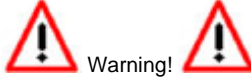# INNOVATE
MOTORSPORTS

SCG-1
User Manual

⚠️ Warning! ⚠️

The Oxygen Sensor used in this device gets very hot in operation.
Do not touch a hot sensor. Do not let a hot sensor touch a combustible surface. Do not use the sensor with or near flammable liquids or gases. Failure to heed these warnings may result in severe burns, explosions, fires, or other dangerous events.

1. SCG-1

   The SCG-1 is a boost solenoid controller gauge with an integrated wideband AFR (lambda) control. The SCG-1 also has advanced safety boost cuts based on AFR and/or boost pressure. Although it can be operated stand alone, it has digital I/O for integration with other Innovate Motorsports MTS compatible products and one configurable analog output for integration with ECU's and 3rd party data loggers. The following section will help you get familiar with the SCG-1.
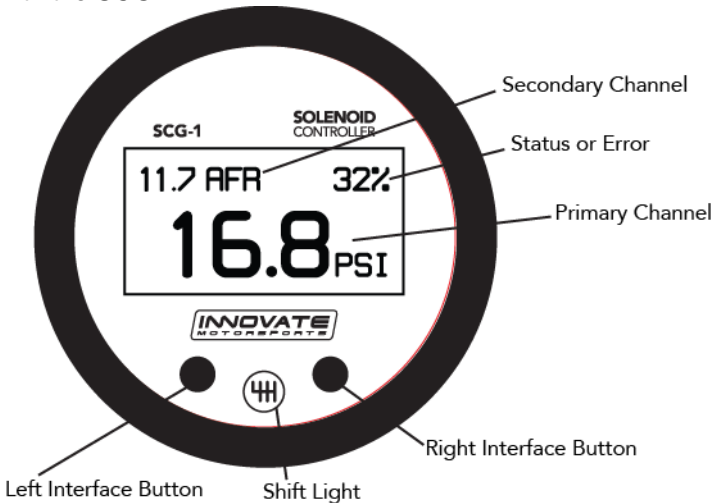
1. Channel Displays
-   The SCG-1 has four different displays modes that can be cycled through on the main screen with the left and right interface buttons. It can be configured to display A/F or pressure as primary channels or both A/F and pressure in both the primary and secondary channel viewports.

2. Status or Error display
-   The upper right hand viewport of the SCG-1 is reserved to display the status of the wastegate duty or any error codes that might be present.
-   O2 error codes will supersede all other statuses.
-   In an O2 error state, all solenoid functions are automatically disabled.

3. Interface Buttons
-   Pressing either the left or right interface buttons will allow you to cycle through the 5 different display modes.
-   From the main screen, pressing and HOLDING the left interface button will put the gauge in setup mode. Once in setup mode,

pressing and HOLDING both interface buttons together will move you to the menu or main screen. The gauge will revert back to the main screen if no there have been no button presses for 15 seconds.

- From the main screen, pressing and HOLDING both the left and right interface buttons will disable/enable solenoid control. If there are no other error codes on the status viewport of the screen, the SCG-1 will display "SC OFF".

- From the Peak boost display, press and HOLD the right interface button to clear the stored peak boost value.
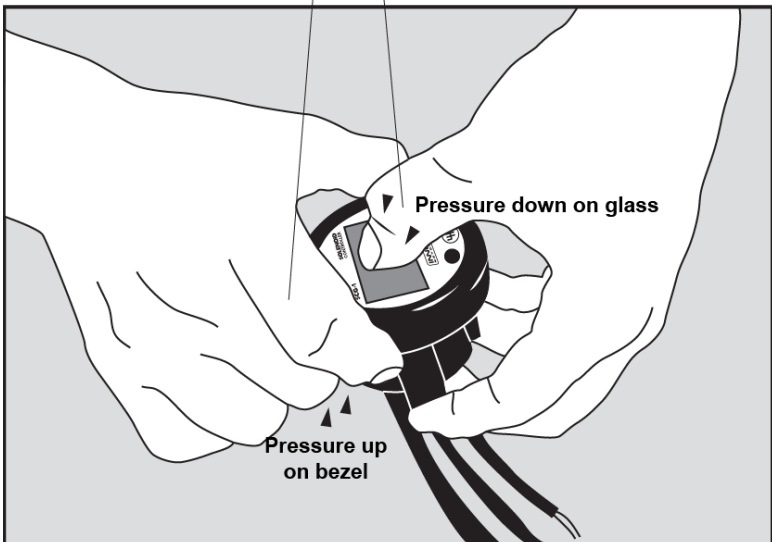
4. Shift Light
- Illuminates when the trigger shift RPM is reached.

