Accurate Lambda Meter

ALM Communication Protocol

-CAN bus

V2.0

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Chapter1 SAE J1939 protocol

1.1 General Description

This version of manual applicable to ALM that has one or two CAN bus channels. Each channel broadcasts 2 Frame, there are 4 Frame for two channels with different IDs.

The CAN channel2 setting is invalid for ALM with single-channel CAN bus.

Channel1 Frame1 (PGN1:65280), the default ID is 0x0CFF0001; it is Ecotrons Specified Information, compatible with the original ALM.

Channel1 Frame2 (PGN2:61454), the default ID is 0x18F00E01; it is adapted to receive the Frame2 device.

Channel2 Frame1 (PGN1:65280), the default ID is 0x0CFF0002; it is Ecotrons Specified Information.

Channel2 Frame2 (PGN2:61454), the default ID is 0x18F00E02.

They are supported to change the Baud Rate, CAN ID and Frame Type; with different formats of data broadcast. Channel1 Frame1 and Channel2 Frame1 data broadcast format is the same, Channel1 Frame 2 and Channel2 Frame 2 data broadcast format is the same.

Ecotrons CAN protocol is suitable for SAE J1939 protocols or the customized subsets (Channel1 Frame1 and Channel2 Frame1).

The default CAN bus Baud Rate is 250kbs, 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)

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1.2 Channel1 Frame1 and Channel2 Frame1 Ecotrons Specified Information

Channel2 Frame1 and Channel1 Frame1 data broadcast format is same, but with different frame ID. About Channel2 Frame1 data broadcast format, please refer Channel1 Frame1.

Ecotrons CAN data bytes: 8-Bytes of data includes: Lambda, O2%, Duty Cycle of Heater, Sensor Temp, and DTC. **Note: The PWM duty cycle is 12 bits.**

Byte 1								Byte 2								Byte 3								Byte 4							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
O2%																Lambda value															

Byte 5								Byte 6								Byte 7								Byte 8							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Sensor temperature																PWM duty cycle (Low 4 bits)				Sensor faults				PWM duty cycle (High 8 bits)							

For SAE J1939 specific terminology, please contact SAE.
http://www.sae.org/standardsdev/groundvehicle/j1939a.htm

Channel1 Frame1 Ecotrons Specified Information

The purpose of this PGN is to group the wide band oxygen sensor data as below:

- O2% (2 bytes),
- Lambda value (2 bytes),
- Sensor temperature (2 bytes),
- PWM duty cycle of heater (12 bits),
- Sensor faults (4 bits).

Message Transmission Rate:	10 ms
Data Length:	8 bytes
Extended Data Page:	0
Data Page:	0
PDU Format:	255
PDU Specific:	0
Default Priority:	3

Parameter Group Number: 65280 (0xFF00)

Start Position	Length	Parameter Name	SPN
1-2	2 bytes	O2%	3217
3-4	2 bytes	Lambda value	520193
5-6	2 bytes	Sensor temperature	520194
7.1	4 bits	Sensor faults	520196
7.5,8	12 bits	PWM duty cycle of heater	520195

SPN 3217 (R) Aftertreatment bank1 O2%

Data Length: 2 bytes
Resolution: 0.000514 %/bit, -12 % offset
Data Range: -12% to 21%
Operational Range: same as data range
Type: Measured
Supporting information:
PGN 65280

SPN 520193 Aftertreatment bank1 Lambda

Data Length: 2 bytes
Resolution: 0.000244 / bit, 0 offset
Data range: 0.5 - 16
Operational Range: same as data range
Type: Measured
Supporting information:
PGN: 65280

SPN 520194 Sensor Temperature

Data Length: 2 bytes
Resolution: 0.023438 deg K/bit, 0 offset
Data range: 840 - 1303 deg K
Operational Range: same as data range
Type: Measured
Supporting information:
PGN: 65280

SPN 520195 PWM duty cycle of heater

Data Length: 12 bits
Resolution: 0.08 %/bit, 0 offset
Data range: 0 - 100%

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Operational Range: same as data range
Type: Measured
Supporting information:
PGN: 65280

SPN 520196 LSU Sensor Faults

ALM has on-board-diagnostics capability to detect most common errors. The first thing user should do when ALM is not working is to read DTCs.

