Installation
Weight	8.63 lbf (3.91 kgf)
Mounting	Electrical Connector At Top Preferred

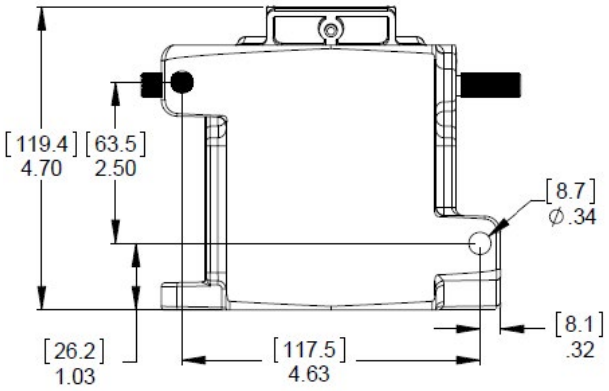
3 INSTALLATION

Linkage arrangement of any actuator system is always important. Use high quality rod end bearings. Rod end bearings that have high friction can cause instability and require servicing. Levers and linkage should be sturdy yet low in mass for the fastest response speed.



Dimensions:
[mm]
in





YES

Vertical orientation allows for the draining of fluids in moist environments. Do not install with the connector facing upwards.

NO

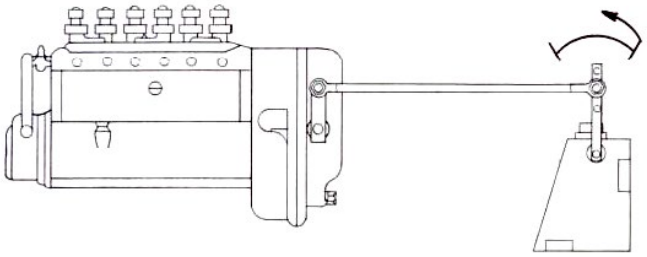
Avoid Extreme Heat

Arrangement of the linkage for actuation of the engine fuel control is an important application consideration.

For **proportional actuators to operate with linear control systems**, it is important to obtain a linear relationship between actuator stroke and fuel delivery.

The linkage configuration for diesel fuel systems is typically as illustrated in **Diagram 1**. The lever on the actuator should be nearly parallel to the pump lever at the mid fuel position for linear fuel control.

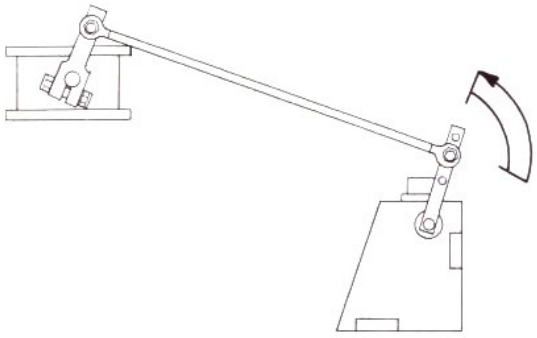
DIAGRAM 1 FUEL LEVER AT MID FUEL POSITION



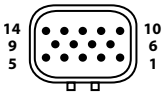
For **proportional actuators to operate with non-linear systems**, it is important to obtain a non-linear relationship between actuator stroke and fuel delivery. Carbureted, PT Pumps (CUMMINS), or other non-linear fuel systems require a non-linear fuel linkage configuration as illustrated in **Diagram 2**. A non-linear fuel system results when more engine power is developed for a given stroke at positions of low fuel settings rather than at high fuel settings. In this case the levers should be parallel at full load.

In general, the linkage should be adjusted so that the fuel control lever minimum and maximum fuel stops are used rather than the actuator internal mechanical stops. The actuator should be adjusted so that it operates over at least one half (12 degrees) of its available travel.

