GC1000
Dual Fuel Conversion

+1 413 233 1888
www.governors-america.com

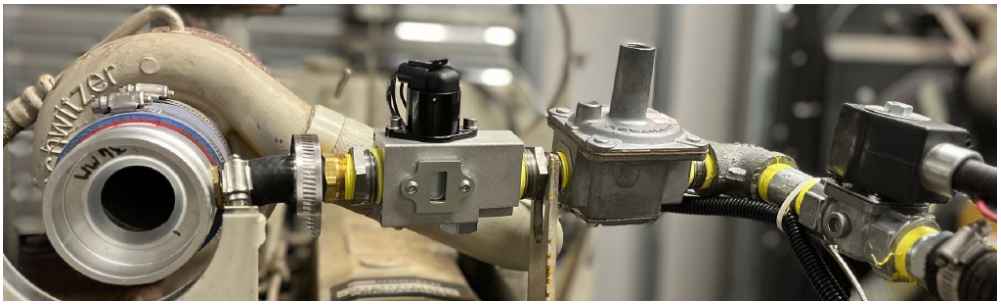
1 DUAL FUEL DIESEL - GASEOUS CONVERSION

GACs dual fuel solution controls the flow of gaseous fuel, and does not affect the diesel fuel system, meaning there is no need for governing system updates on the diesel side. Our solution requires no modifications to the core engine or to the factory fuel management system.

A dual fuel system allows for the simultaneous combustion of 2 fuels. Using the existing diesel system, gaseous fuel is introduced. As load increases, gas is increased into the system, supporting load with gaseous fuel to maintain the desired speed / load regulation. The gaseous controller automatically controls the ratio of diesel to gaseous fuel.

This solution requires no modifications to the core engine or to the factory fuel management system. A dual-fuel engine can operate on 100 percent diesel fuel or a mixture of diesel and gas fuel, with an optimal mixture of 30% diesel and 70% natural gas, delivering the same power, torque, and transient response as the single fuel diesel engine.

This simple, clean solution automatically controls gas flow based on increased demand. A table in the gaseous controller software controls the stepper motor increment of gaseous fuel to support load changes.



2 GC1000 CONTROLLER SPECIFICATIONS

PERFORMANCE	
Isochronous Operation / Steady-State Stability	± 0.25 %
Speed Range / Governor	400 - 10 kHz (Mag Pickup)
Speed Drift with Temperature	< ±1 % MAX
Idle Adjust	Full Range
INPUT / OUTPUT	
Supply	12 - 24 V DC Battery Systems (6.5 - 33 V DC)
Polarity	Negative Ground (Case Isolated)
Power Consumption	100 mA MAX. Continuous plus Stepper, and MIL
Speed Sensor Signal	0.5 - 120 V RMS
PHYSICAL	
Dimension	See Section 4, GC1000 Installation
Weight	1.1 lbf [0.49 kgf]
Mounting	Any position,vertical preferred
COMPLIANCE / STANDARDS	
Agency	CE and RoHS Requirements
Communications	RS-232-C, IEEEE J1939

PARAMETERS	
Flywheel Teeth	50 - 250
Fixed Speed Settings*	0 - MAX rpm
Overspeed Settings*	0 - MAX rpm
Starting Fuel	0 - 100 %
Fuel Valve Setpoint	0 - 100 %
ENVIRONMENTAL	
Temperature Range	-40 to 80 °C [-40 to 185 °F]
Relative Humidity	up to 95 %
RELIABILITY	
Vibration	7g @ 20 - 2000 Hz
Shock	20 g Peak
Testing	100% Functional Testing

*Maximum RPM is based on the Flywheel Teeth. RPM = Frequency x 60 / Flywheel Teeth. Maximum Frequency is 10,000 Hz timing retard/ advance.

WARNINGS AND NOTICES

Shut off the gas supply at the main manual shutoff valve before installing or servicing the control. Failure to shut off the gas supply can result in the release of gas during installation or servicing, which can lead to an explosion or fire, and may result in severe personal injury or death.

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage. The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

Components vary by engine. See your GAC representative before ordering parts or installing this solution.

GAC makes no warranties for the conception and engineering of the technical installation as a whole. This is the responsibility of the user. It is the users responsibility to verify whether the performance features of our devices will meet the intended purposes. The user is responsible for correct commissioning of the total installation.

The examples, data and any other information contained in this manual are intended elusively as instruction aids and should not be used in any particular application without independent testing and verification by the person making the application.

This manual describes how to install and initially tune a dual fuel system using a GC1000 controller. Read the entire manual and all related publications before installing, operating, or servicing this equipment. Practice all local safety rules. Failure to follow these instructions can result in personal injury and/or property damage and are not the responsibility of GAC.

This solution is not intended for highway use.

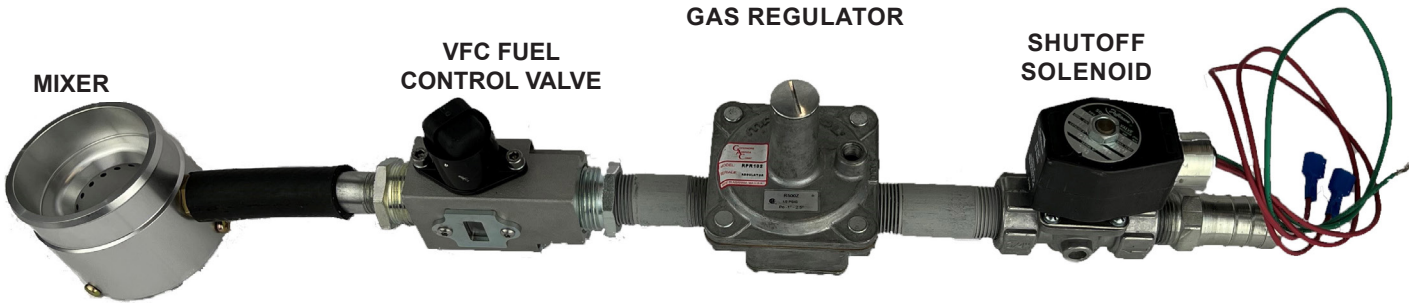
3 GASEOUS CONVERSION COMPONENT LIST

The following components are generally used to create this gaseous fuel system solution. Components vary by engine. See your GAC representative before ordering parts or installing this solution.

COMPONENT	GAC PART NUMBER	DESCRIPTION
Dual Fuel Controller	GC1000	Diesel to Dual Fuel Controller
DF Mating Connector	EC1501	Connector J1 (35 pin)
Stepper Control	VFC106	Fuel Control Valve with stepper motor
Stepper Mating Connector	EC1507	4-pin Delphi Mating Connector for Gaseous Fuel Control Valve
Zero Pressure Gas Regulator	RPR10X	Regulator with NPT fittings
Exhaust Gas Temperature Sensor (EGT)	STE101	Type K Thermocouple w/ Mini-TC Connector and Mate, 1/4 NPT
Gas Shutoff Solenoid	SOS10X-X	Shutoff solenoid
Fuse Holder Kit	EC1505	Fuse Holder Assembly
Magnetic Speed Pickup	MSP6732C	Magnetic Speed Sensor
RS232 PC Interface	EAM204	USB to RS232 Adapter
Serial Connector	EC1516	DB-9 Female Connector
Venturi Mixer	MXCxx of MXDxx	Gaseous Fuel Mixer, per engine size
Current Transformer or Pressure Sensor	SPM1000 CT200	Pressure Sensor 0-5V CT 0-5V, 200 Amp
J1939 CAN Reader (Optional)	JDR100	J1939 Data Reader
JDR Harness (Optional)	CH417-4572	15 ft JDR Harness Assembly
JDR Mating Connector (Optional)	EC1331	JDR Connector
Gaseous Fuel Filter (Optional)	GFL10X	Gas Fuel Filter
Filter Element Replacement (Optional)	GFL106/109	Replacement Filter

4 HARDWARE SYSTEM OVERVIEW

The dual fuel solution consists of a Shutoff Solenoid (SOS), a zero Gas Pressure Regulator (RPR) , a Fuel Control Valve (VFC) (stepper motor) and mixer and a Load Signal sensor. Gaseous fuel enters the inlet air stream through a shutoff solenoid, gas pressure regulator, fuel control valve and mixer. The GC1000 controls the percent of gaseous input to ensure constant engine speed is maintained under load. The solution does not control engine speed. Load changes are measured with a 0-5 V DC output sensor, such as a pressure sensor (BPS) or current transformer (CT). The exhaust gas temperature sensor and MSP provide general engine data to the controller. In a diesel engine gaseous fuel enters the engine's air intake through a mixer installed upstream of the turbocharger(s) at a single-point admission. Incoming gas timing is determined either at RPM or based on load. The incoming gas supply is filtered prior to a pressure regulator and shutoff valves.




GC1000


CURRENT TRANSFORMER


PRESSURE SENSOR

LOAD SIGNAL


MAGNETIC SPEED SENSOR


EXHAUST GAS TEMPERATURE SENSOR

5 GASEOUS MIXER SELECTION AND INSTALLATION

The air-fuel mixer and control valve adjust the air to fuel ratio of the incoming gaseous fuel. While the Fuel Valve Control (VFC106) stepper motor controls the quantity of gas, the mixer controls the quality and volume of the gaseous mixture.

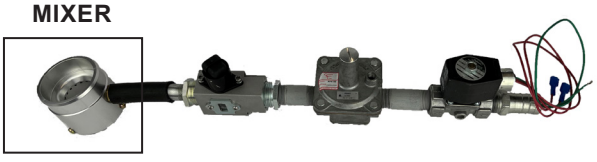
Using your engine size (liters) use the following table to determine the mixer size required for your system.

MIXER SELECTION			
Engine (Liters)	Throat Size [mm]	Mixer Part Number	Venturi Mixer Ring Part Number
3	32	MXC32	PL332-5
3.5 -4	33	MXC33	PL333-5
4 - 5	35	MXC35	PL334-5
5 - 6	36	MXC36	PL335-5
6 - 8	38	MXC38	PL336-5
8 - 10	40	MXC40	PL343-5
10-14	48	MXD48	PL347
14-16	54	MXD54	PL344-5

Standard mixers come with a mixer ring using 24 evenly spaced 5mm diameter gas flow holes.

Any change to air intake can change calibration including air filter or piping changes.

