EcoEFI

ALM-LED Manual

Accurate Lambda Meter
With built-in LED display

V2.6

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Note: If you are not sure about any specific details, please contact us at info@ecotrons.com.

Check before you power on ALM-LED:

- 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-LED is correctly connected to DC power supply or 12V battery;

ALM-LED includes parts:
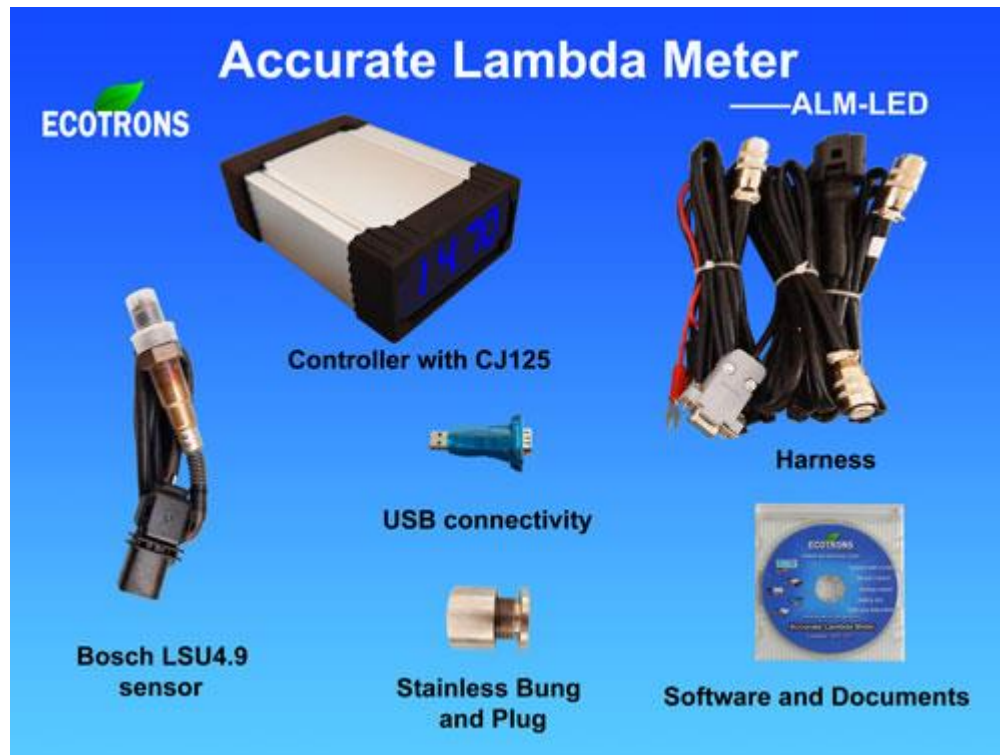
List of ALM-LED parts

- ◆ Small ALM controller
- ◆ Built-in LED display
- ◆ Harness (60in default, 120in optional)
- ◆ Bosch LSU 4.9 sensor
- ◆ Sensor plug and bung
- ◆ Serial communication cable
- ◆ USB to serial converter (included)
- ◆ CD - documents and ALM GUI software

Table of Content

Chapter 1   ALM-LED Product Overview

ALM (Accurate Lambda Meter) is an air-fuel-ratio (AFR) meter which uses the Bosch LSU 4.9 wideband oxygen sensor and Bosch integrated circuit chip CJ125 to accurately measure the AFR or lambda for variant combustion engines.

ALM-LED is a version of ALM that has a built-in LED display instead of a separate gauge. This version has all the ALM functions plus the built-in LED. The rugged enclosure makes it perfectly an engine tuning instrumentation either in the lab environment or in the vehicle. The LED display is very bright and even striking directly under the sun light. There are 4 digits, including 2 float digits, compared to a typical 3 digit after-market gauge. It can be configured to display AFR, Lambda, or O2 concentration.

The advantages of ALM-LED: save you a gauge, and make the whole package more compact, and you get higher resolution of the display, and the configurable display variable. In some applications, you don't have a console to mount your round gauge. This LED box is perfect to sit anywhere flat.

