

SDG500 Series Smart Digital Governor



Purpose

The purpose of this manual is to provide the necessary information for installing, wiring, configuring and troubleshooting the **SDG500 Series (Smart Digital Governor)**. The target audience for this manual is OEMs, however OEMs should feel free to copy the needed information from this manual into their application service manuals.

This version of this manual applies to all **SDG500 Series** models. There are four variations of the **SDG500 Series**:

Model	Description	Recommended Cable Harness	Pin Out Box
SDG510	Deutsch connector	CH-510-1F00-LXX	TSE-510
SDG511	Samtec connector	CH-511-1F00-LXX	TSE-511
SDG512	Deutsch connector w/ Gain Adjustment	CH-510-1F00-LXX	TSE-510
SDG513	Samtec connector w/ Gain Adjustment	CH-511-1F00-LXX	TSE-511

Intended Application

The SDG500 Series (Smart Digital Governor) is designed to regulate engine speed on diesel and gas/gasoline reciprocating engines. The SDG 500Series (Smart Digital Governor) is a suitable replacement for any mechanical system that needs more flexibility, precision or control in governing speed. The SDG500 Series is an integral part of a closed loop control. When connected to an electric actuator and supplied with a magnetic speed sensor signal, the governor will direct the engine to the desired speed setting. The SDG500 Series (Smart Digital Governor) is designed for industrial applications ranging from generators and mechanical drives to pumps and compressors.



Compatible Products

Actuators

- All **GAC** actuators, except ACB2001*
- Connections to actuator may vary. Consult HT for compatibility.

Magnetic Pickups

- All **GAC** magnetic pickups

Introduction

The SDG 500 Series (Smart Digital Governor) is a solid state microprocessor based speed control unit that offers precise (+/- 0.25%) isochronous speed control with fast response to transient load changes. Designed for high reliability and ruggedly built, the **SDG 500 Series** is hard potted to withstand the harsh engine environment and can be mounted directly in the engine compartment. The **SDG500 Series** has several built in configurable features: three fixed and variable speed with correlating droop settings; engine shutdown protection; speed ramping from idle to operation speed; and start fuel control for lower engine exhaust emissions.

The factory standard **SDG500 Series** is pre-programmed to OEM's specifications. The **SDG510** and **SDG511** have no end user modifiable settings. The **SDG512** and **SDG513** are equipped with a single turn gain trim potentiometer for field adjustments.

If needed, configuration and tuning of the SDG500 Series can be accomplished by the OEM via GAC's configuration software. The software allows users to save the current configurations and data to disk or file. Saved settings can be utilized for configuring multiple units.

1.0 Installation

1.0 Hardware & Tools Needed for Mounting

- Two M4 Screws
- Screwdriver and Drill
- Cable Harness **CH-510** or **CH-511**

1.1 Optional for Use with Software

- USB/Serial Adapter
- Interface Cable / Pin out Box

1.2 Software Operating Requirements

- IBM compatible PC, 486DX2 or faster (100 MHz or higher microprocessor is recommended)
- Microsoft Windows 98 or later Operating System
- One available RS-232 serial port or USB Port (optional)

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that work right from the beginning.*

Murgenthalstrasse 30
CH-4900 Langenthal
Phone: +41 (0)62 916 50 30
Fax: +41 (0)62 916 50 35
E-Mail: sales@huegli-tech.com

BEFORE BEGINNING INSTALLATION

Disconnect all battery power to the engine. Make sure the engine cannot operate during installation. Follow all safety warnings of the machine manufacturer. Read and follow instructions carefully.

Please read the following instructions and visually inspect this product for damage from shipping before installing. It is your responsibility to have a qualified person install this unit and make sure it conforms to local codes.

2.0 Mounting the SDG

Locate the SDG Series control a distance from extreme heat, wires or coils. Operating temperature range is from -40° to 85° C (-40° to 185°F).

See **DIAGRAM 1 & 2.** (for the SDG510 & SDG512) and **DIAGRAM 2.** (for the SDG511 & SDG513).

To mount the SDG to a panel, drill 2 (4.7mm Ø) holes for mounting screws. Place module in front of the panel aligning with the pre-drilled holes. Secure the module in place with two M-4 screws.