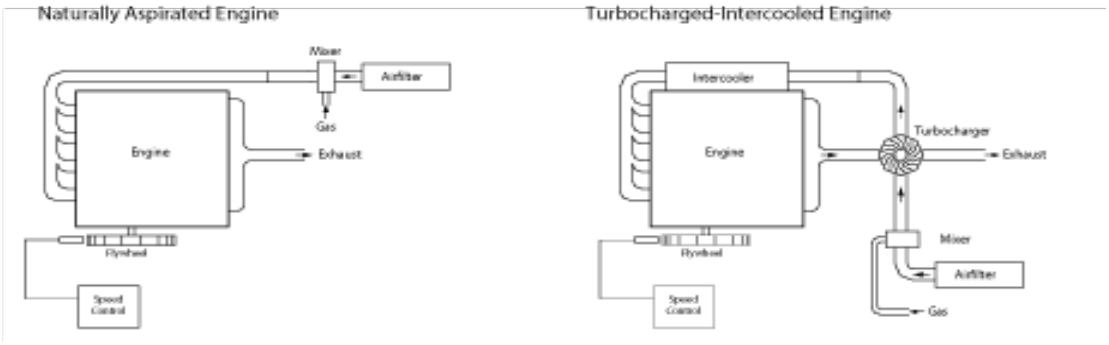
MIXER



5 GASEOUS MIXER SELECTION AND INSTALLATION (CONTINUED)

INSTALLING THE MIXER

The mixer must be installed closest to the air intake. The following figures apply to NATURALLY ASPIRATED ENGINES and TURBO ENGINES, showing the optimal mixer locations.

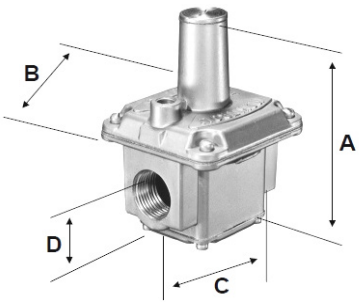


1.	Clean the mounting area to the flange of the turbocharger inlet (or adapter) as well as the air filter connection from debris including old gaskets or previously applied sealants if present.
2.	Install the mixer. Ensure the mixer is aligned in the correct orientation prior to seating it to the flange and that the fuel inlet is horizontal.

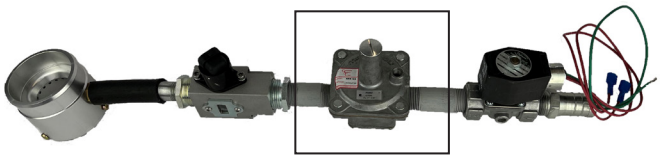
6 ZERO PRESSURE GAS REGULATOR

A Zero Pressure Gas Regulator (RPR) is attached to the fuel inlet port between the shutoff valve and gaseous fuel control valve to regulate the pressure to the assembly. The regulator has a reference / feedback port on top of the unit in order to regulate pressure. In most cases select the correct version of the regulator by choosing the size fitting you prefer and ensuring that the pressure drop is within the allowable range using the manufacturer provided data.

The mixer and fuel control valve assembly may have a different size fittings, select interconnect plumbing accordingly. Use the following table to select a zero pressure gas regulator.



GAS REGULATOR



The mounting location depends on the dimensions of the gas pressure regulator. The following regulators are available from GAC. GAC carries a full range of regulators so contact us if what you need is not on the list.

The gas regulator MUST be installed with the adjustment post pointing upward and the regulator body extended horizontally to guarantee consistent operation.

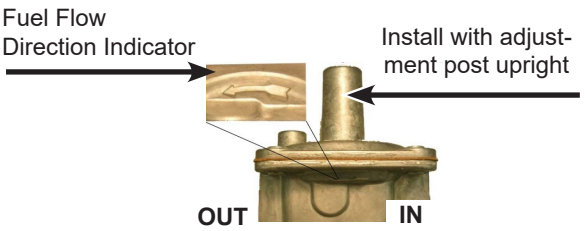
GAC PN	PIPE SIZE	VENT CONNECTION	MAX PRESSURE	SWING RADIUS IN [MM]	DIMENSIONS IN[MM]			
					A	B	C	D
RPR102	0.75 in	1/8 in NPT	0.5 psi	3.6 [90]	4.7 [119]	3.1 [79]	3.0 [79]	1.2 [30]
RPR103	0.75 in	1/8 in NPT	1.0 psi	4.3 [109]	5.7 [144]	3.9 [98]	4.0 [102]	1.5 [37]
RPR106	1.0 in	1/8 in NPT	5.0 psi	4.3 in [109]	5.7 [144]	3.9 [98]	4.0 [102]	1.5 [37]
RPR104	1.0 in	1/2 in NPT	5.0 psi	5.4 [138]	9.0 [229]	7.0 [178]	6.0 [152]	2.4 [60]
RPR105	1.5 in	1/2 in NPT	1.0 psi	5.4 [138]	9.0 [229]	7.0 [178]	6.0 [152]	2.4 [60]

6 ZERO PRESSURE GAS REGULATOR (CONTINUED)

ZERO GAS PRESSURE REGULATOR INSTALLATION

Ensure the fuel supply is shut off or disconnected when working on fuel system plumbing.

1. Position the gas pressure regulator no further than 6 ft [2 m] from gaseous fuel control valve and install an interconnect between the regulator and the gaseous fuel control valve using pipe unions or barbed fittings into the fuel inlet port for the mixer.
   - If pipe unions are used use an approved pipe thread sealant to ensure the connection is leak proof.
   - If barbed fittings are used, ensure that properly-sized, high-quality, hose clamps are installed in pairs.
2. The zero pressure gas regulator is directional. This figure identifies the fuel flow direction indicator. Ensure the fuel flow direction is toward the mixer and fuel control valve during installation.
3. Connect a hose (or equivalent) to the feedback port that is long enough to reach the air cleaner or air filtration system connection point.
4. Once all the plumbing is complete, enable the fuel supply, and ensure the inlet pressure to the regulator is positive but within the guidelines shown for your application considerations.
5. Complete the SmartVU GC Series startup configuration settings.
6. Remove the slotted cap on the regulator adjustment post to locate the pressure adjustment screw.



7 ELECTRONIC SHUTOFF SOLENOID INSTALLATION

The electronic gas shutoff solenoid (SOS) valve gives the gaseous controller authority over gas flow into the regulator, increasing over-all safety and performance. Initial gas flow is set up based on RPM or Load Signal (LS Fuel Threshold) as displayed in SmartVU. The following SOS hardware options are available.

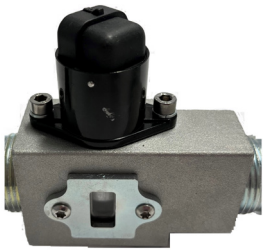
MODEL	DESCRIPTION
SOS100-12	12 V DC / 0.75 in [19.05 mm] / Direct-Acting / Pressure Diff 0 - 3 psi [0 - 0.2 bar] MIN-MAX
SOS100-24	24 V DC / 0.75 in [19.05 mm] / Direct-Acting / Pressure Diff 0 - 3 psi [0 - 0.2 bar] MIN-MAX
SOS101-12	12 V DC / 1.0 in [25.40 mm] / NPT Fittings / Pilot-Operated Quick Open / Pressure Diff 0.015 - 3 psi [0.001 - 0.2 bar] MIN-MAX
SOS101-24	24 V DC / 1.0 in [25.40 mm] / NPT Fittings / Pilot-Operated Quick Open / Pressure Diff 0.015 - 3 psi [0.001 - 0.2 bar] MIN-MAX
SOS102-12	12 V DC / 1.0 in [25.40 mm] / NPT Fittings / Direct-Acting / Pressure Diff 0 - 0.75 psi [0 - 0.5 bar] MIN-MAX
SOS102-24	24 V DC / 1.0 in [25.40 mm] / NPT Fittings / Direct-Acting / Pressure Diff 0 - 0.75 psi [0 - 0.5 bar] MIN-MAX
SOS103-12	12 V DC / 1.5 in [38.10 mm] / NPT Fittings / Pilot-Operated Quick Open / Pressure Diff 0.015 - 3 psi [0.001 - 0.2 bar] MIN-MAX
SOS103-24	24 V DC / 1.5 in [38.10 mm] / NPT Fittings / Pilot-Operated Quick Open / Pressure Diff 0.015 - 3 psi [0.001 - 0.2 bar] MIN-MAX

SHUTOFF SOLENOID INSTALLATION

1. Check the mounting pipes for dirt. Small particles of dirt can cause solenoid valves to malfunction.
2. Determine mounting placement:
   - Note flow direction when installing the valve as indicated by the arrow on the valve body.
   - Install the valve with the coil facing upward with a maximum deviation of 90° and the valve mounted horizontally with the vent pointing down to reduce the risk of collecting dirt in the valve. DO NOT install the valve with the top in the down position or in any location with excessive vibration.
   - Never connect the coil to the power supply when it is not mounted on the solenoid valve.
3. Holding the valve in the desired position, use a wrench on the flats of the valve to hold it in place and tighten each pipe into the inlet and the outlet. Avoid pipe strain by aligning valve with piping. Do not allow the valve body to twist with the pipe during installation. If using pipe compound DO NOT apply compound to the valve as it may enter the valve and cause issues.
4. Tighten the nut sufficiently to make sure that the coil does not rotate or vibrate, but avoid over tightening in order to prevent damage. Recommended torque is 5 N·m (44.25 in-lbs).

8 VFC STEPPER MOTOR INSTALLATION

The VFC106 is directly controlled by the System Tuning table in the SmartVU software, which controls the percent of gas added into the system.



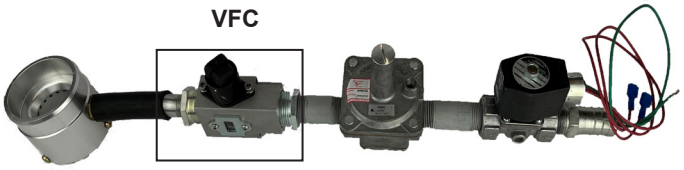
The fuel control valve is not a shutoff valve. The gaseous shutoff function is performed by a SOS or separate shut-off valve.

To install and set the VFC fuel valve:

1. Install the valve in series between the regulator and the mixer. Connection piping should be the same diameter as that currently in use.