Again, all our ALM have the high accuracy and fast response characteristics, which are the root of our design at the very beginning.

Furthermore, it has the new feature of CAN bus communication as optional. This is a more advanced feature for professional engine controls where CAN bus is used widely and AFR signal can be broadcasted on the CAN bus.

First, ALM uses the more advanced LSU 4.9 wideband sensor. And it can also use LSU ADV sensor by using the ALM GUI to set.

Second, Bosch chip CJ125 is the integrated chip (IC) specifically designed for LSU 4.9 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/en/de/produkte/catalog_products_1_760313.php
The link may be updated by Bosch, please use the link on our website.

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

Products	Communication	Display	O2 Sensor Channels supported	ANOUT(Range）	O2 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）	LSU4.9(default)/ ADV	NO	NO	YES	YES
ALM-B-AN OUT	SCI(0～5v)	NO	1	YES（0～5v）	LSU4.9(default)/ ADV	NO	NO	NO	NO
ALM-B-CAN	CAN	NO	1	NO	LSU4.9(default)/ ADV	NO	NO	NO	NO
ALM-B-RS485	RS485	NO	1	NO	LSU4.9(default)/ ADV	NO	NO	NO	NO
ALM-LED	**RS232**	**LED （4 bit)**	**1**	**YES（0 - 5v）**	**LSU4.9 (default)/ ADV**	**NO**	**NO**	**YES**	**YES**
ALM-CAN	CAN	NO	1	NO	LSU4.9(default)/ ADV	NO	NO	NO	NO
ALM-CAN-II	CAN	NO	2	NO	LSU4.9(default)/ ADV	NO	NO	NO	NO
ALM-II	RS232	LCD(128*64)	2	YES（0 - 5v）	LSU4.9(default)/ ADV	NO	NO	YES	YES
ALM-LD	RS232/CAN/USB	LCD(640*480)	2	YES（0 - 10v）	LSU4.9(default)/ ADV	YES	YES	YES	YES

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

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Chapter 2   ALM-LED technical specifications

Power supply
- ◆ Input voltage range   DC 9V~15 V (12V Typical)
- ◆ Input current   70mA typical plus the heater current
- ◆ Voltage protection   Reverse polarity protected, & over voltage protected
- ◆ Load Dump Clamp   Maximum Voltage 33V

Sensors
- ◆ Compatible   LSU 4.9 (Support LSU ADV, LSU 4.2 capable but not recommended)
- ◆ Number of Sensors   One
- ◆ Free air calibration   No need (it measures the free air O2%)

Accuracy
- ◆ Lambda range $\lambda= 0.5 \sim \infty$
- ◆ Lambda accuracy   ±0.008 @ λ=1.00
$\pm$0.01 @ λ=0.80
$\pm$0.05 @ λ=1.70
- ◆ Air/Fuel Ratio   Fuel dependent (see lambda range and accuracy)
- ◆ Oxygen concentration range   -21% ~ 21%

Heater
- ◆ Control   Built-in PID control with CJ125
- ◆ Current   Typical 1A; Peak 3.5A
- ◆ Heater return (H-)   Standalone Heater return wire

Response time
- ◆ 5ms updating rate
- ◆ 0-5v analog output in 5ms updating rate;
- ◆ CAN bus message in 10ms broadcasting rate
- ◆ SCI message in 20ms broadcasting rate

Output (default)
- ◆ Lambda analog output   0~5V user programmable
- ◆ Analog accuracy   ±0.005V error with a 10-bit DAC chip
- ◆ Simulated narrow band oxygen sensor output

Input
- ◆ RPM input   Acquisition fuel injection signal (or 12V single pulse signal)

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
- ◆ 4 digit LED display
- ◆ Including 3 digit floating numbers
- ◆ AFR, lambda, O2% configurable