1.1   *Changing the SCG-1's gauge face and/or bezel*

1. Lay the SCG-1 face down and remove the three #2 phillips screws from the outside rim of the back plate.

2.

Pull the bezel (black ring) upwards to remove.

Thumb must be pressing down on the glass

**Pressure down on glass**

Pressure up on bezel

* When disassembling, be careful not to lose the clear plastic light pipe from the shift light opening as it can fall out.

** Pulling the bezel upwards while NOT holding the glass down can potentially damage the SCG-1

3. Configure the gauge as desired by changing the gauge face and/or bezel.

4. Make sure every piece is positioned correctly using the locating tab and reassemble the gauge.

5. Reinstall the three #2 phillips screws verifying that the buttons are not binding on the gauge lens.

2   Installation
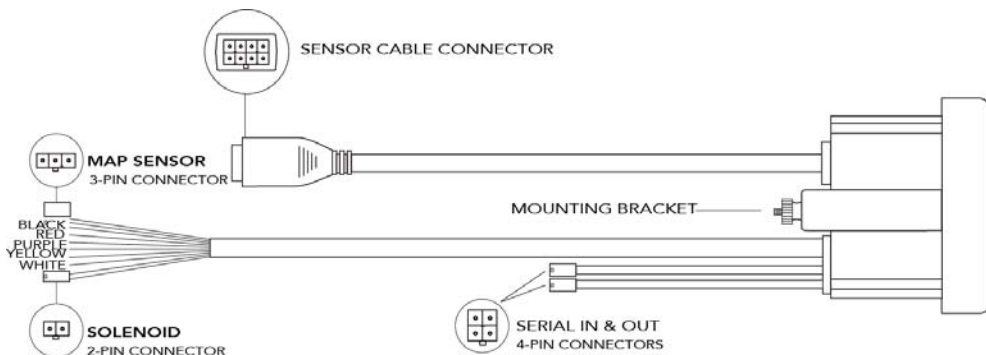
2.1   *Wiring*

The SCG-1 has 5 stripped wire leads:

1   Connect the **RED** wire to an isolated switched 12V source in your vehicle. A switched 12V source goes ON as soon as "key on" power is active. The circuit to which you will pull power from should be able to support a 3 amp draw. Make sure this connection is protected with a 5A fuse (not supplied.)

⚠️ Circuits that share power with the vehicle's stereo, ignition system, ECU, lighting, or fuel pump should not be used. When in doubt, create an additional circuit using an automotive relay available at any automotive parts supplier. See the next section for a relay installation diagram.

2   The **BLACK** wire should be grounded to a solid ground source. The best possible ground source would be the battery ground (-) post.

⚠️ If other Innovate Motorsports devices are going to be daisy-chained along with the SCG-1, it is recommended that all devices be connected to a single ground point, ideally the battery ground (-) post.

3   Connect the **WHITE** wire to a headlight power wire (a wire that goes hot with 12V when the headlights are on)). This enables the display to dim for better nighttime viewing. DO NOT CONNECT THIS WIRE TO THE HEADLIGHT DIMMING WIRE. Connection to this rheostat type of switch will cause the gauge to malfunction. If you chose not to utilize the dimming feature, connect the WHITE wire to ground.

