LCU-ONE CAN connected to

MXL QM and EVO3 QM

User Manual

INDEX

Chapter 1 – LCU–ONE

LCU-ONE is a lambda controller unit for the wide band BOSCH LSU 4.9 Lambda probe; it fits petrol (2 and 4 strokes), diesel and methane engines as well as alcohol based fuel engines. It is intended to check lambda probe proper working as well as to transmit the Air/fuel ratio values providing **MXL Pro/Pista QM** (from here onwards **MXL QM**) and **EVO3 Pro/Pista QM** (from here onwards **EVO3 QM**) with lambda values through the CAN bus.

Lambda value is defined as: **LAMBDA =(A/F)/(A/F) Stoichiometric**

Where:

A= incoming part of air;
F= parts of petrol the carburettor introduces in the engine;
A / F Stoichiometric = parts of air needed to burn Stoichiometric F;

Gasoline, for example, needs 14,57 parts of air to completely burn a part of gasoline, obtaining Lambda value= 1 read by the probe.

LCU–ONE controller can detect lambda values in a range from 0.65 to 1.6 (free air).

It is reminded that LAMBDA values lower than 1 means a rich mixture, while LAMBDA values higher than 1 means a lean mixture.

Wide band Lambda probe need to be heated to work properly and not poisoned with exhaust gas. **LCU-ONE** controller precisely manages the probe heater so to keep temperature value within the optimum working range.
During its working period, Lambda probe used with **LCU-ONE** controller becomes very hot (around 700-800 °C, 1292-1472 °F); it is thereby necessary **AVOIDING:**

- **Touching it**;
- **Placing it in contact with flammable stuff or fuel**.

Please note:
disrespect of these precautions can cause shocks, burnings or explosions.

1.1 – Part number

Kits part number are:

- **Controller LCU-ONE** (Complete kit with Lambda probe)   **X08LCU03K0**
- **BOSCH LSU 4.9 Lambda probe**   **XO5LSU490**

# Chapter 2 – LCU–ONE and Lambda probe mounting

LCU-ONE controller should be installed in a flat location and far from heat sources; it should be mounted steady using the suited bracket.

The wiring has to be arranged so to be far from heat sources.

BOSCH LSU 4.9 lambda probe should be installed on the vehicle exhaust pipe using a specific adaptor that comes with the kit and should be welded on the same pipe. The probe should be sufficiently near to the engine.

Probe working temperature should not exceed 900°C (1652°F), neither be exposed to the free flame coming from the exhaust system.

Probe installation angle should be of at least 10° to avoid liquid condensation stuff to come in contact with the probe, polluting it.
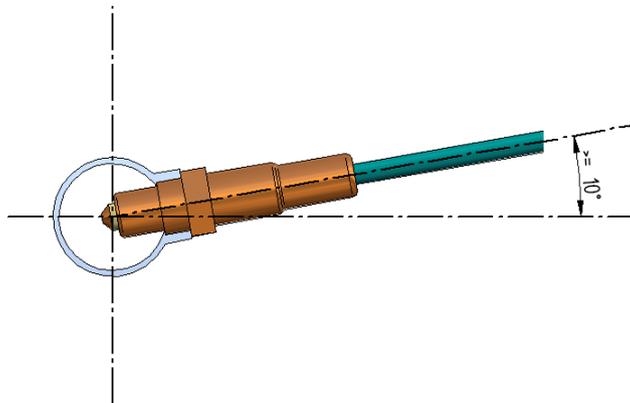
When the probe has been installed, do not let the cable pass close to heat sources (the exhaust pipe for example).

BOSCH LSU 4.9 probe auto-calibrates: no calibration is then required.

Solvents or additives should not be used to clean the probe connector. We would thereby suggest to remove it from the dragster when cleaning the vehicle, to avoid probe pollution caused by detergents.

REMINDER: never switch the vehicle on with Lambda probe installed and not connected to a correctly working **LCU-ONE** controller: a probe not heated and exposed to exhaust gas would be irremediably damaged.

Attention: BOSCH LSU 4.9 Lambda probe has been designed to be used with unleaded or diesel engines. It can be used with other kinds of engine too, but its duration needs to be verified by the user with specific tests.

We suggest to install Lambda controller and the related probe as shown in the following pictures.

Moreover we advise to install a 10 Ampere fuse in series between the external battery and lambda controller.
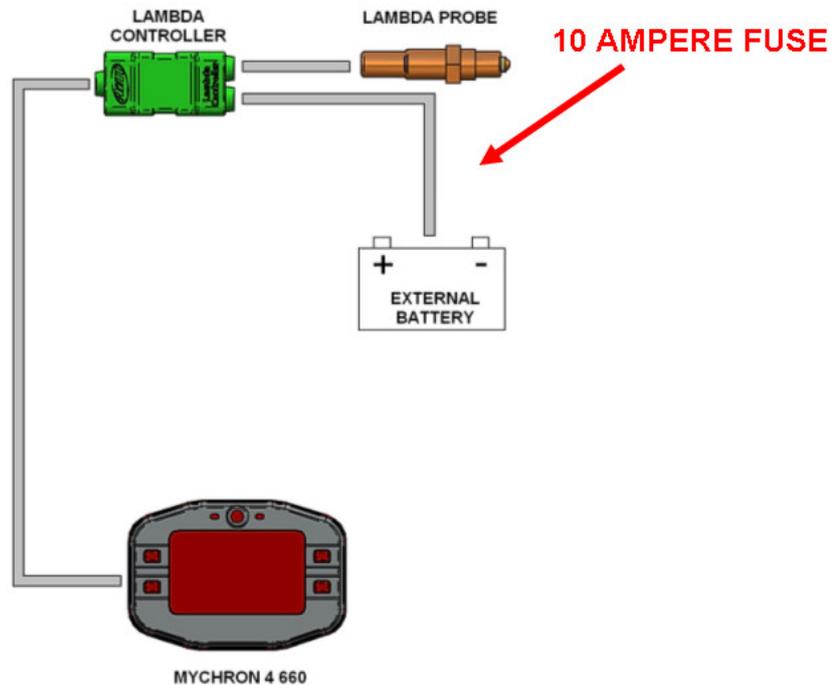
We would suggest to install the probe in the exhaust pipe (see picture below):
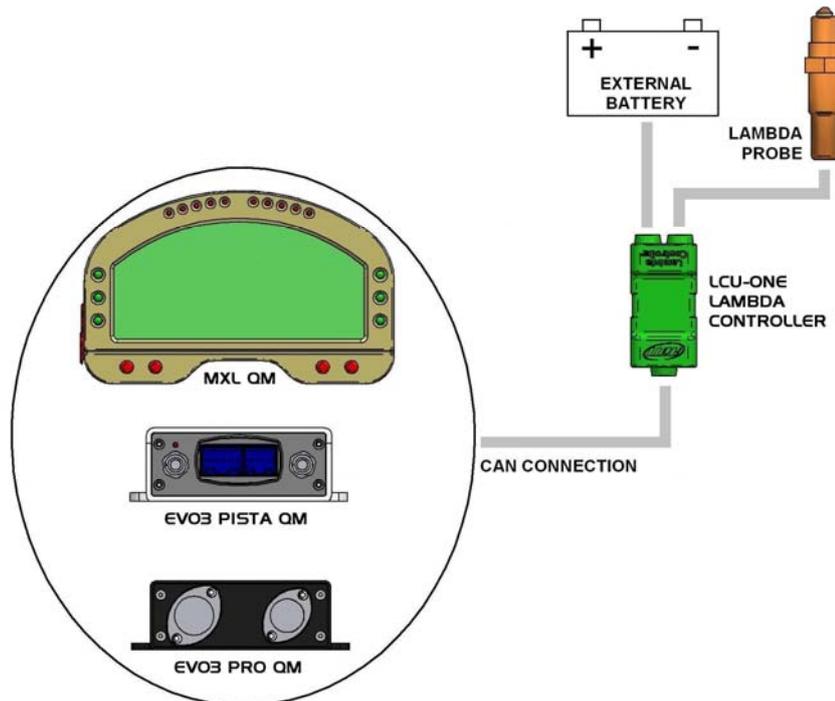
Chapter 3 – Connection to MXL – EVO3 QM

LCU-ONE CAN can be connected to all **MXL** and **EVO3 QM**.

