ALM-Gauge

Accurate Lambda Meter

__with a separate gauge

Manual

V2.2

ECTORONS LLC

Check before you power on ALM-Gauge:

- The oxygen sensor is installed in the right way; or if it's left in the free air, make sure it's dry and it's not close to the inflammable materials;

The ALM-Gauge is correctly connected to DC power supply or 12V battery;

Website: http://www.ecotrons.com

Email: info@ecotrons.com

ALM-Gauge included parts:

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Chapter 1 ALM-Gauge Product Overview

ALM (Accurate Lambda Meter) is an air/fuel ratio (lambda) meter which uses Bosch LSU 4.9 wideband oxygen sensor and Bosch driver chip CJ125 to accurately measure the exhaust air/fuel ratio (AFR) of variant combustion engines.

ALM-Gauge is a smaller size version of our previous ALM . It has the same accuracy and fast response characteristics like ALM, but much smaller size. The controller box has the size of 4"x2.6"x1", or similar to a business card size. It has a primary 0-5v linear analog output which can be used as the feedback control signal for an ECU. It also has an analog signal output to the 52mm digital LED gauge. The gauge is optional, because some professional tuners already have a lot of gauges which include AFR display as a part.

ALM-Gauge uses more advanced LSU4.9 sensor instead of LSU4.2 which is still used by most other wideband controllers. LSU4.9 is the new generation wideband sensor evolving from LSU4.2. It is superior to LSU4.2 with the obvious proof: Bosch uses LSU4.9 across the board for their wideband applications. (See the appendix: LSU4.2 vs. LSU4.9 for a quick comparison)

Here is why LSU4.9 is superior to LSU4.2:
http://www.ecotrons.com/technology/bosch_lsu_49_is_superior_to_lsu_42_sensors/

ALM-Gauge can also use LSU4.9D sensor, but the need to update the software, if you need to use LSU4.9D, please explain in advance at the time of purchase ALM.

Bosch chip CJ125 is the integrated chip (IC) specifically designed for LSU 4.9/4.2 Sensors. Bosch's own wideband controller, "LambdaTronic", uses CJ125 driver chip. In fact, Bosch uses this chip wherever a LSU sensor is used. The CJ125 and LSU sensor are mated-pair by Bosch. Presumably LSU sensors work the best with CJ125 chips.

See here for Bosch Motorsport's wideband controller, LT4:
http://www.bosch-motorsport.de/media/catalog_resources/Function_Manual_LT4pdf.pdf

Together, LSU 4.9 and CJ125 make our ALM a more accurate lambda meter in the automotive aftermarket.

Besides air/fuel ratio measurement, ALM-Gauge provides some supplemental functions which make your measurement or tuning more convenient: linear analog output to your ECU; LED digital display; engine RPM probe, data logging with a serial communication to a PC, etc.

List of ALM parts

- Small ALM controller
- 52mm digital LED gauge (optional)
- Harness (60in default, 120in optional)
- Bosch LSU 4.9 sensor
- Sensor plug and bung
- USB to serial converter (included)
- CD - documents and ALM GUI software

Products	Communication	Display	02 Sensor Channels supported	ANOUT(Range)	02 Sensor Supported	Exhaust temperature sensor	Exhaust pressure sensor	Engine Speed Input	Virtual narrow band o2 sensor output(NBOUT)
ALM-Gauge	**RS232**	**AFR Gauge**	**1**	**YES (0 ~ 5v)**	**LSU 4.9(default)/ADV**	**NO**	**NO**	**YES**	**YES**
ALM-B-ANOUT	SCI(0 ~ 5v)	NO	1	YES (0 ~ 5v)	LSU 4.9(default)/ADV	NO	NO	NO	NO
ALM-B-CAN	CAN	NO	1	NO	LSU 4.9(default)/ADV	NO	NO	NO	NO
ALM-B-RS485	RS485	NO	1	NO	LSU 4.9(default)/ADV	NO	NO	NO	NO
ALM-LED	RS232	LED (4 bit)	1	YES (0 - 5v)	LSU 4.9(default)/ADV	NO	NO	YES	YES
ALM-CAN	CAN	NO	1	NO	LSU 4.9(default)/ADV	NO	NO	NO	NO
ALM-CAN-II	CAN	NO	2	NO	LSU 4.9(default)/ADV	NO	NO	NO	NO
ALM-II	RS232	LCD(128*64)	2	YES (0 - 5v)	LSU 4.9(default)/ADV	NO	NO	YES	YES
ALM-LD	RS232/CAN/USB	LCD(640*480)	2	YES (0 - 10v)	LSU 4.9(default)/ADV	YES	YES	YES	YES