DIAGRAM 2 FUEL LEVER AT FULL FUEL POSITION

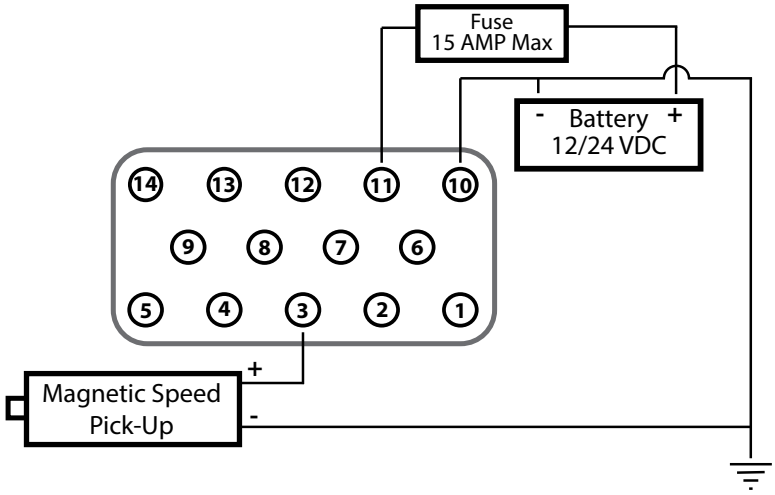


4 WIRING



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

IGA MATING CONNECTOR BASIC WIRING



PIN	DEFINITION	GAUGE	NOTES
1	-	-	-
2	-	-	-
3	Magnetic Pickup (+)	#20 AWG	Ground to Pin 10
4	Aux Input	#20 AWG	0 - 10 V Range, 5 V 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 # 13
13	(CAN L / RS232 TX)	#20 AWG	Twist Wires 14 turns per foot.
14	(CAN H / RS232 RX)	#20 AWG	

RECOMMENDATIONS

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

Use an overspeed shutdown device, independent of the governor system, to prevent loss of engine control which may cause personal injury or equipment damage.

Do not rely exclusively on the governor system electric actuator to prevent overspeed. A secondary shutoff device, such as a fuel solenoid must be used.

If the IGA225 detects no input from the magnetic pickup, the IGA will be set to 0 V DC and the speed set to 0 RPM. After the IGA has detected loss of magnetic pickup, the LED 1 will flash red and the system must be reset. To reset the IGA, DC power must be cycled.

4 WIRING (CONTINUED)

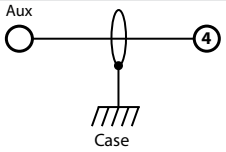
PIN 3 MAGNETIC SPEED PICKUP

- 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. (.51mm)
- Speed sensor voltage should be at least 1 V AC RMS during crank

PIN 4: ACCESSORY INPUT (AUX)

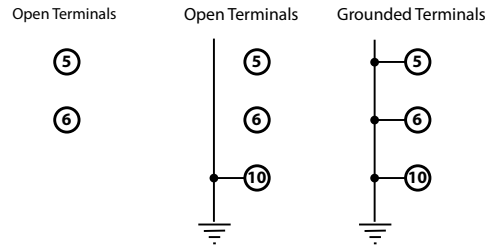
Aux accepts signals from

- 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



PIN 7: COMMUNICATION

Pin 7 on the IGA must be grounded for communication to SmartVU.

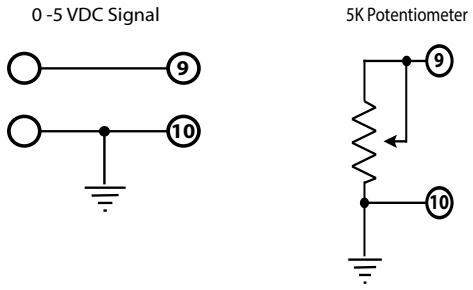
PIN 8: OVERSPEED OUTPUT

If the IGA225 detects the engine speed has reached the value specified by OVERSPEED parameter (Main menu), the IGA225 will command the engine speed to 0 RPM and the actuator output to 0 V DC. After the IGA has detected an overspeed, LED #1 will flash and the system must be reset. To reset the IGA, DC power must be cycled.

PIN 9: VARIABLE SPEED

Variable speed is enabled when pins 5 and 6 are not grounded. See WIRING COMBINATIONS. A 5K potentiometer or a 0 - 5 V DC signal can be connected to pin 9.

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 for Variable Speed Setup Procedure.