Warning: connect LCU-ONE to MXL QM or EVO3 QM OFF.
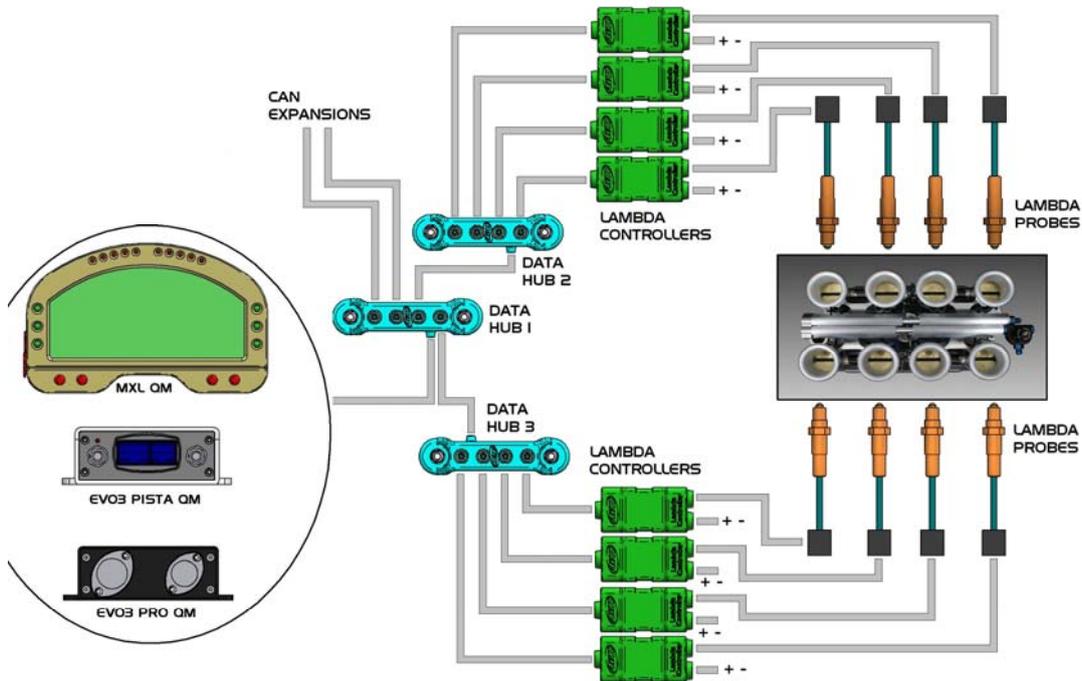
3.1 – LCU-ONE CAN Connection

Lambda controller connection scheme is showed above.
To protect Lambda Controller we suggest to insert one 10 A fuse for each controller in series between external battery and Lambda controller.

LCU-ONE CAN is to be powered, like the logger, by the engine master switch.

As far as connection with the loggers is concerned, please refer to those systems user manuals.

In case more than one Lambda Controller are to be connected, for a better engine control (one probe for each engine bank or even one probe for each cylinder), peripherals connection scheme is the following:

Each Lambda controller has to be connected to the battery.
We would suggest to protect each Lambda controller with a 10 A fuse.
When **MXL/EVO3 QM** is switched off all peripherals are automatically switched off.

3.2 – LCU-ONE CAN + GPS MODULE Connection
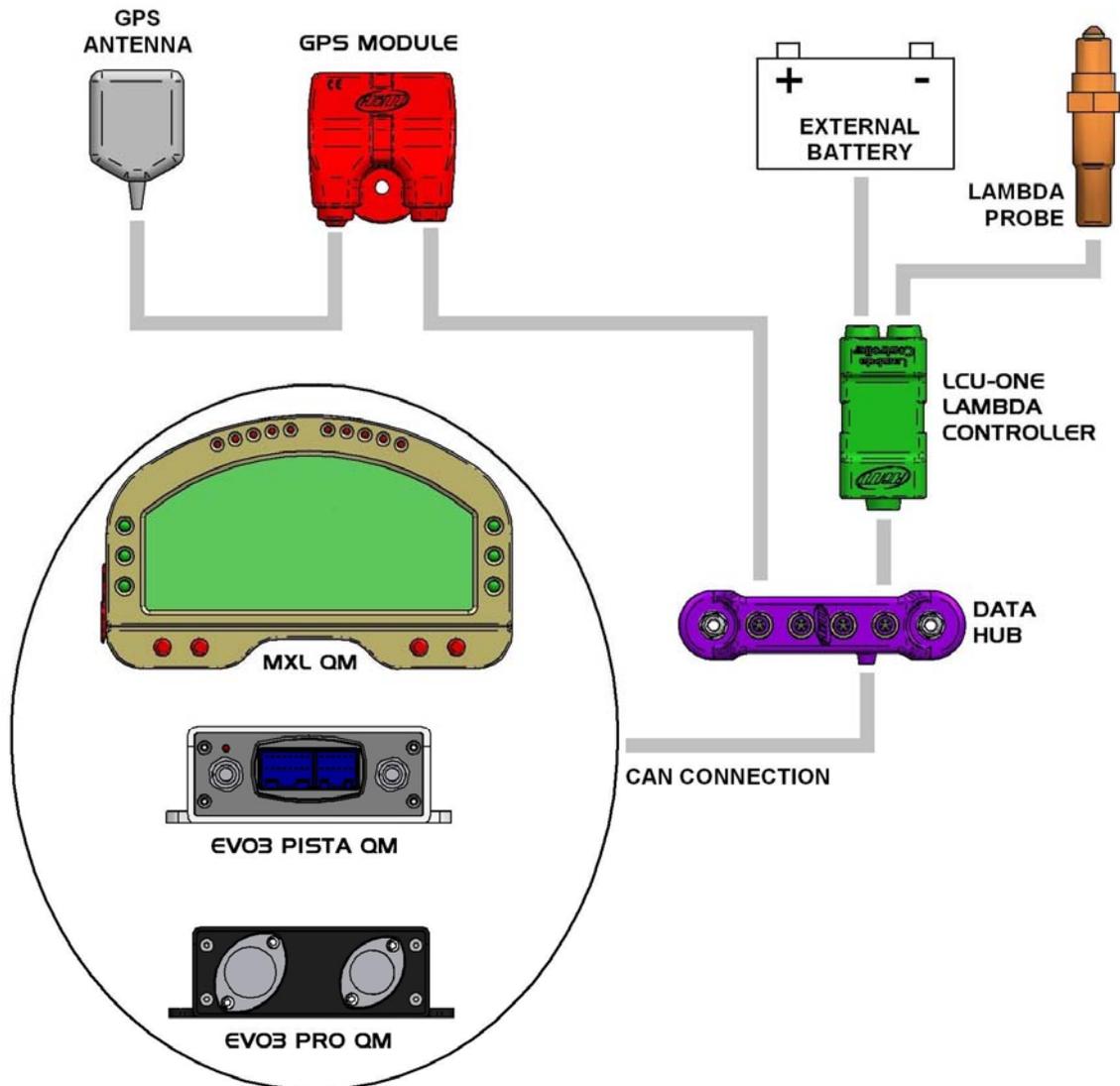
Lambda controller connection to other CAN peripherals scheme is shown above.
We suggest to insert a 10 A fuse in series between External Battery and Lambda controller to protect the latter.