Note: Blue font represents the current user manual supported of ALM units.

Chapter 2 ALM-Gauge technical specifications

Power supply

- Input voltage range: DC9V~15 V (12V Typical)
- Input current: 90mA typical plus the heater current
- Polarity protection: Reverse polarity protected
- Load Dump Clamp: Maximum Voltage 33V

Sensors

- Compatible: LSU4.9 (Support LSU4.9D, LSU 4.2 capable but not recommended)
- Number of Sensors: One
- Free air calibration: No need (we measure the free air O2)

Measurement

- Lambda range: λ = 0.5 ~ ∞(Gasoline AFR: 7.35 to free air)
- Lambda accuracy: ±0.008 @ λ =1.00; ±0.01 @ λ =0.80; ±0.05 @ λ =1.70
- Air/Fuel Ratio: Fuel dependent (see lambda range and accuracy)

Heater

- Control: Built-in PID control with CJ125
- Current: Typical 1A; Max 1.5A
- Heater return (H-): Separate wire from Ground

Response time

- 5ms updating rate (everything finished in 5ms)

Output

- Lambda analog output: 0~5V user programmable
- Analog accuracy: ±0.005V error with a 10-bit DAC chip
- Analog type: Reference ground to ECU
- Second Lambda analog output: 0~5V for a third party gauge, user programmable
- Narrow band O2 sensor simulated output

Input

- RPM input: Injection pick-up

Communications

- Advanced CAN bus communications (optional)
- RS232 or USB (via a converter) for logging or programming
- User-friendly PC software for data acquisitions and analysis

Display

- 52mm digital gauge with numbers in the censor and bar-graph LED around

Main-Processor

- CPU: Freescale MC9S12P128 16-bit micro-processor S12P (Auto industry rated)
- Speed: 32MHz
- Memory: 128k Flash, 6k RAM, 4k Data

Special features

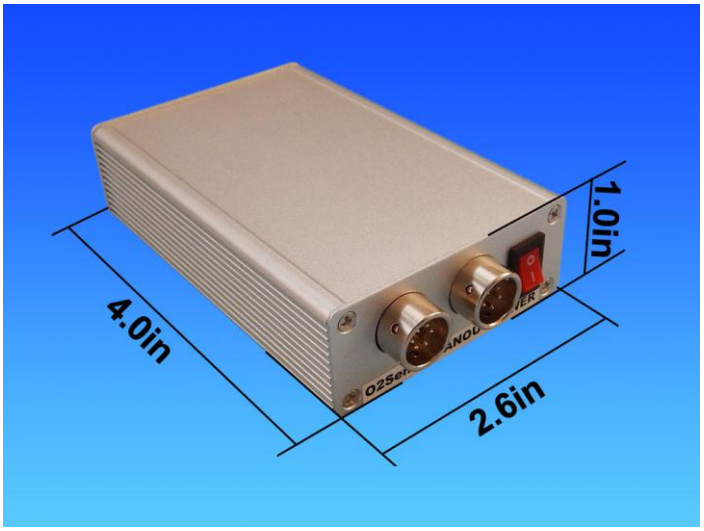
- On-Board-Diagnosis and error report

- Self-learning of part-to-part variations, aging effect
- Working with different types of fuels (gasoline, diesel, E85, etc.)