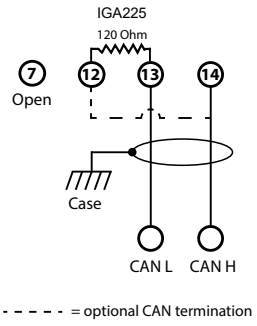


PINS 12, 13, and 14: CAN or RS-232

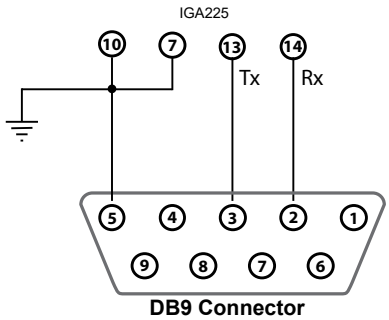
If CAN termination is required, tie pin 12 to pin 14.

- RS-232 enable to ground in order to communicate (Pin 7).
- On CANbus there is only engine speed output. It cannot take speed requests. The ECU ID is 26 on the CANbus with message EEC1.

CAN WIRING

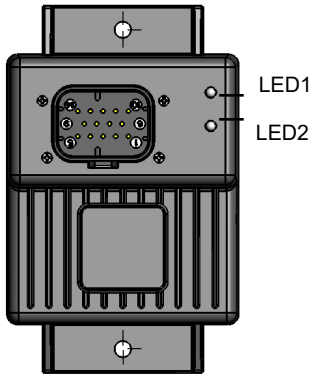


RS232 WIRING



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	Will pulse 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 & 2 is enabled and controller has achieved the chosen running speed.



6 SMARTVU

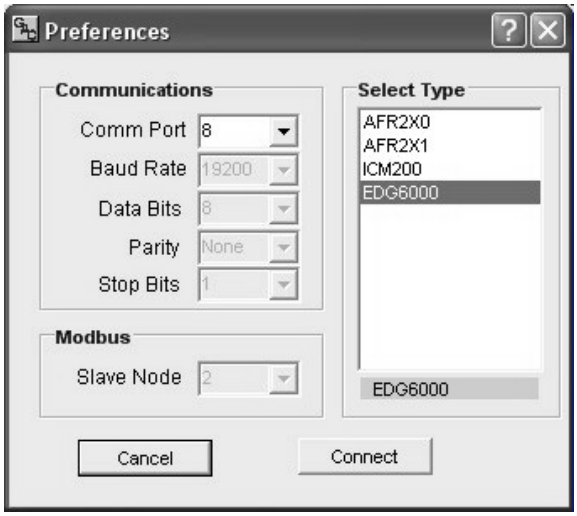
The IGA225 is programmed using GAC's SmartVU software. The SmartVU installation file are found at www/governors-america.com/. All hardware must be installed prior to using SmartVU.

SETTING UP SmartVU CONNECTIONS

IMPORTANT If your PC only has a USB and no serial port, you need an adapter. You also need to find which COM port will communicate with the IGA.

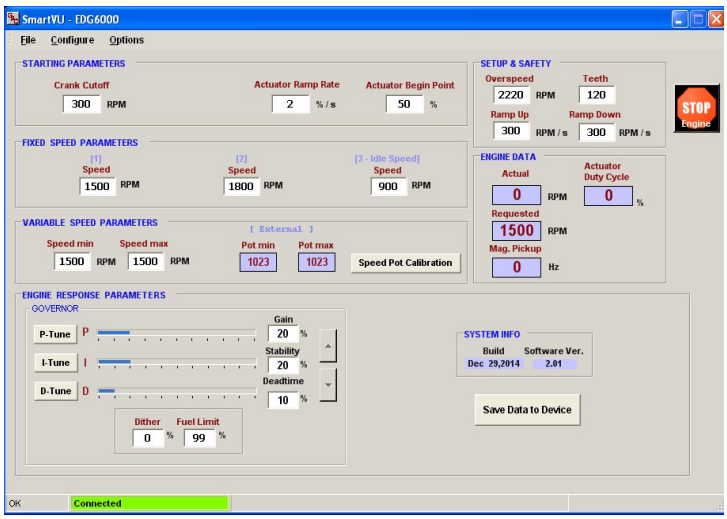
After installing SmartVU, to connect to the IGA to SmartVU:

1. Launch SmartVU from your desktop.
2. From the Main menu, select Configure → Setup Connection to display the Preferences menu.
3. Select EDG6000 under Select Type and click Connect.
4. After SmartVU recognizes the device, parameters can then be adjusted using the Main Menu and the Governor Advanced Settings Menu.



