

PDM 32

User Manual



VER 1.02



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1. The PDM 32



The PDM 32 is a multifunctional integrated device, designed to manage a good number of important features in a modern race car:

- **Power Module**: it powers the different electrical devices in the vehicle such as solenoid, pumps, fans, lights, and electronic devices such the ECU.
- **Dash controller:** the dash, in installations with the PDM 32, becomes a very simple and inexpensive device, connected to the PDM through a 1.5 GHz LVDS cable.
- **Automatic Lap Timer:** thanks to the high precision GPS Module and a huge database of thousands of maps all over the world, the lap time is automatically calculated, shown in the display and recoded for future evaluations
- **Datalogger:** the PDM32 has a huge 4 gigabytes not volatile memory, that allows to record not only all the data coming from the sensors, from the ECU, from the expansions, but also all the current consumption of all the Power Outputs. The data are correlated with the position on the track, with the map of the track and, eventually, with the images recorded by the video camera SmartyCam

The PDM 32 should only be configured and installed by qualified personnel as to ensure the correct wiring and connections for all the inputs and outputs. High levels of current are present and can result in overheating and may cause risk of damage or injury to personnel and/or equipment, if not installed correctly.



2. Connections

The PDM 32 has 6 connectors:

1 Surlok Power Connector to connect to the +V battery

1 Rosenberger LVDS connector to connect the display (6" or 10")

2 35 pins AMP connectors

2 Binder connectors, 5 and 3 pins, for the connection to the USB port and to the analog mirror camera



| PIN | DESCRIPTION | PIN | DESCRIPTION | PIN | DESCRIPTION | PIN | DESCRIPTION |
|--------|---------------------|------|---------------------|-----|----------------------------|-----|--|
| 1 •• | High power output 1 | 19 | Low power output 6 | 1 | Half bridge power output 1 | 19 | Speed 2 input |
| 2 | Mid power output 1 | 20 | Low power output 7 | 2 | Half bridge power output 1 | 20 | Speed 1 input |
| 3 | Mid power output 2 | 21 | Low power output 8 | 3 | Low power output 9 | 21 | Channel input 9 |
| 4 | Mid power output 3 | 22 | CAN0 High | 4 | Mid power output 9 | 22 | Channel input 10 |
| 5 | Mid power output 4 | 23 🔍 | High power output 2 | 5 | Mid power output 10 | 23 | Ignition |
| 6 | Mid power output 5 | 24 😐 | High power output 3 | 6 | Low power output 10 | 24 | Half bridge power output 3 |
| 7 | Mid power output 6 | 25 🔵 | High power output 3 | 7 | Low power output 11 | 25 | Half bridge power output 3 |
| 8 | Mid power output 7 | 26 | Channel input 11 | 8 | Mid power output 11 | 26 | Channel input 1 |
| 9 | Mid power output 8 | 27 | Channel input 12 | 9 | Mid power output 12 | 27 | Channel input 2 |
| 10 | GND | 28 | CAN2 High | 10 | Low power output 12 | 28 | Channel input 3 |
| 11 | CAN0 Low | 29 | CAN2 Low | 11 | Half bridge power output 2 | 29 | Channel input 4 |
| 12 🔍 | High power output 2 | 30 | CAN1 High/RS232TX | 12 | Half bridge power output 2 | 30 | Channel input 5 |
| 13 🔵 🔴 | High power output 1 | 31 | CAN1 Low/RS232RX | 13 | P GND | 31 | Channel input 6 |
| 14 | Low power output 1 | 32 | +Vb ext CAN | 14 | P GND | 32 | Channel input 7 |
| 15 | Low power output 2 | 33 | +Vb out CAN | 15 | LIN | 33 | Channel input 8 |
| 16 | Low power output 3 | 34 😐 | High power output 4 | 16 | +5V Analog Vreference | 34 | Half bridge power output 4 |
| 17 | Low power output 4 | 35 😐 | High power output 4 | 17 | +Vb output | 35 | Half bridge power output 4 |
| 18 | Low power output 5 | | | 18 | GND | | 1000000 000000000000000000000000000000 |

High Power Out 1 has internal serie diode

High Power Outs (1,2,3,4) have internal freewheeling diode



Loom wires and connectors pin selection are very important. Be sure to select wire size according to load current specification.

2.1 AMP connectors



PDM 32 connectors mate with AMP 776164-1 (black) and AMP 776164-4 (grey). Connector terminal: AMP 770520-3. This is the gold-plated version rated up to 17A.