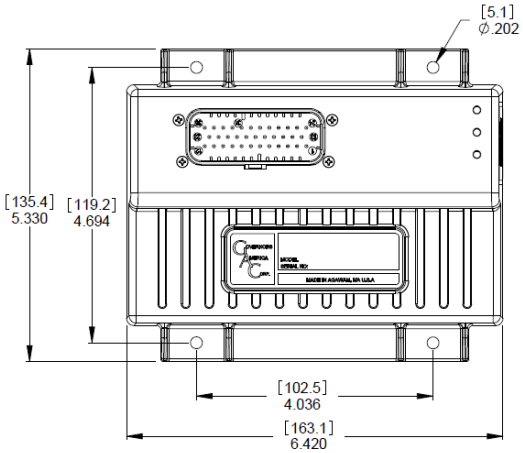
IMPORTANT To avoid condensation in the electronics housing, do not install with motor facing down to avoid condensation in the electronics housing.

2. Allow room for the wiring harness from the GC1000 to the VFC106 to connect to the stepper motor input.

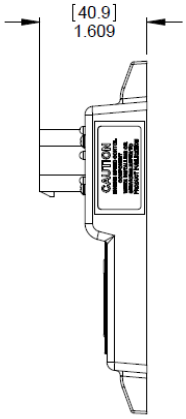


9 GC1000 CONTROLLER INSTALLATION

The GAC Dual Fuel system revolves around the GC1000 controller. The location of each component will vary depending on your environment.



Vertical orientation allows for the draining of fluids in moist environments.



Dimensions: in [mm]

Avoid Extreme Heat

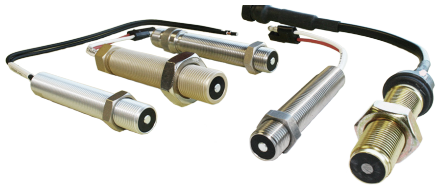
Mount in a cabinet, sealed metal box, or directly to the engine.

Do not mount next to turbocharger, exhaust manifold, or high temperatures.

GC1000 MOUNTING PROCEDURE	
1.	Clean the mounting area of any dirt or debris.
2.	Mount the GC1000 using a bracket or a direct to bulkhead mounting scheme using the dimensions and application information provided. If stand-offs or vibration isolators are required, make sure these are in place prior to proceeding.
3.	Insert the mounting hardware selected into the four holes on GC1000. Pre-drill and tap the locations as required prior to installation.
4.	Using standard values, apply torque evenly and gradually, and being sure not to over torque, tighten the selected mounting hardware to a maximum of 0.34-0.68 N·m (3.00 - 6.00 in-lbs) to avoid damaging the mounting tabs or flexing the controller.

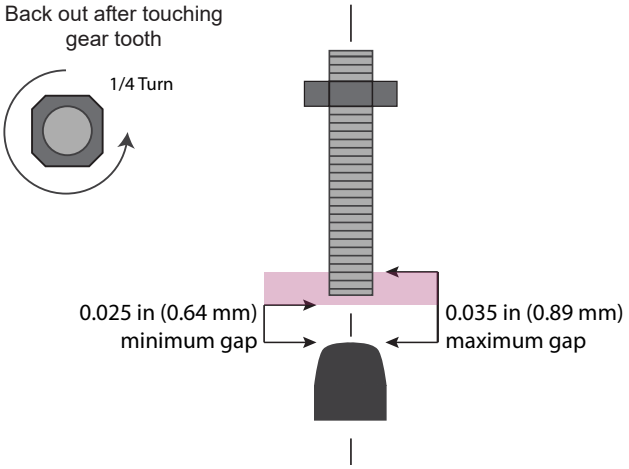
10 MAGNETIC SPEED SENSOR INSTALLATION

Magnetic Speed Sensors (MSP) detects when ring gear teeth (flywheel) pass the tip of the sensor. The output signal is an AC sine wave whose frequency is converted to crankshaft revolutions per minute (RPM) by the GC1000. Further details on mag pickups options and mag pickup installation are available from your GAC representative.



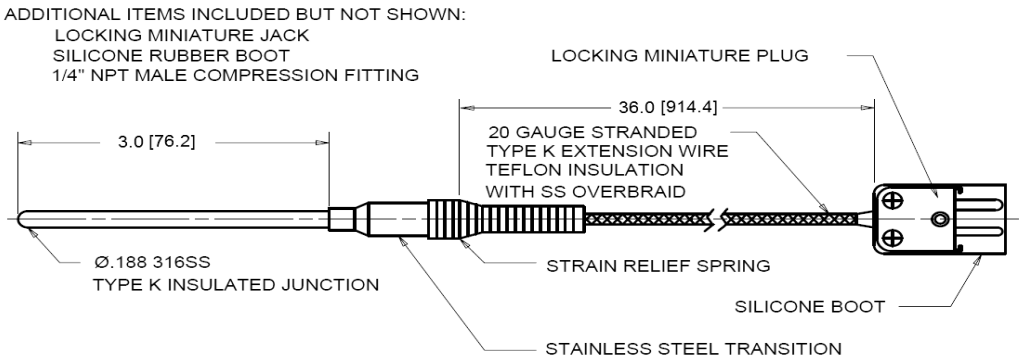
MAG PICKUP INSTALLATION

1.	Ensure the engine is not running and the ignition switch is turned to the OFF position.
2.	Install the magnetic pickup in the engine bell housing, ring gear case, or fabricated bracket.
3.	Screw the speed sensor in until it touches a gear tooth and back it out 1/2 turn.
4.	Adjust the pickup to a nominal 0.025 in [0.64 mm] - 0.035 in.[0.89 mm] gap clearance between teeth and sensor.
5.	Secure the speed sensor using the supplied locknut.
6.	Use an AC voltage meter to verify proper magnetic pickup installation. During cranking, sensor output should be greater than 1.0 V AC.



11 EXHAUST TEMPERATURE SENSOR INSTALLATION

The engine gaseous exhaust temperature (EGT) sensor is monitored by the GC1000 for engine protection in the event of a high exhaust temperature condition during operation. When the EGT limit is met, the GC1000 controller lowers the gaseous fuel flow to the engine and re-samples the exhaust temperature. If the EGT senses temperature has returned to an acceptable level the system restores the gas flow to table settings. If after 3 samples the temperature does not fall inside acceptable range as set in SmartVU the system shuts off the flow of gaseous fuel.



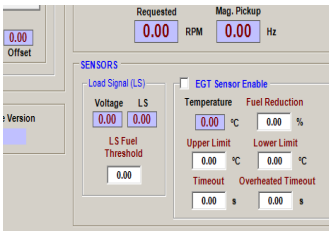
Use caution when installing the sensor. The sensor is easily damaged. Use Type-K wire and connectors only. Do not mix dissimilar metals.

EGT TEMPERATURE SENSOR INSTALLATION

1.	Mount the exhaust temperature probe in the engine exhaust outlet as near as possible to the point where all of the cylinders merge. Alternatively, the sensor can be placed in the manifold outlet pipe. Ensure the tip of the probe is well within the outlet exhaust flow.
2.	For best results use a weld bung for installation access.
3.	Mount the sensor using a 1/8 in NPT fitting.
4.	Thread the sensor finger tight into the selected location.
5.	Once stable, turn the sensor 2 full turns past finger tight.

12 LOAD SIGNAL SELECTION AND INSTALLATION

Load Signal is the measure of amperage draw being requested from the engine generator main to the GC1000 controller. This data can be provided by a 5 V DC sensor that provides 0 - 5 V DC output sensor. GC1000 does not control system load, it responds to sensed load and changes fuel input based on load. As load changes are sensed, the GC1000 System Tuning table implements pre-set fuel value increases, adding or removing fuel as indicated by load.



When using a turbo diesel engine, GAC recommends using a Boost Pressure Sensor to measure the increase in pressure requested as load increases.

When using a non-turbo (naturally aspirated) diesel engine, a Current Transformer (CT) is recommended. Other solutions may be possible. This manual details the CT and Pressure sensor options.

The current Load Signal value is displayed on the GC1000 SmartVU Advanced screen.

BOOST PRESSURE SENSOR (BPS) FOR LOAD SIGNAL

When using a Pressure Sensor, the sensor monitors the turbo boost pressure within the intake manifold. The engine control unit uses this data to gauge the proper amount of fuel.

Mount the sensor on the engines' turbo boost intake manifold using a 1/8" NPT 27 fitting.
Connections for the GAC sensor use the following connections:
Red - 5+
Black - GND
Yellow or Green - Out