4 *Optionally*, the **YELLOW** analog output can be connected to the analog input of other devices such as data loggers or ECUs. If this wire is not being used isolate and tape it out of the way. The default analog output configuration is 0V = 7.35 AFR and 5V = 22.39 AFR.

5 *Optionally,* the **PURPLE** wire can be connected to a tach signal to log engine RPM and to use the shift light function. A tach signal can be acquired from the negative lead of a coil, ECU, negative lead of an injector, or directly from the ignition box if running a multi-spark (i.e. MSD 6AL).

Note: A tach signal can not be acquired from the negative lead of the coil on vehicles running CDI ignitions. For these applications use the negative lead of an injector or a tach adapter (if available for your model ignition).

2.1.1   Single Innovate Device Relay Wiring Instructions
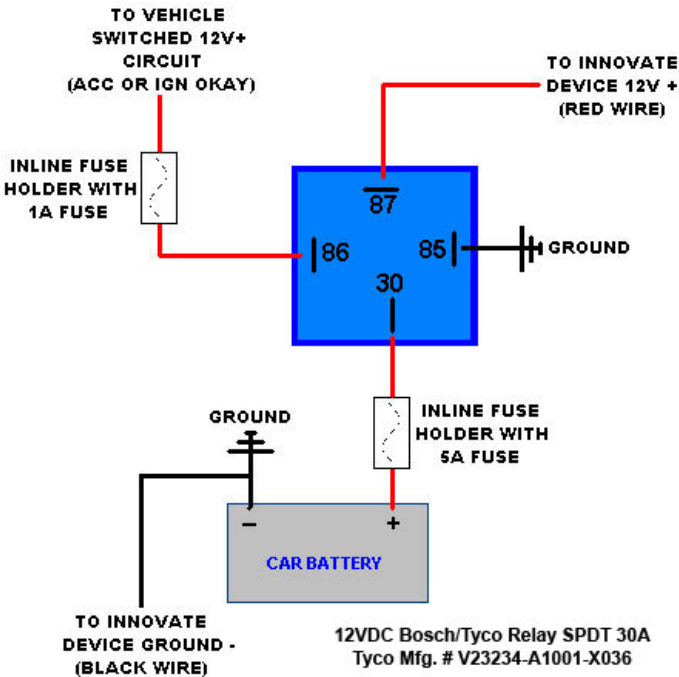

2.2   Gauge Mounting and Routing

The SCG-1 gauge fits in any standard 2 1/16" (52mm) gauge pod. Mounting of the gauge should be done in such a manner that the cables are not being forcefully pulled and strained from the gauge itself. Route the sensor and solenoid cables avoiding contact with the exhaust system and other vehicle

components that could damage the cable. Also avoid routing the cables near ignition components or other sources of RF (radio frequency) and EMI (Electromagnetic interference) noise.

2.3   Solenoid Installation

- Mount the solenoid in a suitable location away from high temperatures or near ignition components.
- Secure hoses with cable ties.
- Make sure not twist or pinch any of the hoses.
- The solenoid will make audible clicking noises when in operation, this is normal.
- Route the solenoid cable through the firewall, to the gauge and connect to the 2 pin connector.
- Confirm that you do not have any air leaks when the engine idles.