Wire sizes qualified for this terminal are: 20AWG, 18AWG, 16AWG.

2.2 Surlok connector



Connection to POWER is made by a Surlok connector, Amphenol SLPRATPSO.

This connector is rated up to 120A and can manage wire from 16mm² to 25mm². Mating part code is SLPPA25BSO and both are IP67.

Bigger advantage of this kind of connectors is that user does not require any special tools to make reliable connection. It features an automatic quick lock and press-to-release function.



2.3 Rosenberger LVDS connector



PDM has an external high-speed link used to manage remote display. This link is realized by AIM custom cable (FCCA 682000). Link transmits to remote display the TFT information and the status LEDs activity. On the other side receives from remote display light sensor data and push buttons status. Same link is used also to power the remote display making a simple and reliable connection. Rosenberger connectors allow high immunity noise levels and IP67 class connection.

Mechanical data

Mating cycles ≥ 25 Engagement force ≤ 30 N Engagement force waterproof ≤ 40 N Disengagement force ≥ 5 N Retention force latch ≥ 110 N Retention force primary lock ≥ 80 N Retention force secondary lock ≥ 60 N Polarization feature effectiveness ≥ 80 N

Environmental data

Temperature range -40 °C to +105 °C Thermal shock IEC 60068-2-14 Vibration IEC 60068-2-64 Mechanical shock IEC 60068-2-27 Temperature and humidity USCAR 2-4 5.6.2 Dry heat IEC 60068-2-2

3. Standard compliances

PDM complies with the following standards:

- ECE Regulation No.10 Add.9 Rev.5
- IEC 61000-4-2 exceeds level 4 30 kV (air discharge) 30 kV (contact discharge)
- ISO10605 C = 330 pF, R = 330 Ω 30 kV (air discharge) 30 kV (contact discharge)
- ISO 7637-2:
 - Pulse 1: VS = -150 V
 - Pulse 2a: VS = +112 V



- Pulse 3a: Vs = -220 V
- Pulse 3b: Vs = +150 V
- Formerly pulses 5a and 5b
- ISO 16750-2 Tests A and B

4. Installation

A PDM manages current values that may be rather high, and its temperature strictly depends upon the total load current. It must be installed in an aerated area and far from hot parts.

5. Status LEDs

The PDM 32 has 32 status LEDs, one for every power output:

| 1 | a | 9 | 4 | 5 | 6 | 7 | в | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | | J 32 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-------------|
| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | STS | DOd |

- GREEN: the output is enabled, and its status is OK
- RED: the output status is in alarm mode i.e. short circuit, open load, etc...
- OFF: the output is not active.

There are also 2 additional LEDs: ON and STS (Status).

ON is green when PDM is active.

STS may be:

- GREEN: everything is OK.
- YELLOW:
 - Ext battery voltage value is between 12 and 11 V
 - Internal temperature of PDM is between 70°C and 85°C
- RED you have an existing fault on the circuit and the power has been interrupted. These are the possible

cause of the faults:

- Ext battery voltage value is below 11 V
- Internal temperature of PDM is over 85°C
- Any of internal peripheral not working properly



6. Inputs

The PDM32 has the following input channels:

• 1 Ignition input:

IGNITION INPUT: this is a special input, only digital and not programmable by user. It is active HIGH (internal pulldown hardwired) and when activated by external voltage, switch ON the PDM. Some functionality, for example display, are IGN dependent. This means that when IGN is active, also display is switched ON. Ignition could be used in user configuration as condition for other

Ignition Input Example application:

IGN connected to Main switch and CH_IN12 connected to Hazard switch. With IGN active (+12V) all functions on PDM are enabled. With IGN off (disconnected or tied to GND) and Hazard switch active (+12V) PDM enables only outs related to HAZARD function (typically front and rear directions lamps in hazard blinking mode).

• **8 channels (CH_IN1 - CH_IN8)**: can be both analog and digital in dependence upon the configuration (please, refer to the paragraph "Input channels configuration).

If they are configured as analog, a 2KOhm pull-up can be activated.

If they are configured as digital, it is possible to activate an internal pull-up or pull-down depending on whether they are closed to ground or closed to VBatt.

• **4 channels (CH_IN9 - CH_IN12)** : they are only digital and can have a pull-up or a pull-down depending on whether they are connected to ground or to VBatt.

The input channels CH_IN11 and CH_IN12, when connected to VBatt, can activate the PDM without turning on the display. This can be useful for activating the Hazard, or keeping a fan on even with the engine off until the temperature reaches a correct value etc.