General

- Temperature range -40^{o}C ~ 125^{o}C
- Dimensions 4.0" x 2.6" x 1.0"

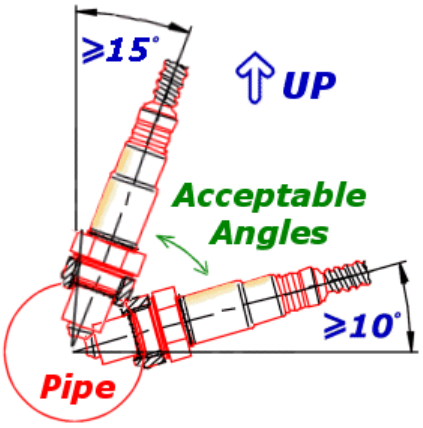
Chapter 3 Appearance and size



Chapter 4 Protect your oxygen sensor

Installation

Correct installation of the oxygen sensors is a must to avoid sensor damage. It protects the oxygen sensor from condensations and gives the sensor longer life. It also can make the measurement more accurate. The sensor body should be perpendicular to the exhaust gas flow, and it should also be tilted in the range of 10°~75° from the horizontal line (see below figure). The typical tilt-angle is 30°. The sensor head should be close to the center of the exhaust pipe.



After finding the right location on the exhaust pipe, drill a hole of 18 mm in diameter. Weld the sensor bung on it.

Note: do not weld the bung with the sensor in it.

Note, if you vehicle has a Bosch switching oxygen sensor (LSF) on your vehicle, you can just un-plug the LSF, and plug-in the wideband LSU sensor into the hole. Bosch LSU and LSF have the same size of the thread.

More User Notes

- ⚠ LSU sensors are not designed to work with leaded gasoline. Using LSU sensor with leaded gasoline will reduce the sensor life.
- ⚠ With the LSU sensor installed in the exhaust pipe, whenever the engine is running, please also run ALM-Gauge, which controls the LSU heater. Otherwise, long-time-running engine with LSU sensor not heated can cause damage of the sensor.
- ⚠ LSU sensor is preferred to run within the temperature range of 500~900°C, the best temperature is 780°C. Too high temperature (>1030°C) will cause damage of the sensor. Refer to Bosch LSU4.9 data for more details about the variant temperature requirements.

  www.**bosch**-motorsport.de/pdf/sensors/lambda/**LSU49**.pdf
- ⚠ Avoid heating the LSU sensor before the engine is running. At the engine start, there may be condensations in the exhaust gas, which can cause damage of the sensor. The preferred order: start the engine first, then immediately turn on the ALM-Gauge, which will ramp up the heating power smoothly.