2.3.1   Internal Wastegate
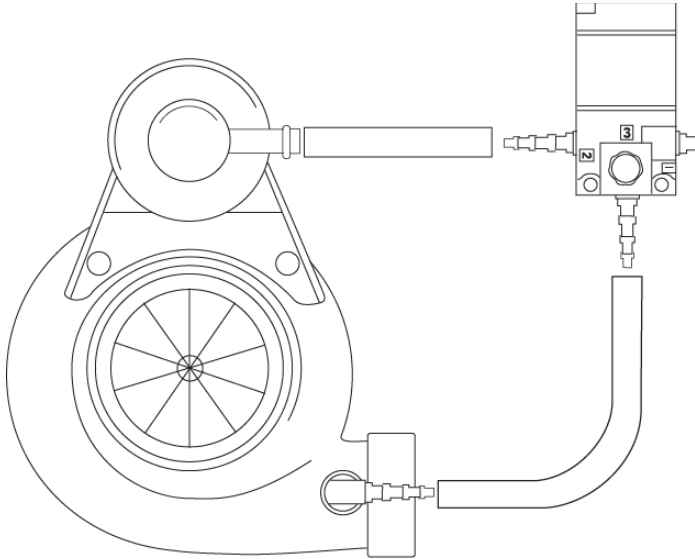
2.3.2   External Wastegate
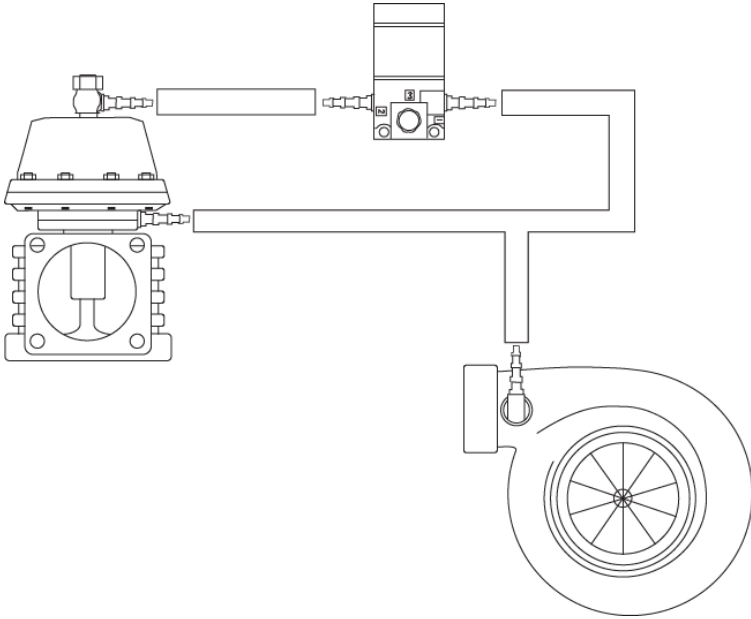
2.4   MAP sensor

1. **The MAP sensor MUST be installed with the hose fitting facing down.** It is very important that the sensor be isolated from heat sources, mounted away from all ignition and/or other potential RF emitting sources, and protected against excessive vibration.

    The MAP sensor has two 1/8" holes that can be used to secure the sensor. Another viable option is to use double-sided mounting tape.

2. Locate a vacuum source on the intake manifold, after the throttle body and connect it to the hose barb on the sensor. Use the provided "T" and hose to make this connection if needed. To secure the hose use tie-wraps or hose clamps.

3. With the engine idling, confirm that you do not have any air/vacuum leaks.

2.5   Wideband Oxygen Sensor Setup

2.5.1   Oxygen Sensor Placement

Optimum bung placement will vary from application to application, but using the guidelines below will ensure the longest sensor life with the most

accurate readings. Using a bung is the preferred method for mounting the oxygen sensor in all applications.

- Weld the bung at least **24 inches** after the turbocharger.

- Using a clock as reference, mount the bung between the **9:00 o'clock and 3:00 o'clock position**. Welding the bung in the lower section of the exhaust pipe can result in sensor damage caused by condensation making contact with the sensor's internal heating element.

- A **1" bung** (provided in the kit) will best protect the sensor. When fully threaded, the sensor's tip will sit flush with the inside of the exhaust piping, this does **not** adversely effect the readings.

- The bung should always be welded before the Catalytic Converter. Welding the bung after the catalytic converter will skew the readings toward lean. The skew in readings will vary with engine load and the efficiency of the catalytic converter.

- Leaded fuel and two stroke applications will reduce the sensor's life. There are many other factors that dictate the sensor's lifespan so it is impossible to predict total sensor longevity.