• 2 speed inputs



6.1 Analog Inputs

The Analog Inputs may acquire any source in the different ranges:

0-50 mV

0-500 mV

0-5V

0-12V

In case an input is configured as Analog Input, you may enable an internal 2kOhm pull up resistance, as shown in the following picture:



6.2 Digital Inputs

In case an input is configured as **Digital input**, it is possible to enable an internal pull-up or pull-down resistance, depending on whether they are closed to ground or closed to VBatt, as shown in the following picture







Most of the time, a Digital Input is connected to a pushbutton: the PDM offers different ways of manaiging it. As explained in the "Digital Input Configuration" paragraph, it is possible to manage the input in order to produce momentary, toggle or multistable channels

- **Momentary**: the channel is active when the pushbutton is closed
- **Toggle**: the channel is activated the first time you close the circuit and deactivated the second time the circuit is closed as shown here below
- Multistable: Each time the connected button is pressed, the channel value changes from 0 to N (this value depends on the configuration), then returns to 0.





7. Power Outputs

| M32 ³⁴ | | | | | | |
|---------------------------------------|---|------------------------|------------------------------------|--------------------|--|-------|
| lava Stave As | Close Toursmit | | | | | |
| nels ECU Stream CAN2 S | tream CAN Expansions Math Channels | Status Variables Shift | Lights and Alarms Trigger Comm | ands Power Outputs | Icons Manager Display SmartyCam Stream CAN Output | |
| Black Connector (35 Pin Male) | Grey Connector (35 Pin Male) | | still available power outputs: 128 | | High Power Out 3 on Black Connector (35 Pin Male) Pin: 24: | |
| | | — | Recorded and the | 10000 | | |
| | C | | | ALA | Name Pigeros | |
| 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | 1 | Higheon | Hdt Hower OLE 1 B 10 1X | 20,04 | Settings | |
| | | 2 Pager02 | High Hower Out 2 8 12, 23, | 20,04 | Generated Load (up to 29,04) 21 | A |
| ت سیلیسیت | Connelance | | representation of the second | | Der Direct and Office 0 | ser. |
| Descripton Mas | Pis Description Max | 4 HighPola | High Hower Occ4 0 14, 15, | 20,05 | Coll Stop in a lime of 1 and | |
| 3 High Power Out 1 (20,0 | 1/2 Half Bridge Power Cut 1 (35,0.4) | 5 Maron | Mid Power Cul 1 0 2 | 15,0.4 | PVM based on Fequency of 100 Hz | _ |
| tild Power Out 1 (15,5 | 1/0 3 Lew Power Out 9 (10,0/4) | | Wei Pewer Cor2 B X | 15,05 | Tody Delay (0. | 3 800 |
| Uld PowerOut 2 (15,0 | 4 Mid Power Dut 9 (15,0.4) | 7 Mideos | Mid Power Curis 84; | 15(0)A | tileimum Custed 0 | |
| tild Power Out 3 (15,0 | 14) 5 Mid Power Out 19 (15,0.4) | 8 Marca | Mid Power Cut 4 0 5. | 15,0.4 | | |
| tad Power Out 4 (15,0 | 15) 6 Lew Power Out 10 (10,0.5) | U Maros | Mid Pewer Cul 5 B 6, | 15,0.6 | | |
| tild Power Out 5 (15,0 | 140 7 Lew Power Oat 11 (10,0.4) | 10 MidFO6 | Md Pawar Cut 6 97. | 15,0.4 | Same concilion on advance preparation | |
| tild Power Out 6 (15,0 | 0 Ind Power Out 11 (15,0.5) | 11 MdPO7 | Mid Pewer Cut 7 B 8; | 15,0.4 | | |
| tild Power Oat 7 (15,0 | 9 Mid Power Out 12 (15,0.4) | 12 MidPOS | Mid Power Cut 8 8 9 | 15,0A | | |
| thd Power Out 8 (15,0 | 14) 10 Low Power Out 12 (10,0.4) | 13 MidPOR | Mid Power Cut 9 G 4; | 15,0A 🌯 | It is activated when | |
| 23 High Power Out 2 (20) | 141 11; 12 Half Bridge Power Cul 2 (35,074) | 14 MdF010 | Mid Power Cull 10 G.5; | 15,0.4 | (Aways Hubb) | |
| Low Power Out 1 (10,0 | 140 24.25 Half Bridge Power Out 3 (36,0.4) | 15 MdF011 | Mid Pawar Cut 11 G 8, | 15,0A | | |
| Low Power Cel 2 (10,5 | 1A) 34 35 Half Bridge Power Cut 4 (35,3A) | 10 M MidPO12 | Mid Pawar Cut 12 G 9; | 15,04 | It is advated when | |
| Low Power Cells (10) | | 17 LowP01 | Low Pawer Out 1 8 14; | 10,0.4 | | |
| Low Point Call (10) | 161 | 18 LowPC2 | Low Pewer Out 2 B 15; | 10,0.A T | 1 | |
| Low Press Cald. (10.5 | 4 | 10 LowPO3 | Low Power Out 3 8 16; | 10,0.4 | | |
| Low Prosp Out 7 (10.0 | 41 | 20 LowPO4 | Low Power Out 4 8 17, | 10,0.4 | | |
| Low Poper Out 8 (10.0 | 40 | 21 LowFOb | Low Pawer Out 5 B 18, | 10,0.4 | | |
| 25 Hat Power Dat 3 (20.5 | | 22 LowP06 | Low Pawer Out 6 8 19: | 16.04 | | |
| 35 High Power Oal 4 (20,1 | 141 | 23 LowP07 | Low Power Out 7 8 20; | 10,0A S. | | |
| | | 24 LowPOR | Low Pewer Out 8 8 21 | 10,0.4 | | |
| | | 25 LOWPON | Low Press Out 9 G.3: | 10.04 1 | | |
| | | 28 LowP010 | Low Prove Out 10 Git | 10.04 9. | | |
| | | 27 LowPO11 | Low Pawer Out 11 O.7: | 10.00 | | |
| | | 28 LowP012 | Low Power Out 12 Q 10 | 10.04 1 | | |
| | | | Hall Dortra Roser (hd 1, G 1 2 | 38.84 | 1 | |
| | | | Mattheine Power 042, 0 11 12 | 35.04 | - | |
| | | 1 21 L0003 | Unif O false Depart O 42 C 26 26 | 35.04 FI | | |
| | | | indication from 0.44 0.25 25 | 100 PM | | |
| | | L se Heros | Hardinge Fowel Out 4 IG 34, 35 | aster a | 3 | |