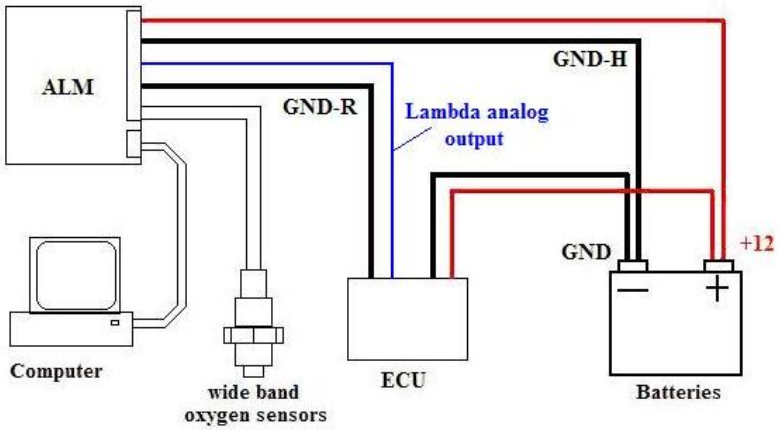
Chapter 5 ALM-Gauge hardware connection

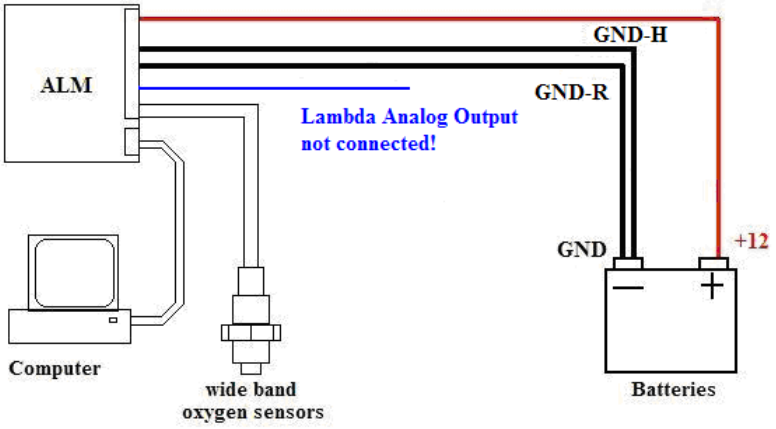
5.1 ALM-Gauge main connector pin-out

Connector	Pin#	Wire#	Name	Description	Min	Max
RS232/ I/O	1	Gray	TXD	Serial communication port	-15V	15V
	2	Purple	RPM	Injection signal input	0V	12V
	3	yellow	RXD	Serial communication port	-15V	15V
	4	Green	NO2OUT	Simulated narrow band oxygen sensor output	0V	1V
	5	Black	GND-R	Ground (Reference ground)	0V	0V
GAUGE	1	Yellow	+12V	+12V Output	12V	12V
	2	Red	+12V	+12V Output	12V	12V
	3	Black	GND-R	Ground	0V	0V
	4	Green	GAUGE	coarse analog output to the gauge (optional)	0V	1V
ANOUT/ POWER	1	Black	GND-R	Ground (Reference ground)	0V	0V
	2	Red	+12V	+12V Power supply	9V	15V
	3	Black	GND-R	Ground (Reference ground)	0V	0V
	4	Blue	ANOUT	Lambda linear analog output (fine)	0V	5V
	5	Black	GND-H	Ground (Heater circuit ground)	0V	0V
O2 Sensor	1	Red	IP	wideband oxygen sensor input	—	—
	2	Yellow	VM		—	—
	3	White	H-		—	—
	4	Grey	H+		—	—
	5	Green	IA		—	—
	6	Black	UN		—	—

Note: LSU4.9 pin-out numbers are different than LSU4.2, but they have the same color scheme.

5.2 Connection overview

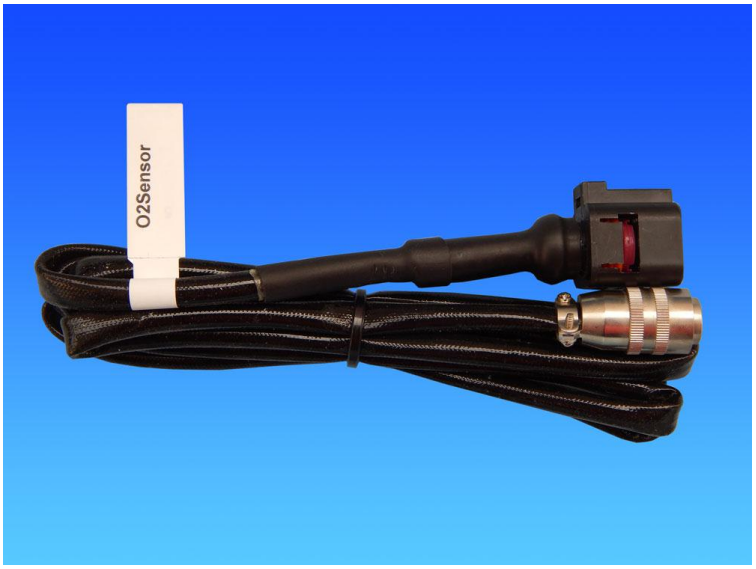




1) Plug-in the four connectors from the harness into ALM-Gauge, Connect Gauge to your ALM-Gauge.