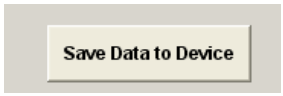
6 SMARTVU (CONTINUED)

The IGA225 is programmed using GAC's SmartVU software.
The Main menu lets you access the basic settings. The following details initial setup and then advanced governing settings.



IMPORTANT

Click Save Data to Device to update IGA225 memory.



7 PRE-START

Before starting the engine:

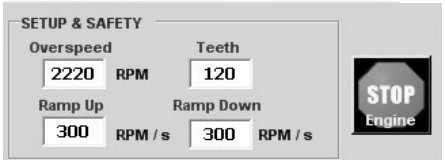
- Reconfirm that the actuator linkage is not binding and that friction is minimal.
- Before starting the engine, push the actuator to the full fuel position and release. It should return instantly to the no fuel position without any binding.

The following minimum parameters must be set in SmartVU before starting the engine:

SETUP & SAFETY

SETUP & SAFETY

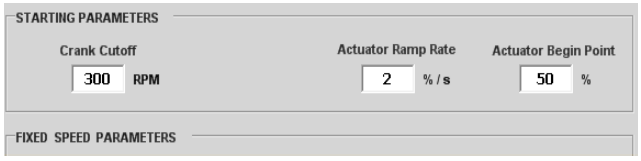
Name	Range	Default	Definition
Overspeed	Cust. Dep.	2220	RPM at which SmartVU automatically shuts off fuel to the actuator
Teeth	50-250	120	Number of teeth on flywheel [freq(Hz) = (RPM/60) x (# of gear teeth)]
Ramp Up	0 - 9999	300	Allows for rapid engine speed response with minimal overshoot during engine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



STARTING PARAMETERS

STARTING PARAMETERS

Name	Range	Default	Definition
Crank Cutoff	100 - 500	480	RPM at which IGA 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 (%).



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 RAMP RATE will control the rate at which fuel is increased to start the engine.

Once the engine has been started, the linkage can be optimized by temporarily inserting an ammeter in one of the wires between the speed control unit and the actuator or by measuring the voltage across the actuator. Measure the actuator current or voltage at no load and full load. The range and the starting current or voltage are important for optimizing the linkage system. Typical values are shown in the following table for 12 V DC and 24 V DC systems.

	ACTUATOR CURRENT/VOLTAGE RANGE CHART	
	12 VOLTS	**24 VOLTS**
No Load	2.5 A, 4 V DC	0.5 A 12 V DC
Full Load	4 A, 6 V DC	1.2 A, 18 V DC

To increase the range of the actuator voltage or current: move the linkage to a lower hole on the actuator lever. A lower range of actuator current than suggested can cause instability or poor performance.

To increase or decrease the no load current or voltage: Adjust the length of the link between the actuator and the engine fuel control. Smaller angles of actuator travel may improve transient performance, but will reduce available force at the fuel control lever. Allowing the actuator to operate through at least one half (12 degrees) of its stroke will usually provide near optimum response.

9 ADJUSTING FOR STABILITY

Once the engine is running at operating speed and at no load, the following governor performance adjustment can be made to increase engine stability.

PARAMETER	STABILITY ADJUSTMENT PROCEDURE
P (GAIN)	1. Increase this parameter until instability develops. 2. Gradually decrease this parameter until stability returns. 3. Decrease this parameter one increment further to ensure stable performance. If instability persists, adjust the stability parameter.
I (STABILITY)	Follow the same adjustment procedure as the P parameter. If instability persists, adjust the deadtime parameter.
D (DEADTIME)	Follow the same adjustment procedure as the P parameter.

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, refer to Section (11) GOVERNOR ADVANCED SETTINGS and Section (12) SYSTEM TROUBLESHOOTING.

NOTE For more details on these parameters, see Section 11, GOVERNOR ADVANCED SETTINGS.

10 GENERAL PARAMETERS SETTINGS

IMPORTANT When setting parameters, good practice is to save settings often by clicking Save Data to Device.