0000 -- No faults
0001 -- Internal communication error
0010 -- Internal register error
0011 -- LSU yellow wire (VM) short to power
0100 -- LSU yellow wire (VM) short to GND
0101 -- LSU black wire (UN) short to power
0110 -- LSU black wire (UN) short to GND
0111 -- LSU green wire (IA) short to power
1000 -- LSU green wire (IA) short to GND
1001 -- Operating voltage too low
1010 -- Heater circuit damaged
1011 -- Heater circuit short to power
1100 -- Heater circuit short to GND
Data Length: 4 bits
Resolution: 1 / bit, 0 offset
Data range: 0 - 12
Operational Range: same as data range
Type: Status
Supporting information:
PGN: 65280

Diagnostic Trouble Code table

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

For example:

O2% = (Byte2 * 256 + Byte1) * 0.000514 + (-12)

Lambda = (Byte4 * 256 + Byte3) * 0.000244

Sensor temperature = (Byte6 * 256 + Byte5) * 0.023438 - 273 (deg C)

PWM duty cycle of heater = (Byte7 / 16 + byte8 * 16) * 0.08

(Byte7 / 16 * 256: Get low 4 bits of PWM duty cycle of heater)

(Byte8 * 16: Get high 8 bits of PWM duty cycle of heater)

Sensor faults = Byte7 bitwise & 0x0F

1.3 Channel1 Frame2 and Channel2 Frame2 Aftertreatment 1 Intake Gas 1

Channel2 Frame2 and Channel1 Frame2 data broadcast format is the same, but with different frame ID. About Channel2 Frame2 data broadcast format, please refer Channel1 Frame1.

In Channel2 Frame1 or Channel2 Frame2 mode, ECOTRONS ALM only supports SPN3217, SPN3218, SPN3219, SPN3221, SPN3222 data analysis, other SPN default transport 1.

Byte 1								Byte 2								Byte 3								Byte 4							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
NOx																O2%															

Byte 5								Byte 6								Byte 7								Byte 8							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Ⅳ		Ⅲ		Ⅱ		Ⅰ		-	Ⅵ			Ⅴ				-				Ⅶ				-				Ⅷ			

Channel1 Frame2 Aftertreatment 1 Intake Gas 1 - AT1IG1

The purpose of this Frame is to group the after treatment intake sensor data for bank 1. These values include the NOx, O2%, Status's of the sensors with respect to the power being supplied and the heating element, errors and stability of the readings.

Message Transmission Rate: 50 ms
Data Length: 8 byte
Extended Data Page: 0
Data Page: 0
PDU Format: 240
PDU Specific: 14
PGN Supporting Information:
Default Priority: 6
Parameter Group Number: 61454 (0xF00E)

Start Position	Length	Parameter Name	SPN
1-2	2 bytes	Aftertreatment 1 Intake NOx	3216
3-4	2 bytes	Aftertreatment 1 Intake %O2	3217
5.1	2 bits	Aftertreatment 1 Intake Gas Sensor Power in Range (Ⅰ)	3218
5.3	2 bits	Aftertreatment 1 Intake Gas Sensor at Temperature (Ⅱ)	3219
5.5	2 bits	Aftertreatment 1 Intake NOx Reading Stable (Ⅲ)	3220
5.7	2 bits	Aftertreatment 1 Intake Wide-Range O2% Reading Stable(Ⅳ)	3221
6.1	5 bits	Aftertreatment 1 Intake Gas Sensor Heater Preliminary FMI (Ⅴ)	3222
6.6	2 bits	Aftertreatment 1 Intake Gas Sensor Heater Control (Ⅵ)	3223
7.1	5 bits	Aftertreatment 1 Intake NOx Sensor Preliminary FMI(Ⅶ)	3224
8.1	5 bits	Aftertreatment 1 Intake Oxygen Sensor Preliminary FMI (Ⅷ)	3225