The PDM32 has 32 power outputs: 28 are High Side, while 4 can be configured High Side, Low Side or possibly Half Bridge.

The max current that the PDM 32 may load is 120A: this value is related to High Side outputs use. When using bridge outs in Low Side mode, please calculate 17A for GND pin connected (4 GND pins available).

Please, note that high level of continuous current can overheat the PDM if not installed correctly.

The outputs are divided into the following groups:

• **H1-H4**: 4 High Power High Side outputs capable of delivering a maximum current of 20A continuous and up to 100A inrush current.

H1 has a diode series to prevent reverse current from load. This output could be used for example to directly drive a Starter.

All H type outs have an internal **freewheeling diode** that allow to connect high inductive loads, i.e. Solenoids

- **M1-M12**: 12 Middle Power High Side outputs with a maximum output current of 15 A, and a maximum inrush peak current of 80A.
- **L1-L12**: 12 Low Power High Side outputs with a maximum of 10 A supplied current, and a maximum inrush peak of 35A.
- **HB1-HB4**: 4 Half Bridge/High Power outputs with a maximum of direct current supplied of 35 A, with a maximum inrush peak current of 100 A.

The HB1-HB4 outputs can be used in two different ways: High Side or Low Side.

In High Side Mode they supply current, while in Low Side Mode the external device is powered by the battery, and the output closes the circuit to ground. These 4 outputs can also be used as Half Bridge: in this case, when an output works in High Side Mode, the complement is in Low Side Mode. By alternating the two operating modes, the current reverses the direction: a typical application of the use of Half bridges is the management of the wiper.





FULL BRIDGE CONFIGURATION This configuration requires 2 half bridges to work. FULL BRIDGE Load is connected between the outputs. Selecting BATT BATT which out is active high or low, we can reverse voltage across load. Due to this functionality, if we connect a motor between the outs, we can manage the rotation M in both directions. Another useful condition in this configuration is the brake. Pulling LOW both output pdm could brake motor in specific position. Naturally, L using PWM we can also manage the speed of the motor. ٦.