FIXED SPEED

FIXED SPEED PARAMETERS

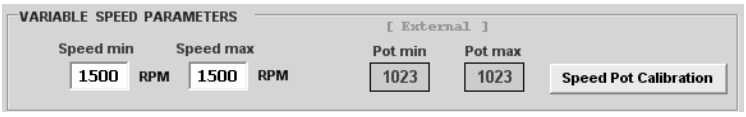
Name	Range	Default	Definition
Speed 1, 2, 3	0 - 9999	1500,1800,900	EDG selects one of three fixed speeds. Fixed Speed 3 is Idle Speed (RPM)

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

VARIABLE SPEED

VARIABLE SPEED PARAMETERS

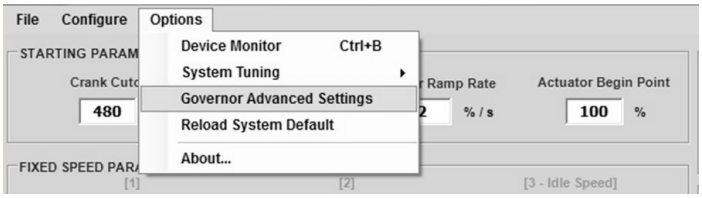
Name	Range	Default	Definition
Speed Min	0 - 9999	1500	Minimum allowed RPM desired
Speed Max	0 - 9999	1500	Maximum allowed RPM desired

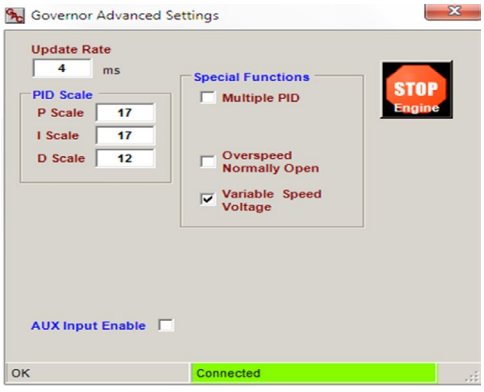


Perform the following procedure with the unit powered and the engine not running to set the variable speed limits. The potentiometers must be calibrated to those limits afterwards.

VARIABLE SPEED SETUP PROCEDURE

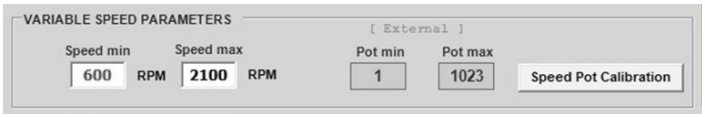
1. In the [3 - Idle Speed] parameter under FIXED SPEED PARAMETERS, input a value 50 RPM below the desired idle speed setting.
2. From the Main menu, select Options → Governor Advanced Settings.
3. In Special Functions, enable Variable Speed Voltage. If using a 5KΩ potentiometer, leave Variable Speed Voltage unchecked.
4. Return to the main menu. Under VARIABLE SPEED PARAMETERS, input the desired idle RPM in the box labeled Speed min and click Enter.
5. Set speed input to either 0 V or turn the potentiometer full counter clockwise.
6. Click Speed Pot Calibration and click Save Data to Device.
7. Set speed input to is maximum, 5 V DC, or turn the potentiometer full clockwise.
8. Click Speed Pot Calibration and click Save Data to Device.





The displayed values under Pot min and Pot max are counts. When a 5k potentiometer is used as a variable speed input, the total speed range will be 0 to 2.5 V DC, which is equivalent to 0 to 512 displayed counts.

When a 0 to 5 V DC input is used, the full range of 0 to 1023 counts will be displayed and the unit will operate at its best resolution.