LCU-ONE CAN is to be powered, like the logger, by the engine master switch.

As far as connection to the loggers is concerned, please refer to those systems user manual.

Chapter 4 – Configuration

Configuration is done through **DragOn**, the software properly developed by AIM to configure its QM products. This software is rich of features: we would suggest to practice the software before starting, using its advanced configuration functions. To run the software double click on its desktop icon, shown here below
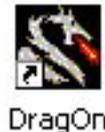
Otherwise follow this path: Start \ Program \ AIM Racing Data Power \ Dragster \ DragOn.

This window appears.
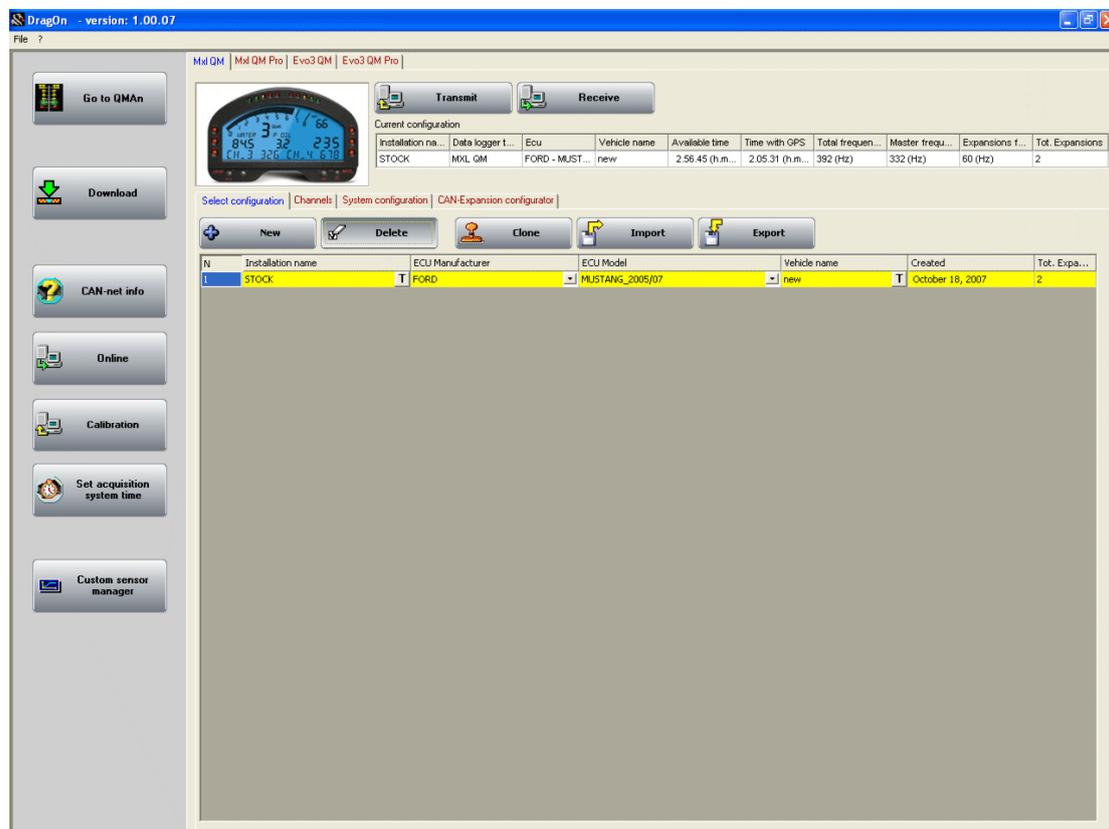
On the left of the window is a vertical keyboard with 7 buttons, only three[1] of which are of interest in this tutorial:

- "Go to QMAn": runs QMAn, the analysis software properly developed by AIM to analyse data stored in its QM products;
- "CAN-net info": shows all CAN expansions connected to **MXL**/**EVO3 QM**, LCU-ONE CAN included;
- "Online": checks that all the network works properly.

On top of the window four top layers: one for each QM product. By default the software opens on "**MXL QM**" layer. All layers have the same structure.

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[1] As far as all other keyboard buttons are concerned, refer to **MXL/EVO3 QM** user manual.

On top of each layer is a photo of the logger the layer refers to. On its right are:

- "**Transmit**" button: transmits the configuration to the logger;
- "**Receive**" button: reads the configuration of a logger connected to the PC and stores it in the configuration database;
- "**Current configuration**" **table**: shows all the most important information concerning the configuration user is working on.

To **transmit a configuration**:

- connect the logger to the PC USB port through the included USB cable;
- turn the logger on;
- click on "Transmit".

Warning: transmission of a configuration deletes all data stored in the logger memory. It is thereby recommended to make data download before transmitting a configuration to the logger.

To receive a configuration:

- connect the logger to the PC USB port through the included USB cable;
- turn the logger on;
- click on "Receive" button

Configuration database will show one more row, highlighted in yellow, on bottom of the central table of "Select Configuration" layer.

4.1 – Select configuration

DragOn software features a configuration database to trace all possible data acquisition settings. In "Select configuration" layer is a **top keyboard** that allows the user to:

- **New**: create a new configuration
- **Delete**: delete an existing configuration
- **Clone**: copy an existing configuration
- **Import**: import a configuration in the database
- **Export**: export a configuration

Under the keyboard is a **central table** whose columns are:

- **N**: progressive number of the configuration in this database; this digit cannot be modified and is attributed to the configuration when it is created/imported/cloned
- **Installation Name**: shows the configuration name; to edit it double click on the cell.
- **ECU Manufacturer**: if the vehicle the logger is connected to is equipped with an ECU supported[2] by DragOn software, it is possible to select its manufacturer in the pop up menu that appears double clicking on the cell; default setting is "none".
- **ECU Model**: if the vehicle the logger is connected to is equipped with an ECU supported by DragOn software, it is possible to select its model in the pop up menu that appears double clicking on the cell; default setting is "none".
- **Vehicle Name**: shows the vehicle name; double click on the cell to change it.
- **Created**: creation date of the configuration
- **Tot. Expansions**: number of CAN expansions the logger is connected to.

