ALM-Board

Accurate Lambda Meter
– Mini Board Version

V2.4.6

Http://www.ecotrons.com

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

Check before you power on ALM-Board:

- 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-Board is correctly connected to DC power supply or 12V and 5V battery.

ALM-Board included parts:

List of ALM-Board parts

- Small ALM board 2.4"x1"x0.5"
- 10-pins mini plug to the main board (optional)
- Sensor Harness (24in default, 120in optional)
- Bosch LSU 4.9 sensor
- Stainless plug and bung
- CAN bus, SCI, 0-5V analog output (pick one only)
- CD - documents and ALM GUI software (N/A for some configure)

Table of Content

Chapter 1 ALM 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 semiconductor chip CJ125 to accurately measure the AFR or lambda for variant combustion engines.

ALM-Board is a version of ALM that trims off the peripheral parts and keeps the minimum set of electronics, yet providing the core function of the wideband controller. It is a mini-size board, 2.4"x1"x0.5", and it can be plugged in to the main controller board easily. The only thing that needs from the main board is 5V voltage supply. ALM-Board has the full control function for LSU 4.9 sensor. Same as our other ALMs, it has a CJ125 chip built-in. It measures the O2 concentration accurately, and converts it to either lambda, or AFR, as you want. It controls the sensor temperature in a close loop mode, accurately around 780^{o}C degrees. ALM-Board communicates with the main board via a few different options: CAN bus, SCI, RS485. Users can choose to use one of them.

ALM-Board is designed to fit into the OEM's controller case with a very small foot print. It has its own LSU 4.9 sensor connector and cable. It can be connected to the main board via a mini 10-pins connector. Or you can request a customer connection between the ALM-Board to your main board. We do customization for small manufacturers.

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

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, "Lambda Tronic", 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 market.

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）	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-Board technical specifications

Power supply

◆ Input voltage range	DC 5V for the board, 12V for the O2 sensor
◆ Input current	60mA typical for the board; the heater current directly from 12V supply

Sensors

◆ Standard configuration	LSU 4.9 (Support LSUADV; LSU 4.2 capable but not recommended)
◆ Number of Sensors	One
◆ Free air calibration	No need

Accuracy

◆ Range of measurement	λ = 0.5 ~ ∞
◆ Measurement 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)
◆ Range of O2%	-21% ~ 21%

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

Heater

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

Output

◆ Lambda analog output	0 ~ 5V analog the user can set
◆ Analog accuracy	±0.005V error with a 10-bit DAC chip

Communications

- CAN bus or SCI communications (Customers can choose one of them)
- RS485 customer protocols (optional)

Main-Processor

◆ CPU	Freescale MC9S12P128 16-bit micro-processor (Automotive level)
◆ Speed	32MHz
◆ Memory	128k Flash, 6k RAM, 4k Data

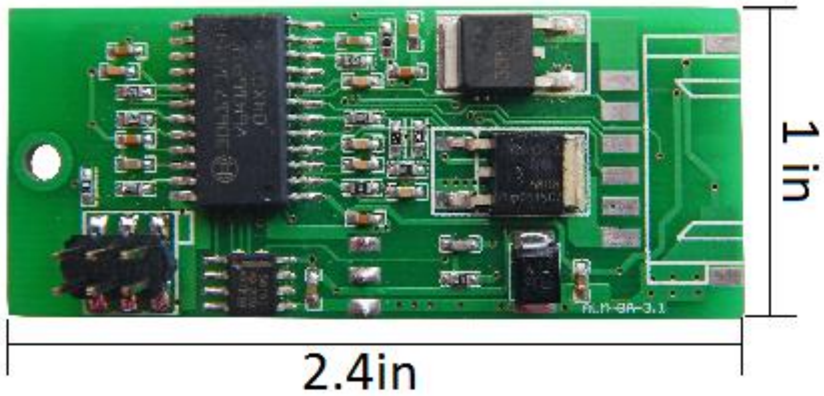
Special features

- 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)

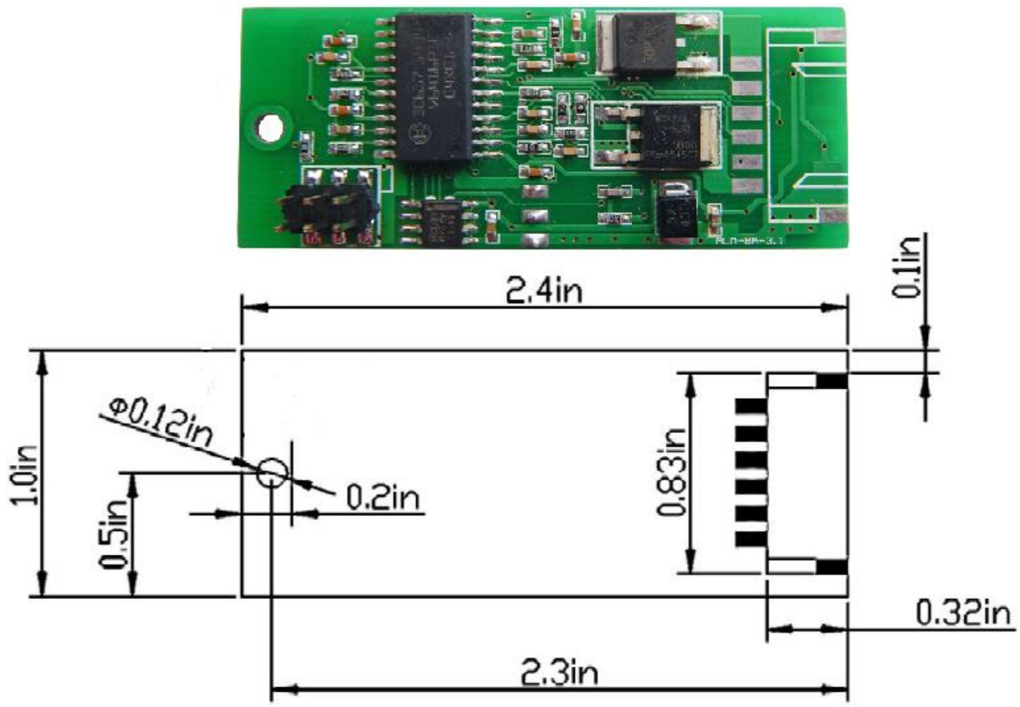
General

◆ Temperature range	-40^{o}C ~ 85^{o}C
◆ Dimensions	2.4" x 1" x 0.5"