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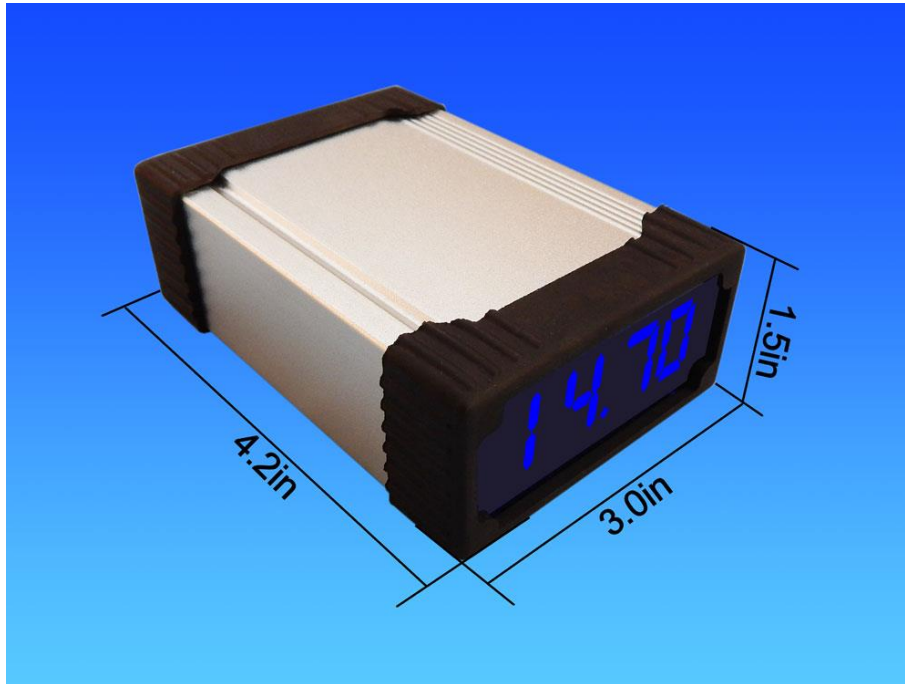- ◆ Memory   128k Flash, 6k RAM, 4k Data

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   -25°C ~ 85°C
- ◆ Dimensions   4.2" x 3.0" x 1.5"

        http://www.ecotrons.com

Chapter 3   Appearance and dimension

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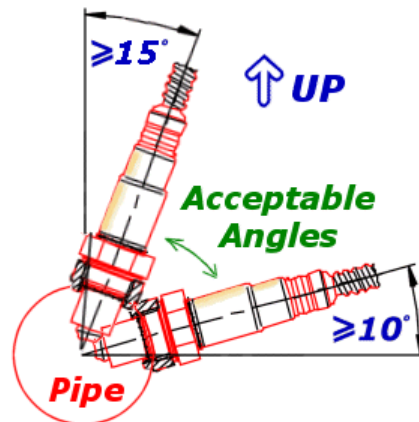
After finding the right location on the exhaust pipe, drill a hole of 18 mm in diameter. Weld the sensor bung on it.

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-LED 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^oC, the best temperature is 780^oC. Too high temperature (>1030^oC) will cause damage of the sensor. Refer to Bosch LSU4.9 data for more details about the variant temperature requirements. http://www.etas.com/en/downloadcenter/5858.php

⚠ 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-LED, which will ramp up the heating power smoothly.

Chapter 5   ALM-LED hardware connections

5.1 ALM-LED main connector pin-out

Connector	Pin#	Wire#	Name	Description	Min	Max
Connector A	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
Connector B	1	Red	IP	wideband oxygen sensor input	—	—
	2	Yellow	VM		—	—
	3	White	H-		—	—
	4	Grey	H+		—	—
	5	Green	IA		—	—
	6	Black	UN		—	—
Connector C	1	Black	GND-R	Ground (Heater circuit 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

LSU sensor connector:

Note: LSU4.9 pin-out numbers are different than LSU4.2, but they have the same color scheme. The pin-out of LSU4.9 are the same as the LSU-ADV, but the 5th pin(IA) of LSU-ADV is reserved.