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[2] To know if the ECU installed on the vehicle is supported by DragOn software refer to ECU-AIM logger Pdf document available on aim website download area/documentation.

4.2 – Channels

In order to correctly sample data transmitted by any additional sensor connected to the logger, each sensor needs to be connected to a proper analog channel and configured. To do so, it is necessary to set "Channels" layer. First of all activate it as shown here below:
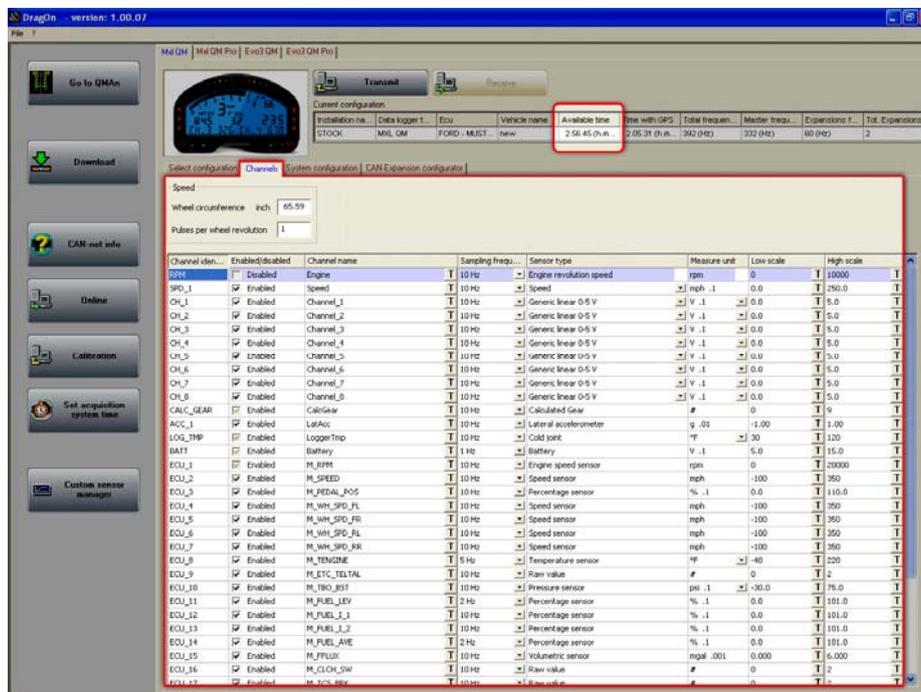
Central in this layer is channels table, whose columns are:

- **Channel identifier**: shows default channel identifier and cannot be modified.
- **Enabled\Disabled**: shows channel status; "enabled" means the channel will be sampled, "disabled" means it won't. To change channel status check/un-check the related checkbox.
- **Channel name**: shows the channel name: double click on the cell to change it.
- **Sampling frequency**: shows logger sampling frequency of that channel.
  Note: the higher is total sampling frequency, the less is the available time (red circled in the above figure), because memory fills up quicker. Each channel is set on a default sampling frequency that depends on the type of sensor installed on that channel. It is suggested to be careful changing this value, because it may impact on the quantity of runs the logger can store. AIM QM products can acquire up to 2000Hz total sampling frequency (max 500Hz per channel depending on the sensor installed; thermocouples, for example, cannot sample more than 100Hz).
- **Sensor type**: shows the type of sensor installed on that channel; to select the right sensor double click on the cell and scroll the pop up menu.
- **Measure unit**: shows unit of measure used to sample that channel. It can be changed double clicking on the cell.
- **Low / High Scale**: shows the range of values used to draw QMAn[3] graphs.

Some channels (i.e. speed) need additional information to properly acquire data. In this case additional panel(s) appears **over channels table**. In the above image the logger has one speed and the related panel needs to be filled in.

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[3] **QMAn** is the analysis software properly developed by AIM to analyse data stored by its QM products. It is available for free download on AIM website download area/software.

4.3 – System configuration

System configuration is the most important operation to make in order to correctly sample data and show them on the logger display (if available). This layer layout depends on the logger to be configured: activate "System configuration layer" and fill in the window.

4.3.1 – Configuring MXL QM
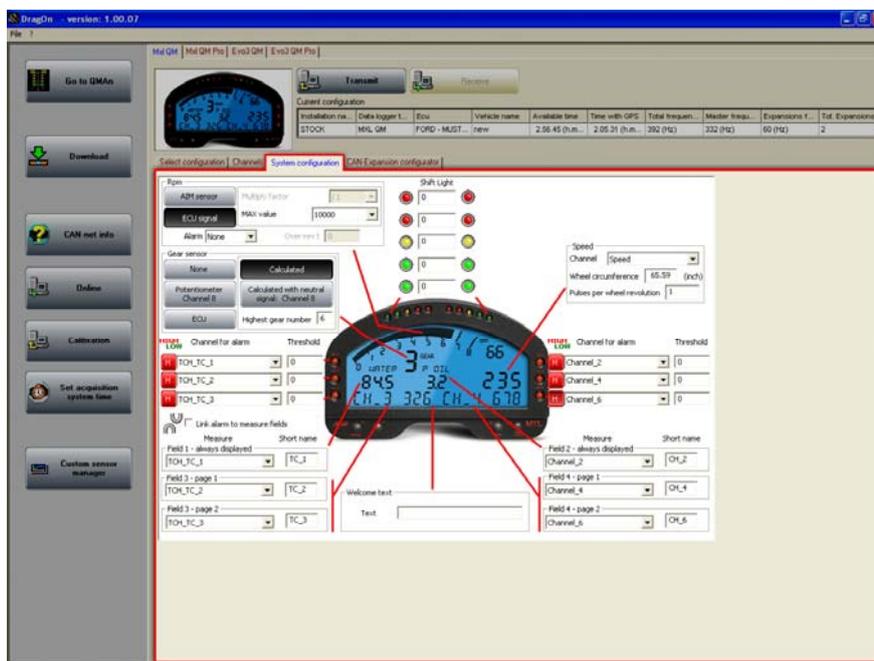
RPM box:

If the info comes from a sensor installed on the vehicle, press "AIM sensor": 'multiply factor' case enables: insert the proper multiply factor and RPM max value.

In case this info comes from the vehicle ECU, insert only RPM Max value.

Moreover it is possible to link an alarm led to an over-rev threshold value to be inserted in the related case.

Gear sensor box:

The engaged gear number can be sampled and shown or not (In this case press "None" button). As shown here on the right the information can come from a gear potentiometer installed on the vehicle, from the ECU or can be calculated through an algorithm based on RPM and speed. Press the button corresponding to the vehicle situation and insert highest gear number if required.
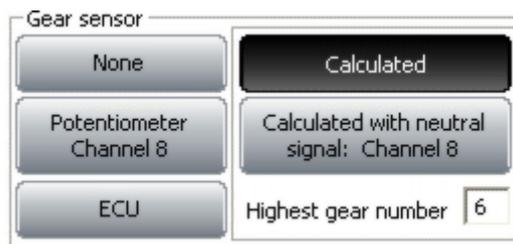
Channel for alarm and measure fields box:

Each channel of the logger can be linked to one of the six lateral alarm leds of **MXL QM.**

These channels can also be displayed on **MXL QM** display with the short name inserted in the related cell.

