Auto Meter COMPETITION INSTRUMENTS

2650-1835-77

IMPORTANT WEAR SAFETY GLASSES

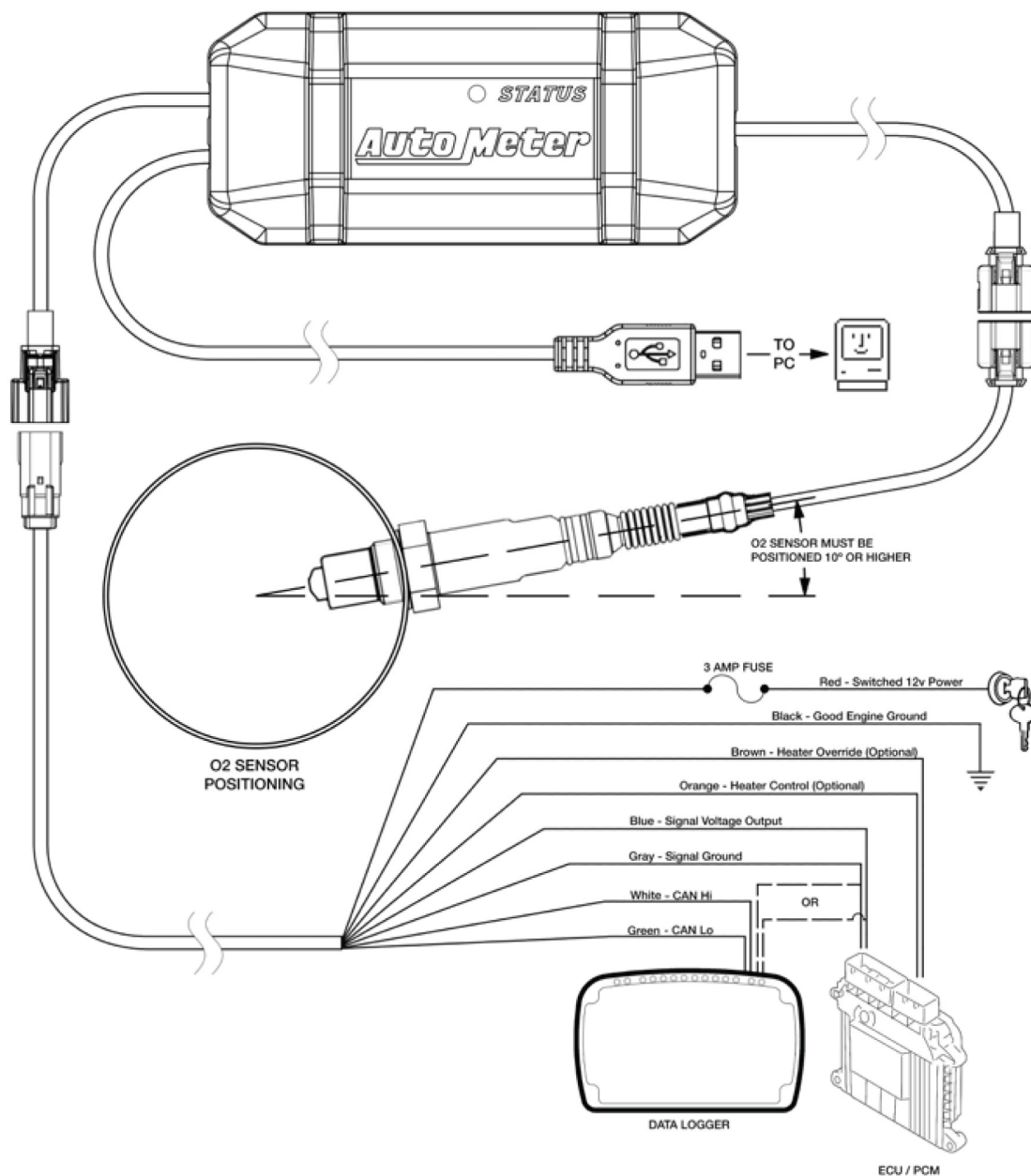## Includes

Qty. 1 - Inline Wideband Controller
Qty. 1 - LSU4.9 Lambda Sensor
Qty. 1 - Sensor M18x1.5 Weld Fitting & Plug
Qty. 2 - Stainless Steel Ball Lock Ties, 12 in.