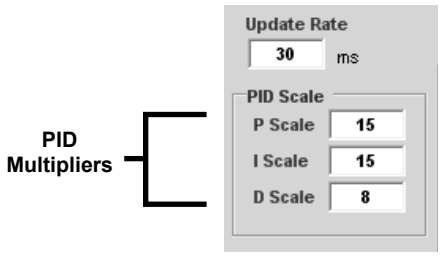


11 GOVERNOR ADVANCED SETTINGS

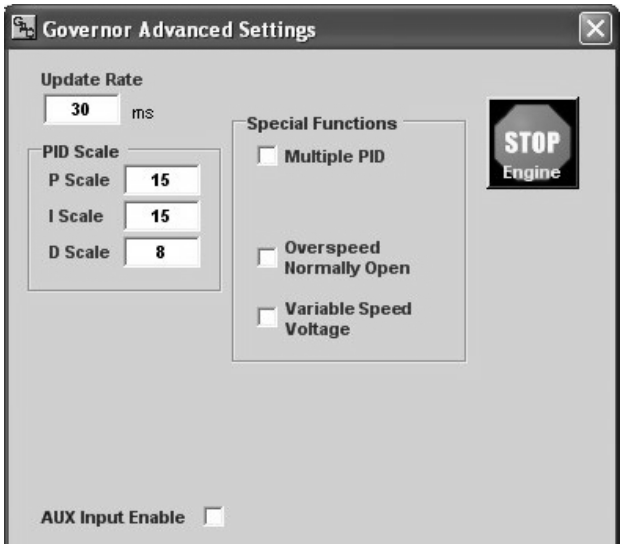
Governor Advanced Settings will further adjust engine stability and can be accessed through the Options pull-down menu on SmartVU's Main Menu.

UPDATE RATE and PID SCALE

Name	Range	Default	Definition
Update Rate	4 - 250	4	Sets the rate the PID routine is called. (ms)
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 two ways.
I Scale	0 - 20	17	
D Scale	0 - 20	12	



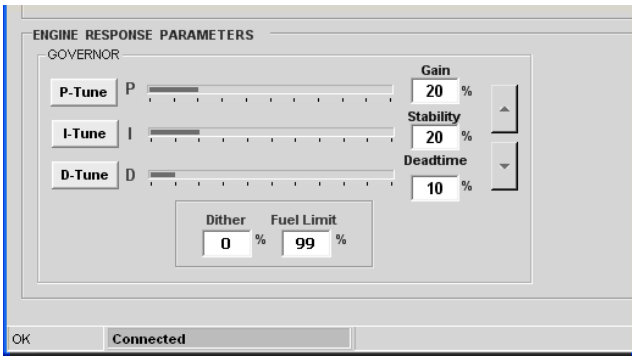
*If the multiplier is decreased by 1, the corresponding parameter will double. If the multiplier is increased by 1, the corresponding parameter will halve.



If Multiple PID (See SPECIAL FUNCTIONS below) is enabled, you cannot change the PID scale. Uncheck to disable and make PID changes.

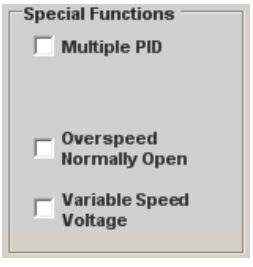
ENGINE RESPONSE PARAMETERS

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



SPECIAL FUNCTIONS

Name	Range	Default	Definition
Multiple PID	Off, On	OFF	Enables or disables the multi-PID tables which display a variable map over full engine speed and actuator duty cycle range.
Overspeed Normally Open	Off, On	On	Enables active high output for overspeed indication
Variable Speed Voltage	Off, On	Off	Selects type of input for variable speed signal. Checked = 0-5 V DC, Unchecked = 5 K Ω Potentiometer



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

A 5kΩ potentiometer provides 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.

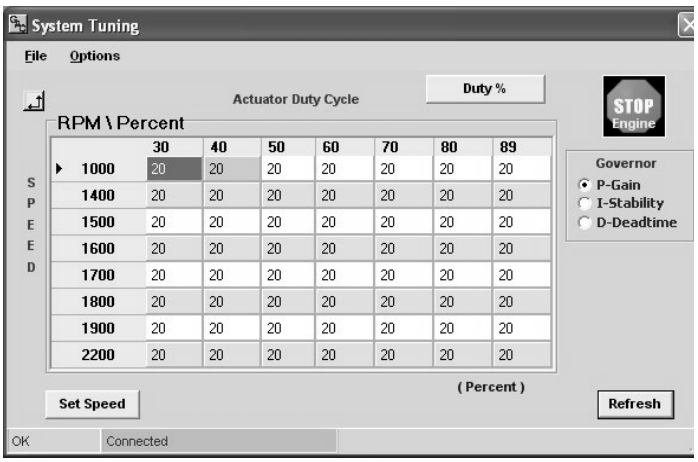
11 GOVERNOR ADVANCED SETTINGS (CONTINUED)

SYSTEM TUNING

Gain(P), stability(I), and deadtime(D) as well as Fuel gain(P) and stability(I) can be adjusted across the range of speed and loads by selecting Options → System Tuning → Governing from the main menu.