Moreover it is possible to link alarm leds to the fields displayed, enabling the checkbox circled in the image here on the right. In this case, when a channel displayed on a field of **MXL QM** reaches a set threshold value, the led linked to that field switches on. If alarms are linked to measure fields, user can only set threshold value and short name of the channel.

Welcome text box:

Inserting a message in the box shown here above it is possible to show for a few seconds a welcome message at **MXL QM** start up.

Speed box:

The logger can sample speeds coming from sensors installed on the vehicle and speeds coming from the vehicle ECU. It is possible to show one of these speeds on **MXL QM** display, selecting it in the drop down menu menu of speed box. Once selected the speed to show, it is necessary to insert wheel circumference and pulses per wheel revolution.

Shift light box:

These cases correspond to the ten top leds of **MXL QM**. They can be switched on at a fixed RPM value to warn the pilot to shift gear.
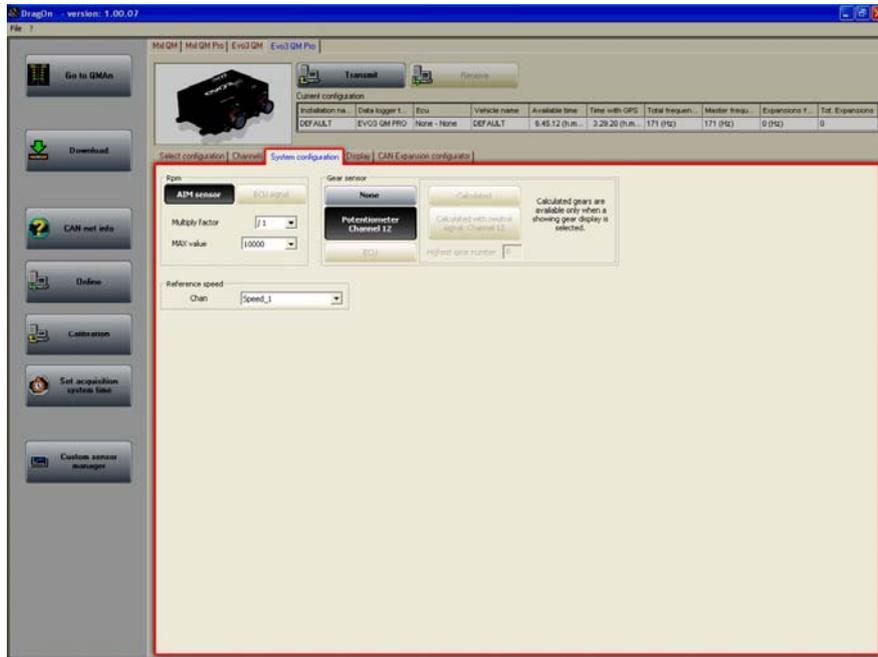
Note: always refer to MXL QM user manual for any further information concerning the system configuration not expressly discussed in this tutorial.

4.3.2 – EVO3 QM

RPM box:

If this info comes from a sensor installed on the vehicle, press "AIM sensor" button: 'Multiply factor' case enables: insert the proper multiply factor and RPM max value.
If this info comes from the vehicle ECU, only insert RPM Max value.
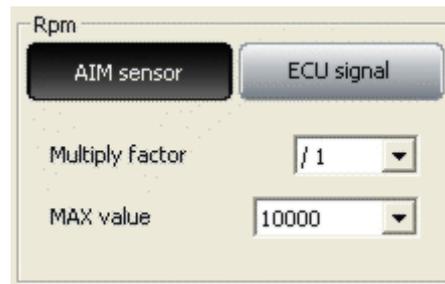

Gear sensor box:

Engaged gear number can be sampled and shown or not (press "None" button). The information can come from the ECU, from a gear potentiometer installed on the vehicle, or can be calculated through an algorithm based on RPM and speed. Press the button corresponding to the vehicle situation and insert highest gear number if required.
Please note: calculated gears are available on **EVO3 QM** only if a showing gear display is connected to the logger.
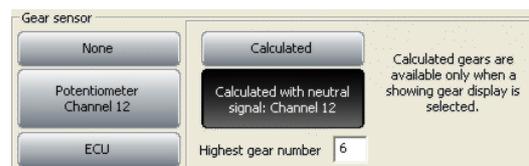

Reference speed box:

The logger can sample speeds coming from sensors installed on the vehicle and from the vehicle ECU. Reference speed is used to calculate gear: it is strongly suggested to select the speed of a driving wheel.
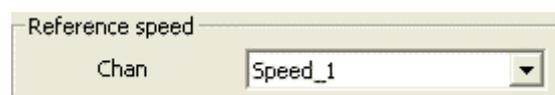
Note: always refer to MXL QM user manual for any further information concerning the system configuration not expressly discussed in this tutorial.

Chapter 5 – Configuration on MXL QM – EVO3 QM

To use **LCU-ONE CAN** with **MXL/EVO3 QM** you need to configure it using **DragOn** software. Please refer to the installation manual for further information about the software. To configure Lambda Controller run the software and select the logger manager layer as explained before. To configure **LCU-ONE** it is necessary to activate "CAN-Expansions configurator" layer, present in all loggers manager layer

In case of very first configuration the layer appears empty as shown below.
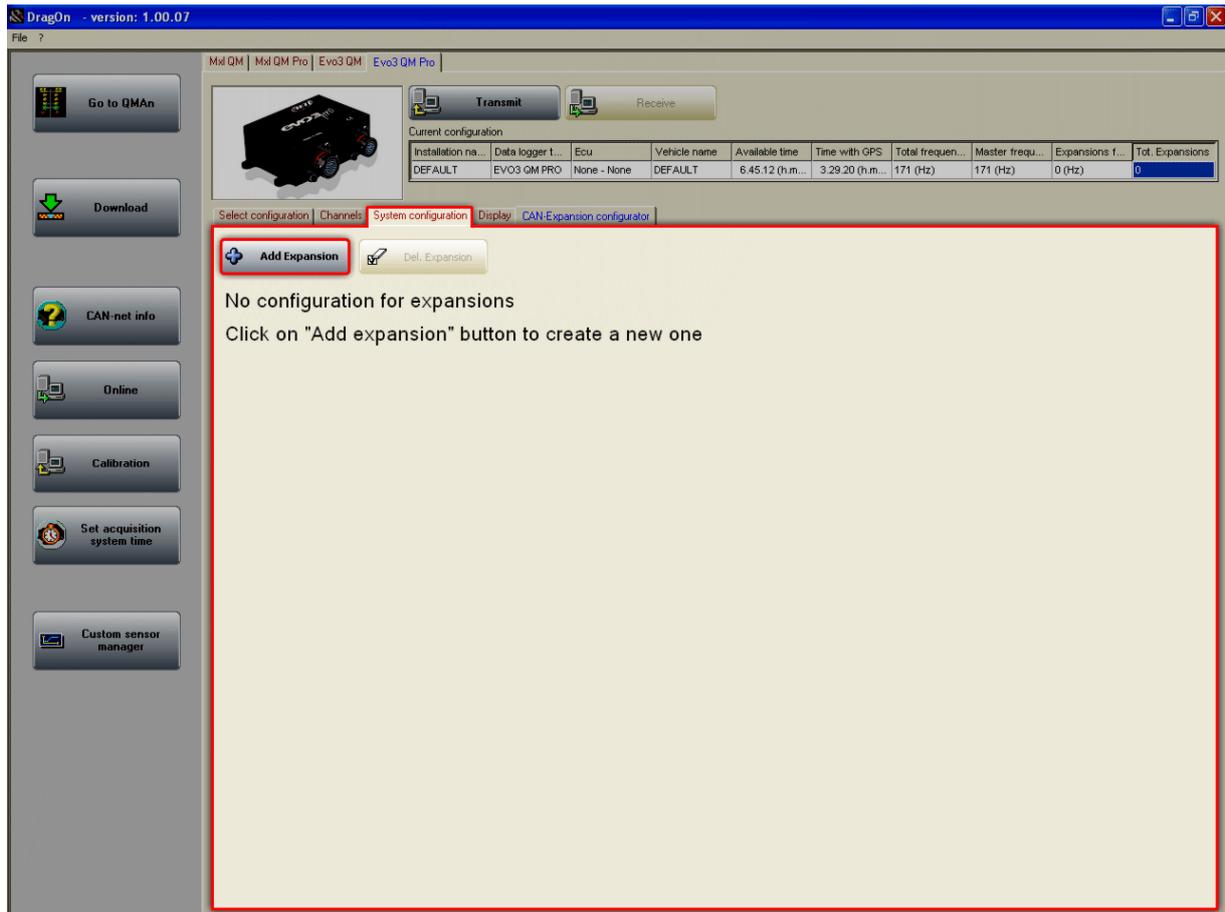