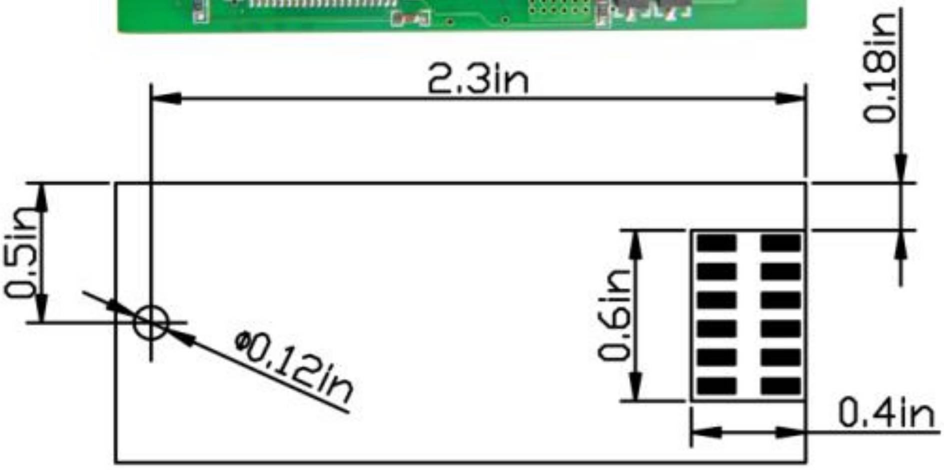
Chapter 3 Appearance and dimension



3.1 Front view



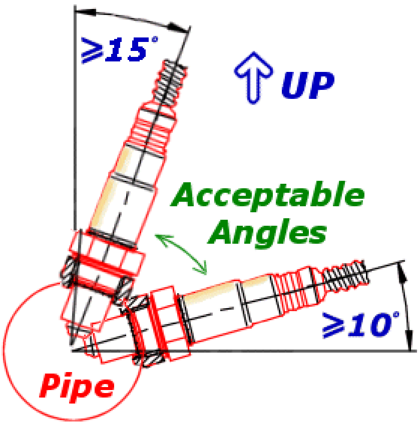
3.2 Rear view



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^o~75^o from the horizontal line (see below figure). The typical tilt-angle is 30^o. 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 18mm in diameter. Weld the sensor bung on it.

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

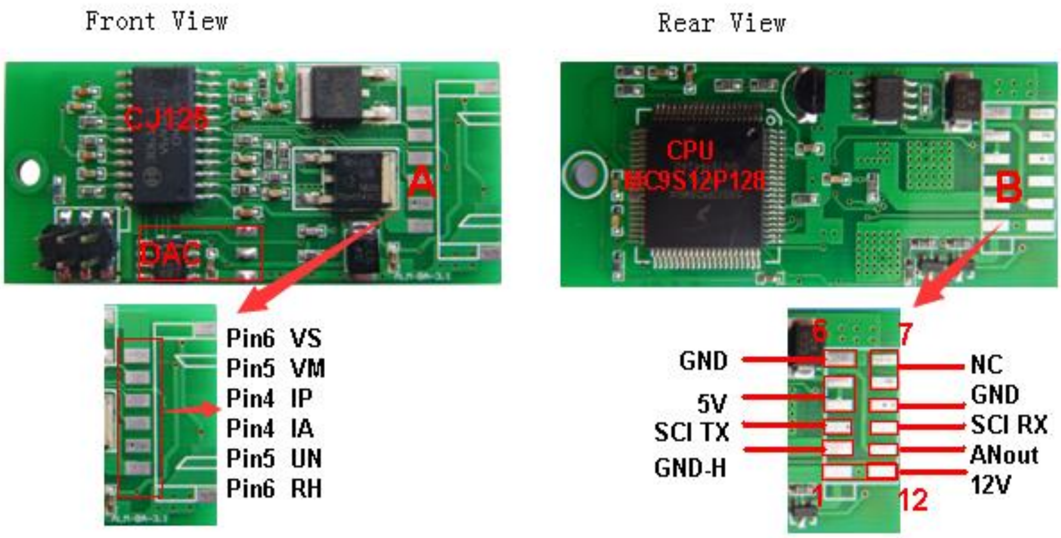
Note, if your vehicle has a Bosch narrow band oxygen sensor (LSF) on your vehicle, you can just un-plug the LSF, and plug-in the wideband LSU sensor into the same hole. Bosch LSU and LSF have the same size of the thread.

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-Board, 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^{o}C, the best temperature is 780^{o}C. Too high temperature (>1030^{o}C) will cause damage of the sensor. Refer to Bosch LSU 4.9 data sheet 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-Board, which will ramp up the heating power smoothly.

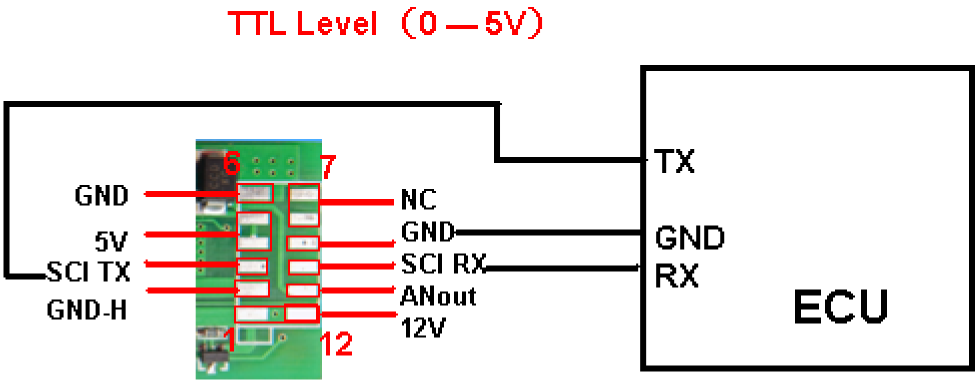
Chapter 5 ALM-Board operating instructions

5.1 ALM-Board with SCI communication



Connector	Pin#	Name	Description	Min	Max
Connector A	1	RH	wideband oxygen sensor input	—	—
	2	UN		—	—
	3	IA		—	—
	4	IP		—	—
	5	VM		—	—
	6	VS		—	—
Connector B	1	+12V	+12V Power supply	—	—
	2	GND-H	Ground (Heater circuit ground)	0V	0V
	3	TX	ALM-Board SCI bus TXD	0V	5V
	4	+5V	+5V Power supply	0V	5V
	5	+5V	+5V Power supply	—	—
	6	GND-R	Ground (Reference ground)	0V	0V
	7	NC		—	—
	8	NC		—	—
	9	GND	Ground	0V	0V
	10	RX	ALM-Board SCI bus RXD	0V	5V
	11	ANOUT	Lambda linear analog output	0V	5V
	12	+12V	+12V Power supply	9V	15V

5.1.1 Connect ALM-B to the main board with SCI bus



ALM-Board with SCI has a SCI communication port. It receives and transmits **TTL** level signal, level range is 0V to 5V.

5.1.2 Connect ALM-B to the laptop with SCI bus

ALM-Board with SCI port outputs a TTL level signal, voltage range is 0V to 5V. It needs a conversion circuit if you want ALM-Board to connect to computer, converting TTL level to RS232 level. Ecotrons can offer you MAX232 adapter module, but it is an optional.
The following is the MAX232 adapter module and pin definition

DB9 Male(PIN)	Interface signal
1	NC
2	TXD
3	RXD
4	NX
5	GND
6	NC
7	NC
8	NC
9	NC

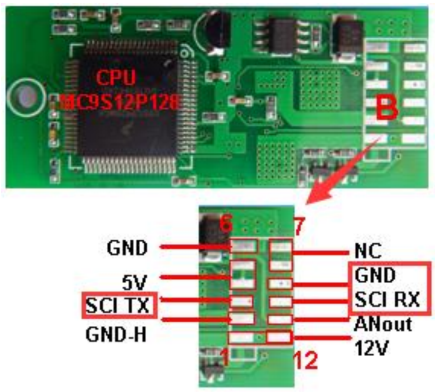
DB9 Female(PIN)	Interface signal
1	5V
2	TXD
3	RXD
4	NC
5	GND
6	NC
7	NC
8	NC
9	NC

The following is the picture of DB9 female on board and pin definition

DB9 Female(PIN)	Interface signal	The wire color
1	NC	
2	RXD	White
3	TXD	Purple
4	NX	
5	GND	Black
6	NC	
7	NC	
8	NC	
9	NC	

Now we have two versions of the ALM-Board, one is a new version with 5V chip and the other is an older version without 5V chip

If customers' ALM-board is an older version, it is without 5V chip. If the customer bought the ALM recently, there may be without a DB9 female on board. Users need to solder a DB9 connector on the ALM-Board according to the instructions showed below.