Qty. 1 - Wire Harness w/ 8 Pin conn., 4ft.
Qty. 1 - USB Drive - Instr. & Config Software
Qty. 1 – Connector USB 2.0 Adapter

Installation

STATUS

AutoMeter

TO PC

O2 SENSOR MUST BE POSITIONED 10° OR HIGHER

O2 SENSOR POSITIONING

3 AMP FUSE

Red - Switched 12v Power
Black - Good Engine Ground
Brown - Heater Override (Optional)
Orange - Heater Control (Optional)
Blue - Signal Voltage Output
Gray - Signal Ground
White - CAN Hi
Green - CAN Lo

OR

DATA LOGGER

ECU / PCM

Wiring

Red Wire (Power) – Connect to a fused and switched +12V source. This product should be protected with a 3 amp automotive fuse (available commercially) on this lead. It is recommended that vehicles without alternators connect this wire to a separate switch or direct to the vehicle's master cutoff switch. (See sensor heating element Section)

Black Wire (Ground) - Connect this lead to a good engine ground.

Brown Wire (Optional Heater Override) – On vehicles equipped with a total loss electrical system (no alternator) connect this wire to a driver-operated normally open momentary closed wire to +12V. Closing this switch after the engine is running will trigger sensor heater cycle operation on applications where supply voltage to the RED wire does not exceed the 13.5V threshold to automatically start sensor heating.

Orange Wire (Heater Control) – On applications where manual sensor heater control is desired (such as when connected to an aftermarket engine control unit) utilize the ORANGE wire. When this wire is closed to ground it will activate the sensor heater and shut it off when ground is removed. The Inline Wideband Module must be configured for Manual Heater control via the software. (See Module Configuration section for more info)

Blue Wire (Analog Voltage Signal Output) – When utilizing the Inline Wideband Module to output a signal to a Data Acquisition System such as AutoMeter and Stack Displays and Data recorders or Engine Control Units, connect this wire to the analog sensor input voltage connection point (input +). This may be user-configured utilizing the PC software for either 0-1V Narrowband O2 sensor signal simulation or 0.5 -4.5V Wideband output. (See Setting Signal Output Section for more details)

Gray Wire (Analog Signal Ground) – When utilizing the Inline Wideband Module to output a signal to a Data Acquisition System or Engine Control Unit, connect this wire to the analog sensor ground reference (input -).

The Inline Wideband Module is capable of sending sensor data over CAN directly to devices equipped to receive this input type, such as such as AutoMeter and Stack configurable race displays and data recorders or 3rd party aftermarket engine control units. This allows for multiple O2 sensors to be multiplexed over a two wire connection enabling multiple cylinders / primaries to be monitored while simplifying vehicle wiring and freeing up valuable analog inputs on these devices for other uses.

White Wire (CAN – Hi) – Connect to CAN + on compatible device. (See CAN Output Section for more Details)

Green Wire (CAN – Lo) – Connect to CAN – on compatible device. (See CAN Output Section for more Details)

In order to preserve maximum device accuracy, shortening / lengthening of sensor wiring is not recommended. When applications demand longer wiring runs between module and sensor, contact AutoMeter for technical assistance.

Avoid wiring runs that place strain on the leads and protect all panel pass throughs with a grommet of appropriate size to prevent chafing / shorts and damage to the device.

If you are not utilizing any of the output wiring options noted above, it is important to insulate the ends of these wires and tape / cable tie them safely out of harm's way to prevent accidental contact or shorts, false readings, and potential damage to the module.

Mounting - Sensor

The included Bosch LSU4.9 heated oxygen sensor comes with a stainless steel weld-in bung, plug (in the event the module is not being used and the sensor has been removed), and wiring harness with a weather pack connector. The oxygen sensor should be installed on the exhaust manifold as close to the cylinder head as is reasonably possible so that the sensor reaches operating temperature quickly while not exceeding the maximum hexagon temperature of 1,112ºF (600ºC) and maximum exhaust gas exposure temperature of 1,706 ºF (930º C).

If long tube headers are used, the oxygen sensor should typically be installed in the collector for applications where individual cylinder readings are not required. If cast iron manifold(s) or shorty headers are used, install the sensor in the pipe just below the manifold seeking an ideal distance of 18 in. (46 cm) from cylinder head exhaust port or turbo exhaust port. In multi-bank applications where a single sensor is being utilized mounting in the left or right side is acceptable and should ideally place the sensor on the bank known to house the leanest cylinder. Open header applications will require a minimum length of 18-24 in. (46-61 cm) of exhaust pipe after sensor for proper reading at idle and part throttle.

Sensor Tightening Torque – 33 – 44 ft. / lbs.

Route sensor cable away from sources of heat (such as exhaust pipe) and RF / EMI such as charging system, fuel pump, and ignition wiring.

IMPORTANT!