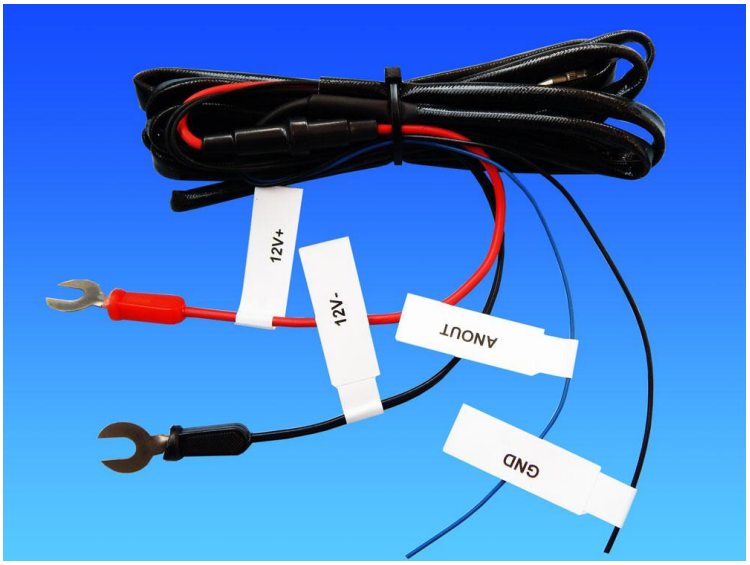
Gauge

2) Connect the 6-pin LSU4.9 mating connector to the O2 sensor.



Connector to the O2 sensor

3) Connect the 12V+ to 12V battery plus or the DC power supply +;



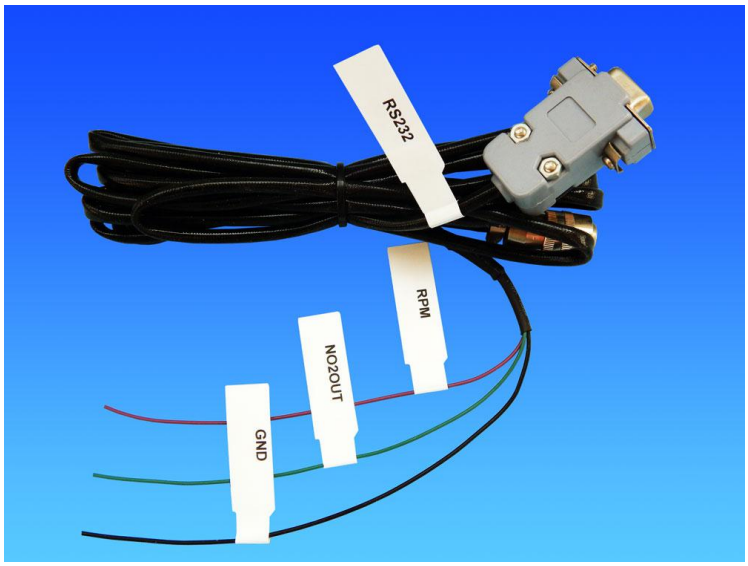
Power supply and ANOUT

4) Connect the 12V- to 12V battery minus or the DC power supply- ;

5) If you do not want to output the lambda analog signal to your ECU, connect the GND (reference ground, pin4) to the 12V battery minus or DC power supply ground; otherwise, refer to step 4.5 for GND connection.

6) If you want to output the lambda analog signal to your ECU, connect the ALM-Gauge lambda analog output to your ECU analog input, and then you must connect the ALM-Gauge GND (reference ground, pin4) to the ECU analog GND (most likely your ECU has a sensor ground for analog inputs).

7) Optional: Splice the injector-driver wire on the ECU side (usually low-side-driver type), and tap the ALM-Gauge RPM input wire to it. Use the electrical tape to wrap it.



RPM, COM and NBOUT

8) Optional: connect the switching O2 sensor simulated output (NBOUT) to the OEM ECU. This can prevent the OEM ECU turn on the MIL light. Note, the OEM switching sensor can be different from each other, and it's your responsibility to figure out how to connect the wires

correctly.