5.2 Installation Procedures

1) Plug-in the three connectors from the harness into ALM-LED.
2) Connect the 6-pin LSU 4.9 mating connector to the O2 sensor.
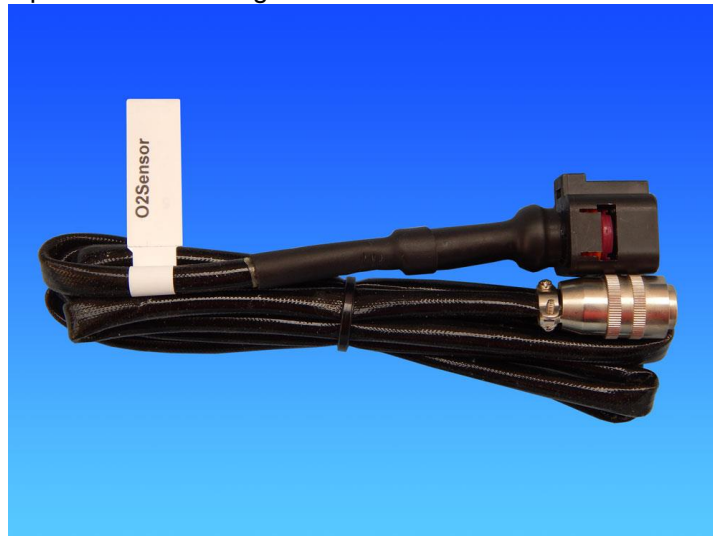
Connector to the O2 sensor

3) Connect the 12V+ wire (red) to 12V battery plus or the DC power supply +;
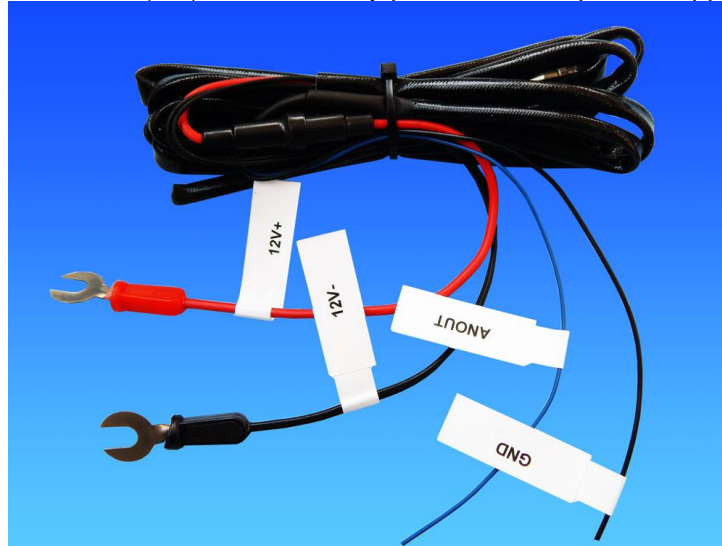
Power supply and ANOUT

4) Connect the 12V- wire (Black) 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-R **(reference ground, pin4)** to the 12V battery minus or DC power supply ground. Example of the ALM running alone:
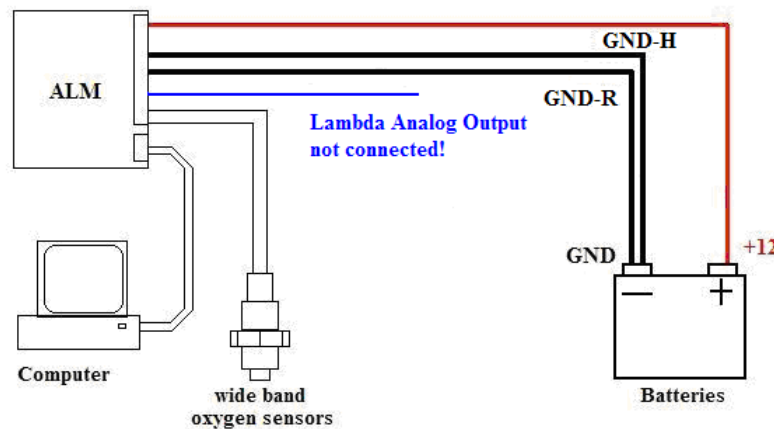
6) **If you want to output the lambda analog signal to your ECU, connect the ALM-LED "ANOUT" wire to your ECU analog input, and then you must connect the ALM-LED GND-R (reference ground, pin4) to the ECU analog GND** (ECU generally has an analog ground).