- **AutoMeter recommends welding supplied stainless steel bung with a TIG welder.**
- **Sensor bung should be welded at an angle that places the sensor a minimum of 10 degrees above horizontal (paralled to the ground) to allow for condensation drain and less than 90 degrees from horizontal to avoid overheating the sensor.**
- **Exhaust pipe in front of the sensor should not contain any pockets, projections, protrusions, edges, flex-tubes, etc. in order to avoid accumulation of condensation which can damage the sensor.**
- **Open and/or leaky exhausts and camshaft overlap are known causes of false lean sensor readings at light to moderate engine loads. Once engine load increases and increased exhaust volume is present reading accuracy improves as fresh air spoiling the readings is expelled from the sensor element.**
- **Always install the sensor prior to any Catalytic Converters present on the vehicle's exhaust to ensure proper readings as the catalytic converter will cause readings which are leaner than actual, the amount of variance is affected by engine load and efficiency of the converter.**
- **Sensor will got very hot during operation – exercise appropriate caution when working near to the sensor to avoid burns and locate accordingly to avoid damage to nearby vehicle components which may be heat sensitive.**
- **This sensor is considered a wear / consumable part (which is not covered under warranty) with many contributing factors that make it impossible to predict longevity for all applications – plan spares accordingly.**
- **Leaded fuels, Nitromethane, two stroke mix (oil), engine coolant (blown head gaskets), particulates / carbon (excessively rich mixtures), sensor shock (impact or drops), and exceeding safe operating temperatures (excessively lean conditions) are specifically known to reduce overall sensor life.**

Mounting – Module

The AutoMeter Inline Wideband Module is completely weatherproof (IP67 sealing standard) with the design intention of being safe for installation outside the passenger compartment where exposure to the elements may be possible.

The face of the module features a multi-color status indication LED. Mounting location should given consideration to ease of visibility of this light for ease of setup and troubleshooting.

IMPORTANT!

- **While the module is extremely resistant to the elements, care should be taken to place the device away from sources of heat (vehicle exhaust) and RF/EMI such as high tension ignition leads (plug wires), spark boxes, fuel pump and fan wiring, etc.**
- **Operating temperature range for the module is 250ºF to -40ºF (121ºC to -40ºC)**

Locating grooves are placed in two places on the housing to allow for installation utilizing the included metal cable ties. Utilize the mounting template below to drill holes when mounting to a flat panel.
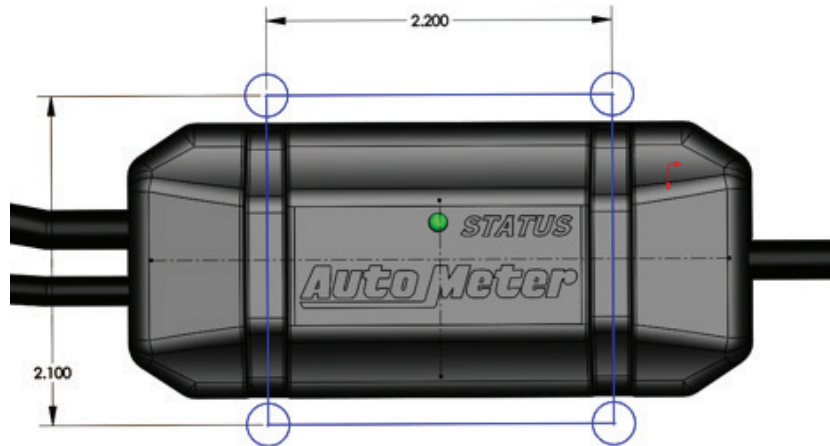
Heater Control Mode

All O2 sensors must be heated before an accurate signal is produced. Potential sensor damage can occur if the gauge begins to heat the sensor before the engine is running due to condensation that forms on the sensor tip and in the exhaust.

To accommodate this, an internal trigger within the module will automatically begin heating the sensor when 13.5 volts or higher is seen on the Red wire ("Normal" operating mode). While the module does not require 13.5 volts to operate (12 volts will suffice), this voltage is used to indicate to the gauge that the engine is running, as most regulated charging systems will maintain 14 volts or higher.