The third pin of the DB9 female you need to solder is connected to the SCI TX of the ALM-Board, the second pin is connected to the SCI RX of the ALM-Board and the fifth pin is connected to the GND of the ALM-Board.

Now our ALM-Board comes with DB9, whether your ALM is a new version or an older version. Users can connect the ALM-Board to your computer by using customizable MAX232 adapter and customizable USB-RS232 converter directly, as follows.

Note: The customizable MAX 232 adapter and customizable USB-RS232 are optional, and they are not included in the standard ALM-Board kits.

5.1.3 Communication protocol for SCI TTL or RS232 bus

The software protocols used for SCI and RS232 bus are same. The only difference is the voltage levels. SCI is at 5v TTL, while RS232 is at +/- 12V.

SCI communication is based on automotive standard KWP2000 protocol, default baud rate is 115200, no parity bit, 8 data bits, 1 stop bit.

Send the ‘Get Data Request’ command to ALM, you will receive data from ALM in 20ms rate.

More details, please refer to the chapter 1.2.2 of ALM Communication Protocol - SCI You can download the ALM Communication Protocol from the link.

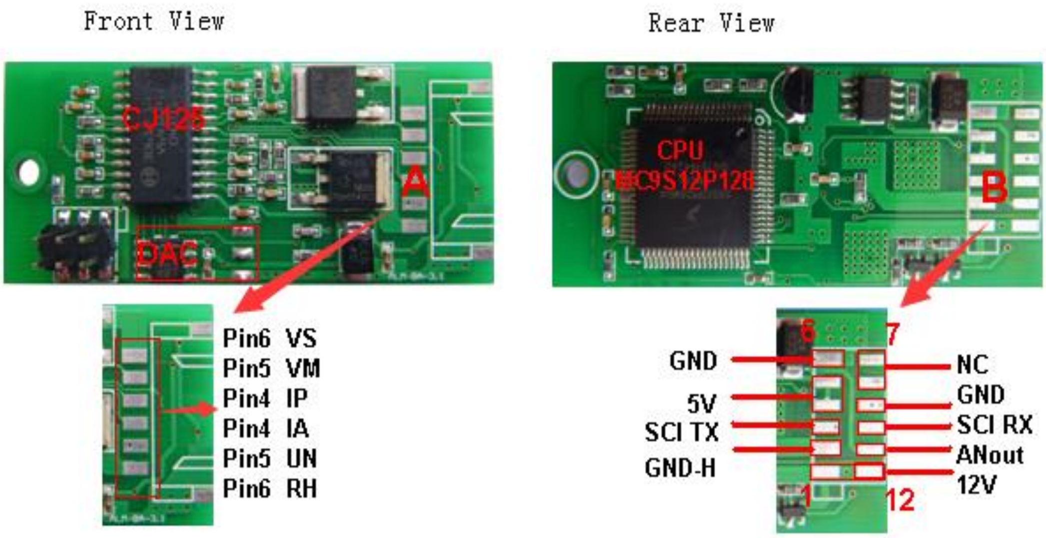
http://www.ecotrons.com/support/.

Command	Direction			Data(Hex)	Data(Physical)
Get Data Request	Host → ALM	Header	Fmt	0x80	
			Tgc	0x8F	
			Scr	0xEA	
			Len	0x03	
		Data	Data 1	0x9C	
			Data 2	0x0D	
			Data 3	0x00	
		Checksum	Checksum	0XA5	
Get Data Response	ALM → Host	Header	Fmt	0x80	
			Tgc	0x8F	
			Scr	0xEA	
			Len	0x22	
		Data	Sid	0xE5	
			Command	0x0D	
			Data3	Sensor 1 Lambda High 8 bits	Lambda 1 = (Data3 * 256 + Data4) / 1000
			Data4	Sensor 1 Lambda Low 8 bits	
			Data5	Sensor 2 Lambda High 8 bits	Lambda 2 = (Data5 * 256 + Data6) / 1000
			Data6	Sensor 2 Lambda Low 8 bits	
			Data7	Rpm High 8 bits(optional)	Rpm = (Data7 * 256 + Data8) * 40 (optional)
			Data8	Rpm Low 8 bits(optional)	
			Data9	Vin 1 High 8 bits(optional)	Vin 1 = (Data9 * 256 + Data10) * 5 / 1024 (optional)
			Data10	Vin 1 Low 8 bits(optional)	
			Data11	Vin 2 High 8 bits(optional)	Vin 2 = (Data11 * 256 + Data12) * 5 / 1024 (optional)
			Data12	Vin 2 Low 8 bits(optional)	
			Data13	Sensor 1 Temp High 8 bits	Sensor 1 Temp = (Data13 * 256 + Data14) * 0.023438-273 (DegC)
			Data14	Sensor 1 Temp Low 8 bits	
			Data15	Sensor 2 Temp High 8 bits	Sensor 2 Temp = (Data15 * 256 + Data16) * 0.023438-273 (DegC)
			Data16	Sensor 2 Temp Low 8 bits	
			Data17	Sensor 1 O2% High 8 bits	Sensor 1 O2% = (Data17 * 256 + Data18) / 1024
			Data18	Sensor 1 O2% Low 8 bits	
			Data19	Sensor 2 O2% High 8 bits	Sensor 2 O2% = (Data19 * 256 + Data20) / 1024
			Data20	Sensor 2 O2% Low 8 bits	
			……	Reserved	Sensor 1 AFR = Lambda1 * Fuel Ideal AFR
			Data34		Sensor 2 AFR = Lambda2 * Fuel Ideal AFR
		Checksum	Checksum	Checksum byte	

5.2 ALM-Board with 0-5v analog output

The aftermarket version of ALM-Board comes with a 0-5v analog output (ANOUT) for the main controller to read. 0-5v analog output is linear to the Lambda、O_2% or AFR that ALM measures from the exhaust gas.

ANOUT option and SCI option can co-existing on the same board.



Section	Pin#	Name	Description	Min	Max
Section A	1	RH	wideband oxygen sensor input	—	—
	2	UN		—	—
	3	IA		—	—
	4	IP		—	—
	5	VM		—	—
	6	VS		—	—
Section B	1	+12V	+12V Power supply	—	—
	2	GND-H	Ground (Heater circuit ground)	0V	0V
	3	TX	ALM-Board SCI bus TXD	0V	5V
	4	+5V	+5V Power supply	0V	5V
	5	+5V	+5V Power supply	—	—
	6	GND-R	Ground (Reference ground)	0V	0V
	7	NC		—	—
	8	NC		—	—
	9	GND	Ground	0V	0V
	10	RX	ALM-Board SCI bus RXD	0V	5V
	11	ANOUT	Lambda linear analog output	0V	5V
	12	+12V	+12V Power supply	9V	15V

5.2.1 Connect ALM-B to the main board with ANOUT

This analog output from ALM-Board is linear to the actual Lambda/AFR/O2% measured. By setting the lower point and upper points of voltage vs Lambda/AFR/O2% linear relation, the scaling between the voltage and Lambda/AFR/O2% is determined.