Diagram 1.
Mounting for SDG510 & SDG512
Deutsch connector

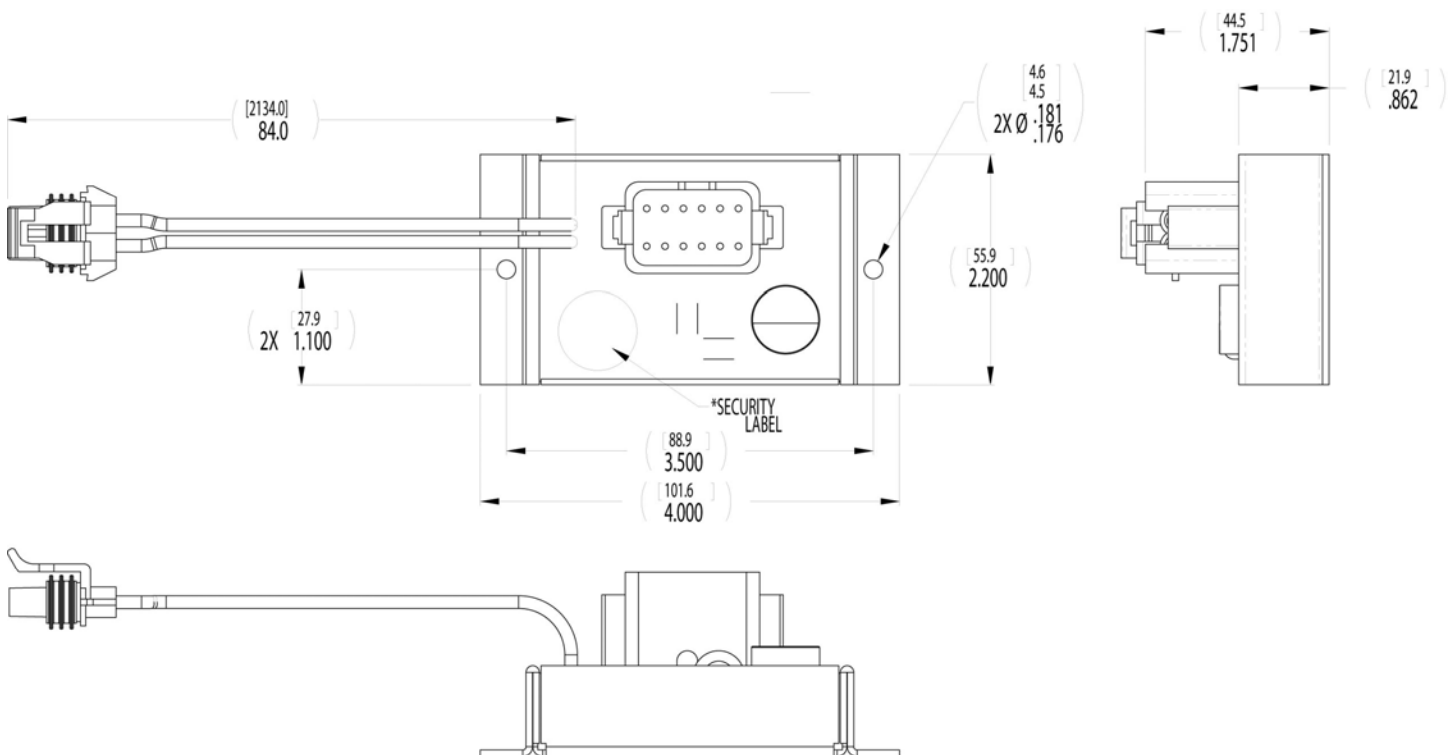
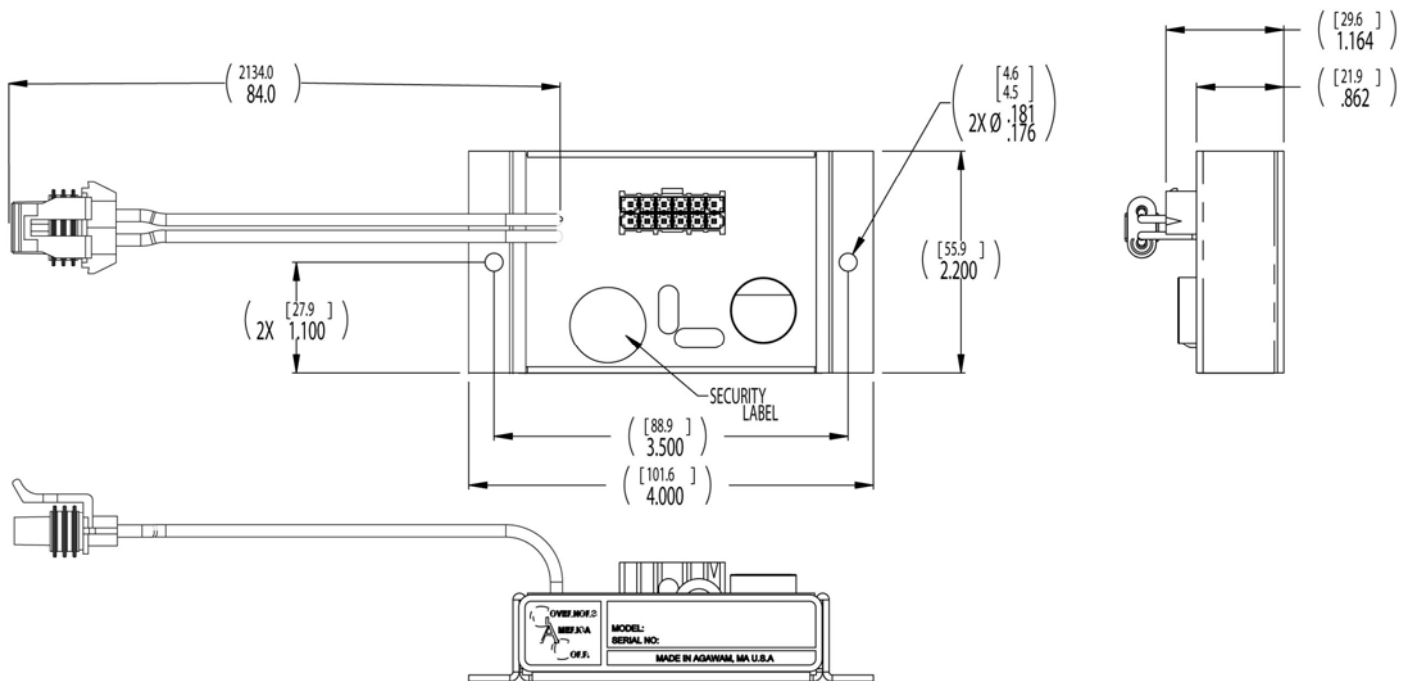