Once the module sees 13.5 volts the status LED will blink YELLOW to indicate the heater is active. When the sensor is heated, the status LED will blink GREEN and the module will begin reading air/fuel ratio or Lambda in real-time. In applications where a standard charging system is not used (vehicles without a regulated alternator, for example) there is an override available that will allow sensor heating to occur without the module reading a 13.5 volt trigger

To Override Automatic control in Normal Operating Mode:

- While the status LED is showing solid YELLOW (indicating supply voltage is insufficient to trigger automatic sensor heating cycle), close ground to the module BROWN (HEATER OVERRIDE) wire via a driver-controlled normally open momentary closed switch to begin the heater process.
- Once heater override has been triggered, the status LED will blink YELLOW indicating that sensor heater is in operation
- When sensor has reached operating temperature, status LED will blink GREEN to indicate that sensor and module are functioning correctly and providing AFR / LAMBDA readings

0.5 - 4.5V Analog Output - Lambda and AFR Readings

The AutoMeter Inline Wideband Module offers a signal output for supplying information to a Data Acquisition System such as AutoMeter / Stack Displays and Data recorders or 3rd party Engine Control Units. To activate this setting follow the instructions (See Setup Software Operation section for more info) for connecting to the device via USB port on your laptop equipped with the Inline Wideband control software and click the '0.5-4.5V' button.

The signal provided is a linear output voltage ranging from 0.5 V to 4.5V. (See charts below for details)

If it is desirable to express this as a formula for input into a 3rd party device, you may plot the output utilizing a point slope algebraic equation (y=mx+b) where in our needs the following applies:

y = Lambda or AFR

m = slope of the plotted line (Lambda or AFR high – Lambda or AFR low) / (4.5V – 0.5V)

x = output voltage from the module

b = offset (Lambda or AFR value at 0V)

Using the programmed values of 10:1 AFR (Gasoline) for 0.5V and 20:1 AFR (Gasoline) for 4.5V the formula looks like this:

y = ((10/4)*v)+8.8

If we plug 1.25V into that equation then we get 11.9 AFR = (((20-10)/(4.5-0.5))*1.25)+8.8 which falls right along the plot chart.

IMPORTANT!

AFR values and stoichiometric points change with fuel type and with the particular blend of gasoline being utilized. The information shown below assumes Unleaded Gasoline with no ethanol content as the basis for the information presented. The chart below provides a reference for a variety of common alternative fuel types.

Fuel Type	Lambda	Stoichiometric Air / Fuel Ratio
Unleaded Gasoline	1.00	14.7:1
Methanol	1.00	6.4:1
Ethanol	1.00	9.0:1
LPG (Propane)	1.00	15.5:1
CNG	1.00	17.2:1
E85	1.00	9.8:1

The target operation modes shown below are suggestions intended only as a baseline / starting reference for interpreting sensor information based upon AutoMeter's experience working with different vehicle types and professional builders.

There are many variables involved in each engine build and use which make it impossible to accurately provide a single chart which address ideal air / fuel mixtures for every combination. It is the ultimate responsibility of the user to confirm proper target values and calibration for the application. AutoMeter holds no responsibility for improper use of this product that results in engine damage. We recommend that you consult your tuner or engine builder for specific values appropriate to your application as they may vary from the chart below.

Target Operation	Voltage	Lambda	AFR (Gasoline)
Out of Range	-	0.59	8.8
	0.10	0.61	9.0
	0.20	0.62	9.3
	0.30	0.64	9.5
	0.40	0.66	9.8
	0.50	0.68	10.0
High Boost Forced Induction and Air Cooled Power	0.75	0.72	10.6
	1.00	0.76	11.3
	1.25	0.80	11.9
Low Boost Forced Induction & Naturally Aspirated Power	1.50	0.85	12.5
	1.75	0.89	13.1
Idle, Part Throttle, Cruise & Economy	2.00	0.93	13.8
	2.25	0.97	14.4
	2.39	1.00	14.7
	2.50	1.02	15.0
	2.75	1.06	15.6
	3.00	1.10	16.3
Lean	3.25	1.14	16.9
	3.50	1.19	17.5
Too Lean - Detonation, Misfire, and Engine Damage May Result	3.75	1.23	18.1
	4.00	1.27	18.8
	4.25	1.31	19.4
	4.50	1.36	20.0
Out of Range	4.60	1.37	20.3
	4.70	1.39	20.5
	4.80	1.41	20.8
	4.90	1.42	21.0
	5.00	1.44	21.3

0-1V Narrowband O2 (NB) Output - Lambda and AFR Readings

The AutoMeter Inline Wideband Module may be configured utilizing the setup software to output a Narrowband O2 signal (rather than a 0.5-4.5V Wideband Analog signal) when required to satisfy 3rd party device requirements when it is desirable to upgrade to a higher resolution sensor for the purposes of tuning / monitoring. To activate this setting follow the instructions (See Setup Software Operation section for more info) for connecting to the device via USB port on your laptop equipped with the Inline Wideband control software and click the '0-1V' button.