The default setting is

0V~ Lambda 0.50

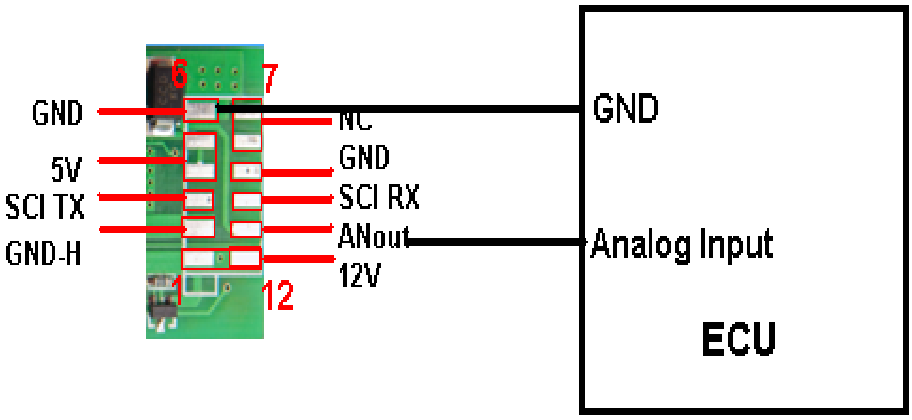
5V~ Lambda 2.00

Lambda = Volt * (2.00-0.50)/ (5-0) + 0.50, which is: Lambda = Volt * 0.30 + 0.50;
Volt ~ ANOUT voltage.

User can change this setting by using ALM GUI. The max setting is:

0 Volt at Lambda 0.50;

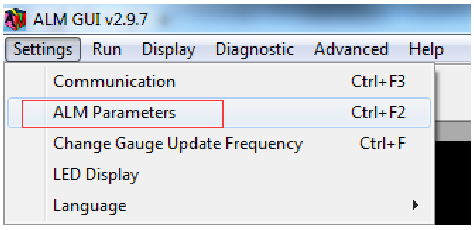
5 Volt at Lambda 16.0



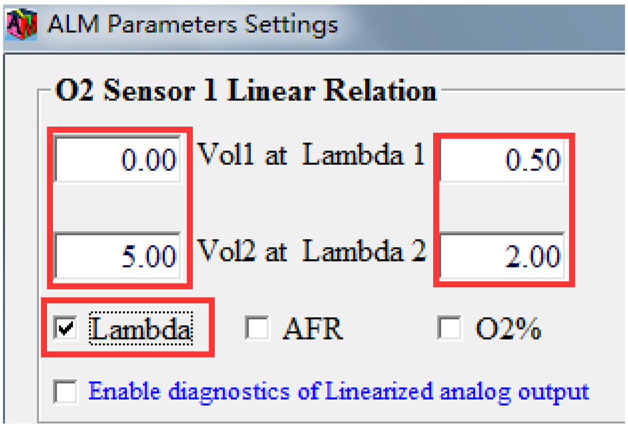
5.2.2 How to Configure 0-5v Analog Output

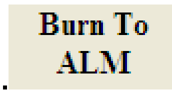
You can use computer software, ALM GUI to change the linear relation of ANOUT and lambda.

1) Connect ALM-Board via a SCI-RS232 adapter and then a RS232-USB adapter to a computer; (it cannot be connected directly to the computer, but need an adapter, see section: 5.1.2)
2) Run ALM GUI, and connect to ALM-Board;
3) To set the ALM analog output range, gauge range, and fuel type, etc. Click Settings→ALM Parameters, open ALM Parameters window.



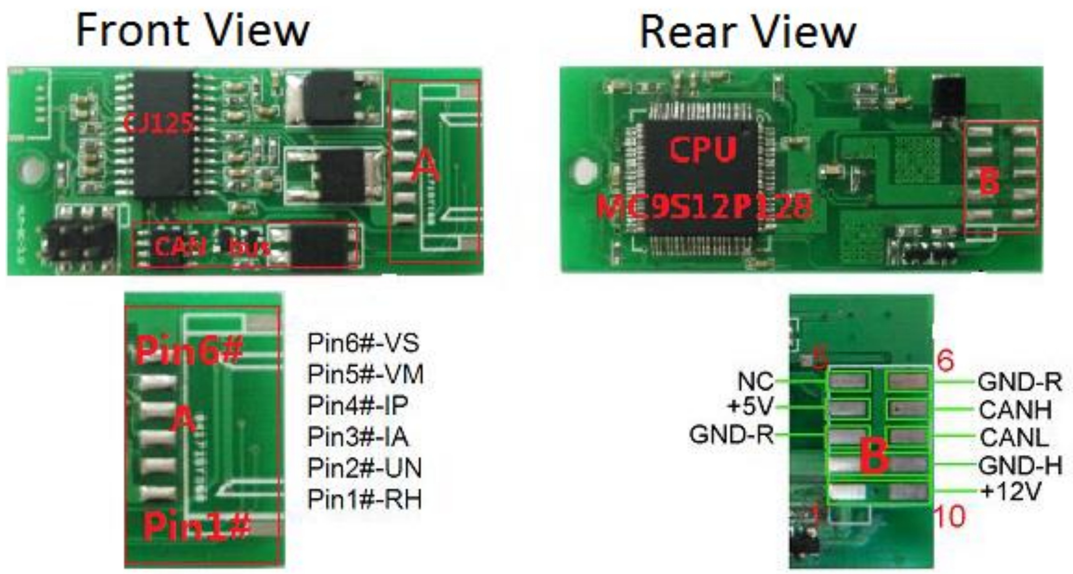
4) For example, set 0V—lambda 0.5 5V—Lambda 2



Click 'Burn To ALM' after changing the setting. 

More details please refer to the chapter 2.4.1 of ALM GUI Manual. http://www.ecotrons.com/support/.