Diagram 2.
Mounting for SDG511 & SDG513
Samtec connector



3.0 Wiring the SDG

The SDG 500 control has an operating range of 10 to 32 VDC with nominal voltage range of 12 or 24 VDC.

TABLE 1.

SDG510 and SDG512 use the below listed DIAGRAMS and TABLES	SDG511 and SDG513 use the below listed DIAGRAMS and TABLES
General Wiring Instructions	General Wiring Instructions
DIAGRAM 3.	DIAGRAM 4.
TABLE 2 & 3.	TABLE 2 & 4.
Deutsch Cable	SAMTEC



GENERAL WIRING INSTRUCTIONS

For specific wiring instructions on **Connector Pins 2 & 3** for the **Samtec / Deutsch Connector** see **TABLE 2**. Battery connections to **Connector Pins 1 & 5** should be 16AWG (18mm²) or larger. Long cables require an increased wire size to minimize voltage drops.

Battery positive (+) input to **Connector Pin 1** should be fused for 15A.

The Magnetic Speed Sensor connections to **Connector Pin 8** on the SDG511 & SDG513 must be twisted and/or shielded for their entire length. The speed sensor cable shield should be connected to ground.

The shield should be insulated to insure that no other part of the shield comes in contact with engine ground, otherwise stray signals may be introduced into the SDG500 Series causing erratic operation.

Connect the **GAC** Standard Two Wire Actuator Connector to the connector on the actuator.

Table 2.

All SDG500 Series		Speed Select
Connector Pin 2	Connector Pin 3	
No Connect	No Connect	Variable Speed*
No Connect	Battery -	Fixed Speed 1
Battery -	No Connect	Fixed Speed 2
Battery -	Battery -	Fixed Speed 3

* A 10K Variable Speed Potentiometer needs to be connected to activate.

Diagram 3.