Narrow Band Out		
Voltage	Lambda	AFR (Gasoline)
0.000	1.028	15.112
0.100	1.023	15.043
0.200	1.017	14.944
0.300	1.010	14.846
0.400	1.003	14.747
0.448	1.000	14.7:1
0.500	0.996	14.648
0.600	0.990	14.550
0.700	0.983	14.451
0.800	0.976	14.353
0.900	0.970	14.254
1.000	0.967	14.215

Controller Area Network (CAN) Signal Output

The Inline Wideband Module is capable of sending sensor data over CAN directly to devices equipped to receive this input type, such as such as AutoMeter and Stack configurable race displays and data recorders or 3rd party aftermarket engine control units. This allows for multiple O2 sensors to be multiplexed over a two wire connection enabling multiple cylinders / primaries to be monitored while simplifying vehicle wiring and freeing up valuable analog inputs on these devices for other uses.

To activate this setting follow the instructions (See Setup Software Operation section for more info) for connecting to the device via USB port on your laptop equipped with the Inline Wideband control software and click the 'CAN On' button. Conversely, clicking 'CAN Off' will disable this mode. The signal output is scaled to lambda times one thousand. One of eight different CAN addresses can be selected in the CAN ID box. This allows up to eight separate In-Line Wideband modules on the same CAN bus.

AutoMeter and Stack configurable race displays and data recorders already include the necessary data within their CAN library to employ the Inline Wideband module, requiring no additional work beyond selecting the device and input type required within the DataPro software.

If however, you are connecting the Inline Wideband Module to a 3rd party CAN enabled device, please utilize the following details to set up the appropriate channel / channels for this hardware to operate correctly with your hardware.

CAN Message Address: 0x101 (default). May be adjusted to any hex value from 0x101 to 0x108 using the Wideband Configurator Utility to accommodate conflicts or multiple Inline Wideband Modules enabled on the CANbus.

CAN Message Format: 11-bit Standard filter settings (not extended), Big Endian / Motorola byte ordering.

CAN Bit Rate: 1Mbit/s

CAN Channel Values: Lambda is multiplied by 1000 and transmitted high hex byte in CAN data byte [0], low hex byte in CAN data byte [1].The other 6 bytes are 0. Lambda = 1.00 would be 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x03, 0xE8.

Start Bit: 8

Bit Count: 16

Units: Lambda

Type: Unsigned

CAN Channel Resolution: .001

Offset: 0

Minimum: 0

Maximum: 65

NOTE: There are CAN terminating resistors present within the Inline Wideband Module. There must be another set of terminating resistors at the other end of the CAN bus, and none in between in order to preserve network communications. Please plan wiring and placement of this device on your CANbus accordingly.

Configuration Software Operation and Inline Wideband Module Setup

PC Requirements:

The software described below has been tested on Windows 7 and 10 operating systems. The host PC must have all the latest updates installed, including the .NET framework.
A copy of the AutoMeter Wideband Configurator is included on a USB memory stick included in the packaging with your Inline Wideband Controller. The latest software updates for this product can be obtained by visiting AutoMeter.com.

To install the software on your Windows PC using the included USB Flash Drive:

1. Insert the flash drive into a USB port on your computer. ...
2. Depending on how your computer is set up, a dialog box may appear. ...
3. If a dialog box does not appear, open Windows Explorer and locate and select the flash drive on the left side of the window to view the contents.
4. Copy the files to your desktop for ease of access.