5.3 ALM-Board with CAN bus

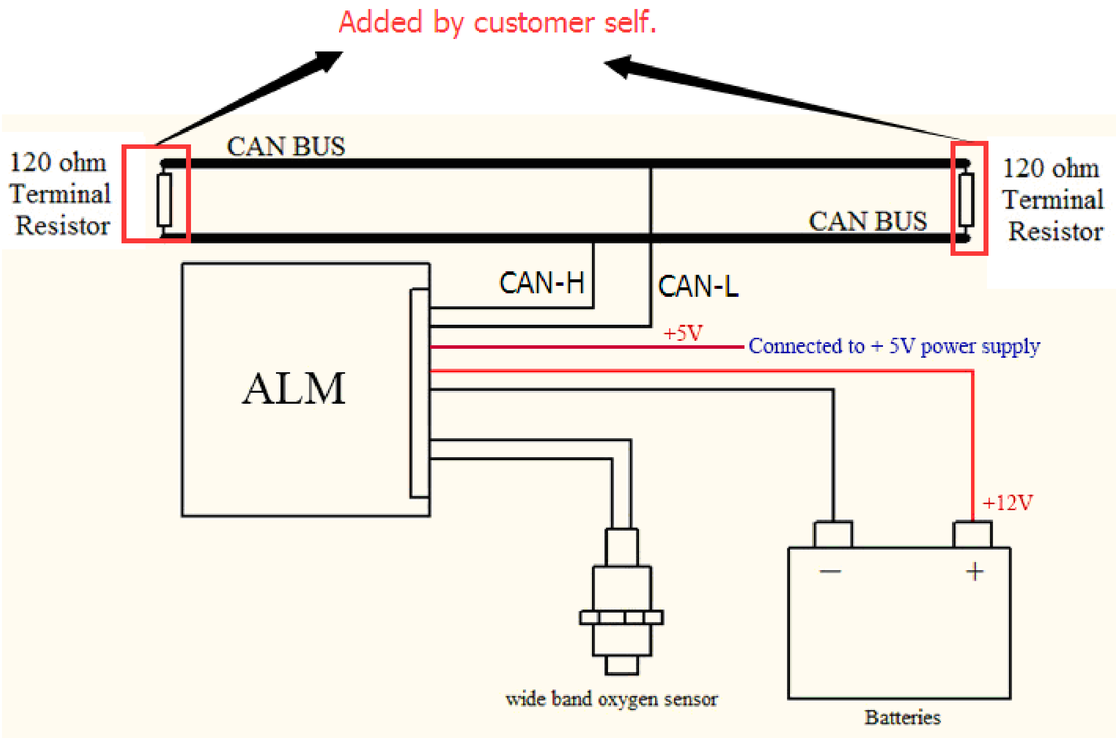


Connector	Pin#	Name	Description	Min	Max
Connector A	1	RH	wideband oxygen sensor input	—	—
	2	UN		—	—
	3	IA		—	—
	4	IP		—	—
	5	VM		—	—
	6	VS		—	—
Connector B	1	+12V	+12V Power supply	9V	15V
	2	GND-H	Ground (Heater circuit ground)	0V	0V
	3	GND-R	Ground (Reference ground)	0V	0V
	4	+5V	+5V Power supply	5V	5V
	5	NC		—	—
	6	GND-R	Ground (Reference ground)	0V	0V
	7	CAN-H	CAN bus high	2.5V	3.5V
	8	CAN-L	CAN bus low	1.5V	2.5V
	9	GND-H	Ground (Heater circuit ground)	0V	0V
	10	+12V	+12V Power supply	9V	15V

5.3.1 Connect ALM-Board to the main board with CAN bus

Notes: ALM-Board CAN does NOT contain a 120 ohm termination resistor.

Multiple ALM-Board CAN units could be connected on the CAN bus; but the ALM-Board IDs must be different, and configured via an ALM GUI. More details about ALM-Board CAN communication settings please refer to ALM GUI Manual (http://www.ecotrons.com/support/).



5.3.2 How to customize CAN ID

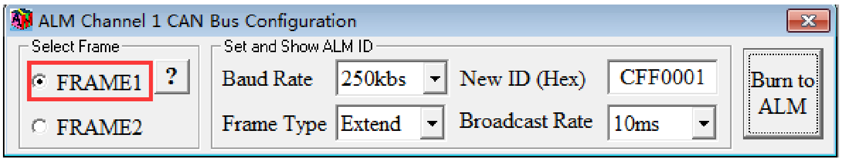
By default, ALM-CAN follows the SAE J1939 standards, where all CAN IDs are defined as PGN, as 29 bit IDs. And the CAN baud rate is default 250k.

ALM-CAN IDs can also be changed to 11-bit values with ALM-CAN GUI software.

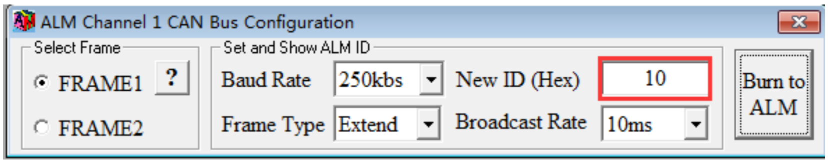
Plus, the CAN bus baud rate can also be changed to 500k or 1M bps (bit per second).

For example: to modify the first ALM ID (Frame1) to 0x10 (11 bit), more details please refer to ALM GUI Manual http://www.ecotrons.com/support/

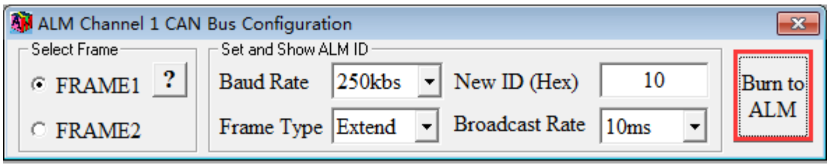
1) Select Frame1.



2) Enter 10 (hex) in the New ID text box.



3) Click “Burn to ALM”. If the ALM ID is modified successfully, it will pop up message at the bottom of the window.



5.3.3 Communication protocols for CAN bus

This version is applicable to ALM-CAN that supports 1 or 2 LSU sensors. Each sensor has 2 corresponding CAN IDs, or two Frames.

Frame1 corresponding to the CAN ID 0x0CFF0001; it is Ecotrons Specified PGN, used by the original ALM-CAN.

Frame2, corresponding to the CAN ID 0x18F00E01; it is a standard SAE J1939 PGN.

Either Frame has the Lambda, or O2% information. The reason to have both Frames available is to give the customer the option to use either one. You can enable/disable either Frame or both Frames, via ALM-CAN GUI.

The default CAN bus Baud Rate is 250kbs, in extended frame.

Standard SAE J1939 CAN protocol message format:

PDU						
	PGN					
Priority	Extended Data Page	Data Page	PDU Format	PDU Specific	Source Address	Data Domain
P	EDP	DP	PF	PS	SA	Data
3 Bit	1 Bit	1 Bit	8 Bit	8 Bit	8 Bit	8 Bytes
29-Bit identifier						

Here, 29-Bit identifier is the CAN ID. (Note, 11 bit CAN ID is optional, as customer specific required)

More details,please refer to ALM Communication Protocol – CAN file.
http://www.ecotrons.com/support/

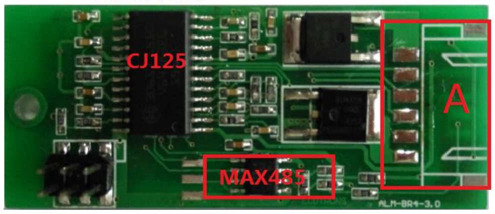
Hardware:		CAN Bus Details • 250 kbps Rate • Broadcast parameters are based on SAE J1939 standard • All 2 bytes data is stored [LowByte, HighByte] Num = HighByte*256 + LowByte • Conversion from 2 bytes to signed int is per the following: Num = HighByte*256+LowByte if (Num>32767) then Num = Num - 65536
Additional Notes:	This document defines the CAN based parameters that the ECU is broadcasting for the firmware listed above. **The ALM does not contains a 120 ohm termination resistor.**	