- Exhaust leaks, camshaft overlap, and open (shorty) exhausts will cause false lean readings at light engine loads. Typically, once the engine is under load and the exhaust gas volume increases, you will see accurate readings.

- When installed in the exhaust, the oxygen sensor must be connected to a powered, functional SCG-1 (no error codes) whenever the engine is running. An un-powered sensor will be damaged in a short period of time when exposed to exhaust gas.

- Do not pre-warm the sensor before starting the engine, start the engine as you normal would. Allowing the sensor to pre-warm before starting the engine will increase the possibility of damaging the sensor from shock-cooling.

- The maximum temperature of the sensor at the bung (the sensor mounting location) should not exceed 500 ^{o}C or 900 ^{o}F. If these temperatures are exceeded in your application you should install the Innovate Motorsports HBX-1 heat sink bung extender. (p/n 3729.)

As the O2 sensor measures the oxygen content of the exhaust gas to provide an accurate O2 reading, even a small pin-hole leak in a poorly welded sensor bung will effect the accuracy and performance of your O2 sensor. Remember, any deviation from the instructions provided for proper sensor installation will lead to inaccurate O2 readings.

2.5.2   Sensor Calibration

Once the unit has been wired and a suitable location has been found for both the gauge and the sensor. it is time to perform the sensor calibration. Innovate Motorsports' 'Direct Digital' wideband measurement principal allows you to calibrate the sensor to compensate for sensor wear. This procedure takes just a few moments and it will ensure the most accurate readings throughout the oxygen sensor's life. This procedure is required anytime a NEW oxygen sensor is installed.

The calibration procedure requires that the oxygen sensor be in **free air**, this means removed from the exhaust system completely.

1. With the **sensor disconnected**, apply power to the SCG-1.

   Confirm that the top right-hand corner viewport displays "O2 E2." This is an error code, indicating that no sensor is detected. Leave unit powered on for a minimum of 30 seconds.

2. **Power down** the SCG-1 and attach the oxygen sensor using the cable provided. When making these connections, make sure they are fully seated and locked. Again, make sure that the sensor is in free air (not in the exhaust).

3. **Power up** the SCG-1.

   The SCG-1 will start warming up the sensor, this is indicated on top right-hand corner viewport of the display by showing "O2 HTR." After 30-60 seconds, the display will switch from "O2 HTR" and quickly flash "O2 CAL", indicating that the sensor is being calibrated.

   The calibration procedure has completed and the system is now ready for use.

   Important: You can disconnect and reconnect the sensor and sensor cable for installation without losing your calibration. However, if you power up the SCG-1 without a sensor connected, **your calibration will be reset** (see step #1 above).

2.5.3   Calibration Schedule

Turbo Application, daily driver (tuned rich)
- Calibrate before installation of new sensor
- Calibrate new sensor again after 3 month of use
- Thereafter calibrate twice a year or every 10,000 miles, whichever comes first

Race Application
- Calibrate before first installation of new sensor
- Calibrate once per race weekend

3   Boost Controller Setup

3.1   Entering Setup Configuration

The SCG-1 can be configured directly from the gauge itself or by connecting it to a computer with the LM Programmer software.

3.1.1   Configuration using SCG-1's interface buttons
1. From the main screen, press and HOLD the left interface button to put the gauge in setup mode
2. Pressing either the left or right interface buttons will allow you to cycle through the 14 different setup parameters in the menu.
3. Once the desired setup parameter is displayed, press and HOLD the left interface button to make a change. Once the parameter's configuration has been entered it will start flashing.
4. Make changes by using the left or right interface buttons.
5. Once in setup mode, pressing and HOLDING both interface buttons together will move you to the menu or main screen. The gauge will revert back to the main screen if no there have been no button presses for 15 seconds.

3.1.2   Configuration using the LM Programmer software
Refer to chapter 4, Logworks 3 & LM Programmer Software Package to gain access to the software.