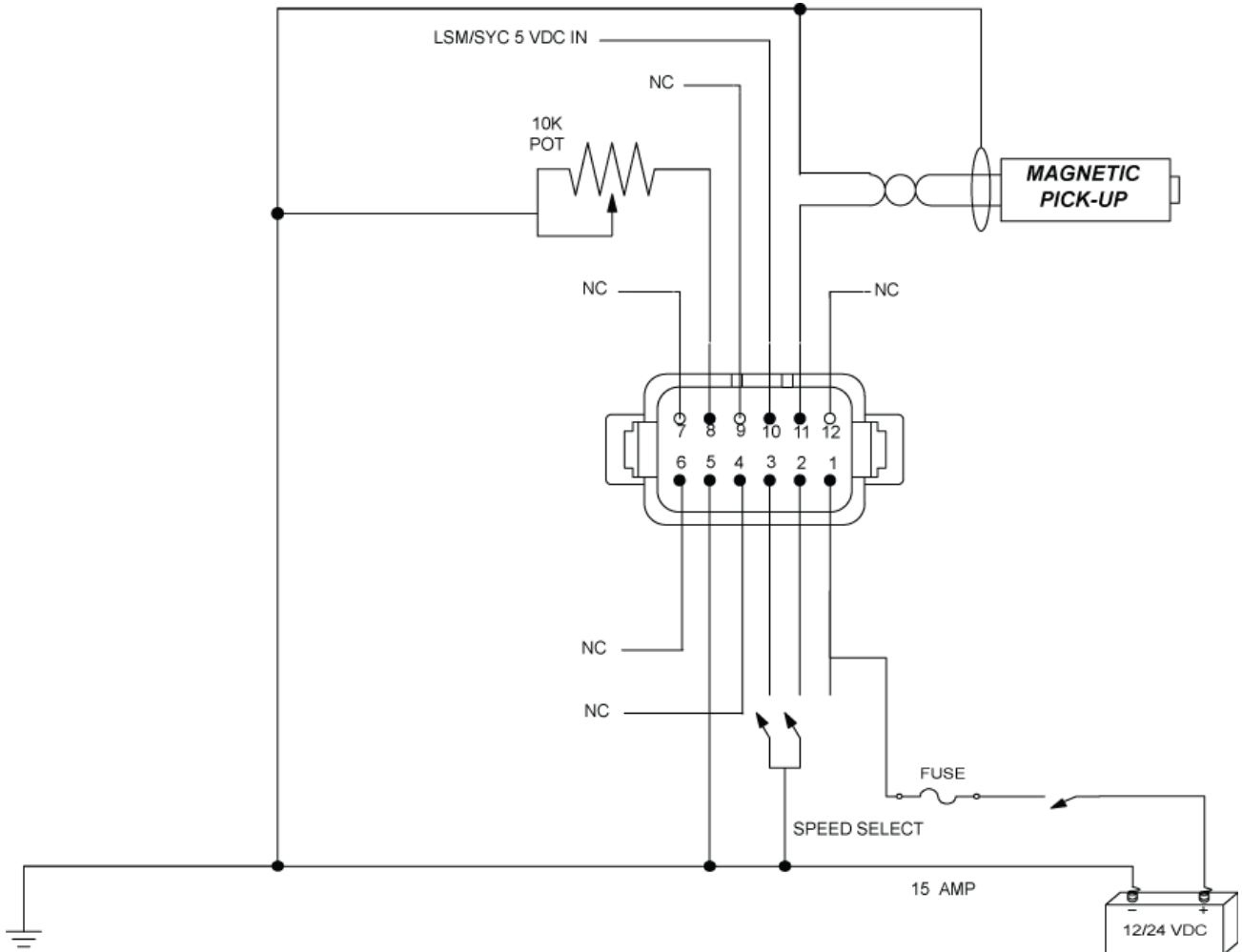


Table 3.

Deutsch Connector SDG510 and SDG512		
Connector Pin #	Description	Comment
1	+ 12 / 24 VDC Input Power	Supplies power.
2	Speed Select 1	See TABLE 2 for Speed Select Settings
3	Speed Select 2	See TABLE 2 for Speed Select Settings
4	No Connection	No Connection
5	Input Power Ground	Ground for the 12 / 24 VDC Input Power
6	No Connection	No Connection
7	No Connection	No Connection
8	0-5 VDC Input	Input for 25K Potentiometer for Variable Speed Control
9	No Connection	No Connection
10	0-5 VDC Input	Input for communication of LSS
11	MPU +	MPU speed signal input
12	No Connection	No Connection

Diagram 4.