All the outputs can be activated as **PWM**, with variable duty cycle and with some differences based on the outputs:

- the L M H outputs have a fixed frequency of 100 Hz



- the HB outputs have a configurable frequency from 1 Hz to 10 KHz

- All outputs can then be managed as a square wave, with configurable Time ON and Time OFF, from 0.1 to 10 sec

The management parameters of each single output are:

| Soft Stort in a time of 1 sec | Maximum Value of Requested Load (up to 15.0 A) | 15 | Α |
|---------------------------------|--|-----|-----|
| Soft Stop in a time of 1 sec | Over Current Latch-Off Time | 0.5 | sec |
| | Number of Retries | 1 | |
| /M based on frequency of 100 Hz | Retry Delay | 0.5 | sec |
| | Minimum Current | 0 | A |
| | Check Open Load in Off State | | |

For every output user can set:

- **MAX continuous current**: this is the trip level of cut off current. After Over Current Latch-off Time the output will be disabled
- Over Current Latch-off Time: during this period, we allow current over MAX selected by user
- Number of Retries: after latch-off occurred, pdm retries to activate out up to this setting value
- **Retry Delay**: time between retries
- **Minimum current**: this is the low level of current allowed. Lower value activates the alarms for Open load
- Check Open Load in Off State: available for L and M output types. Check load presence also in OFF state. If you enable this check, a very low current constantly flows through the output, and, sometimes, it is enough for activating the connected device
- Soft Start and Soft Stop are useful to reduce high inrush current. These settings perform a first stage activation with PWM going from 0 to 100% and viceversa in deactivation. User could also set a duration time for this mode. In case of PWM mode selected on this out, soft start reaches user PWM value.
- In B type outputs, there is also the possibility to set PWM frequency



7.1 Power Outputs protections

Every output is protected against:

- over voltage
- under voltage
- short circuit
- over current
- over temperature

Please, refer to the paragraph "Power Output related channels" for further information

Every output channel has two related channels showing Status and Current.

The High-Power Output 1 has an internal diode in series

The High-Power Outputs (1,2,3,4) have an internal freewheeling diode protection

7.2 High Power Output 1 Protection diode

H1 output of PDM is a dedicated output protected by a series diode. This diode could be very useful to power devices that, when activated, can generate a current toward the PDM. Of course, H1 output could anyway be used as a standard High Side output.



A typical example of a device that needs such a protection is the starter motor. During the starter activation, a current flow from the PDM output to P1 of Starter. From P1 current goes to GND through the internal aux solenoid to P4 and then through the main solenoid to P3. During this phase, the internal aux solenoid closes the main switch of starter, connecting P2 to P4.

The starter motor now is activated and its rotation switches ON the vehicle Engine.

When the engine is ON, PDM out must be disabled. Internal diode block reverse current that would flow from P4 (shorted to P2) to P1 and finally to PDM out.



Without internal series diode, this reverse current flows into PDM out and keeps the starter motor engaged.

7.3 High Power Output 1,2,3,4 Freewheeling protection diode

The High-Power Outputs 1,2,3,4 have an internal freewheeling protection diode. The picture here down shows what happens when a power output turns off a high inductive load:



The red line is the negative voltage spike without diode. Blue one is the clamped voltage with diode. -VF could reach very high value: -350V, -400V are typical of solenoid loads. -VD is limited to -1V by internal freewheeling diode.

As indicated in picture, voltage level is clamped to very low value. This action protect Power Mosfet inside PDM avoiding complete output destruction.

Typical inductive loads are: big relè, solenoid valves, starter solenoid, big fans, etc...



8. Powering



The Surlok connector (+V BATT) is dedicated to the connection to the PLUS connector of the battery. It is rated up to 120A continuous current. All current sourced from PDM to the loads flow here.

GND connections in this example are divided in GND for PDM logic and Low side function up to 34A, GND for external sensors reference and GND for AiM CAN BUS.

Internally all GND pins are tied together but they are split in different pins, to eventually simplify the loom connection.



The PDM32 may be turned ON in two distinct ways:

- Connect the IGN input to a switch: in this case the system, and all the devices, are powered
- Connect one of the two input channels CH_IN11 and CH_IN12 to VBatt, leaving the IGN input OFF. In this case, the display is not turned ON, and you may choose which devices you wish to activate. This may be useful for activating the Hazard or keeping a fan ON even with the engine OFF until the temperature decreases till a defined value.



9. Other devices

The PDM 32 may manage some external devices:

- Display
- Mirror camera
- GPS

9.1 Display

The PDM32 supports one display. It may be 10" or 6"



The connection is through a dedicated high frequency LVDS cable to connect to the Rosenberger connector at the side of the PDM:



Please, refer to the section "Display Configuration" for configuring it





9.2 GPS



Gps 08 module is supplied with a standard male 712 Binder 5 pin plug, that needs to connect to CanOH (Aim Expansion Can) (22) and CanO L (11) with ground (10) , +VBext(32) and +Vbout (33)

A 1 mt patch cable with a female 712 Binder inline socket is in the kit and should be wired as shown here.