1. Connect the OUT port of the SCG-1 to the provided serial programming cable. Connect the other end of the serial programming cable to your computer. If your computer does not have a serial port, you can purchase a USB to Serial adapter from Innovate Motorsports (P/N 3733) or use any USB to serial adaptor that includes drivers. Make sure that nothing is connected to the IN port of the SCG-1

2. Power up the SCG-1.

3. Launch **LM Programmer.** The LM Programmer application can be launched from *Start->Programs->LogWorks3->LM Programmer* from the Windows task bar.

Once you have completed your desired changes, press the **Program** button on the lower right on the software application. You will know that the SCG-1 has been programmed successfully when the **Program** button grays out.

3.2 Display Settings (Gauge Abbreviations)

1. **Wideband O2 Units (WB O2 Units)** – Allows the gauge to display O2 units in either AFR or Lambda. Default setting is AFR.

2. **MAP Units -** Allows the gauge to display pressure in either inHG/PSI, kPa or BAR. Default setting is inHG/PSI

3. **Enable Wideband O2 (WB O2 State) –** Allows the wideband to be disabled or enabled. Also indicates the sensor type used (sensor type can only be changed by connecting the SCG-1 to LM Programmer.) *NOTE: If the wideband is disabled, the O2 sensor should be removed from the exhaust to avoid damaging it.* Default setting is O2 enabled.

4. **Fuel Type –** Change to different fuel types when SCG-1 is setup to display in AFR. Default setting is Gasoline.

3.3 RPM Settings (Gauge Abbreviations)

1. **Mode (RPM Mode) -** Select how many pulses per rotation (ppr) based on your tach signal source. When setting up Mode using the gauge interface, you will also see a real-time display of the RPM to ease the setup. Default is 1 pulse per rotation.

2. **Scale (RPM Scale) –** Select either 10230 or 20460 RPM scales. Default is 10230

3. **Shift RPM –** Set to desired RPM to trigger illumination of the shift light on the SCG-1. Default is 10230 RPM.

3.4 Solenoid Settings (Gauge Abbreviations)

In an O2 error state, all solenoid functions are automatically disabled. To continue using the solenoid functions without the safety cuts, the wideband function of the SCG-1 may be disabled from the setup menu.

1. **Wastegate Duty** (WG Duty) – Adjusts the solenoid duty cycle in 2% increments. The higher the duty cycle percentage the higher boost pressure will be achieved over the base wastegate spring pressure. When wastegate duty is active, the SCG-1 will display the duty cycle percentage on the upper right hand corner viewport. Default setting is 4%
   Tuning Tip: Start small and work up. Do not increase Wastegate Duty if Boost/AFR cuts occur. Remedy Boost/AFR cuts before increasing Wastegate Duty.

   Note: Because of flow restrictions, wastegate spring size, and other factors, not all applications will be able to achieve desired target boost pressure.

2. **Gain –** Ramps up the solenoid Duty Cycle to help with boost pressure drop at high engine speeds. Gain is calculated as a percentage of what the current wastegate duty is set at (Max Duty with Gain = (Gain% * Duty%) + Duty%). For example, if your Wastegate Duty is set at 30% and your Gain is 50% the SCG-1 will gain up to an additional 15% (Max Duty with Gain =45%). Gain is triggered 1.5 seconds into active boost and will ramp up until Max Duty is gained. The SCG-1 will display the active duty cycle and progressive Gain on the upper right hand corner viewport when active. Default setting is 0%.
   Tuning Tip: Tune your wastegate duty and spring pressure settings before gain.

3. **Spring Pressure (Spring Press)** – Sets the activation pressure for the solenoid. Set this value at or less than your mechanical spring pressure. Be aware that setting this value too low may cause boost spikes, setting it too high may cause an extreme delay in the activation of the solenoid. Default setting is 4.9 PSI
   Tuning Tip: A good starting point is 1 to 2 PSI below the wastegate's mechanical spring pressure.