9) Optional: connect ALM-Gauge to your laptop / PC via the serial communication cable (DB9 connector). If you computer does not have a serial port, you need an extra USB-RS232-converter.

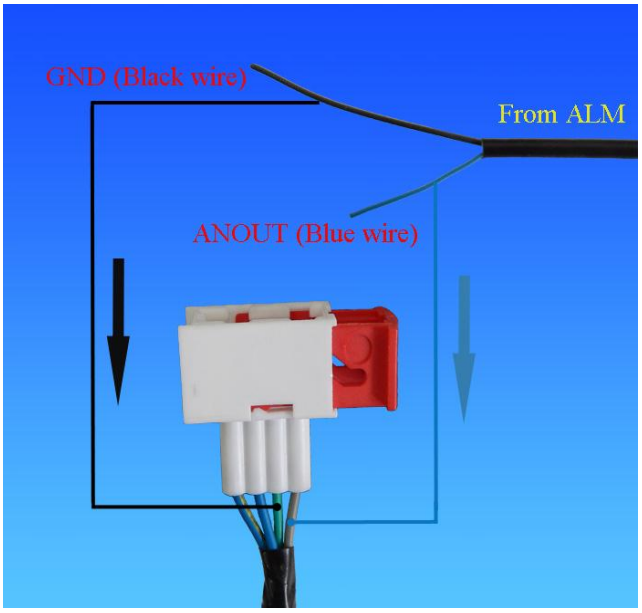
10) Users can set the ANOUT output AFR or Lambda. We will set it in our factory according to the uses' requirement. The standard ANOUT output is AFR. If users want it to output lambda or O2%, users can modify it by using ALM GUI. Connected ALM-Board to computer, click Settings→ALM Parameters, open ALM Parameters window. You can select what you want to modify the ANOUT output and Burn to ALM.

5.3 Connection ALM to ECU

There are 2 ways to connect ALM to (Ecotrons) ECU:

- Connected via NB O2 connector
- Connected via performance switch. We recommend the first connection.

5.3.1 ALM connection via NB O2 connector



From left to right in the picture:

- Heater circuit - (Blue-Yellow)
- Heater circuit + (Blue)
- Reference Ground (Green)
- O2in - O2 sensor input (Gray-Black #8)

Our ALM-Gauge harness comes with 2 wires:

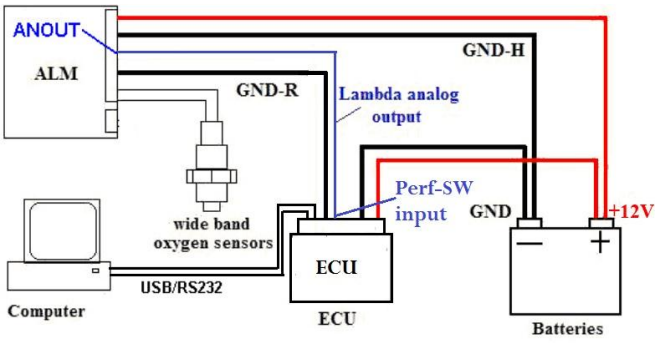
ANOUT (Blue) - analog output representing the lambda
GND (Black) - reference ground

You need to connect the ANOUT (Blue) to O2in (Gray-Black #8) and GND (Black) to Ground (Green).

5.3.2 Connect ALM to ECU via performance switch

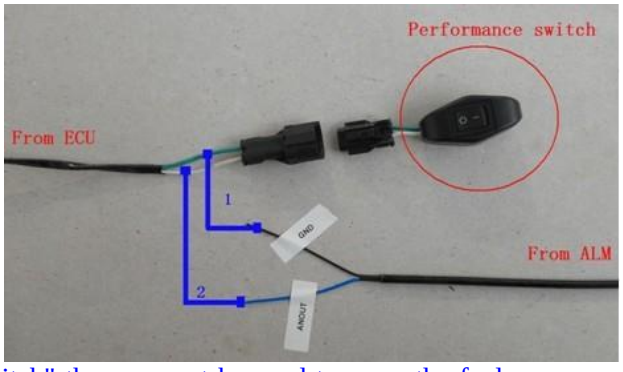
For some two-stroke engines, maybe, there is no NB O2 sensor when buy the EFI kits, so it doesn't have NB O2 sensor connector on the harness, it only has a performance switch.