Please, refer to the dedicated chapter that explains how to use the GPS 08 module.



9.3 Mirror camera

The mirror camera is a small add-on that can be useful in some situations. You may connect it to the PDM through the 5 pin Binder connector



To activate the mirror camera, please, refer to the "Trigger Command" section in this manual





10. Software Race Studio 3



Aim Software Race Studio 3 lets you execute the following activities:

- Configure your PDM 32
- Transmit a new version of the firmware to your PDM 32
- Look ONLINE at all the data, power consumption, temperatures, Output status while your PDM 32 is installed on your vehicle
- Manage the tracks database, to automatically calculate the Lap Time and other correlated features.
- Download all the data and look at them in data Analysis

Please, download our RaceStudio3 software here:

https://www.aim-sportline.com/en/sw-fw-download.htm After the installation, you will see The RaceStudio3 icon on your PC:



Please run the software for stating the configuration of your PDM32.

The top line of the PC shows some icons

| | 2 01 × | 17 E | € ± | 10 | | | | | | | | | |
|----------|------------|-------------|----------------|---------------|------------------|------------|-------------------------|------------------|---------------|---------------|---------|------------------|------------|
| Save | Save As | Close | Transmit | | | | | | | | | | |
| Channels | ECU Stream | CAN2 Stream | CAN Expansions | Math Channels | Status Variables | Parameters | Shift Lights and Alarms | Trigger Commands | Power Outputs | Icons Manager | Display | SmartyCam Stream | CAN Output |

11. PDM32 Configuration



click



"Configurations" icon and the configurations page appears





• click "New" and a new configuration panel appears: please, select "PDM32".

Now you must follow the TABS to configure all the aspects of the PDM32:

Channels: to configure all the digital, analog and internal inputs

| Channels | to configure all the digital, analog and internal inputs |
|------------------|--|
| ECU Stream | To select the protocol for connecting your PDM32 to the ECU of the vehicle |
| CAN2 Stream | To select the protocol for communicating with other devices through the CAN 2 |
| CAN Expansion | To manage other AIM devices, such as: |
| | RIO 02 https://www.aim-sportline.com/download/technical-sheets/aim_rio02_102.pdf |
| | GPS08 https://www.aim-sportline.com/en/products/gps08-module/index.htm |
| | SmartyCam https://www.aim-sportline.com/en/products/smartycam-hd-rev2.1/index.htm |
| Math Channels | In case you need to produce a channel that is a mathematical computation of other channels |
| Status Variables | In case you need to manage a Boolean channel depending upon other channels and inputs |
| Parameters | General purpose parameters |
| Shift Lights and | Only if a display is connected |
| alarms | |
| Trigger commands | A way for activating some special functionalities, such as page change, alarm shut etc. |
| Power Outputs | Power outputs configuration |
| Display | Display configuration |
| Icon Manager | Icon configuration |
| CAN Output | Configuration of the CAN out messages |
| SmartyCam Stream | Configuration of the data to be transmitted to the SmartyCam |
| | https://www.aim-sportline.com/en/products/smartycam-hd-rev2.1/index.htm |

11.1 Channels and Variables

The activity of the PDM is based on the value of a whole series of variables, which can be divided in:

- Input channels: i.e. both analog and digital values, dependent on sensors or buttons, which can be directly connected to the inputs or via CAN connections

- Status variables, i.e. variables, defined by the user, which assume different status based on configurable formulas

- Power Outputs. Activations towards the outputs, based on the defined conditions, the value of the status variables and the input channels.



12.2 Input Channels Configuration

| * | 10 | 12 | 13 | 13 | - | + | 40 | 13 | |
|--------|---------|-------|----------|-------|-----|----------------|-------|------------|------|
| 78 HD | 1022 10 | POM | 22 11 11 | | | | | | |
| | | Ine | | (1) | - | Treme | | | |
| Channe | ofs too | Sheer | CAR | Sheet | CAN | 1. sportsector | . 184 | 5 Chierren | 51.0 |