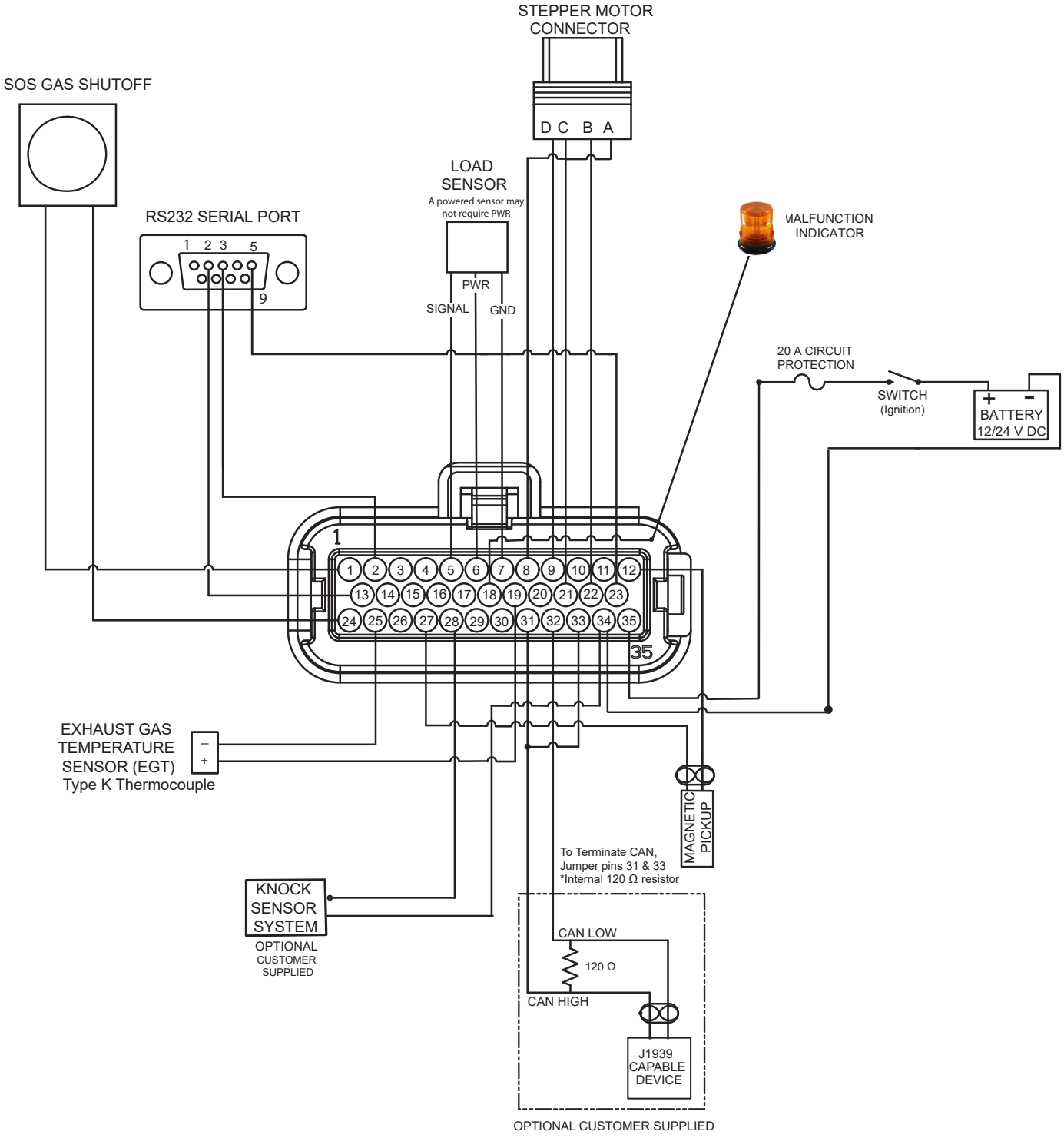
CURRENT TRANSFORMER (CT) FOR LOAD SIGNAL

When using a Current Transformer, the CT sends a load signal representing amperage from the engine generator main to the GC1000 controller.

Install the CT on one leg of the generator output to obtain the required measurements and connect it to the GC1000. Following the wiring installation diagram, connect the CT to the GC1000. The recommended CT is self powered and uses plus (+) for Signal and negative (-) for Ground.

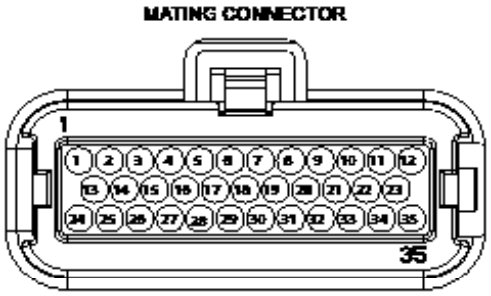
If the CT or other selected sensor requires power or has other power requirements, wire the sensor or CT V+ to a power source other than the GC1000 ensure that power source and the GC1000 share a common ground.

13 DUAL-FUEL CONVERSION WIRING



13 GC1000 DUAL-FUEL WIRING (CONTINUED)

MATING CONNECTOR



GC1000 35-PIN CONNECTOR WIRING

PIN	DESCRIPTION	COMMENT	WIRE
1	SOS	Shutoff Solenoid	16 AWG
2	RS232 Pin 3 Receive	RS232 Communication Port	20 AWG
3	Not Used	NA	NA
4	Not Used	NA	NA
5	Load Signal	CT, BPS or other 0 - 5 v DC signal sensor	20 AWG
6	Load Power	BPS or other 0 - 5 v DC signal sensor requiring power	20 AWG
7	Load Ground	CT, BPS or other 0 - 5 v DC signal sensor	20 AWG
8	VFC Stepper Motor Connector A	Stepper Motor Control Output 1	20 AWG
9	VFC Stepper Motor Connector D	Stepper Motor Control Output 2	20 AWG
10	Not Used	NA	NA
11	Not Used	NA	NA
12	Mag Pickup Ground	Magnetic Speed Pickup Sensor Ground	20 AWG
13	RS232 Transmit	RS232 Communication Port	20 AWG
14	Not Used	NA	NA
15	Not Used	NA	NA
16	Not Used	NA	NA
17	Not Used	NA	NA
18	MIL	Malfunction Indicator Lamp Output - 2 A	16 AWG
19	EGT (+)	Exhaust Gas Temperature Input +	20 AWG
20	Not Used	NA	NA
21	VFC Stepper Motor Connector C	Stepper Motor Control Output 3	20 AWG
22	VFC Stepper Motor Connector B	Stepper Motor Control Output 4	20 AWG
23	RS232 Ground	RS232 Communication Port Ground	16 AWG
24	SOS	Shutoff Solenoid	20 AWG
25	EGT (-)	Exhaust Gas Temperature Input	20 AWG
26	Not Used	NA	NA
27	Mag Pickup Input	Magnetic Speed Pickup Input	20 AWG
28	Knock Sensor System	0 - 5 V DC (Optional) Ground to Pin 34	20 AWG
29	Not Used	NA	NA
30	Not Used	NA	NA
31	CAN High	CAN High Signal	20 AWG
32	CAN Low	CAN Low Signal	20 AWG
33	CAN Termination	CAN Termination Resistor (when tied to CAN High - Jumper)	
34	Battery Ground	Battery Ground	16 AWG
35	Battery	12/24 V DC Battery Power with 20 A fuse	16 AWG

NOTES

1. Wire the GC1000 through a switched (On / Off Switch) DC power source of 12 to 32 V DC and circuit protected with a 20 A fuse or circuit breaker.
2. Not all of connections may apply to your application.
3. Unpopulated table entries represent unused connector pins.
4. Twisted pair groupings are represented by letters.

13 GC1000 DUAL-FUEL WIRING (CONTINUED)

PIN 2, 13, 23 RS-232 COMMUNICATION

Connect the RS-232 (GAC P/N: EC1516) to the GC1000 to following this table. The DB9 connector is connected to the computer.

GC1000 PIN	DB9-F PIN
2	5
13	2
23	3

PIN 8, 9, 21, 22 STEPPER MOTOR FUEL CONTROL VALVE VFC106

The VFC106 fuel control valve with inline stepper motor uses a high-resolution bipolar stepper motor to control the fuel being added to the system. The VFC106 has two separate coils (A and B) which, when provided the correct signal in the correct orientation, move the valve clockwise (extend) or counter-clockwise (retract).

The System Tuning S-Stepper control logic table in SmartVU details the stepper motor input combinations for operation.

EXTEND ↓

STEPPER MOTOR CONTROL LOGIC				
PHASE	A PIN A	/A PIN B	B PIN C	/B PIN D
1	+	-	+	-
2	+	-	-	+
3	-	+	-	+
4	-	+	+	-

↑ RETRACT

PIN 1 AND 24 GAS SHUTOFF SOLENOID (SOS)

The gas shutoff solenoid (SOS) valve gives the gaseous controller authority over gas flow into the regulator increasing over-all safety and performance. Signals from the GC1000 control the valve. The valve will automatically close if overspeed or exhaust temperature is exceeded or power is lost or no speed signal is available.

PIN 5, 6 AND 7 LOAD SIGNAL

Load Signal, the amount of requested load in 0 - 5 V DC output, is provided by either a Current Transformer (CT) or a Boost Pressure Sensor. The Load Signal provides a signal representing load to the GC1000 controller. This signal is reported on the SmartVU main screen and is used to set the stepper motor gaseous increases in the System Tuning table. The CT determines load from the generator and the Pressure Sensor provides load based on turbo pressure.

PIN 34 AND 35 BATTERY POWER

Wire the GC1000 through a switch (On/ Off) DC power source of 12 to 32 V DC and fused for 20 A. Terminals 34 (battery ground) and 35 (battery 12/24 V DC) connect to the battery.

PIN 12 AND 27 MAGNETIC SPEED PICKUP SENSOR

The magnetic speed pickup monitors engine speed by counting flywheel teeth. The output signal is an AC sine wave whose frequency is converted to crankshaft revolutions per minute (rpm) via the input flywheel teeth value. The installation gap between the sensor and flywheel teeth must be minimized to create the most usable speed signal. Typically this frequency is in the several thousand Hz range at rated speed. The exact number of flywheel teeth is set using **SmartVU**.

PIN 18 MALFUNCTION INDICATOR OUTPUT (OPTIONAL)

The malfunction indicator output is triggered to match the FAULT LED. This output can drive a 12 V DC indicator where one side is connected to ground and the max current is 2 A.

PIN 19 AND 25 EXHAUST GAS TEMPERATURE

Exhaust Gas Temperature (EGT) sensor monitors a type K thermocouple to measures engine exhaust gas temperature. If the temperature limit set in SmartVU is exceeded during operation, the GC1000 reduces the VFC gaseous flow by the configured amount, retires and shuts down if engine temperature condition does not improve.

PIN 28 AND 34 KNOCK SENSOR SYSTEM (OPTIONAL)

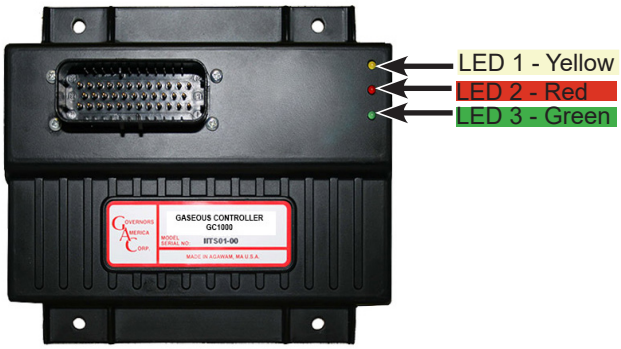
A knock sensor system is an optional input that if used will automatically shut down gas flow to the system if knock system triggers are encountered. The GC1000 controller is pre-programmed to shutdown on knock sensor notification. A knock sensor error displays a blinking yellow LED and the error is recorded in the Diagnostics Log available on the SmartVU Options-Diagnostics-Logging screen. The knock sensor uses a common ground (Pin 34).

PIN 31, 32, 33 CAN / J1939

The GC1000 is not designed to be the end-of-line device on a CAN bus. If the GC1000 is located at the end of the CAN bus, use a 120 Ω termination resistor across CAN H and CAN L. CAN bus applications require a matching 120 Ω resistor at the other end of the bus for a total parallel resistance of 60 Ω. GC1000 CAN output supports J1939 protocol for basic engine sensor information and Diagnostic Trouble Codes (DTCs). Jumper pins 31 and 33 to use the internal 120 Ω resistor.