Press "Add Expansion" button and the window here on the right appears.

Select **LCU-ONE CAN** (only CAN). The field under the keyboard enables, press "Get serial number from a connected expansion" button and the system reads the **LCU-ONE** serial number. It is also possible to manually insert the serial number getting it from **LCU-ONE**. This operation is to be repeated as many times as many Lambda probes are connected.

The layer will be modified as shown below and as many additional layers as many lambda probes have been added appear.
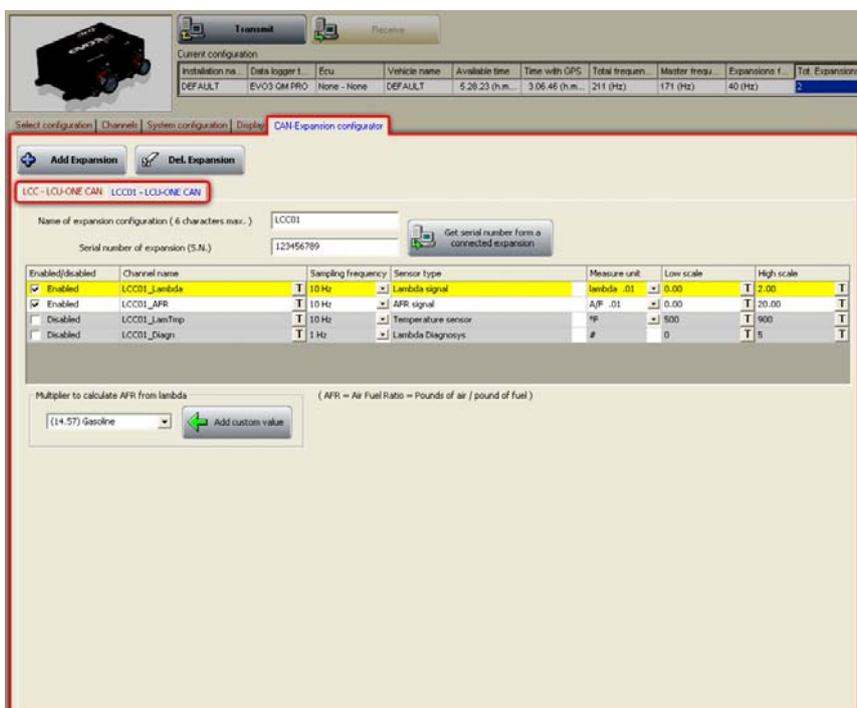
In case serial number has not been get, press "Get serial number from a connected expansion" button.

Warning: this operation is necessary to be able to transmit the configuration to the logger.

**LCU-ONE** layer is shown above.

On top

- **Name of expansion configuration** (6 characters max.) and serial number fields. Inserting a configuration name the layer label is modified live.

Central in the page a table shows LCU-ONE channels. The table has 7 columns.

- *Enabled/Disabled*: shows the channel status (enabled/disabled) and can be modified checking or un-checking the related checkbox. LCC_lambda (lambda value) and LCC_AFR (AFR value) channels are enabled by default.
- *Channel name*: shows the channel name and can be modified double clicking on the cell, which becomes editable.
- *Sampling frequency*: shows the channel sampling frequency and can be set selecting the desired value from the pop up menu that appears double clicking on the cell (accepted values are from 1 to 50 Hz).
- *Sensor Type*: shows the sensor installed on that channel and cannot be modified.
- *Measure Unit*: shows the selected unit of measure of that channel and can be modified double clicking on the cell.
- *Low/High scale*: shows the channel high and low scale and can be modified double clicking on the cells, which become editable.

Under the table is "Multiplier to calculate AFR from lambda" field. It allows the user to change the used fuel and to insert a new one. Select the used fuel to see its AFR value.

In case a fuel not included in the database is being used and **only in case its Stoichiometric value** is known, press "Add custom value" button and the window shown below appears.
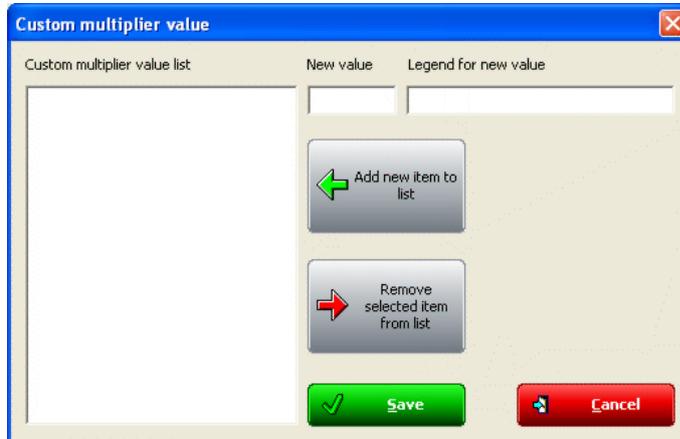

Fill in the window with Multiplier value and related legend. Press "Add new item to list" and then "Save".

Likewise, selecting a multiplier from the left box labelled "Custom multiplier value list" and pressing "Remove selected item from list" button the multiplier is removed.