Example of connecting the ALM's analog output to an ECU as the feedback signal:
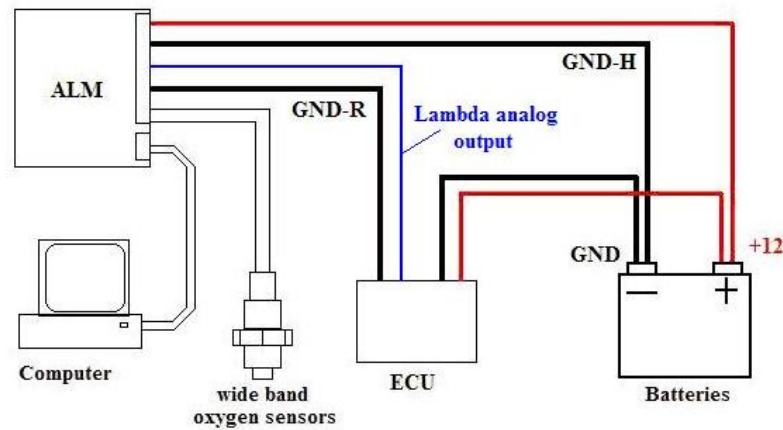
7) Optional: RPM input to ALM-LED. Splice the injector-driver wire on the ECU side (usually low-side-driver type), and tap the ALM-LED RPM input wire to it. Use the electrical tape to wrap it.
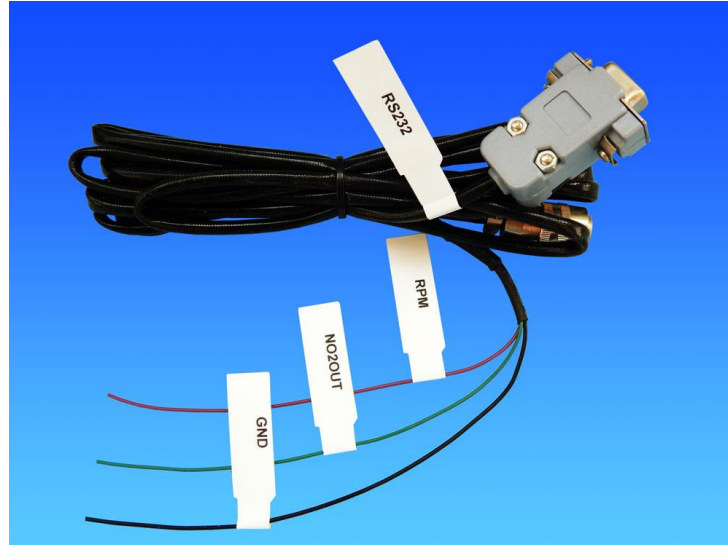
RPM, COM and NBOUT

8) Optional: Connect an analog narrowband oxygen sensor output (NBOUT) to the OEM's ECU, which can prevent some OEM's ECU from turning on the alarm light. Note, the OEM NB O2 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-LED to your laptop / PC via the serial communication cable (DB9 connector). If your computer does not have a serial port, you can use Ecotrons USB-RS232 converter.
10) Users can set the ANOUT analog output to correspond to AFR, Lambda, or oxygen concentration. We will set it in our factory according to the uses' requirement. The standard ANOUT output is lambda. If users want it to output AFR or O2%, users can modify it by using ALM GUI. Connected ALM-LED 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.

Users can use the ALM GUI software to connect the ALM-LED. This software can display Lambda, AFR, O2%, O2 sensor temperature; calibration ANOUT and set ANOUT output

range; read fault codes; record and playback data, etc.