14 GC1000 LED CODES

The GC1000 has both a general LED display and a blink code for use when a computer is not available.



LED	COLOR	LED STATE	DEFINITION
1	Yellow	OFF	While engine is running, indicates no new entries in the alarm / warning history.
		ON	EGT is open. Indicates malfunction has been logged or indicates a bad sensor.
		BLINKING	A warning or shutdown is active. The light turns off when the condition is gone and the unit has been power cycled.
2	Red	BLINKING	Unit is changing fuel valve position.
	Red	ON	Valve not moving
3	Green	OFF	Unit is not powered on.
		ON	Unit is powered on.
2 / 3	Red + Green	ON	Running and checking fuel valve position.

GC1000 FAULT INDICATION BLINK CODES

COUNT	ALARM/WARNING
1	Not Used
2	Engine Speed Input Circuit Malfunction or No Signal
3	Engine Overspeed occurred
4	Not Used
5	Not Used
6	Not Used
7	Not Used
8	Not Used
9	Not Used
10	EGT sensor over configured temperature limit

DISPLAYING BLINK CODE HISTORY

1.	Power OFF the GC1000.
2.	Power ON the GC1000, without the engine running
3.	The fault LED (LED 1) will blink through the entire fault history in reverse chronological order (newest code first, oldest last).
	Once the GC1000 has reached the end of the list, it will stop flashing fault codes.

15 SMARTVU FOR GC SOFTWARE INSTALLATION

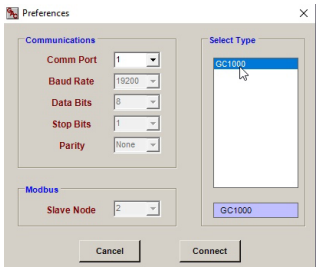
The GC1000 controller and dual fuel system is configured using GAC SmartVU GC Series software. Once SmartVU has been installed, connect the GC1000 controller to the computer using the RS232 communications port. This simple software allows you to tune and modify the system on the fly, as well as creating the turning table that balances gaseous flow into the solution. Previously saved configurations can be loaded to replace the factory settings as detailed in Section 22.

SMARTVU GC SERIES SOFTWARE INSTALLATION

A computer and internet connection are required to download and run GAC's SmartVU GC Series software. The SmartVU installation file and instructions are found at www.governors-america.com/software-downloads. Download the software file to your PC and make sure you have administrator privileges to install the package. See your IT support for help as necessary. After the installation is complete, note the icon on your desktop.

CONNECTING SMARTVU TO THE GC1000

Before making any changes to the software, ensure the fuel supply is disconnected from the engine prior to performing any of the following configuration procedures. Pressing Stop Engine shuts down the gaseous fuel flow.



Once SmartVU is installed, complete the following:

1. Connect a serial port (or USB to serial adapter) to the GC1000 using a pass-through DB9 F/M cable.
2. Launch SmartVU GC Series software from the computer.
3. Select the GC1000 from Configure → Setup Connection menu. SmartVU will recognize the connected device.
4. Adjust any Communications or Modbus settings.
5. Click Connect. This will open the SmartVU software.

16 BASIC CONFIGURATION WITH SMARTVU

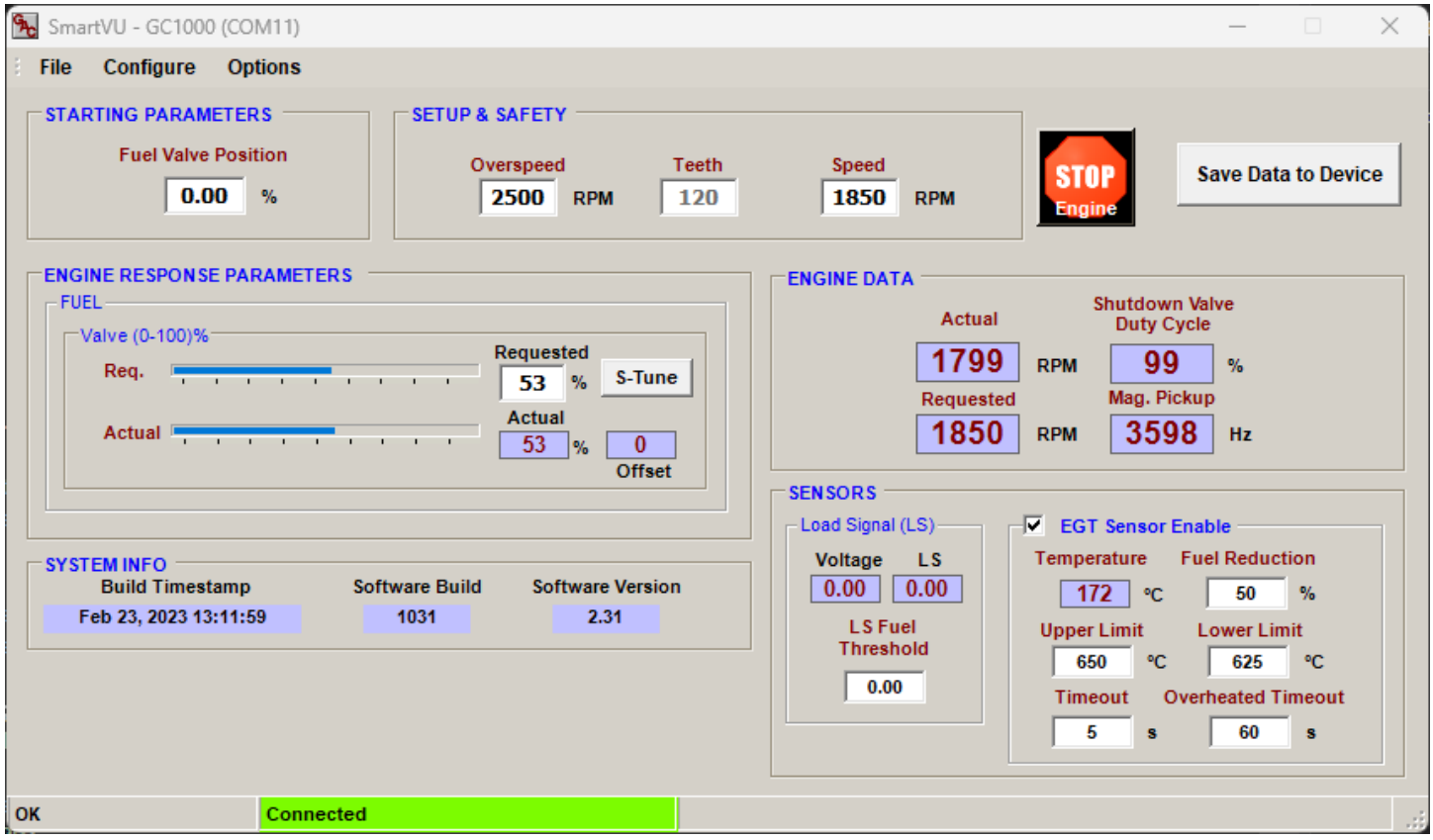
Once hardware installation is complete, use SmartVU to set up basic parameter values to start and run the engine. Advanced settings can then be set to further fine tune it to achieve your application objectives. The parameter adjustment and setup order shown here requires the setting A through F are complete before starting your engine. SmartVU provides the ability to STOP the actuator to shut down the engine using the actuator manually or through various maximum settings.

The following is the suggested setup and tuning adjustment order.

PARAMETER ADJUSTMENT ORDER	
1	Setup & Safety
2	Starting Parameters
3	Fixed Speed Parameters
4	Variable Speed Parameters
5	Engine Data
6	Sensors
7	Engine Response Parameters - Governor
8	Engine Response Parameters - Fuel

1. Adjust each parameter to your best understanding of your engine. Press the **Enter** key after changing each parameter to save the change.
2. Click **Save Data to Device** to update speed controllers memory. The device does not auto-save settings changes. You must use the **Save Data to Device** button to store changes made to the calibration. Otherwise, the controller will lose any changes since the previous save in the event the power is cycled to the controller.
3. It is good practice to save often and after any changes which are final.

IMPORTANT SmartVU and the GC1000 do not automatically save settings. Press Enter after each update and press **Save Data to Device** to update the GC1000 memory.



17 GC1000 BASIC CONFIGURATION

STARTING PARAMETERS

Name	Range	Default	Definition
Fuel Valve Position	0 - 100%	0	The % start position on the stepper valve while cranking. This is the initial setting for the amount of gaseous fuel added at startup. The valve will move itself to this position after the unit has been powered up and the valve is calibrated. Once the engine speed passes crank cutoff, the fuel valve moves to the open loop position dictated by the fuel table.

SETUP & SAFETY

Name	Range	Default	Definition
Overspeed	Application Dependent	2220	Set value to maximum allowable engine rpm. The controller uses this value to shut down the gaseous fuel flow as a safety measure. Set the value low enough to prevent overspeed but high enough to allow realistic load rejection speeds without limits engine response.
Teeth	50-250	120	Number of teeth on flywheel. The controller uses this information to calculate engine speed: RPM = Hz x 60 / # of gear teeth. **NOTE**: **You cannot edit this parameter while the engine is running.**
Speed	0 - 8500 Hz	1800	Desired isochronous engine speed. The solution does not control engine speed.

SENSORS

Name		Definition
Load Signal	Voltage	Voltage (0- 5) measured from any sensor that outputs a 0 - 5 0 V DC signal. If the sensor is not 5 V DC see GAC for help in determining another power source determine the shared common ground.
	LS	Actual load measurement in 0 - 5 V DC.
	LS Fuel Threshold	User determine load voltage based on engine capabilities.
Temperature	°C	Displays measured exhaust temperature
EGT Sensor Enable	Check box	Check this box if the exhaust gas temperature sensor is installed and in use. This input must be disabled if the sensor is not installed or the gas valve will default to the shutdown position.
	Upper Limit	Temperature (°C) at which gaseous fuel reduction is enabled.
	Lower Limit	Temperature (°C) at which gaseous fuel is re-enabled.
	Fuel Reduction	Percent (%) of temporary gaseous fuel reduction to control EGT to within specified limit.
	Timeout (s)	Time before derating gaseous fuel flow to engine.
	Overheated Timeout (s)	Time before shutting down the gas supply if engine does not return to Lower Limit EGT limit in this time duration.