5. Double Click the Setup icon which will open the Wideband Configurator install wizard
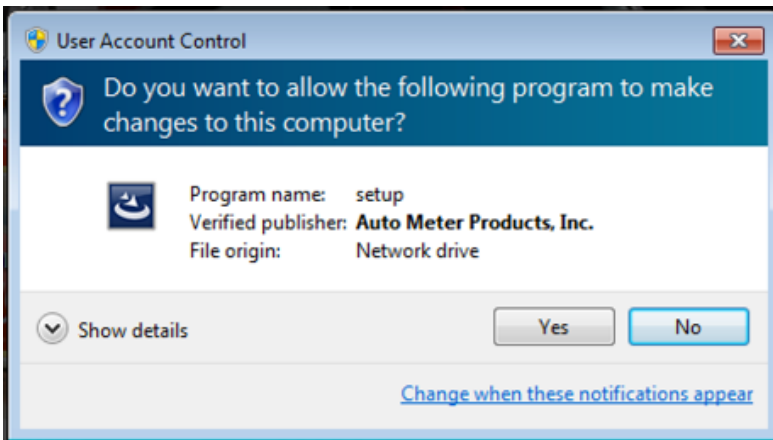
6. A window may open asking if you wish to allow the program to make changes to your computer, click Yes to continue.
7. This window will close followed by a temporary 'Preparing to Install' window.
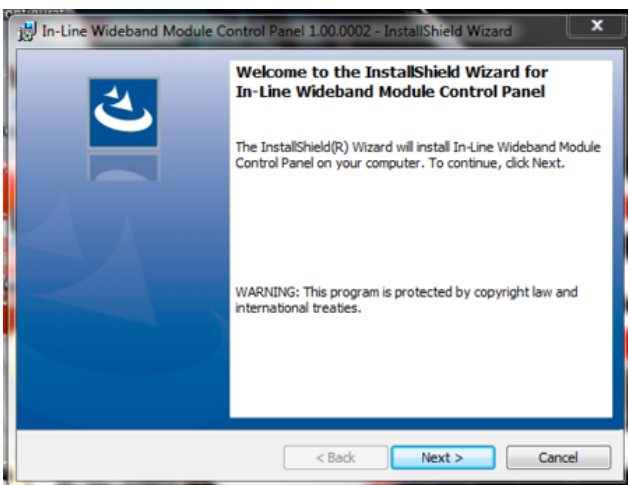
8. The InstallShield Wizard Window will open. Click Next to continue
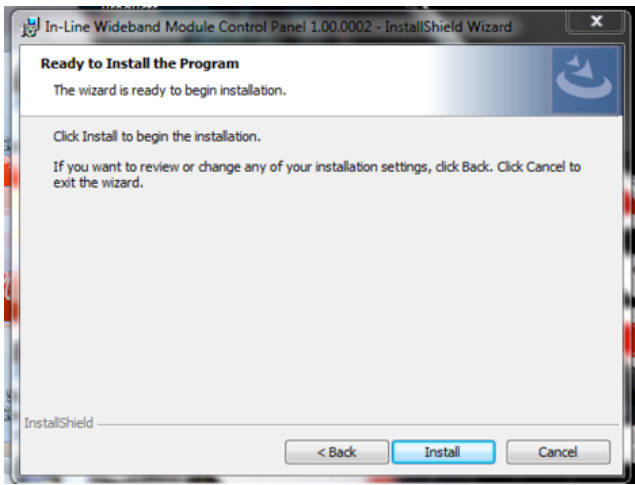
9. Ready to Install The Program Window will open. Click Install to continue.
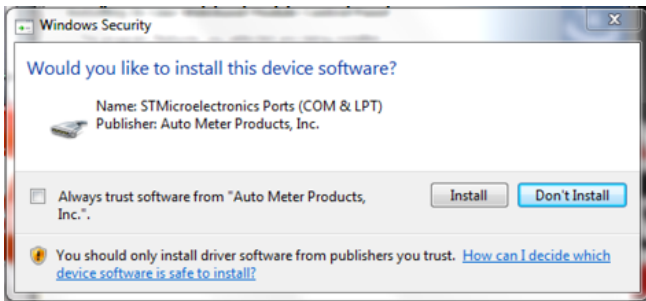
10. Windows Security may ask for permission to install STMicroelectronics Ports (COM & LPT). This is a related program which allows your PC to talk to the Inline Wideband Controller. Click Install to continue.
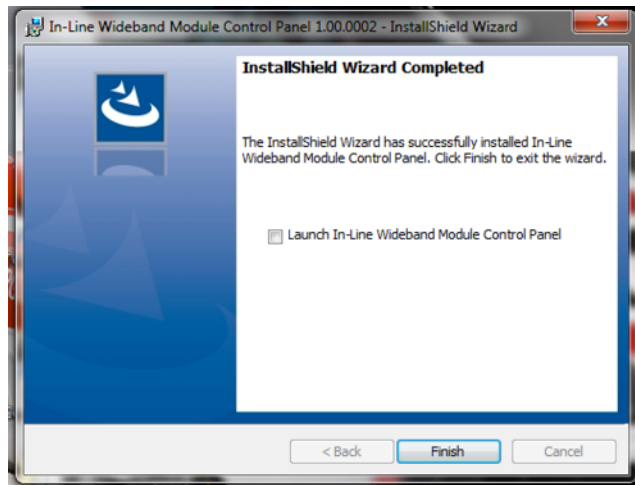

11. The install wizard will complete the installation and open a window indicating that the process has been completed. Click Finish to close the Wizard and complete the installation.