Once enabled/disabled the channels, it is possible to decide if and what Lambda channels to show on the display, depending on the logger and on the connected peripherals. In case of an **MXL QM,** Lambda channels can be shown setting them in "System Configuration" layer as shown here below. In the example enabled channels are: LCC_Lambda, LCC_Diagn and LCC_AFR AND each of them can be shown in one field of the display.
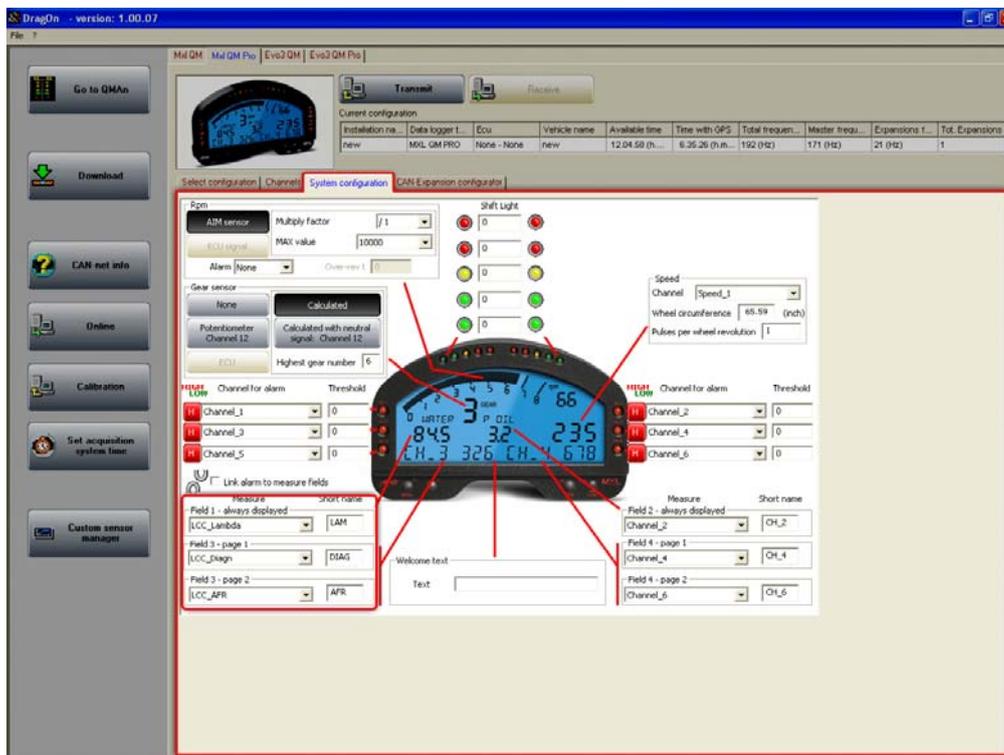
In case of an **EVO3 QM**, data visualisation is only possible if the logger is connected to a Formula Steering Wheel or to a MyChron3 Dash and displayed channels are set in that display configuration, as shown below.
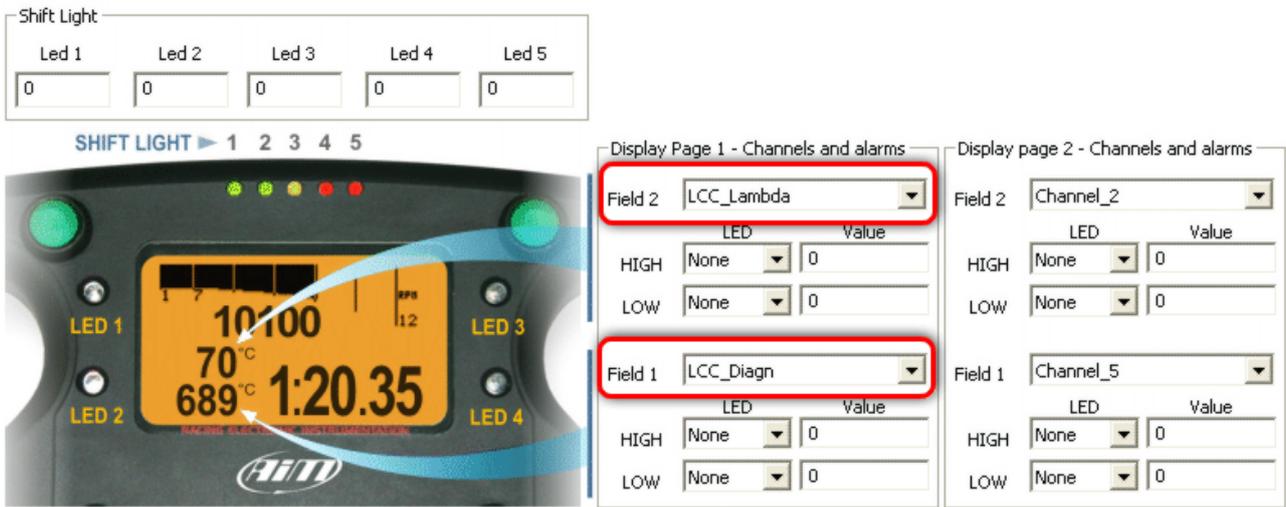

Note: LCC_diagnosys channel shows **LCU-ONE** working status and can show up to four messages:

- 0: status OK
- 1: probe not connected
- 2: +12V short circuit
- 3: GND short circuit

The configuration is now ready to be transmitted to the logger.

Warning: configuration has to be repeated for all LCU-ONE connected to the logger.

Press "Transmit" button on **DragOn** top keyboard. If the transmission is ok no message is shown. If, **LCU-ONE** serial number has not been get, the window here below appears. It tells the user that no serial number has been assigned to the connected expansion. Close this window button and get the expansion serial number as explained before.
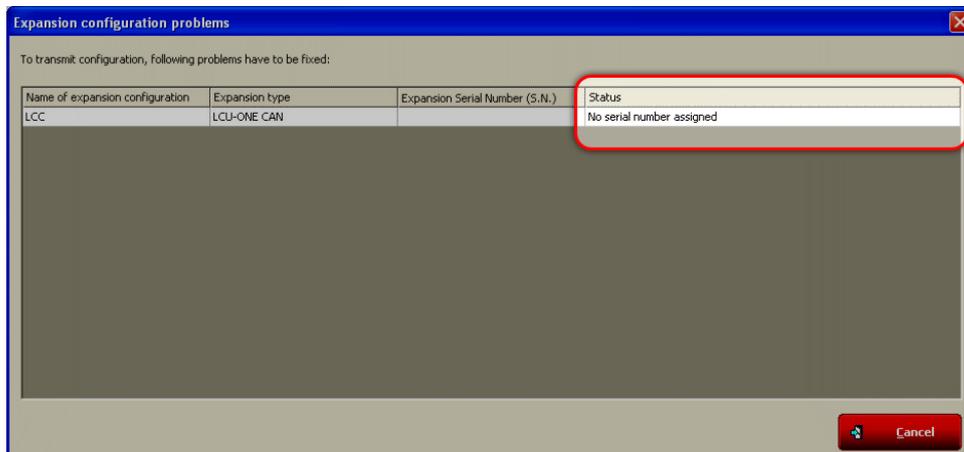
Chapter 6 – Data Visualisation on MXL QM/EVO3 QM

6.1 – Data Visualisation on MXL QM

Lambda channels visualisation on **MXL QM** works exactly like the visualisation of any other **MXL QM** channel: switch from one page to the other is made using "MEM/View" button. Please refer to **MXL QM** user manual for further information. In the image below lambda value is 0.955 and assigned Short Name is LAM.