ENGINE RESPONSE PARAMETERS - FUEL

Name	Range	Default	Definition
S-Tune	0 - 100	0	Press the S-Tune button to display the System Tuning window. Use this table to set Load (0 - 5 V DC) to RPM axis values and the percent of gaseous fuel added at each load step. Fuel valve position can be adjusted over the engine speed and load range.
Requested %	-	0	Edit the S-Tune value for a single cell (speed/load), does not affect any other cell on table.
Actual %	-	0	This displays the actual % opening of gaseous fuel valve position.
Offset	-	-	Displays the difference between the actual and requested % in System Tuning table.

ENGINE DATA

Engine data displays the actual versus requested speed based on the number of teeth and frequency (Hz) read by the magnetic speed pickup sensor.

Actual RPM	Requested RPM	Shutdown Valve Duty Cycle	Mag Pickup (Hz)

18 STARTING THE ENGINE

STOP Engine conducts an emergency shutdown of gaseous fuel to the engine. It does **not** shut down the engine.

IMPORTANT

Starting Parameters and Setup & Safety are required settings prior to engine startup.
LS Fuel Threshold is displayed when Options-Advanced menu is selected.

Before tuning the system to include dual fuel, first create a stable diesel-only run engine by completing basic speed and fuel tuning. Once the engine is running smoothly you can continue to tune to support dual fuel. Do not use the tuning table when first starting the engine.

GAC recommends tuning to a daily fixed working speed, not idle speed. These procedures set a baseline, not the final solution. Once the engine is running smoothly on diesel fuel you will use SmartVU to create a table to introduce gaseous fuel, ensuring smooth transition at each point.

INITIAL STARTUP AND REVIEW PROCEDURE

1. Start the engine, running diesel fuel only. Using a multimeter, monitor Voltage and Amps to the diesel actuator / governor.
2. Add load to the engine in incremental steps to monitor the diesel actuator for reference. Record the actuator voltage or current to better understand your specific engine. Best practice: Record this information for ease of creating a gaseous introduction table later.
3. Remove the load from the engine
4. Turn on the gaseous fuel source and check for leaks.
5. Determine if you want to start with gaseous fuel added or with just diesel fuel.

19 CREATING THE GC1000 SYSTEM TUNING TABLE

The System Tuning table sets the percent the stepper motor opens the gaseous fuel (valve) to allow gas into the system. This section details the steps used to setup and check for the most accurate gaseous ratio for your engine.

WHAT YOU WILL NEED

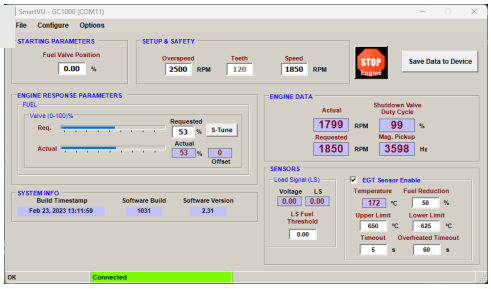
Actuator input must be measured to make accurate settings. This section requires measuring actuator voltage and/or current using a multimeter. Depending on your system an alternate measurement such as a fuel flow meter for a mechanical governor may be required. The ability to add load to the system is also required. The following examples use voltage readings to explain the process. Your measurement tool may vary.

INITIAL SETUP SYSTEM WITH TUNING TABLE

Once the system is installed, complete the following steps while the engine is running.

1. With the engine running, open the SmartVU GC1000 application. **[1]**
2. If not already done, complete the basic configuration setup.
3. Click S-Tune on the main page to display the System Tuning table.
4. Click Set Speed on the System Tuning menu.

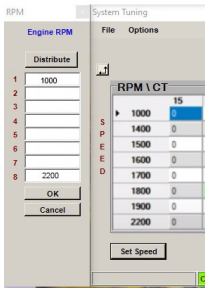
1



SET RPM ROW INFORMATION.

1. Based on your engines expected load settings, enter low RPM in line 1 and high RPM in line 8. **[2]**
2. Click Distribute. The system will automatically fill in the rest.
3. If required, edit the individual RPM cells suite your needs.
4. Click OK to save.

2



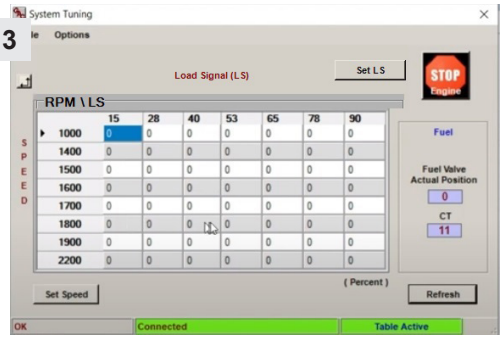
IMPORTANT SmartVU and the GC1000 do not automatically save settings. Press Enter after each update and press **Save Data to Device** to update the GC1000 memory.

READING THE TABLE - LS AND PERCENT GAS SETTINGS

Once the initial RPM settings are added and S-Tune has been pressed, the base table is created.

- The green Connected bar indicates the system is connected.
- In example [3] the table has not been set up; the stepper motor is inactive; zero percent of gaseous fuel is being used.
- The LS (CT) reading is 11. No load operation is 100% diesel fuel.
- GAC suggests measuring actual actuator voltage or current measurements using a multimeter or a fuel flow meter if the engine uses a mechanical governor.

3



CALCULATE VOLTAGE AT LOAD WITH DIESEL

The next steps is to determine the voltage output at each load on just diesel fuel. This information is used to determine what percent of gaseous fuel should be added to support load.

1. Start the engine with diesel fuel only.
2. For each major load measure and record voltage.
3. Track this information in a table similar to **[4].**

4

Percent Load	Actuator V DC, 100% Diesel
100	6.2
75	5.2
50	4.6
25	3.7
0	3.1

19 GC1000 SYSTEM TUNING (CONTINUED)

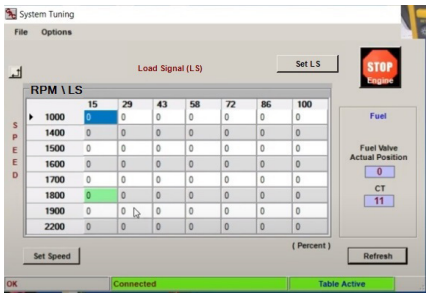
SET LS ROW - CALCULATE LS USAGE

The numbers in the LS column are based on the LS (100 A , 0-5 V) being used. In figure 5 the 100 represents the LS amperage. The numbers used in this table regulate gas flow based as a function of LS. The more precise this information the better the results.

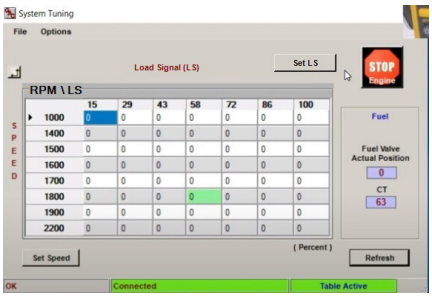
To set the LS row numbers to more accurately match to the actual engine measurements, complete the following:

1. Start the engine on diesel only. Note the green table cell in [5]. This indicates the speed/load operating point. In this example, 1800 RPM at no load.
2. Add 100% load to the system [6]. The green table cell indicator moves to 1800 at the 58 column. The actual reading in the Fuel LS pane to the left indicates 63.
3. Click the Set LS button [7]. Enter the upper end number (65 in this example) in the last cell.
4. Click Distribute and OK to place the new number in the table.
5. Still at 100% load, the green cell [8] moves to the end of the table. This increments the resolution of the table.
6. Remove the load from the engine.
7. Use the **Save Data to Device** button on the Main menu when done. The device does not save automatically.

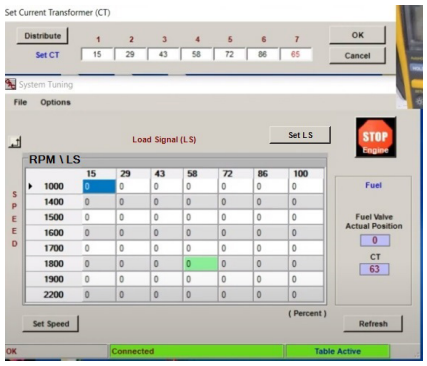
5



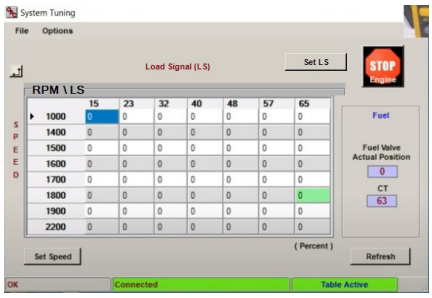
6



7



8



IMPORTANT

1. Click **Save Data to Device** to update speed controllers memory. The device does not auto-save settings changes. You must use the **Save Data to Device** button to store changes made to the calibration. Otherwise, the controller will lose any changes since the previous save in the event the power is cycled to the controller.
2. It is good practice to save often and after any changes which are final.
3. A configuration file can be saved for future using File → Save Config To File on the Main menu.