ID(HEX)	PGN	SPN	Name	Rate (ms)	Start Position	Length	Units	Resolution	Range	Type
0x0CFF00 01	65280	3217	Aftertreatment bank1 O2%	10	1-2	2 bytes	%	0.000514 %/bit, -12 % offset	-12% to 21%	Measured
0x0CFF00 01	65280	520193	Aftertreatment bank1 Lambda	10	3-4	2 bytes		0.000244 / bit, 0 offset	0.5 - 16	Measured
0x0CFF00 01	65280	520194	Sensor Temperature	10	5-6	2 bytes	deg K	0.023438 deg K/bit, 0 offset	840 - 1303 deg K	Measured
0x0CFF00 01	65280	520196	LSU Sensor Faults	10	7.1	4 bits		1 / bit, 0 offset	0 - 12	Status
0x0CFF00 01	65280	520195	PWM duty cycle of heater	10	7.5,8	12 bits	%	0.08 %/bit, 0 offset	0 - 100%	Measured

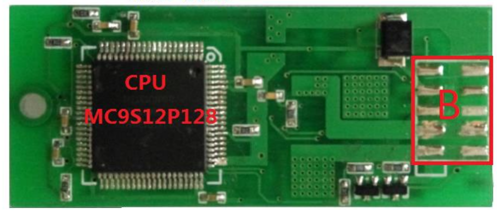
0x0CF00E 01	61454	3216	Aftertreatment 1 Intake NOx	50	1-2	2 bytes	ppm	0.05 ppm/bit, -200 ppm offset	-200 to 3012.75 ppm	Measured
0x0CF00E 01	61454	3217	Aftertreatment bank1 O2%	50	3-4	2bytes	%	0.000514 %/bit, -12 % offset	-12% to 21%	Measured
0x0CF00E 01	61454	3218	Aftertreatment 1 Intake Gas Sensor Power In Range	50	5.1	2 bits		4 states/2 bit, 0 offset	0 to 3	Status
0x0CF00E 01	61454	3219	Aftertreatment 1 Intake Gas Sensor at Temperature	50	5.3	2 bits		4 states/2 bit, 0 offset	0 to 3	Status
0x0CF00E 01	61454	3220	Aftertreatment 1 Intake NOx Reading Stable	50	5.5	2 bits		4 states/2 bit, 0 offset	0 to 3	Status
0x0CF00E 01	61454	3221	Aftertreatment 1 Intake Wide-Range % O2 Reading Stable	50	5.7	2 bits		4 states/2 bit, 0 offset	0 to 3	Status
0x0CF00E 01	61454	3222	Aftertreatment 1 Intake Gas Sensor Heater Preliminary FMI	50	6.1	5 bits		Binary, 0 offset	0 to 31	Status
0x0CF00E 01	61454	3223	Aftertreatment 1 Intake Gas Sensor Heater Control	50	6.6	2 bits		4 states/2 bit, 0 offset	0 to 3	Status
0x0CF00E 01	61454	3224	Aftertreatment 1 Intake NOx Sensor Preliminary FMI	50	7.1	5 bits		Binary, 0 offset	0 to 31	Status
0x0CF00E 01	61454	3225	Aftertreatment 1 Intake Oxygen Sensor Preliminary FMI	50	8.1	5 bits		Binary, 0 offset	0 to 31	Status

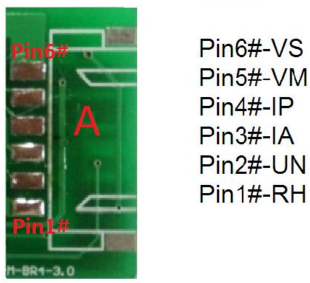
5.4 ALM-Board RS485

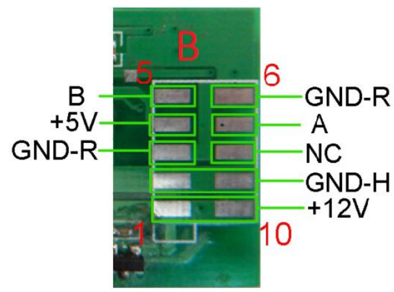
Front View



Rear View







Connector	Pin#	Name	Description	Min	Max
Connector A	1	RH	wideband oxygen sensor input	—	—
	2	UN		—	—
	3	IA		—	—
	4	IP		—	—
	5	VM		—	—
	6	VS		—	—
Connector B	1	+12V	+12V Power supply	9V	15V
	2	GND-H	Ground (Heater circuit ground)	0V	0V
	3	GND-R	Ground (Reference ground)	0V	0V
	4	+5V	+5V Power supply	5V	5V
	5	B	RS-485 Communication	0V	5V
	6	GND-R	Ground (Reference ground)	0V	0V
	7	A	RS-485 Communication	0V	5V
	8	NC		—	—
	9	GND-H	Ground (Heater circuit ground)	0V	0V
	10	+12V	+12V Power supply	9V	15V

5.4.1 Communication protocol for RS485 bus

RS485 communication based on Modbus protocol, ecotrons Modbus protocol using ASCII and RTU mode, support for PLC, DTC, etc.
More details refer to ALM Communication Protocol – SCI.doc
http://www.ecotrons.com/support/

ASCII mode:
Upload O2%, Lambda, LSU Temperature
PLC →ALM, PLC sends: "0A 03 2000 0004 CF"
ALM →PLC, PLC receives: "0A 03 08 xxxx xxxx xxxx xxxx xxxx xxxx xx"