12. Locate the Wideband Configurator Icon on your PC Desktop and Double Click to launch the application.

AutoMeter Wideband Configurator is a PC application for configuring the AutoMeter Inline Wideband Module and providing simple diagnostic capability.
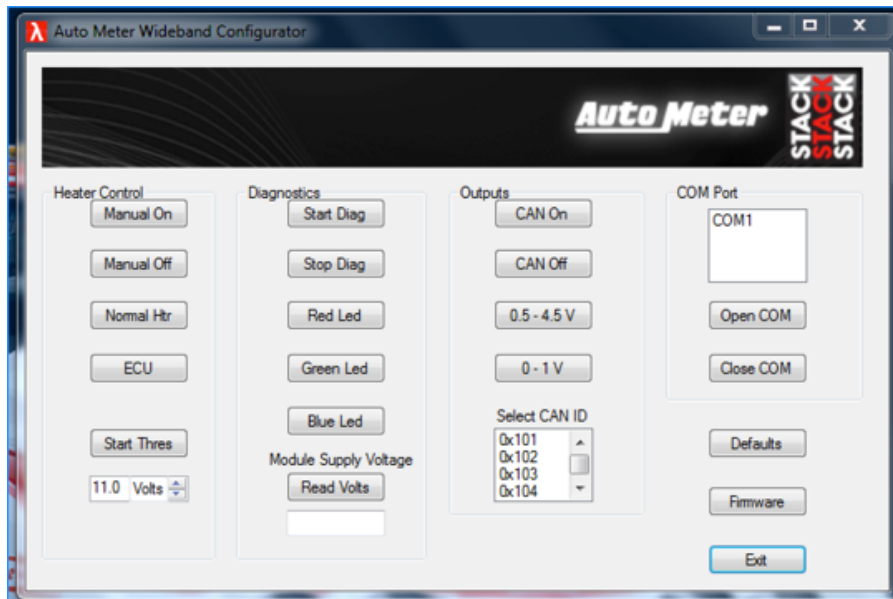
Select your COM port from the list box on the right and click 'Open Com' to establish a connection to your inline wideband controller.

Inline Wideband Module Heater Controls

On the left side of the Configuration Utility window you will find buttons which control the O2 sensor heater controls. The Inline Wideband heater defaults to starting when the battery supply power voltage reaches 13.5 volts.

Manual PC Toggle of Sensor Heater

Clicking the '**Manual On'** button will turn on the sensor heater regardless of other supply voltage or control conditions.

The '**Manual Off'** button will shut off the sensor heater regardless of other supply voltage or control conditions.

3rd Party / External Device Heater Control

Clicking the '**ECU**' button turns control of the heater over to an external device, e.g. the vehicle's electronic control unit (ECU). Once ECU control is enabled, a connected external / 3rd party device can pull the ORANGE wire to ground to activate the O2 sensor heater. When the ORANGE wire is open (not grounded), the O2 Sensor heater is disabled.

Supply Voltage O2 Sensor Heater Control (factory default)

Clicking the '**Normal Htr**' button turns control of the heater back to the Inline Wideband, and will cause it to activate the heater once supply voltage to the Control module exceeds the indicated Start Threshold value.

Adjusting the supply voltage threshold trigger value

On some applications it may be desirable to adjust the voltage trigger, which controls how the Inline Wideband Module activates the O2 Sensor heater. You may change this by adjusting the value in the bottom of the Heater Control button column (bottom left of Configurator window). Once the desired voltage threshold is shown, click the 'Start Thres' button to apply changes to the module.

Diagnostics Control Features

In the Diagnostics controls, the 'Start Diag' button takes the Inline Wideband out of its normal functioning mode. The blue module status led will blink once to indicate it is in diagnostic mode. The heater is switched off while this mode is active and Lambda / AFR data is not available.

Status Indicator

Clicking the 'Red Led,' 'Green Led,' or 'Blue Led' buttons allows you to test the operation of the module's status indicator lamp and confirms that communication between the Configuration Utility and the module is good.

Supply Voltage

Clicking the 'Read Volts' button causes the current battery supply voltage available to the Inline Wideband module to appear in the box below.

Exit Diagnostics / Resume Operation

To exit diagnostic mode and resume normal operation, click 'Stop Diag' (status LED will blink Green), then 'Manual On' (status LED will blink Blue once, blink Yellow during sensor heating, and then blink green when normal sensor operation resumes.

Factory Reset / Restore System Defaults

In some instances it may be desirable to return the device to factory default settings.

To achieve this, click the 'Defaults' button found on the right of the Configurator window. This will return the following features to the Inline Wideband Module:

- Normal heater mode
- 0.5-4.5V analog output
- 13.5 volts heater start threshold
- 0x101 CAN address

The status LED on the module will blink Blue once to indicate that the Factory Reset process has been completed.