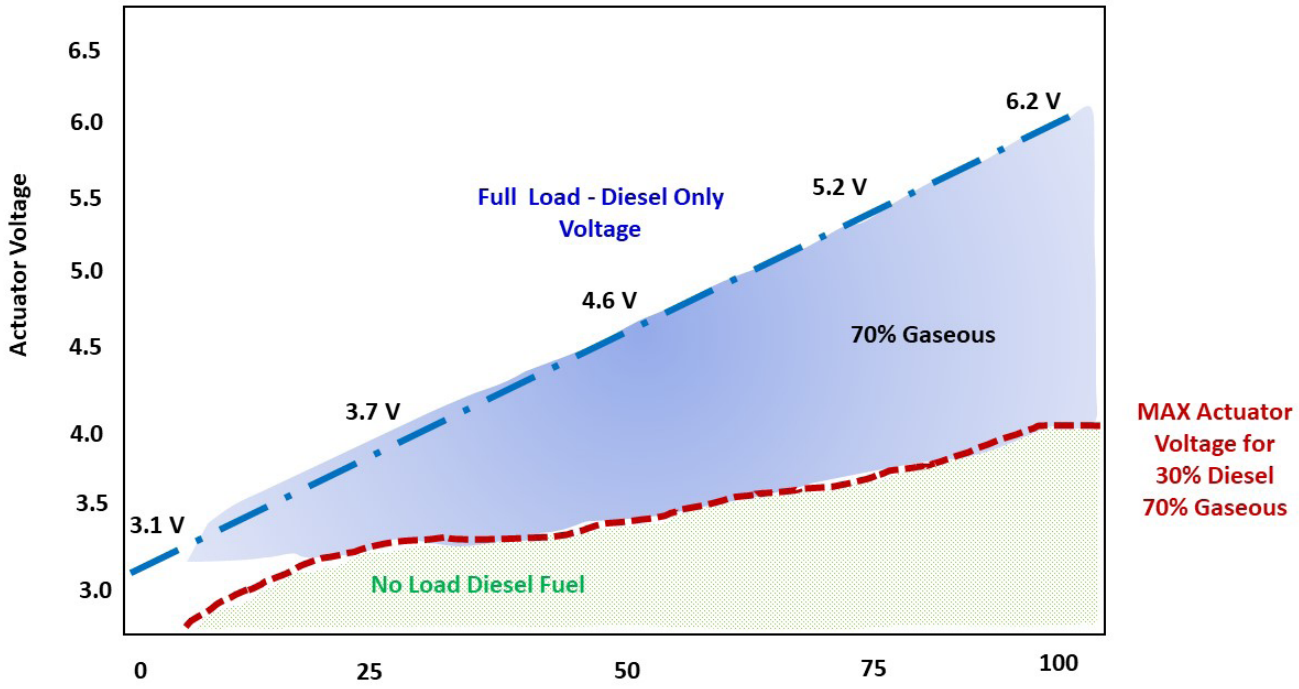
19 GC1000 SYSTEM TUNING (CONTINUED)

CALCULATING GASEOUS PERCENT

The dual fuel conversion system uses a gaseous stepper motor percent (System Tuning) table to set the percent of gaseous fuel introduced to support each load change. Measuring actuator voltage at basic loads on diesel fuel only we can calculate the target voltage or amperage to limit diesel fuel at ≤ 30%. This target voltage (amperage) can also be measured) we determine the percent of gaseous fuel to add using the stepper motor (VFC106). This percent increase is stored in the System Tuning table.

The following table is an example of measurements and calculations taken for a 125 kVA engine with a 30% diesel and 70% gaseous ratio. The formula used to calculate this information is detailed below the table. The basic load measurements and calculations should be made prior to installing the dual fuel solution. Voltage target represent the 30% gaseous not to exceed limits.

Percent Load	Actuator Voltage 100% Diesel	Target Voltage 30% Diesel	Actuator Amps 100% Diesel	Target Amps 30% Diesel
100	6.2	**4.03**	1.9	.78
75	5.2	3.73	1.7	.72
50	4.6	3.55	1.1	.54
25	3.7	3.28	.8	.45
0	3.1		.3	



1. Actuator Voltage at Full Load − Actuator Voltage No Load = Voltage (current) Operating Range
2. Operating Range * 30% = Base Point
3. Base Point + Actuator Voltage at No Load = 30% **Target** Max Diesel Fuel Set Point

The calculation formula is the same for amperage and voltage.

CALCULATE TARGET VOLTAGE

1. 6.2 − 3.1 = 3.1
2. 3.1 × .30 = 0.93
3. 0.93 + 3.1 = 4.03

4.03 = Target V DC with 30% diesel and 70% gaseous fuel at 100% load

CALCULATE TARGET AMPERAGE

1. 1.9 − 0.3 = 1.6
2. 1.6 × .30 = 0.48
3. 0.48 + 0.3 = 0.78

0.78 = Target Amp with 30% diesel and 70% gaseous fuel at 100% load

19 GC1000 SYSTEM TUNING (CONTINUED)

ADD GASEOUS INCREMENTS TO TABLE

The System Tuning table sets the percent of gaseous fuel added by the VFC stepper motor related to each change in load as represented by the LS column supporting the measured load change.

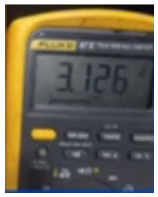
1. Connect the multimeter to the actuator, or your preferred voltage measurement tool, and position it to be easily read while you set up the System Tuning table.

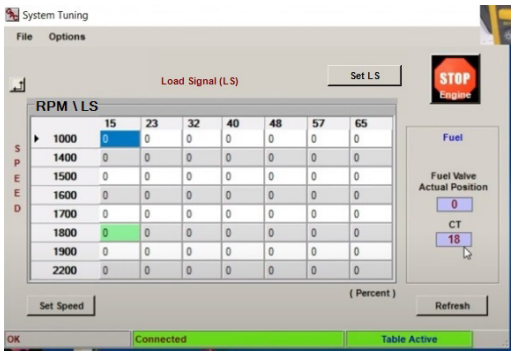
2. Under no load, note the green cell on the table [9] in the LS 15 column and LS reads 18. The voltage reading on multimeter is 3.12 [9]. The zeros (0) in the table indicate no gaseous fuel has been added.

3. Add 100% load to the engine. Note the green cell [10] has moved to the last LS 65 column and the LS reads 63.

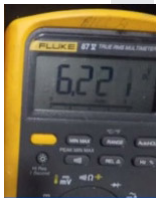
4. Remove the load.

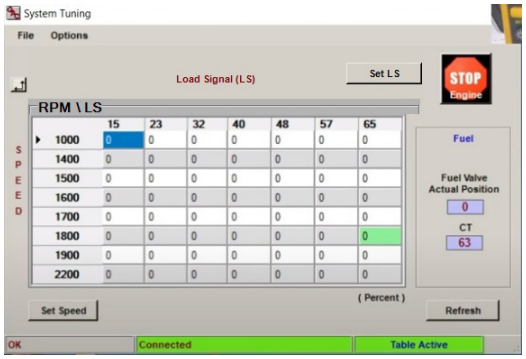
9





10





5. **Start adding gaseous fuel** by selecting either the first or second column and entering the percent of gaseous fuel to be added by the stepper motor.

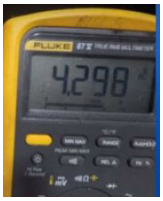
6. Select the LS 23 column and enter 5. In this example [11] the first column is set to zero to create an initial startup of diesel only (0%) and 5% as initial startup gaseous fuel.

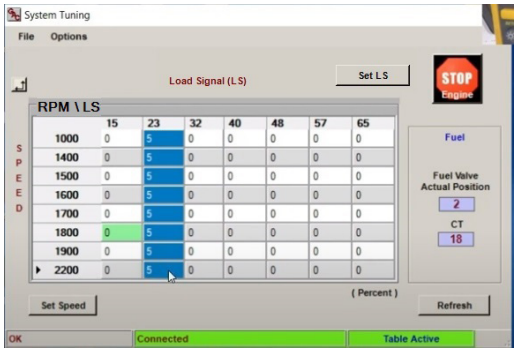
7. Add 100% load to the engine and note the voltage reading. The actuator voltage reads 4.29 VDC. As determined earlier in Calculating Gaseous Percent the target voltage for 100% load is 4.0.

8. Select the 5 and change it to 7 [12], increasing the stepper motor opening and percent of gas added to move closer to the target voltage.

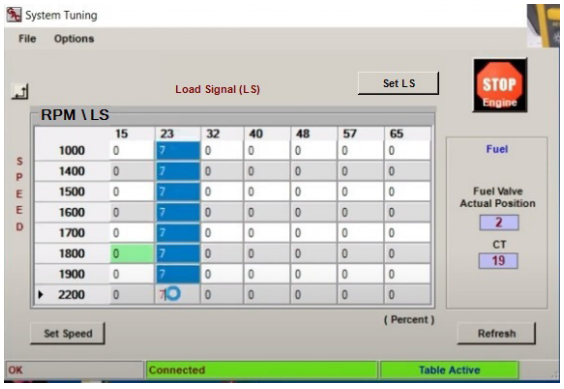
9. The voltage reading is now 4.01, putting it at target voltage.

11





12



IMPORTANT SmartVU and the GC1000 do not automatically save settings. Press Enter after each update and press **Save Data to Device** to update the GC1000 memory.

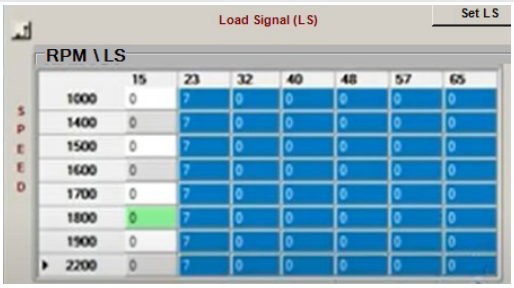
19 GC1000 SYSTEM TUNING (CONTINUED)

ADD GASEOUS FUEL INCREMENTS TO TABLE (CONTINUED)

Each table column is updated based on the voltage (or current).

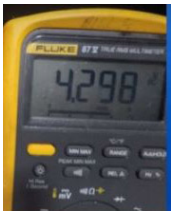
10. Select LS columns 23 and higher to set the base percent to 7 [12] [13]. This creates a base gaseous flow.
11. Change load to 50%.
12. Note the green cell is in the 32 LS column [13]. Note the **Calculating Gaseous Percent** target voltage for 50% load is 3.5 and 4.0 for 100% load.