Powering **MXL QM** and Lambda controller on at the same time, **LCU-ONE CAN** is recognised at start-up and probe warm-up procedure starts. During this period the controller takes the probe to its working temperature (until around 780 °C – 1436 °F).
During warm-up (around 20-30 seconds), displayed lambda value is 1.00.
When the probe is 100% working, displayed value turns, with the engine off, into 1.60 (free air value).
Warning: it is reminded that LCU-ONE, like the logger, has to be powered by the engine master switch.

6.2 – Data Visualisation on EVO3

Lambda channels visualisation on EVO3 QM works exactly as the visualisation of any other EVO3 **QM** channel and is thereby possible only if the logger is connected to a display. The only displays that show Lambda value are **MyChron3 Dash** and **Formula Steering wheel**. Please refer to EVO3 **QM** user manual for further information. In the image below Lambda value is 0.95 and the field is labelled "λ"

Switching **EVO3 QM** on Lambda controller is recognised at start up and probe warm-up procedure starts. During this period the controller takes the probe to its working temperature (until around 780 °C – 1436 °F).
During warm-up (around 20-30 seconds), displayed lambda value is 1.00.
When the probe is 100% working displayed value turns, with the engine off, into 1.60 (free air value).
Warning: it is reminded that LCU-ONE, like the logger, has to be powered by the engine master switch.

Chapter 7 – Data Analysis with QMAn

During data analysis, the presence of Lambda controller adds two channels to measures and laps toolbar (as shown below):
**Lambda**: shows lambda value recorded during the session;
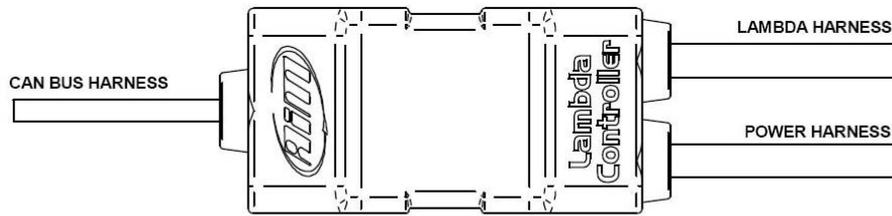**Lambda _Temp**: indicates the probe internal working temperature
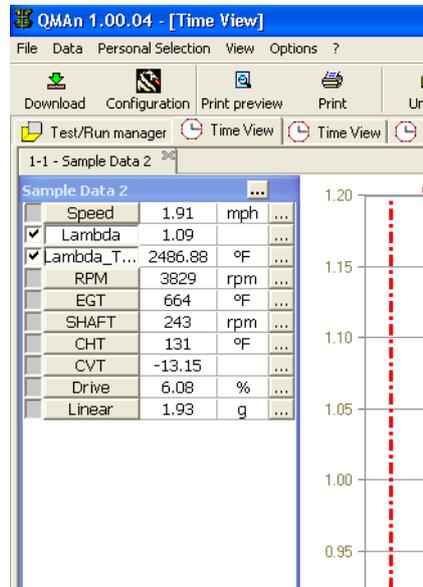
To better analyse carburetor values we would suggest to show XY diagram of Lambda probe with RPM values on abscissa axle and Lambda values on ordinate axle.
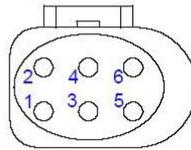This way a more immediate reading of carburetion status is available.
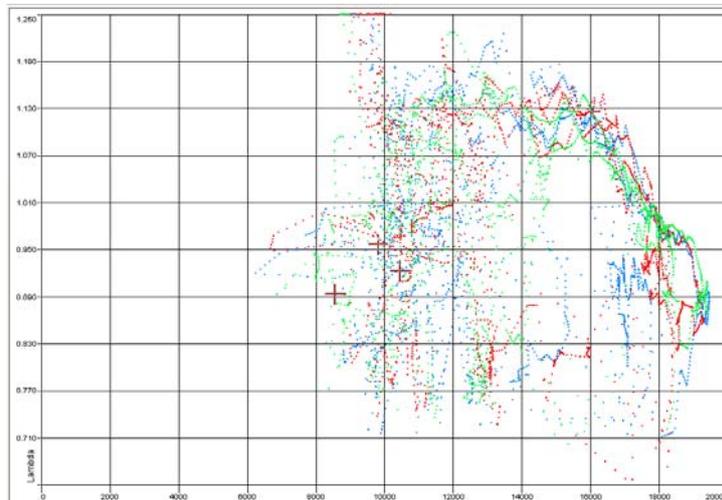
Appendix – Technical drawings
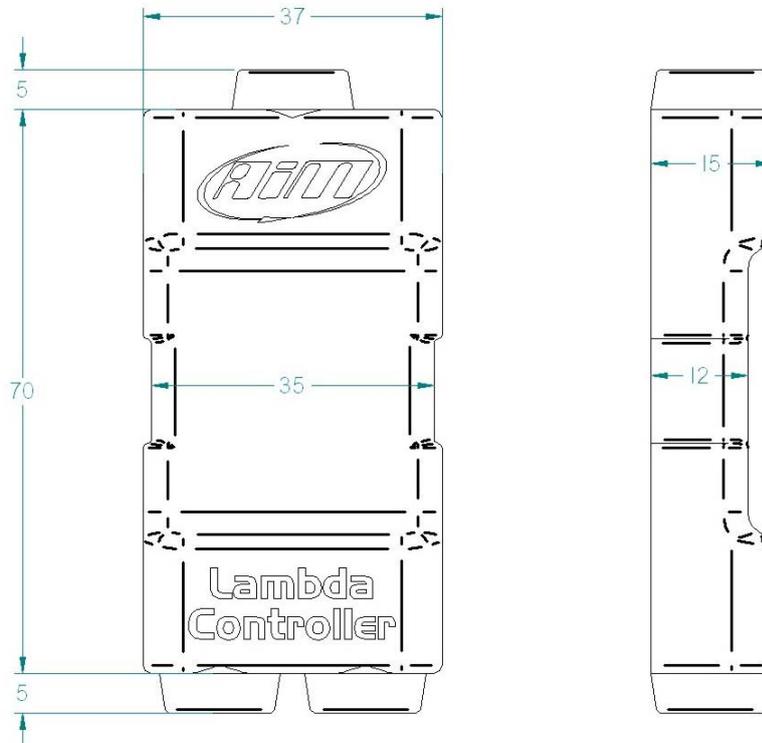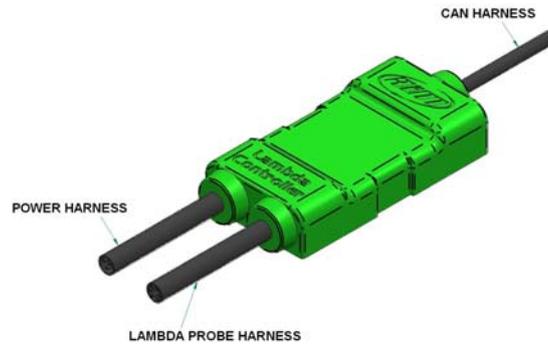
LCU-ONE CAN pinout

CAN BUS HARNESS	
1	CAN+
2	GND
3	+Vb
4	CAN-
5	Vbext

LAMBDA HARNESS	
1	IP+
2	IP-/VS
3	H-
4	H+
5	Rcal
6	VS+

POWER HARNESS	
red	V battery
black	GND
black	GND