Before You Tune:

- Use the axis button to change the axis before modifying any parameters. Modify the axes in reverse order. Start at the highest pressure, located in the far right of the top axis, and work to the left. When changing the RPM values on the side axis, start at the bottom with the highest value and work up to the lowest value. Remember to use the Save Data button on the main menu when done.
- Select each parameter to be altered from the side bar.
- Once axis has been set and a parameter to alter has been selected, the table itself can be modified. The in the table will correspond with the axis set in step 1.



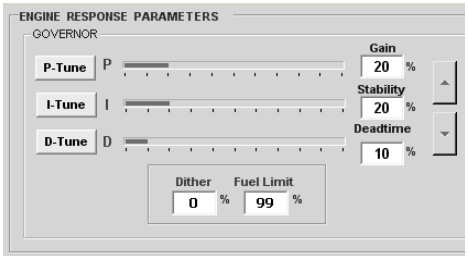
BUTTONS and INTERFACE

- Set Speed or Set Load - Speed and load axis values can be edited to adjust range and resolution of the table.
- Radio buttons on the side panel allow you to switch between tables.
- Refresh updates the maps in real time. Use Refresh after making any changes to ensure the values have been entered correctly.
- A highlighted cell indicates the engine's current speed and load value.
- To return to Main Screen use ctrl+B or select Options → Back to Main Screen or close the window.
- Stop Engine icon can be used to shut down fuel to the engine at any time.

ADVANCED GOVERNOR TUNING PROCEDURE

1.	Open the system tuning window and select the radio button for the Governor P, I, or D table and allow the map to update.
2.	Adjust the speed and load scales by selecting Set Load or Set Speed and entering the required linear values. Press Save and Close when complete
3.	Enter values for P, I, and D as determined from the PID tuning guidelines as a baseline value.
4.	Refresh the map by pressing the Refresh button to assure that all values have been accepted by the controller.
5.	Once complete with preliminary tuning, recheck the response from the system to ensure optimal operation and readjust as necessary.
6.	Adjust each of the values as needed across the speed and load range. Remember to use the Save button on the main page to save your changes when done.

Use caution when adjusting the up/down arrows on the Engine Response Parameters on the Main menu when Multiple PID is enabled since changes made there are made in the specific changed table cell (speed vs. position) but not for the entire table.



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 actuator publication for testing procedure on the actuator.

STEP	WIRES	READING	PROBABLE CAUSE
1	Power 10(-) & 11(+)	Battery Supply Voltage (12 or 24 V DC)	1. DC battery power not connected. 2. Check for blown fuse 3. Low battery voltage 4. Wiring error
2	Pick-Up 3 & Ground	1.0 V AC RMS min while cranking	1. Gap between speed sensor and gear teeth too great Check Gap 2. Improper or defective wiring to the speed sensor 3. 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	1. SPEED parameter set too low 2. Short/open in actuator wiring 3. Defective speed control 4. Defective actuator, see your actuators Installation manual for Troubleshooting

INSTABILITY

INSTABILITY	SYMPTOM	PROBABLE CAUSE
Slow Periodic	An irregularity of speed below 3Hz. (Sometimes severe)	1. 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. 2. Check fuel system linkage during engine operation for: a. binding b. high friction c. poor linkage 3. Add a small amount of droop.
Non-Periodic	Erratic Engine Behavior	1. Increasing 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: a. engine mis-firings b. an erratic fuel system c. load changes on the generator set voltage regulator.

INSTABILITY

SYMPTOM	READING	PROBABLE CAUSE
Engine Overspeeds	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
	Manually hold the engine at the desired running speed. Measure the DC voltage between Pins 1(-) & 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 check for: a. actuator binding b. linkage binding 3. If the voltage reading is below 1.0 V DC: Defective speed control unit
	Check #TEETH parameter.	1. Incorrect number of teeth entered.
Overspeed shuts down engine after running speed is reached	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 reached	Resistance between Pin 3 & Ground should be 30 to 1200 Ω.	1. OVERSPEED set too low 2. If the speed sensor signal is erroneous, then check the wiring.
Actuator does not energize fully	Measure the voltage at the battery while cranking.	1. If the voltage is less than: a. 7 V for a 12 V DC system, or b. 14 V for a 24 V DC system, Then: Check or replace battery.
	Momentarily connect Pin 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	Measure the actuator output, Pins 1 & 2, while running under governor control.	1. If voltage measurement is within 2 V DC of battery supply voltage level, 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