4. **Boost Cut by Pressure** - This is a safety trigger to cut boost by a desired wastegate duty percentage at a specific manifold absolute pressure. There are two setup parameters to trigger this safely cut: **Max Pressure (Boost Cut Press)** and **Cut Percent (Boost Cut %)**. Max Pressure (Boost Cut Press) is the maximum manifold absolute pressure that is safe for the application. Cut Percent (Boost Cut %) is the percentage of wastegate duty that the trigger will cut when the max defined pressure is hit. When the safety Boost Cut by Pressure is triggered, the SCG-1 will display "B Cut" on the upper right hand corner viewport. Default setting is 8 PSI with a 100% cut.
   Tuning Tip: Start with a 100% Cut Percentage.

5. **Boost Cut by AFR** – This is a safety trigger to cut boost by a defined AFR . There are two setup parameters to trigger this safely cut: **Start Pressure (AFR Start Press)** and **AFR Cut. Start Pressure (AFR Start Press)** is the minimum manifold absolute pressure where the safety cut will become active. **AFR Cut** is the defined lean A/F that will trigger the safety cut. When the **Boost Cut by AFR** is triggered, the SCG-1 will display "O2 Cut" on the upper right hand corner. Default setting is a start pressure of 4.9 PSI and 13 AFR.
   Tuning Tip: Set the Start Pressure at the same pressure value as Spring Pressure.

6. **Boost Control ON/OFF –** When configured from the gauge, this setting is accessed from the main screen. Press and HOLD both the left and right interface buttons, this will disable/enable solenoid control. If there are no other error codes on the status viewport of the screen, the SCG-1 will display "SC OFF". In LM Programmer, use the Boost Control ON checkbox to turn the solenoid control ON/OFF. Default setting is ON.

4   Logworks 3 & LM Programmer Software Package

The SCG-1 can be connected directly to your Windows computer to log and analyze data with the Logworks software or to configure with LM Programmer. The software is a free download on the Innovate Motorsports' support section of the website.

4.1   LM Programmer

LM Programmer is used to configure settings on your SCG-1.

1. Connect the OUT port of the SCG-1 to the provided serial programming cable. Connect the other end of the serial programming cable to your computer. If your computer does not have a serial port, you can purchase a USB to Serial adapter from Innovate Motorsports (P/N 3733) or use any USB to serial adaptor

that includes drivers. Make sure that nothing is connected to the IN port of the SCG-1
2. Power up the SCG-1.
3. Launch LM Programmer. The LM Programmer application can be launched from *Start->Programs->LogWorks3->LM Programmer* from the Windows task bar.

4.1.1 Programming Analog Output

Connect the SCG-1 to the computer and launch LM Programmer. Select the Analog Output tab. The analog output configuration screen shows voltage versus Lambda for the analog output. The graph display is automatically scaled to the selected voltages values. The configuration screen allows the user to specify a minimum and maximum lambda or A/F value to a corresponding voltage range.

By selecting the 'use Air-Fuel-Ratio' button you can change the displayed unit of measure for mixture by AFR instead of Lambda. This does not change the programming, only the unit of measure displayed in the configuration screen.

Click the 'Program' button to upload your modified A/F or lambda scaling data into the SCG-1. Once the unit has been programmed, the 'Program' button will grey out.

Factory Programmed Default:
The analog output by default is programmed to output between 0V at 7.35 AFR to 5.0V at 22.39 AFR.

4.1.2 Advanced Analog Output Programming

The 'Advanced' button allows the user to set the analog out update speed and the voltage output during sensor Warm-up and error conditions. The factory defaults of the analog outputs update 1/12 of a second. The default voltage output is set at 0 volts for both the Warm-up and error conditions.
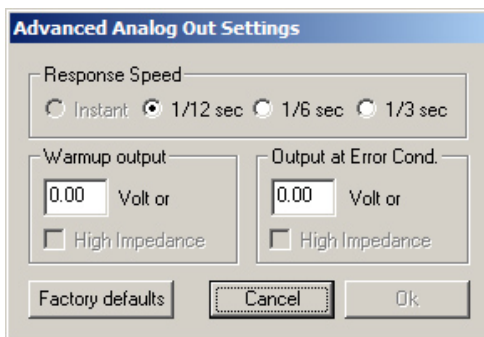
When setting the SCG-1 to the slower response speed settings, the measured mixture data will be averaged over the response time setting before being sent via the analog output.