Firmware Update Procedure

The AutoMeter Inline Wideband module supports the ability to apply feature and usability firmware updates, when available, without the need to return the product to the factory for service.

To update the firmware on your Inline Wideband, follow the steps outlined above to connect the device to your PC which has the latest firmware file downloaded from AutoMeter.com.

Once the Wideband Configurator Software is open and the device is connected follow the steps below to complete the device update.

Click the '**Firmware**' button to initialize the Firmware Update process.

A warning message will open asking you to confirm that you wish to proceed with updating device firmware.

Click Ok to continue.

Click the Exit button for the Wideband Configurator.

This will close the COM port and leave the Wideband Configurator application.

Cycle 12V battery power to the Inline Wideband.

The module status LED will be off.

Open DfuSeDemo. - This is installed initially along with the Configuration Utility and will be placed on your PC desktop during software installation. Alternatively this can be located and opened from Programs.

Once the DfuSeDemo connects it will display the message 'STM Device in DFU Mode'

Click Choose and browse to the .dfu file for the new version of firmware.

Once you have located the desired firmware (.dfu) file previously downloaded to your PC, select it and click 'Open' to continue.

WARNING! *Do not remove power from the Inline Wideband module while firmware upgrade is in process as permanent damage to the hardware may result! Please contact AutoMeter or Stack technical support if you have any questions about this before proceding with the firmware update process.*

Click Upgrade to proceed. (This is a button near the bottom of DfuSeDemo window)

Click Yes to confirm your selection.

After 'Target 00: Upgrade successful !' is displayed, close DfuSeDemo software.

Cycle 12V battery supply power to the Inline Wideband Module.

The module status LED will turn on, indicating the firmware update has been completed.

To locate the latest firmware updates for this device, please visit www.autometer.com or www.stackltd.com or contact AutoMeter or Stack technical support at the details for service found at the end of this document.

Status LED Indications

Blinking Green – module and sensor are functioning properly. Sensor is up to operating temperature and sending Lambda information to the module.

Solid Yellow – Battery / Supply voltage to module insufficient to trigger automatic start to the sensor heater.

Blinking Yellow – Sensor heater is active and bringing device to operating temperature. Status will change to Blinking Green once operating temp is achieved.

Flashing Red – Sensor disconnected, communications issue between sensor and module, or sensor failure.

Replacement Parts

5316 – Sensor O2, Replacement, Wideband Air/Fuel, Pro/Plus

SERVICE

For service send your product to Auto Meter in a well packed shipping carton. Please include a note explaining what the problem is along with your phone number. If you are sending product back for Warranty adjustment, you must include a copy (or original) of your sales receipt from the place of purchase.

12 MONTH LIMITED WARRANTY

AutoMeter Products, Inc. warrants to the consumer that all AutoMeter High Performance products purchased from an Authorized AutoMeter Reseller will be free from defects in material and workmanship for a period of twelve (12) months from date of the original purchase. Products that fail within this 12 month warranty period will be repaired or replaced at AutoMeter's option, when determined by AutoMeter that the product failed due to defects in material or workmanship. This warranty is limited to the repair or replacement of parts in the AutoMeter High Performance product and the necessary labor done by AutoMeter to effect the repair or replacement of the AutoMeter High Performance product. In no event shall AutoMeter's cost to repair or replace an AutoMeter High Performance Product under this warranty exceed the original purchase price of the AutoMeter High Performance Product. Nor shall AutoMeter Products, Inc. be responsible for special, incidental or consequential damages or costs incurred due to the failure of an AutoMeter High Performance Product. This warranty applies only to the original purchaser of the AutoMeter High Performance Product and is non-transferable. This warranty also applies only to AutoMeter High Performance Products purchased from an Authorized AutoMeter Reseller. All implied warranties shall be limited in duration to the said 12 month warranty period. Breaking the instrument seal, improper use or installation, accident, water damage, abuse, unauthorized repairs or alterations voids this warranty. AutoMeter disclaims any liability for consequential damages due to the breach of any written or implied warranty on all products manufactured by AutoMeter Products, Inc. For a comprehensive listing of Un-Authorized Auto Meter Resellers please visit www.autometer.com/autometerlocator/index/unauthorized.

FOR SERVICE SEND TO: **AUTO METER PRODUCTS, INC.** 413 W. Elm St., Sycamore, IL 60178 USA (866) 248-6357

Email us at service@autometer.com

http://www.autometer.com

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