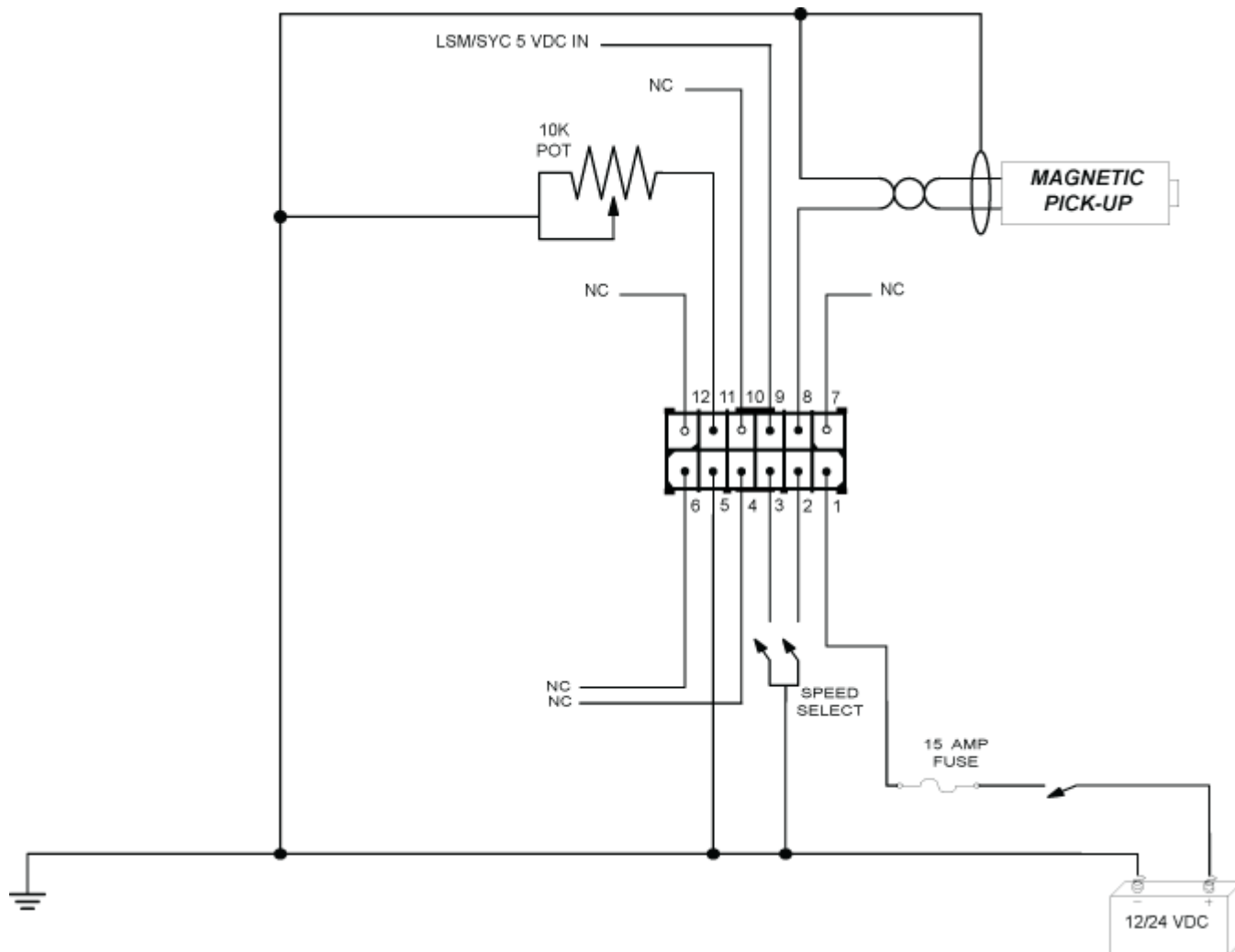


Table 4.

Samtec Connector SDG511 and SDG513		
Connector Pin #	Description	Comment
1	+ 12 / 24 VDC Input Power	Supplies power.
2	Speed Select 1	See TABLE 2 for Speed Select Settings
3	Speed Select 2	See TABLE 2 for Speed Select Settings
4	No Connection	No Connection
5	Input Power Ground	Ground for the 12 / 24 VDC Input Power
6	No Connection	No Connection
7	No Connection	No Connection
8	MPU +	MPU speed signal input
9	0-5 VDC Input	Input for communication of LSS
10	No Connection	No Connection
11	0-5 VDC Input	Input for 10K Potentiometer for Variable Speed Control
12	No Connection	No Connection

4.0 Connecting the SDG to the PC for Configuration

Connect the **TSE** to the **SDG** and the engine's cable harness.

Connect the DB9 connector to your PC and the **TSE**. Optional: Connect using an USB/Serial Adapter. (SDG512/13 only) Set gain trim adjustment to mid-point.

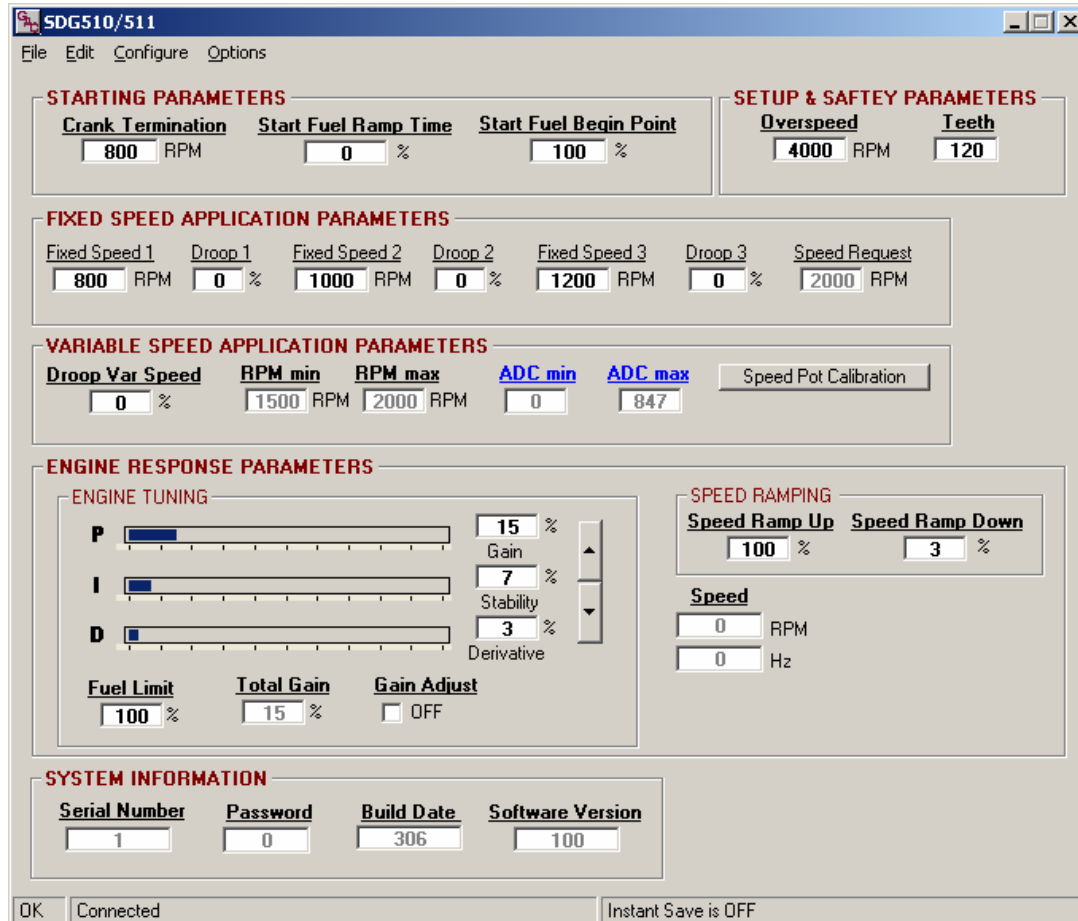
5.0 Installing SDG Software

The software for the SDG does not affect the registry rights of your operating system and therefore is easy to install. Simply copy the file **GAC_SDG51X.exe** to the desired location and double click to execute.