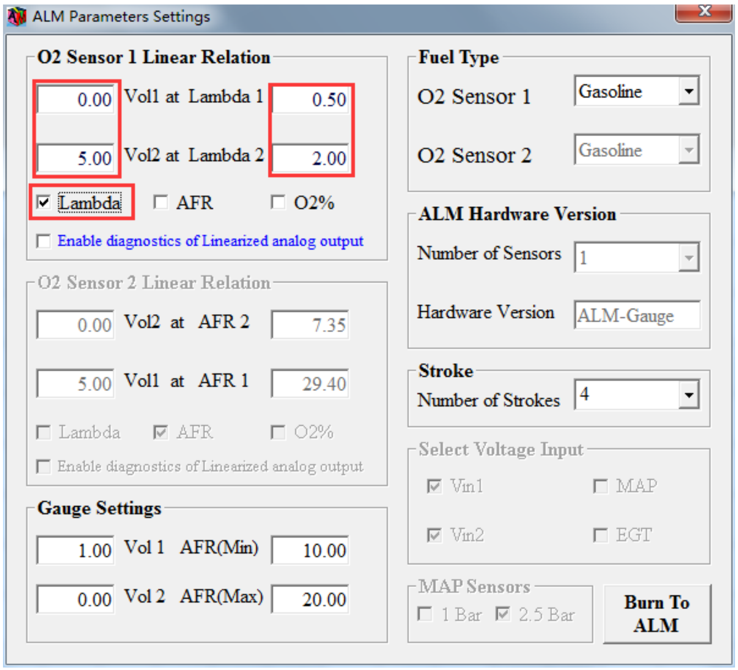
Num		PLC to ALM, PLC sends: "0A 03 2000 0004 CF" ALM to PLC, PLC receives: "0A 03 08 xxxx xxxx xxxx"				Resolution	Range	Units
1	Upload O2%, Lambda, LSU Temperature	Registers for sent data (sending messages)	PLC to ALM Request Description	DATA Character	DATA ASCII (Hex)			
			STX	:	3A			
			ADR Hi	0	30			
			ADR Lo	A	41			
			CMD Hi	0	30			
			CMD Lo	3	33			
			Start Addr Hi	2	32			
			Start Addr Lo	0	30			
			Start Addr Hi	0	30			
			Start Addr Lo	0	30			
			No. Bytes Hi	0	30			
			No. Bytes Lo	0	30			
			No. Bytes Hi	0	30			
			No. Bytes Lo	4	34			
			LRC CHK Hi	C	43			
			LRC CHK Lo	F	46			
			END Hi	CR	0D			
			END Lo	LF	0A			
2		Registers for received data (responding messages)	ALM to PLC Response Description	DATA Character	DATA ASCII (Hex)			
			STX	:	3A			
			ADR Hi	0	30			
			ADR Lo	A	41			
			CMD Hi	0	30			
			CMD Lo	3	33			
			No. Data Hi	0	30			
			No. Data Lo	8	38			
			O2% High 8-bit Hi	x	x	O2% =((O2% High 8-bit) *256 + (O2% Low 8-bit)) * 0.000514 – 12	%	-12% to 12%
			O2% High 8-bit Lo	x	x			
			O2% Low 8-bit Hi	x	x			
			O2% Low 8-bit Lo	x	x			
			Lambda High 8-bit Hi	x	x	Lambda = ((Lambda High 8-bit) *256+(Lambda Low 8-bit)) * 0.000244		0.5 to 16
			Lambda High 8-bit Lo	x	x			
			Lambda Low 8-bit Hi	x	x			
			Lambda Low 8-bit Lo	x	x			
			LSU Temperature High 8-bit Hi	x	x	LSU Temperature = ((LSU Temperature High 8-bit)*256 + (LSU Temperature High 8-bit)) * 0.023438	Deg K	840 to 1303
			LSU Temperature High 8-bit Lo	x	x			
			LSU Temperature Low 8-bit Hi	x	x			
			LSU Temperature Low 8-bit Lo	x	x			
			LSU Faults High 8-bit Hi	x	x	LSU Sensor faults = ((LSU Faults High 8-bit) *256+(LSU Faults Low 8-bit))		0 to 12
			LSU Faults High 8-bit Lo	x	x			
			LSU Faults Low 8-bit Hi	x	x			
			LSU Faults Low 8-bit Lo	x	x			
			LRC CHK Hi	x	x			
			LRC CHK Lo	x	x			
			END Hi	CR	0D			
			END Lo	LF	0A			

RTU mode:
Upload O2%, Lambda, LSU Temperature
PLC →ALM, PLC sends: "50 03 2000 0004 42 48 "
ALM →PLC, PLC receives: "50 03 08 xxxx xxxx xxxx xxxx xxxx"

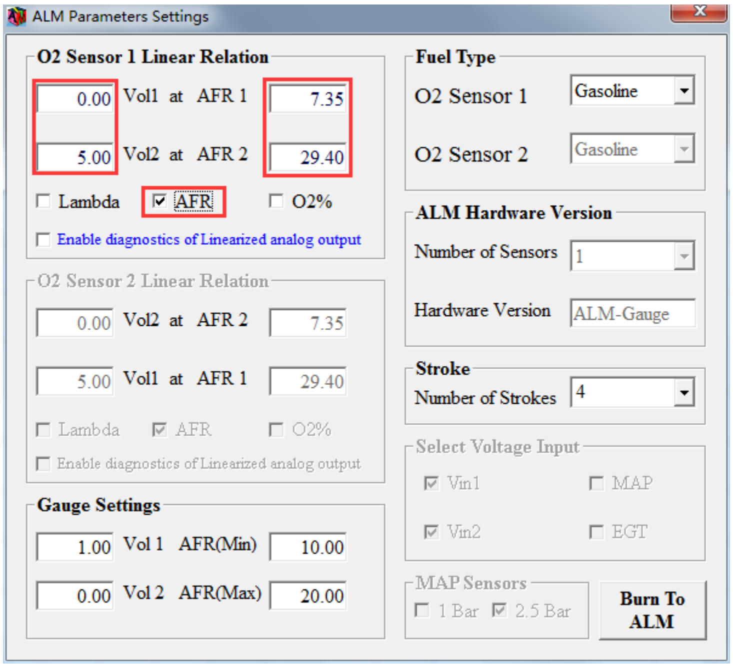
Num		PLC to ALM, PLC sends: "50 03 2000 0004 42 48" ALM to PLC, PLC receives: "50 03 08 xxxx xxxx xxxx xxxx xxxx"			Resolution	Units	Range
1	Upload O2%, Lambda, LSU Temperature	Registers for sent data (sending messages)	PLC to ALM Request Description	Data(byte)			
			ADR	50			
			CMD	03			
			Start Addr Hi	20			
			Start Addr Lo	00			
			No. Bytes Hi	00			
			No. Bytes Lo	04			
			CRC CHK Lo	42			
			CRC CHK Hi	48			
2		Registers for received data (responding messages)	ALM to PLC Response Description	Data(byte)			
			ADR	50			
			CMD	03			
			No. Data	08			
			O2% High 8-bit	xx	O2% =((O2% High 8-bit) *256 + (O2% Low 8-bit)) * 0.000514 – 12	%	-12% to 12%
			O2% Low 8-bit	xx			
			Lambda High 8-bit	xx	Lambda = ((Lambda High 8-bit) *256+(Lambda Low 8-bit)) * 0.000244		0.5 to 16
			Lambda Low 8-bit	xx			
			LSU Temperature High 8-bit	xx	LSU Temperature = ((LSU Temperature High 8-bit)*256 + (LSU Temperature High 8-bit)) * 0.023438	Deg K	840 to 1303
			LSU Temperature Low 8-bit	xx			
			LSU Faults High 8-bit	xx	LSU Sensor faults = ((LSU Faults High 8-bit) *256+(LSU Faults Low 8-bit))		0 to 12
			LSU Faults Low 8-bit	xx			
			CRC CHK Lo	xx			
			CRC CHK Hi	xx			

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



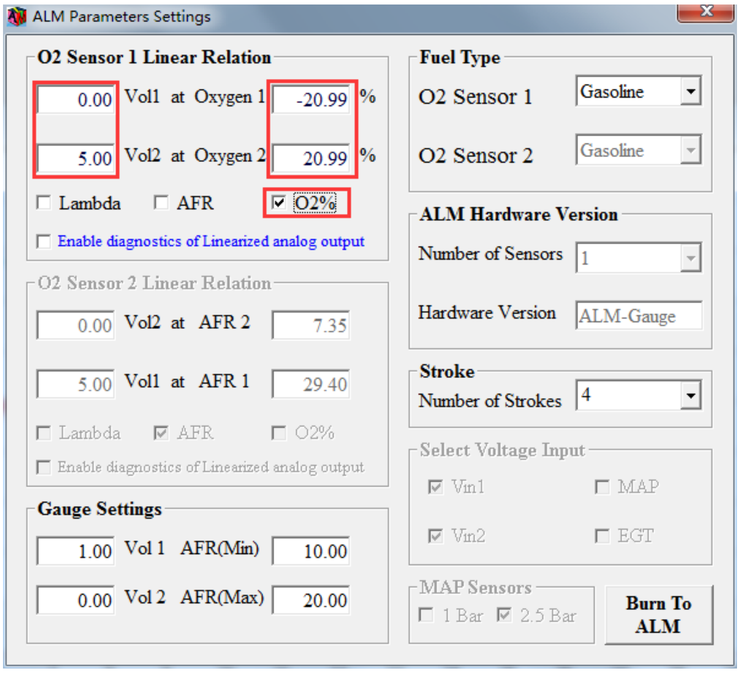
AFR mode, ANOUT used to indicate changes in AFR, the default setting:
0.00 Volt at AFR 7.35
5.00 Volt at AFR 29.4