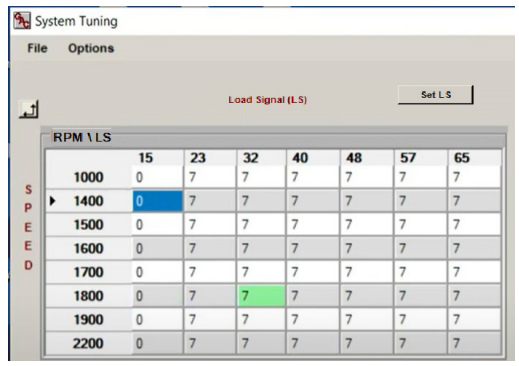
13



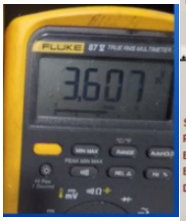
13. Note actual voltage is 4.29 [14] .
14. Select the 32 LS column, enter an estimated % of gaseous fuel to support 50% load - adding 12% brings the voltage to 4.2. Update to the cell to 15 and note the voltage is now 4.1. [15]
15. Update the cells to 17 and the voltage reading is 3.6 - making it near target. [15-16]

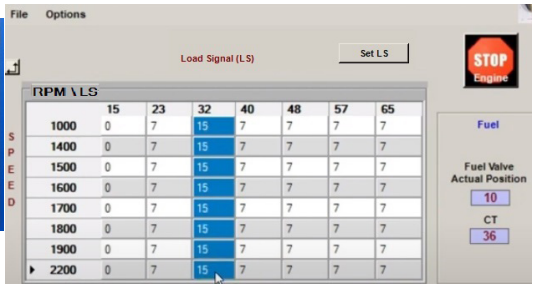
14





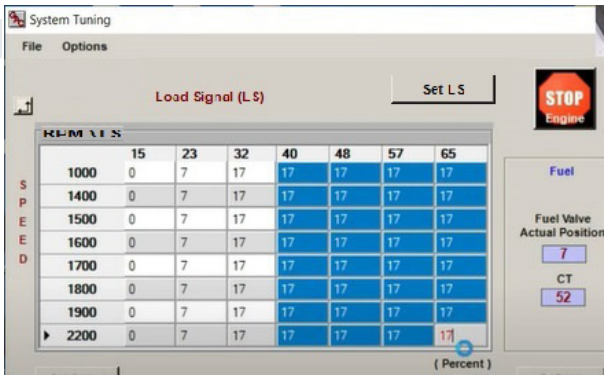
15



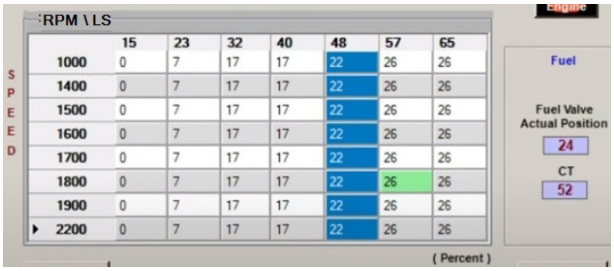


16. Highlight the 40 LS and higher columns [16] and update to 17. Keeping the next rows at the minimum of the previous row settings creates a more accurate reading as you tune forward.
17. Continue to review and update each column [17], viewing the actuator setting and aiming for the target voltage reading.
18. To fine tune the system go back over the table cells and change engine load to 50% or 25% and re-take the voltage readings, further updating the stepper motor position to provide more accurate step changes.
19. Use the Save Data to Device button on the Main menu when settings are complete to save the data.
20. To store settings in a reuseable file, At Main Menu in Smart-VU select File → Save Config To File from the top menu bar.
21. Choose a directory on your PC to save the file to and name it accordingly.
22. Press the Save button.

16



17

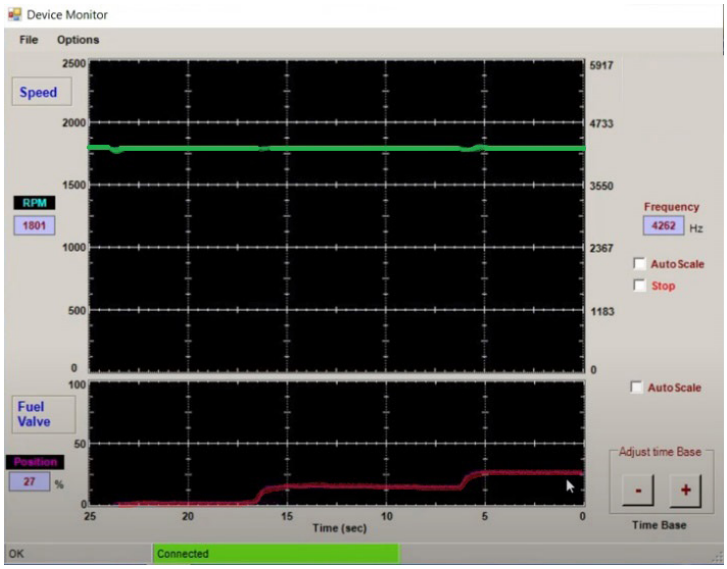


20 DEVICE MONITOR

The device monitor is a visual view of the engines workload.

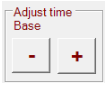
To display the device monitor, select Options → Device Monitor from the menu, or press Ctrl + B.

The device monitor can be used to display the relationship between the stepper motor and fuel mixture.



Speed monitor displays engine speed based on the measured magnetic pickup frequency.

Fuel Valve monitor displays the commanded fuel valve position from 0 - 100 % and allows an adjustable time base for all real-time monitor graphs.



Adjust the time scale to zoom in or out.

21 ERROR CONDITIONS AND DISPLAYS

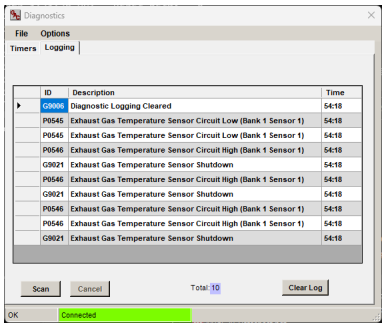
Errors are noted through the GC1000 units LED displays and logged in the diagnostic log of the SmartVU software.

Errors can also displayed with an external indicator such as a strobe light or other visual or audible indicator using the Malfunction Indicator Lamp (MIL).

Diagnostic error codes related to the LEDs and other internal codes display in the Diagnostic screen on the Diagnostics screen of GC SmartVU.

When an EGT error occurs the system will make three (3) attempts to allow the system to cool down, measuring temperature each time and logging an error each time the system has is not within set parameters, finally shutting down the system. This creates multiple errors in the log.

If using an optional knock sensor system, the error from the sensor will be logged in the GC1000 SmartVU diagnostic log. The knock sensor may also cause the engine to shut down.



NOTE: THE GC1000 system controls gaseous flow, not speed. Speed is controlled by the governor on the engine.

22 SAVING AND LOADING CONFIGURATION FILES

SmartVU can save and load tables and settings to or from a file. This allows the user to quickly restore an existing installation or startup a new one once the calibration for the engine has been completed. The configuration is stored within the module itself; SmartVU writes / reads the values to a file so that you do not need to manually enter all of the calibration data individually on subsequent engines.

To Save a Configuration File

1. At Main Menu in SmartVU select **File** → **Save Config To File** from the top menu bar.
2. Choose a directory on your PC to save the file to and name it accordingly.
3. Press the Save button.

To Load a Configuration File

1. At Main Menu in SmartVU select **File** → **Open Config From File**.
2. Locate the configuration file (*.cfg) which matches the engine / application you are working on and press Open.
3. Once complete, verify that the correct values have loaded and that the system is tuned properly.

23 SUPPORTED FAULT CODES

The GC1000 stores a chronological list of diagnostic troubles codes (DTCs). The controller communicates malfunction P-codes, G-codes, and SPN codes. P-codes relay engine and sensor malfunctions and decreases in system performance. These issues may cause poor fuel consumption and excessive emissions output as well as potential engine issues. G-codes show governor system specific malfunctions. These codes can be ready by a JDR or other J1939 reader.

SUPPORTED DTC G-CODES

G-CODE	DEFINITION	POTENTIAL FAILURE CAUSE
G9002	User Emergency Shutdown	User has commanded shutdown in SmartVU (Stop button)
G9004	Reload System Defaults	User has reloaded the calibration / configuration defaults in SmartVU
G9005	Diagnostic Timer Reset	User has reset the diagnostic timer in SmartVU
G9006	Diagnostic Logging Cleared	User has reset / cleared the diagnostic fault code log
G9021	EGT MAX Temperature Shutdown	Exhaust gas temperature maximum limit reached and engine commanded to shut down
G9017	Watchdog timer fault	Software failure. Reset system.
G9028	EEPROM Corrupted	Initialization failure. EEPROM setting check failure.
G9088	Serial communications issue	Error in serial communication. Check connector.

SUPPORTED DTC P-CODES

P-CODE	DESCRIPTION	POTENTIAL FAILURE CAUSE
P0219	Engine Overspeed Condition	Engine mag speed pickup signal exceeded operational limit defined in config. Check for defective sensor
P0544	Exhaust Gas Temperature Sensor Circuit Malfunction (Bank 1 Sensor 1)	Open or short circuit in wiring or connector / Poor connection / Defective sensor
P0545	Exhaust Gas Temperature Sensor Circuit Low (Bank 1 Sensor 1)	Open or short circuit in wiring or connector / Poor connection / Defective sensor
P0546	Exhaust Gas Temperature Sensor Circuit High (Bank 1 Sensor 1)	Engine exhaust gas temperature exceeded operational limit defined in config / Defective sensor
P0725	Engine Speed Input Circuit Malfunction	Open or short circuit in wiring or connector / Poor connection / Defective sensor

SUPPORTED J1939 PGN

PGN	DEFINITION	SPN	NOTES	RATE (ms)
2048	AUXI05	4157	Auxiliary I/O Channel #4	100
		4158	Auxiliary I/O Channel #3	100
61444	EEC1	190	Engine Speed	20
65270	IC1	102	Boost Pressure / Current via CT	500
		173	Engine Exhaust Temperature	
65271	VEP1	168	Battery Potential/Power Input 1	1000
65253	HOURS	247	Engine Total Hours of Operation	1000
64914	EOI	3543	Engine Operating State	250
		3607	Engine Emergency (Immediate) Shutdown Indication	
65153	GFI2	1765	Engine Fuel Valve 1 Commanded Position	Request
65226	DM01	-	Active Diagnostic Trouble Codes (DTC's)	1000
65227	DM02	-	Previously Active Diagnostic Trouble Codes	Request
65228	DM03	-	Clear/Reset Diagnostic Trouble Codes	Request
59904	RQST	-	Request for PGN	Request

SUPPORTED J1939 DTC

JDR TEXT	SPN	FMI	FAULT	POTENTIAL CAUSE - ACTION
Exhaust Gas Temperature	173	0	Data Above Normal Operation - Severe	Exhaust gas temperature exceeded configured threshold - Shutdown
		5	Open and/or malfunctioning circuit	Open circuit on harness or connector / Failed sensor - Shutdown
Engine Speed	190	0	Open Circuit	Engine Overspeed Condition
		14	Over Speed	User Emergency Shutdown
Engine Multiple Cylinder Knock Level	7320	0	Data Above Normal Operation - Severe	Knock Alarm Input Triggered

CALCULATIONS AND FINAL SETUP

Equipment:			**Kw Rating:**		
Date:			**Voltage Rating:**		
Setup By:			**Engine Make:**		
	V DC		**Tuned To V DC:**		
RPM	**No Load**	**25%**	**50%**	**75%**	**100%**