5.1 Establishing a Connection

1. Double click on **GAC_SDG51X.exe** file.
2. If the software does not indicate **Connected** on the bottom left section of the screen, select **Configure** from the drop down menu and choose **Communications**. (see **Figure 1**.)
3. Select the number of the **CommPort** used from the drop down list box, then select **OK**.
4. Select which unit your are configuring from the **Configure** drop down menu.

Figure 1.



6.0 Working in Offline Mode

GAC's configuration software allows you to work offline to input/change parameters that you can save to file and use to load to multiple units. To work in this mode:

1. Select **Configure** from the drop down menu and choose **Offline**.
2. Enter desired configurations.
3. Choose **Save** from the file menu to save to file.
4. Select the **Save Offline Data to SDG** button to save the configurations to the **SDG**.

Changes made in offline mode must be saved before switching to **Instant Save** mode.

7.0 Working in Instant Save Mode

In **Instant Save** mode GAC's configuration software will update and save any changes made instantaneously to the **SDG**. To work in this mode:

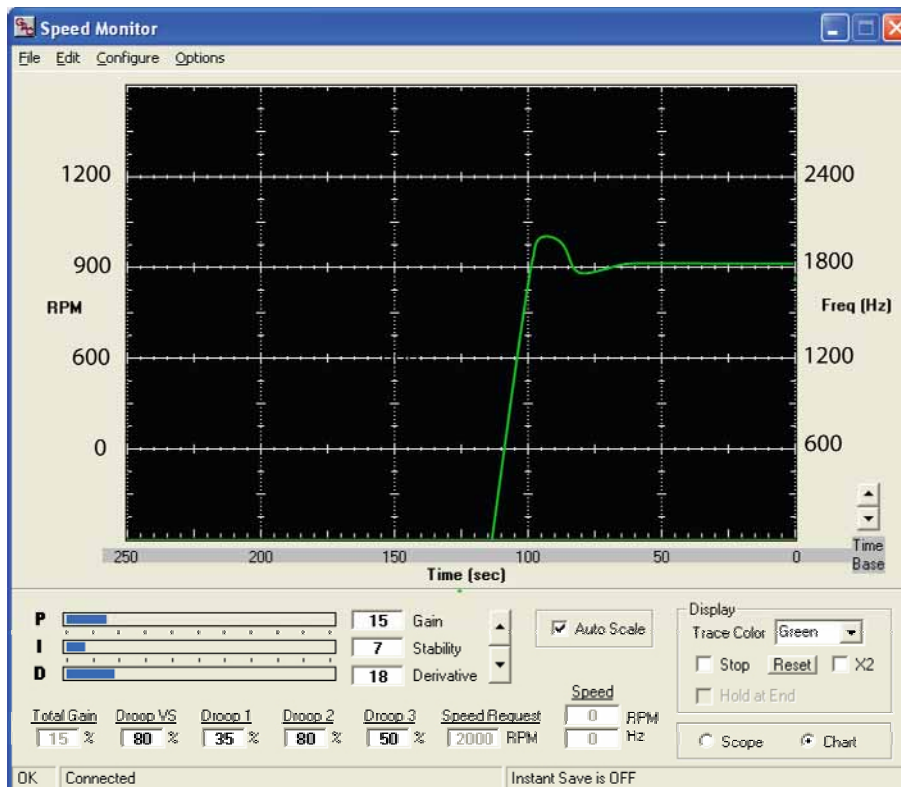
1. Select **Configure** from the drop down menu and choose **Instant Save**.

8.0 Speed Monitor

With GAC's configuration software. to work in this mode:

1. Select **Options** from the drop down menu and choose **Speed Monitor**. (see **Figure 2**.)

Figure 2.





9.0 Description of Configurable Parameters

Setting and values are based on number of teeth on the flywheel and therefore ranges may vary.

Table 5.