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, user can refer to the chapter 2.4 of ALM GUI Manual..

http://www.ecotrons.com/support/

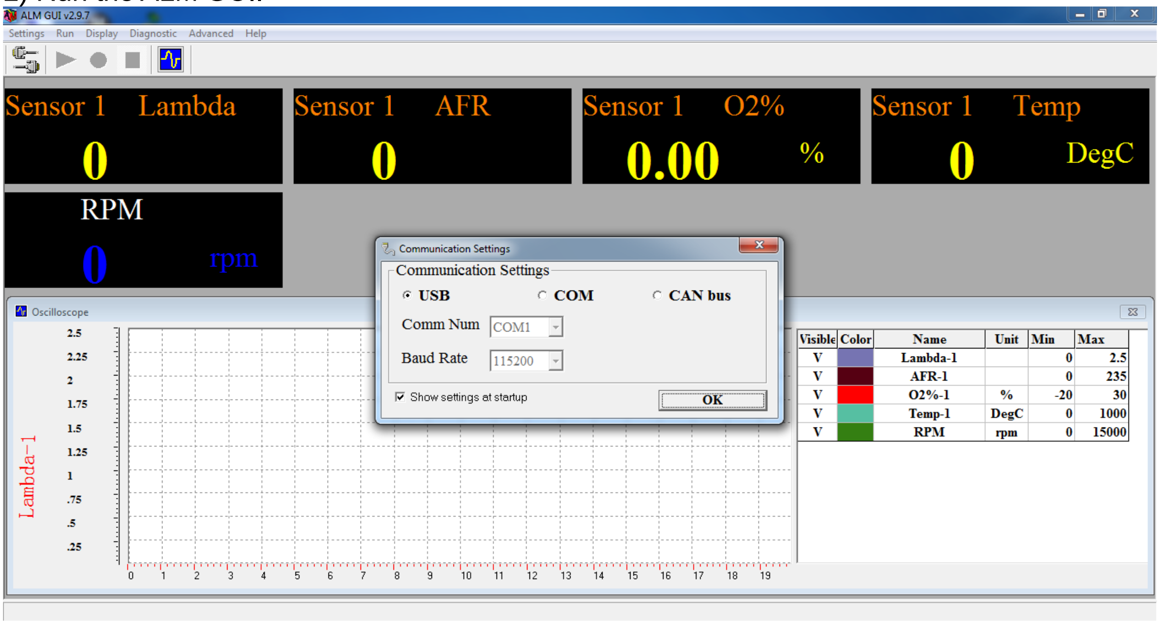
Note: The limit range of analog voltage is 0-5v. The value of lambda is 0.5-16. The low voltage must match the low Lambda. You can't make 5V match 0.5 Lambda. AFR and O2% are same with Lambda.

Chapter 6 How to communicate to ALM GUI

6.1 Communicate to ALM GUI with SCI bus

1) Connect ALM-B-SCI to laptop as follows, and then power on.

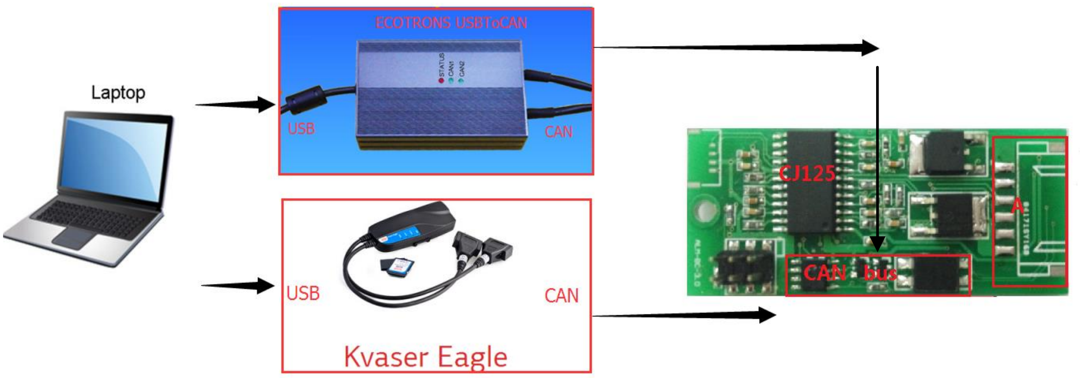
2) Run the ALM GUI.



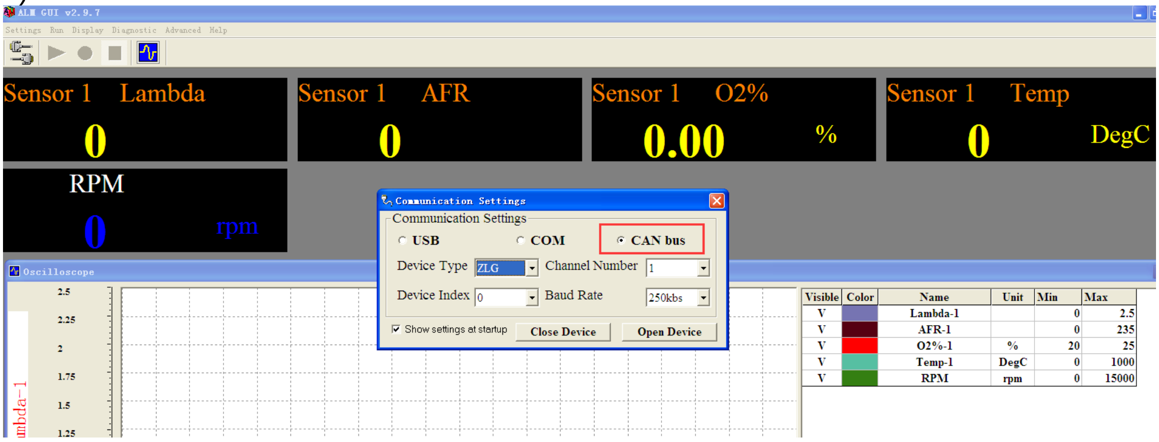
3) Select communication mode of USB. Click connect button to talk with ALM-Board.

6.2 Communicate to ALM GUI with CAN bus

1) Connect ALM-B-CAN to laptop as follows, and then power on.



2) Run the ALM GUI.



3)Select communication mode of CAN bus. Click connect to talk with ALM-Board.

6.3 ALM GUI instructions

Please refer to ALM GUI Manual
http://www.ecotrons.com/support/

Chapter 7 DTC table

Below is the Diagnostic Trouble Code table. ALM-Board has on-board-diagnostics capability to detect most common errors. The first thing user should do when ALM-Board 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	Check the LSU connector
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