4.1.3   Updating the Firmware

⚠ **Do not update the firmware if the versions are the same**. **A firmware update should only be necessary if there has been a new release that specifically fixes a problem that you are experiencing with the controller.**

1. Connect the SCG-1 to the computer and launch LM Programmer.
2. Once connected, LM Programmer will display the current version of the firmware that is installed in the SCG-1. *Do not flash the firmware if the versions are the same.*
3. On the 'Info' tab of LM Programmer you will see a button labeled "Update Firmware," click this button.
4. Select the firmware file with the dld extension. If there have been revisions to the firmware, you will find them available for download from the Support section of the Innovate Motorsports web site.
5. The software will now prompt you to confirm that you wish to overwrite the firmware currently on your SCG-1.
6. Click OK, the gauge of the SCG-1 will go blank. DO NOT power off or disconnect the SCG-1 from the computer until the firmware progress screen completely disappears. Once finished, you may disconnect the unit from the computer and exit out of the software.

4.1.4   Changing Sensor Type

Note: The SCG-1 must be running firmware version 1.08 or later with LM Programmer 4.0 or later to access the sensor type menu.

The *SCG-1* is multi sensor compatible with the Bosch LSU 4.2 and 4.9 sensors. In order to go from one sensor type to another the *SCG-1* must be connected to the LM Programmer software and the appropriate sensor type must be selected. The "Sensor Type to use" setting can be found in the 'Info' tab when LM Programmer connects to the *SCG-1*. Once the sensor type is changed a sensor calibration must be performed with the sensor outside of the exhaust (see Sensor Calibration chapter.)

Sensor Cable P/N	3ft	8ft	18ft
LSU 4.2	3843	3810	3828
LSU 4.9	3890	3887	3889

Sensor P/N	
LSU 4.2	3737
LSU 4.9	3888

Note: All sensor cables for the LSU 4.9 are easily identified by a '4.9' marking molded on the sensor connector side.

⚠️ **Use the appropriate sensor cable for the sensor type as each sensor has a different style connector. Spliced cable can not only affect the wideband's performance but in worst cases it can damage the sensor and/or controller.**

⚠️ **Selecting the wrong sensor type to the sensor being used will not only give you erroneous readings and/or errors. It can also permanently damage the sensor.**

4.2   Logging data from your SCG-1 with LogWorks

Logworks is an invaluable tool to help setup your SCG-1. The SCG-1 has four channels of sensor data built in for the tuning of not only your desired boost levels, but also a safe operating air fuel ratio for your engine. These channels are:

1. Wideband O2: Units in AFR or Lambda
2. RPM
3. Boost
4. Duty: Wategate Duty % of the SCG-1 solenoid

1. Connect the OUT port of the SCG-1 to the provided serial programming cable. Connect the other end of the serial programming cable to your computer. If your computer does not have a serial port, you can purchase a USB to Serial adapter from Innovate Motorsports (P/N 3733) or use any USB to serial adaptor that includes drivers. Make sure that nothing is connected to the IN port of the SCG-1. Power up the SCG-1.
2. Launch LogWorks. The LogWorks application can be launched from *Start->Programs->LogWorks3->Logworks3* from the Windows task bar.
3. Once LogWorks launches go to *File->Connect.* You will be prompted to connect to the serial COM port. Select the COM port the device is connected to and then click Connect.
4. You will now see live data streaming from the SCG-1.
5. *To start recording go to File->New Realtime Log* or, in the Toolbar, click on the 🔴 Tool.