Critical Setting			Description	Configurable Parameters
	Variable Speed Application Parameters	ADC min	Max RPM value from the SDG analog to digital converter.	Read only
	Variable Speed Application Parameters	ADC max	Min RPM value from the SDG analog to digital converter.	Read only
	System Information	Build Date		Read only
!	Starting Parameters	Crank Termination	RPM set point for crank termination. When the engine RPM exceeds the crank termination set point, the SDG switches from start up cycle to PID loop control. This parameter must be set higher than the maximum cranking RPM.	yes
!	Engine Response Parameters	Derivative	PID. Derivative mode is a breaking action to the controller response as the process variable approaches the set point.	yes
	Fixed Speed Application Parameters	Droop 1	The percent of compensation which reduces the governor's reference speed as fuel position or load increases in reference to Fixed Speed 1.	Yes
	Fixed Speed Application Parameters	Droop 2	The percent of compensation which reduces the governor's reference speed as fuel position or load increases in reference to Fixed Speed 2.	Yes
	Fixed Speed Application Parameters	Droop 3	The percent of compensation which reduces the governor's reference speed as fuel position or load increases in reference to Fixed Speed 3.	Yes
	Variable Speed Application Parameter	Droop Variable Speed	The percent of compensation which reduces the governor's reference speed as fuel position or load increases in reference to Variable Speed.	Yes
	Engine Response Parameters	External Gain		
!	Fixed Speed Application Parameters	Fixed Speed 1	Desired RPM set point when the speed select input is set to 1.	yes
!	Fixed Speed Application Parameters	Fixed Speed 2	Desired RPM set point when the speed select input is set to 2.	yes
!	Fixed Speed Application Parameters	Fixed Speed 3	Desired RPM set point when the speed select input is set to 3.	yes
	Engine Response Parameters	Fuel Limit	The percentage limiter set point on the fuel demands that prevents the over fueling after the engine has started.	yes
!	Engine Response Parameters	Gain	PID. Proportional mode responds to a change in the process variable proportional to the current measured error value.	yes
!	Engine Response Parameters	Gain Adjust	Turns the external gain pot on or off. Available only in the SDG513.	yes
!	Set Up & Safety Procedures	Overspeed	RPM Set Point for an Engine Shutdown Signal to the actuator.	yes
	Variable Speed Application Parameters	RPM max	Maximum RPM set point for Variable speed	Read only
!	Variable Speed Application Parameters	RPM min	Minimum RPM set point for Variable speed	Read only
!	System Information	Serial Number	System Information.	Read only
	System Information	Software Version	System Information.	Read only
	Speed Ramping	Speed Ramp Down	The % percent set point to decrease engine speed per second when changing speeds.	yes
	Speed Ramping	Speed Ramp Up	The % percent set point to increase engine speed per second when changing speeds.	yes



	Fixed Speed Application Parameters	Speed Request	Desired speed of engine at the current state.	yes
!	Engine Response Parameters	Stability	PID. In integral mode, the controller output is proportional to the amount and duration of the error signal.	yes
	Starting Parameters	Starting Fuel Ramp	Gradually increases the amount of fuel during the engine crank cycle, which eliminates most unnecessary smoke. The higher the setting the quicker the engine comes to speed. The starting position of the actuator at engine start. The percent to increase the fuel flow per second until the engine reaches 100% or the governors takes control.	yes
	Starting Parameters	Starting Fuel Start Point	Determines how much fuel to begin with before fuel ramping engages. The minimum fuel required for starting the engine. Retards black smoke. The starting position of the actuator at engine start.	yes
!	Setup & Safety Parameters	Teeth	Number or teeth on the flywheel. Used to calculate speed settings and values.	yes
	Engine Response Parameters	Total Gain	The sum of Internal and External Gain.	yes
	Speed	RPM/HZ	Actual RPM/HZ of engine.	Read only

10.0 Parameters

Before starting engine safety, basic parameters on the SDG must be configured

Table 6.

Configurable Parameters	Instruction	Critical Settings
Teeth	Configure first. Used to calculate values and settings.	!
Overspeed	Set typically 10% above desired governing speed.	!
Crank Termination	This parameter must be set higher than maximum cranking RPM. This set point helps the SDG determine in the engine is cranking or running.	!
Speed Select 1, 2, 3	Insure that the Speed Select is wired correctly (see TABLE 5). Set RPM in the appropriate Fixed Speed window.	!
Variable Speed Operation	Make sure the Variable Speed Potentiometer is connected correctly (see DIAGRAM 2) and Configuration Software is open. In Instant Save mode, click on the Speed Pot Calibration button. Set the Minimum position on the potentiometer and then set the RPM min on the screen. Click on the Continue button. Set the Maximum position on the potentiometer and then RPM max on the screen click on the Continue button. Click OK on the popup window to calibrate.	!
ADC min and max (meter)	Represents the min and max values set on the Variable Speed Potentiometer.	

Table 7.

Screen Section 2. Read Only Meters	
Meter	Description
Speed Request	Displays the speed requested for the current state.
RPM / Hz	Displays the SDG's reading of Actual RPM Engine.

Table 8.

Screen Section 3. Advanced configurations that do not need to be configured before starting the engine.	
Configurable Parameters	Instruction



Starting Fuel Ramp	Gradually increases the amount of fuel flow per second during the engine crank cycle, which eliminates most unnecessary smoke. The higher the setting the quicker the engine comes to speed.
Starting Fuel Begin Point	Determines how much fuel to begin with before fuel ramping begins.
Speed Ramp Up	The % percent set point to increase engine speed per second when changing speeds.
Speed Ramp Down	The % percent set point to decrease engine speed per second when changing speeds.
Fuel Limit	Adjusts maximum amount of fuel the SDG will command. During normal starting cycles and short step loads, this function will not engage. Only after a 1 second delay of the Fuel Limit exceeding it's configured value, then the fuel will roll back to the configured value. Helps to reduce engine smoke and prevents engine damage.
Droop Select 1, 2, 3	The % set point that reduces the governor's reference speed as fuel position or load.
Variable Droop Operation	The % set point that reduces the governor's reference speed as fuel position or load.