But for tuning, it needs to install a wideband O2 sensor (ALM), so you can connect the ALM to ECU via performance switch, then ECU can read the Lambda.



You need to connect the ALM'S ANOUT to ECU Performance-Switch input. Follow the following steps to connect:

1) Unplug the ECU Performance switch
2) ALM'S ANOUT (blue line) is connected to the white line of the Performance-Switch
3) ALM'S analog GND (black line) is connected to the Performance-Switch of GND (green line)
4) ANOUT the output voltage from 0V to 5V, and does not need to be modified; it will be varied in accordance with the variation of the lambda.

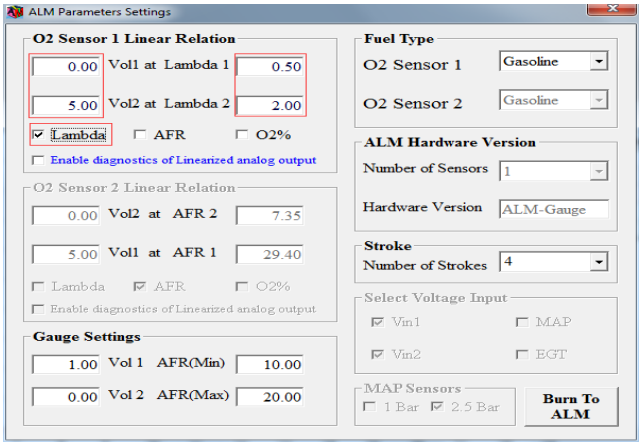


Note: "performance switch" then can not be used to swap the fuel maps any more. You can always connect back to Performance Switch after the tuning is done (ALM is disconnected).

5.4 ANOUT Calibration

Lambda mode, ANOUT used to indicate changes in lambda, the default setting:

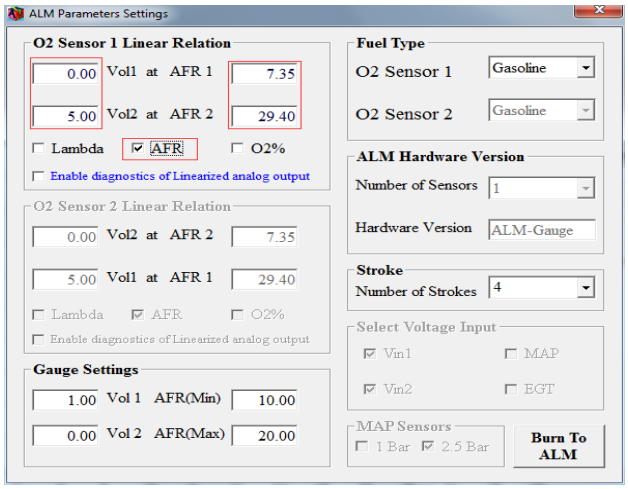
0.00 Volt at Lambda 0.50
5.00 Volt at Lambda 2.00



AFR mode, ANOUT used to indicate changes in AFR, the default setting:

0.00 Volt at AFR 7.35

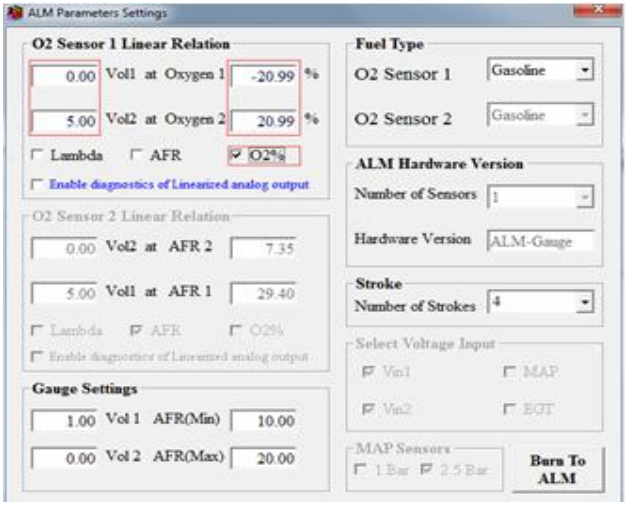
5.00 Volt at AFR 29.4



O2% mode, ANOUT used to indicate changes in O2%, the default setting:

0.00 Volt at O2% -20.99

5.00 Volt at O2% 20.99



If customers want to modify these parameters, customers can refer to ALM GUI Manual 2.4 ALM GUI using COM or USB communication.
http://www.ecotrons.com/files/ALM%20GUI%20Manual.pdf

Note：The limit range of analog voltage is 0-5v. The value of lambda is 0.5-16. The low voltage must match the low Lambda. You can't make 5V match 0.5 Lambda. AFR and O2% are same with Lambda.

How to verify analog voltage matching lambda
Since you have 2 ALMs, the way to compare is easy. You can either cross check 2 ALMs with the same sensor, or check 2 sensors, with 1 ALM.
And the next step to check good lambda:
1) Put the sensor in the free air, and use ALM GUI , to read the O2%;if it is close to 20% ;the ALM and sensor is good, otherwise, you could do Free air calibration.

2) If ALM GUI gives good O2%, then measure the ANOUT analog voltage, with a voltage meter, convert that voltage back to lambda, and compare it against the lambda in the ALM GUI. This is to verify the analog voltage is really matching the lambda measured.

Chapter 6 DIGITAL AIR/FUEL RATIO MONITOR (Gauge)

6.1 Specification

1. Input Voltage: 0 ~ 1v
2. Display Range: digital type is from 20.0% to 10.0%; analog LED type is from 20.0% to 10.0%; both of digital type and analog LED type will show the maximum or the minimum, if the value out off the display range.
3. Accurately of digital type: Every 0.1%.
4. Accurately of analog LED type: Every 0.5%, using BAR type to light up.

6.2 Application

1. General Display: The digital display will show the percentage, and value is corresponding with analog LED.
2. Electrics voltage display & warning function:
   A. When at the start, Red LED (for VOLT only) will light up and digital display will show the value of voltage at 30 seconds. After then, the digital display will show the value of AIR/FUEL. Every 10 minutes show the voltage at 30 seconds.
   B. When the voltage is lower than 11.0v, Red LED (for VOLT only) will shine and the digital display will show the value and keeping shine to warning.
   C. When the value of AIR/FUEL is lower than 10AFR or higher than 20AFR over 3 seconds, the digital display will keeping shine to warning.

Chapter 7 DTC table

Below is the Diagnostic Trouble Code table. ALM-Gauge has on-board-diagnostics capability to detect most common errors. The first thing user should do when ALM-Gauge is not working appropriately is to read DTCs.

Trouble Code	Description	Solutions
E1	Internal communication error	Contact the manufacturer
E2	Internal register error	Contact the manufacturer
E3	LSU yellow wire (VM) short to power	1. Check the harness for short-to-power 2. Change the LSU
E4	LSU yellow wire (VM) short to GND	1. Check the harness for short-to-ground 2. Change the LSU
E5	LSU black wire (UN) short to power	1. Check the harness for short-to-power 2. Change the LSU
E6	LSU black wire (UN) short to GND	1. Check the harness for short-to-ground 2. Change the LSU
E7	LSU green wire (IA) short to power	1. Check the harness for short-to-power 2. Change the LSU
E8	LSU green wire (IA) short to GND	1. Check the harness for short-to-ground 2. Change the LSU
E9	Operating voltage too low	Check the power supply to the ALM spec.
E10	Heater circuit damaged	Contact the manufacturer
E11	Heater circuit short to power	Contact the manufacturer
E12	Heater circuit short to GND	1. Check the harness for short-to-ground 2. change LSU 3. Contact the manufacturer