SPN 3216 Aftertreatment 1 Intake NOx

Data Length: 2 bytes
Resolution: 0.05 ppm/bit, -200 ppm offset

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Data Range: -200 to 3012.75 ppm
Operational Range: same as data range
Type: Measured
Supporting information:
PGN 61454

SPN 3217 (R) Aftertreatment bank1 O2%

Data Length: 2 bytes
Resolution: 0.000514 %/bit, -12 % offset
Data Range: -12% to 21%
Operational Range: same as data range
Type: Measured
Supporting information:
PGN 61454

SPN 3218 Aftertreatment 1 Intake Gas Sensor Power In Range

00 - Not in range
01 - In range
10 - Error
11 - Not available
Data Length: 2 bits
Resolution: 4 states/2 bit, 0 offset
Data Range: 0 to 3
Operational Range: same as data range
Type: Status
Supporting information:
PGN 61454

SPN 3219 Aftertreatment 1 Intake Gas Sensor at Temperature

Data Length: 2 bits
Resolution: 4 states/2 bit, 0 offset
Data Range: 0 to 3
Operational Range: same as data range
Type: Status
Supporting information:
PGN 61454

SPN 3220 Aftertreatment 1 Intake NOx Reading Stable

00 - Not stable
01 - Stable

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10 - Error
11 - Not available
Data Length: 2 bits
Resolution: 4 states/2 bit, 0 offset
Data Range: 0 to 3
Operational Range: same as data range
Type: Status
Supporting information:
PGN 61454

SPN 3221 Aftertreatment 1 Intake Wide-Range % O2 Reading Stable

00 - Not stable
01 - Stable
10 - Error
11 - Not available
Data Length: 2 bits
Resolution: 4 states/2 bit, 0 offset
Data Range: 0 to 3
Operational Range: same as data range
Type: Status
Supporting information:
PGN 61454

SPN 3222 Aftertreatment 1 Intake Gas Sensor Heater Preliminary FMI

Data Length: 5 bits
Resolution: Binary, 0 offset
Data Range: 0 to 31
Operational Range: same as data range
Type: Status
Supporting information:
PGN 61454

SPN 3223 Aftertreatment 1 Intake Gas Sensor Heater Control

00 - Automatic
01 - Preheat 2
10 - Preheat 1
11 - Heater off
Data Length: 2 bits
Resolution: 4 states/2 bit, 0 offset
Data Range: 0 to 3

Operational Range:	same as data range
Type:	Status
Supporting information:	
PGN	61454

SPN 3224 Aftertreatment 1 Intake NOx Sensor Preliminary FMI

Data Length:	5 bits
Resolution:	Binary, 0 offset
Data Range:	0 to 31
Operational Range:	same as data range
Type:	Status
Supporting information:	
PGN	61454

SPN 3225 Aftertreatment 1 Intake Oxygen Sensor Preliminary FMI

Data Length:	5 bits
Resolution:	Binary, 0 offset
Data Range:	0 to 31
Operational Range:	same as data range
Type:	Status
Supporting information:	
PGN	61454

Chapter2 User-Defined CAN protocol

2.1 ALM CAN bus command format description

If the users want to set the frame type, baud rate, CAN ID with third-party software, refer to the following command format.

Note:

1) Before setting the frame type, baud rate or CAN ID, make sure that the PC receives the uploaded data from ALM (ALM and PC communications normal).
2) If communication is unsuccessful, try using a different baud rate.
3) Before setting the CAN ID, make sure the ALM has been connected to the CAN bus. If there are multiple ALM modules on the CAN bus, all of that have the same default CAN ID, then you can only power on one ALM at a time. After the ALM settings is done, power it off, then you can power on another ALM and set it with a different CAN ID, and so on.
4) If you modified the baud rate, you need to reopen USB-CAN device, and the close the ALM power and reopen reset ALM.
5) If you change the baud rate, all the Channel1 and Channel2 baud rate will change.

2.1.1 Set parameters of Channel1 Frame1

This command is used to set the parameters of Channel1 Frame1 (PGN 65280).