| | 12 | | | | | | |
|------|----|-------------------|-------------------|----------------------------|-----------|----------|------------------------|
| | | Special | version fight. | figred Brings | anvola I. | 2011 | schen 1932 publics 1 |
| | | Speed . | Vehicle Red | Retod Rotoor | imiti81 | 20 Hz | sites: \$530; pates 1; |
| | | Channellit | votaje | Galleric # 5 V | 110 | 201-2 | |
| | 1 | Channel02 | voluge | Garrier L. Bolk V | 100 | phone | |
| | 2 | Channel®3 | Waterson | Convertor Brill N | .mix | 28417 | |
| | 2 | Channellill | Votope | Conerc & S v | -991/ | 20 102 | |
| | 12 | Channellin | Volupe | Gamera 816 V | 18M | 2010 | |
| | 1 | Channellili | Voltage | General Bitt V | inti | 3812 | |
| | 1 | Channellif | Voltage | Generic 8-8 V | - 1997 | 20+ir | |
| | 1 | Channeilli | Vetage | Conets #/5 V | - #11/ | 10 148 | |
| | 1 | ChainielStatutti | Digitar Status | UNAL | | 2012 | |
| | 2 | Channel Statue 10 | (Saphi States | Ubilian | | 19911 | |
| | | Channel Statest1 | Ciple Soler | Status | | 28.Hz | |
| | 1 | OwnedStates12 | Digital Bitzlus | BRMI | | 2H 00 | |
| | 12 | Indiversities: | removeral | Internet Assales provider | \$9.25 | 10112 | |
| | | Laterslikes | (administration) | Internal Acculer provider | 40.55 | 36114 | |
| | 2 | Versicalities | whether Accest | Tritornal Accuse tomater | 40.01 | 1012 | |
| | 1 | Sollfiste. | Rul Role | Hereal Cyra | mpsét | 50 Hz | |
| | | Plachilate | Predictions | Harra Grs | aspoint. | 5012 | |
| | 9 | Yawkiese | Taxilla | Indeen of Name | depie 0.1 | - 9491/v | |
| 1.60 | 1 | Magnatit. | Vagodit materix | Infinite of Macanamoranian | | 10111 | |
| - | 1 | MagradY | Vagnotomatory. | Internal Regionanter | 10.01 | . 50 Hz | |
| 2 | 2 | Magnet/ | Vegralsmeter 2 | Internal Magnotomater | 10221 | 10112 | |
| | 2 | GPS Accuracy | GPSAcarecy | 975. | im 0.08 | mitz | |
| | 9 | GPS Saved | Versite Spit | 695 | 1810181 | 101-1 | |
| | | Althube | Alture | 018 | | 10 112 | |
| | | Odometer | University falls | Utionski | No. 2.7 | 114 | |
| | 2 | Laninosty | This beaution | Exercitivation | - | 814 | |
| | | Safelgrition | Number | (politice | | 10.62 | |
| | - | LooperSena | Torgerative | Logger Temperature | c | 144 | |

The PDM32 has the following input channels:

- 8 channels (CH_IN1 - CH_IN8) can be both analog and digital. If they are configured as analog, a 2KOhm pull-up can be activated. If they are configured as digital, it is possible to activate an internal pull-up or pull-down depending on whether they are closed on the ground or closed at VBatt.

- 4 channels (CH_IN9 - CH_IN12) are only digital and can have a pull-up or a pull-down depending on whether they are connected to ground or to VBatt.

The input channels CH_IN11 and CH_IN12, when connected to VBatt, can activate the PDM without turning on the display. This can be useful for activating the Hazard, or keeping a fan on even with the engine off until the temperature reaches a correct value etc.

- 2 speed inputs



- 1 Ignition input:

IGNITION INPUT: this is a special input, only digital and not programmable by user. It is active HIGH (internal pulldown hardwired) and when activated by external voltage, switch ON the PDM. Some functionality, for example display, are IGN dependent. This means that when IGN is active, also display is switched ON. Ignition could be used in user configuration as condition for other

Ignition Input Example application:

 IGN connected to Main switch and CH_IN12 connected to Hazard switch. With IGN active (+12V) all functions on PDM are enabled. With IGN off (disconnected or tied to GND) and Hazard switch active (+12V) PDM enables only outs related to HAZARD function (typically front and rear directions lamps in hazard blinking mode).

Typically, analog sensors are pressure sensors, potentiometers, etc... while digital inputs are used for managing pushbuttons, that may eventually be used for activating the power ouputs.