About ALM GUI usage, please refer to the ALM GUI Manual.
http://www.ecotrons.com/support/

5.3 ALM-LED-CAN

ALM-LED-CAN is ALM-LED with CAN bus version, which is based on the ALM-LED adding CAN bus function. This is a more advanced feature for professional engine controls where CAN bus is used widely. ALM-LED-CAN supports all the functions of CAN bus designed by ECOTRONS, and AFR/lambda/O2% can be broadcasted on the CAN bus.

ALM-LED-CAN pin-out is same with the ALM-LED. The connection can reference ALM-LED. If you want to connect ALM-LED-CAN with CAN bus, please connect the CAN wire correctly. **Dark Green** wire is CAN-L; **Yellow** wire is CAN-H.
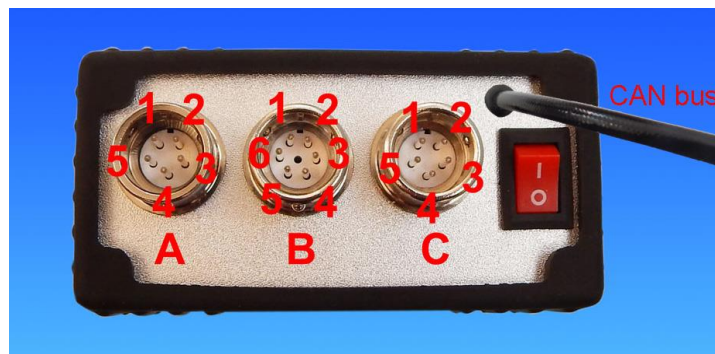
About CAN communication protocol, please refer to the ALM Communication Protocol - CAN. http://www.ecotrons.com/support/

5.4 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 you choose the first.

5.4.1 ALM connection via NB O2 connector
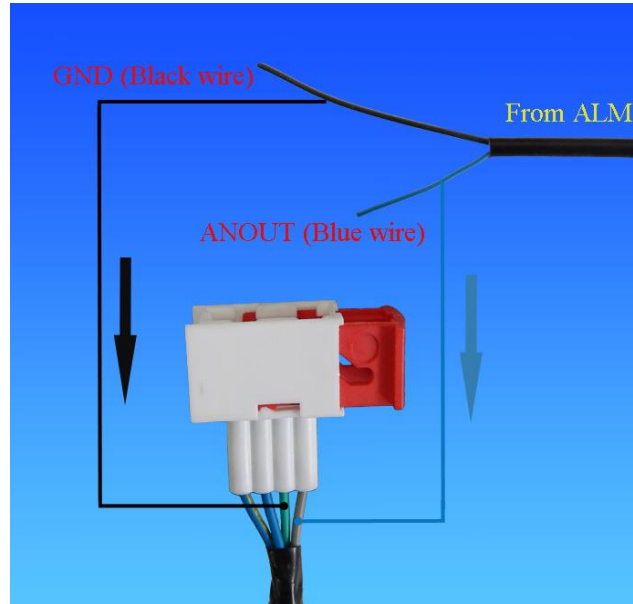
From left to right in the picture:

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

Our ALM-LED harness comes with 2 wires:

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

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

5.4.2 Connect ALM to ECU via performance switch

For EFI systems without narrow-field oxygen sensors, the user needs to connect the linear analog output of the ALM to the performance change switch of the EFI system. Then the ECU can read the Lambda value. The connection diagram is shown below.
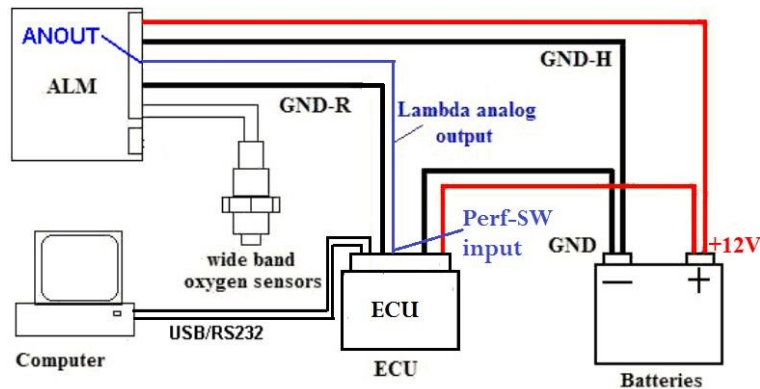
The following is the connection procedure for connecting the analog output of the ALM to the input of the ECU performance changeover switch:

1) The user needs to set the performance change switch to the "O" side; otherwise, the ECU will not read to the correct analog input;

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 GND (green line) of the Performance-Switch

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.
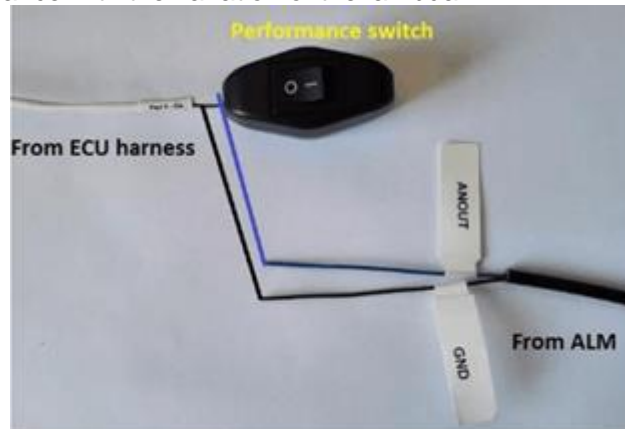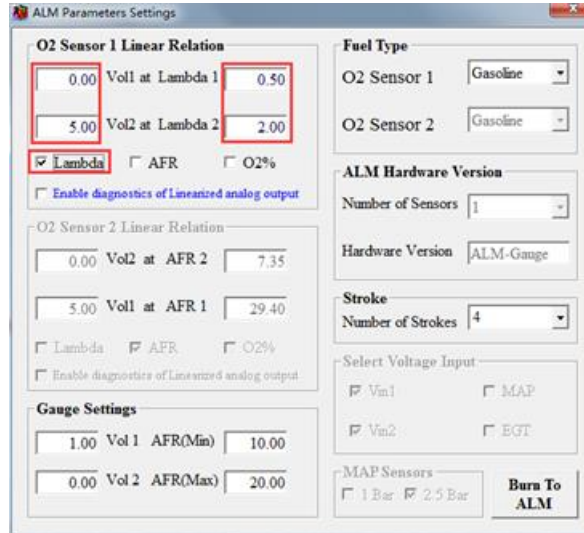
Note: The performance switch is normally not used for fuel switching. And you can set the performance switch to the "I" side at any time after disconnecting the ALM.

5.5 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:
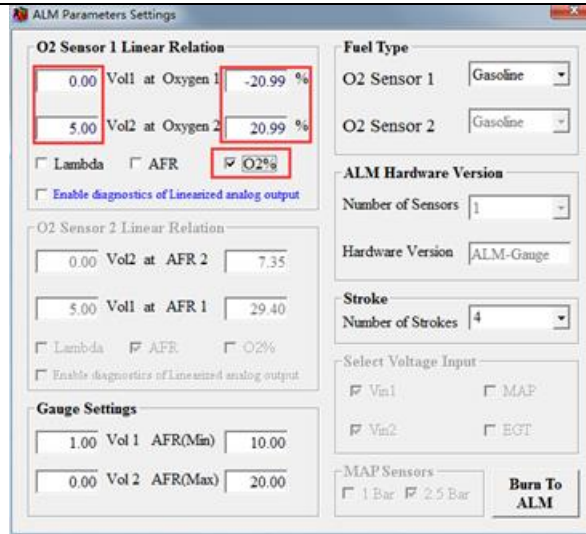   0.00 Volt at AFR 7.35
        5.00 Volt at AFR 29.4

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. The ALM GUI can communicate using with COM or USB.
http://www.ecotrons.com/support/

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.

Chapter 6   DTC table

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

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