PC send: 81 ?? ?? ?? ?? ?? ?? ?? (Hex)

Command Code	81	
Broadcast Rate	??	0:10ms 1:20ms 2:50ms 3:100ms 4:200ms 5:500ms 6:1000ms 7:2000ms
New ID (PGN1)	??	
	??	
	??	
	??	
Frame Type	??	0:Standard, 1:Extend
Baud Rate	??	1:1000kbs 2:800kbs

		3:500kbs 4:250kbs 5:125 6:100 7:50

For example:

Modify the frame ID as 129(Hex), Frame Type as Standard, Baud Rate as 250kbs, the frame ID as converted to 4-bytes: 00 00 01 29.
PC send: 81 00 29 01 00 00 00 04(Hex).

2.1.2 Set parameters of Channel1 Frame2

This command is used to set the parameters of Channel1 Frame2 (PGN 61454).

PC send: 82 ?? ?? ?? ?? ?? ?? ?? (Hex)

Command Code	82	
Broadcast Rate	??	0:10ms 1:20ms 2:50ms 3:100ms 4:200ms 5:500ms 6:1000ms 7:2000ms
New ID (PGN1)	??	
	??	
	??	
	??	
Frame Type	??	0:Standard, 1:Extend
Baud Rate	??	1:1000kbs 2:800kbs 3:500kbs 4:250kbs 5:125 6:100 7:50

2.1.3 Set parameters of Channel2 Frame1

This command is used to set the parameters of Channel2 Frame1 (PGN 65280).

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PC send: 84 ?? ?? ?? ?? ?? ?? ?? (Hex)

Command Code	84	
Broadcast Rate	??	0:10ms 1:20ms 2:50ms 3:100ms 4:200ms 5:500ms 6:1000ms 7:2000ms
New ID broadcast-II (PGN1)	??	
	??	
	??	
	??	
Frame Type	??	0:Standard, 1:Extend
Baud Rate	??	1:1000kbs 2:800kbs 3:500kbs 4:250kbs 5:125 6:100 7:50

For example:

Modify the frame ID as 129(Hex), Frame Type as Standard, Baud Rate as 250kbs, the frame ID as converted to 4-bytes: 00 00 01 29.
PC send: 84 00 29 01 00 00 00 04(Hex).

2.1.4 Set parameters of Channel2 Frame2

This command is used to set the parameters of Channel2 Frame2 (PGN 61454).

PC send: 85 ?? ?? ?? ?? ?? ?? ?? (Hex)

Command Code	85	
Broadcast Rate	??	0:10ms 1:20ms 2:50ms 3:100ms 4:200ms 5:500ms

		6:1000ms 7:2000ms
New ID broadcast-II (PGN1)	??	
	??	
	??	
	??	
Frame Type	??	0:Standard, 1:Extend
Baud Rate	??	1:1000kbs 2:800kbs 3:500kbs 4:250kbs 5:125 6:100 7:50

For example:

Modify the frame ID as 129(Hex), Frame Type as Standard, Baud Rate as 250kbs, the frame ID as converted to 4-bytes: 00 00 01 29.
PC send: 85 00 29 01 00 00 00 04(Hex).

2.1.5 Enable or disable Frame data broadcast

This command is used to set the enable or disable PGN data broadcast. By default, ALM broadcast two channels Frame1 and Frame2 (If ALM has two channels).
PC send: 83 83 ?? ?? 00 00 00 00 (Hex)

Command Code	83	
Command Counter	83	
Channel1Frame1 broadcast	??	0:Disable, 1:Enable
Channel1Frame2 broadcast	??	0:Disable, 1:Enable
Channel2Frame1 broadcast	??	0:Disable, 1:Enable
Channel2Frame2 broadcast	??	0:Disable, 1:Enable
Not available	00	
	00	

For example:

If you want enable channel1 Frame1 and channel1 Frame2 data broadcasting, disable

channel2 Frame1 and channel2 Frame2 data broadcasting.

PC send: 83 83 01 01 00 00 00 00 (Hex)