Table 9.

Screen Section 4. PID Parameters. Must be adjusted after the engine starts for best performance.		
Configurable Parameters	Instruction	Critical Settings
Gain	The PID screens are adjustable by only increments of 1 or 2. Choose increments by selecting the appropriate option button. The use the UP and DOWN buttons for fine tuning.	!
Stability		!
Derivative		!
Gain Enabled	Select YES or NO to turn the GAIN Adjustment ON or OFF. (SDG513 only)	
Total Gain	The sum of Internal and External Gain. (SDG513 only)	

TABLE 10.

Meter	Description
Serial Number	System Information.
Software Version	
Build Date	
Password	

11.0 Starting the Engine

1. Verify parameters settings.
2. Start engine.
3. After the engine has started and it is at running speed adjust the Gain, Stability and Derivative (PID) parameter settings for best performance. (See **TABLE 9.**)



12.0 Trouble Shooting

Engine will not start- checklist after you stop cranking.

1. Check for battery connection, proper polarity, and proper charge.
2. Recheck Flywheel Teeth, Overspeed Setting, Variable and Fixed Speed Settings.

Engine will not start – checklist while cranking the engine.

1. Measure the battery voltage while attempting a crank. If the voltage drops below 8 Volts then the battery is not sufficiently charged.
2. Check that the actuator voltage is no less than 2 volts less than battery voltage. If the actuator voltage checks then verify the proper connection of the actuator.
3. Check Crank Termination setting. Typically the Crank Termination should be set to at least 50RPM higher than the maximum cranking speed of the engine. If possible measure the cranking RPM of the engine. You can try increasing in 100RPM increments. If engine appears to start but cuts out then the Fuel Limit may be too low. Try increasing the Fuel Limit to 100% initially to disable the Fuel Limiting. If the engine starts, the Fuel Limit will have to be reduced from 100% to more optimum level.
4. Verify the Mag Pickup signal is properly connected. If possible measure the pickup signal while the engine is cranking. The voltage must be a minimum of 05.VRMS for proper operation.
5. If possible through the PC Configuration software check the Starting Fuel Limit and the Starting Fuel Start Point.
6. Check set to a shorter time of Fuel Ramp Up through the PC configuration software.

Engine Starts but not running at proper speed.

1. Are the fixed speed inputs properly configured. If one or both of the fixed speed inputs is not connected to ground the SDG will operate in variable speed mode.
2. Make sure the correct number of flywheel teeth is set using the configuration software.
3. Make sure the proper fixed speed is set using the configuration software.

Engine not running at the correct Variable Speed.

1. Make sure the Variable Speed Potentiometer is connected properly. Refer to the configuration section for proper setup. Verify, through the configuration software, that the MIN speed setting is less than the MAX speed setting.
2. Be sure the proper number of flywheel teeth are set.

Overspeed during load transient.

1. The overspeed may be set is too low. Recheck the overspeed setting.
2. The SDG is not tuned properly for the application. Try retuning the SDG.

Overspeed during speed changes.

1. Overspeed setting may be too low. Recheck the Overspeed setting.
2. Speed Ramp setting is set too low. Increase the Speed Ramp setting. This will cause the engine to accelerate more slowly reducing



13.0 Specifications

Performance

Isochronous Operation/Steady State Stability $\pm 0.25\%$
 Speed Range/Governor 400-10KHz
 Speed Drift w/ Temp $< \pm 1\%$ Max.
 Idle Adjust Full Range
 Droop Range 1-17% Regulation
 Speed Trim Range $\pm 5\%$ of Rated Speed

Environmental

Ambient Operating Temperature Range -40° to $+85^{\circ}\text{C}$
 $(-40^{\circ}$ to $+180^{\circ}\text{F})$
 Relative Humidity Up to 95%

Reliability

Vibration 7G@20-100Hz
 Testing 100% Functionally Tested

Input/Output Parameters

Supply 12 - 24 VDC Battery Systems (6.5VDC to 33VDC)
 Polarity Negative Ground (Case Isolated)
 Ground Power Consumption 70 mA max. continuous plus
 actuator current
 Speed Sensor Signal 0.5-120 VRMS
 Load Share/Synchronizer Input for GAC / Comap
 Discrete Output Supply up to 25m rated 20mA@12Vdc

Configuration Parameters

Flywheel Teeth 50-250
 Range (Gain/Stability multiplier) 1-10
 Fixed Speed Settings* 0-max RPM
 Variable Speed Settings* 0-max RPM
 Overspeed Setting* 0-max RPM
 Starting Fuel Preset* 0-max Fuel

* Maximum RPM is based on the Flywheel Teeth. $\text{RPM} = \text{Frequency} \times 60 / \text{Flywheel Teeth}$. Maximum Frequency is 10,000Hz.