11.3 Analog inputs configuration

In the following image you see two different channels configuration windows, for analog or digital input.

| . | Channel Settings | × | 2 | Channel Settings | |
|----------------------|------------------|-------------|------------------------|----------------------------------|--|
| Name | Channel04 | | Name | Channel01 | |
| 8 | Analog | O Digital | | O Analog | Digital |
| Function | Voltage | \$ | Function | Digital Status | \$ |
| 4 | | | Sensor | Status | |
| Sensor | Generic 0-5 V | \$ | Sampling Frequency | 20 Hz | |
| Sampling Frequency | 20 Hz | \$ | | Logged | |
| Unit of Measure | mV | \$ | | | |
| | | | Active when signal is: | O close to ground | close to VBatt use internal pull down 10kΩ |
| Rulli in registance: | use internal | | | Momentary O Toggle | O Multiposition |
| Pullop resistance. | | | | use as button with pressure time | e dependent status |
| | | | | Not active OFF [0] label | Active ON [1] |
| | | | | | |
| | | | | | |
| | | Save Cancel | | | Save Cancel |

Selecting "Analog" options to be set are:

- Channel name
- Function: this parameter is useful in the data analysis process
- Sensor type
- Measure unit
- Sampling frequency
- Display precision: it configures how many decimal digits will be shown on the display

It is possible to enable an internal 2kohm pull-up, as shown in the following picture:









11.4 Digital inputs configuration

To use an input as "Digital Input" its parameters must be configured as follows:

- Working mode: a digital input can work in two different ways: The pushbutton closes to ground (with or without pull up resistor – left image below) ○ The pushbutton closes to VBattery (with or without pull down resistor – right image below)
- Active/Not Active labels: according to the status a Digital channel may assume the values 0/1, High/Low, ON/OFF, Closed/Open, True/False etc...

The two different labels can be defined and eventually shown on the display, used by Math channels, Icons Management, alarm managements and in general, any time a digital channel is required; the labels appear in Device page too.

Signal Type: can be momentary, toggle or multistable

- momentary: the channel is active when the pushbutton is closed
- toggle: the channel is activated the first time you close the circuit and deactivated the second time the circuit is closed as shown here below
- Multistable: Each time the connected button is pressed, the channel value changes from 0 to N (this value depends on the configuration), then returns to 0.

| input | | | | |
|---------------|---|---|---|--|
| Channel Value | | | | |
| Toggle | 1 | | | |
| Input | | | | |
| Channel Value | | | | |
| Multiposition | _ | _ | - | |
| Input | | | | |

Logged: if active, the system records the digital values, else they can be used and shown but they are not recorded.

The status and labels associated to a every single digital input may be dependent upon the time of activation (Time Dependent).

It is possible to enable an internal pull-up resistor, in case the digital input is closed to ground, or an internal pull-down resistor, in case the input is closed to battery, as shown in the here down image.





11.5 Other internal sensors and channels

The PDM offers other internal sensors, that may be used for activating some features or simply for better understanding the vehicle behavior in data analysis:

- IMU 9 Axis: it features 3 axis accelerometer, 3 axis magnetometer, 3 axis gyros.
- Internal temperature sensor
- Brightness sensor (only with a display connected)
- **Safelgnition**: it is ON when the PDM is activated by the IGN input. It is OFF when the PDM is activated by CH_IN11 or CH_IN12
- **POTotCurrent**: it indicates the sum of all the currents drawn by the Power Outputs
- GPS information (only when the GPS module is connected)

11.6 Math channels configuration

The math channels are useful to create some channels depending upon the input data:

| BIAS | CH1/(CH1 + CH2) | The BIAS computes which channel between two is prevailing (typically used for suspensions or brakes) |
|----------------------|--------------------|--|
| Bias with threshold | CH1 / (CH1 + CH2) | As above, but computed only when the two channels exceed a user configurable threshold |
| Calc gear | | it calculates the gear position using engine RPM and vehicle speed |
| Precalculated gear | | To be used when the Load/Shaft ratio is already known |
| Linear correction | VALUE = a * CH + b | |
| SUM | Value = CH1 + CH2 | |
| Division per integer | Value = CH1 / a | |



11.7 Status variables configuration

Status Variables are internal math channels that "generally" have only two different values: 1 (TRUE) or 0 (FALSE). They may be useful for simplifying complex configurations, where it is required to evaluate if to activate alarms, LEDs, Icons etc.

The Status variables have different working modes, to be selected by the user:

| 2 | M | ultiple output values each with its own condition 💲 |
|---|---|---|
| | | Same condition for activation and deactivation |
| : | = | Distinct conditions for activation and deactivation |
| | Ξ | Multiple output values each with its own condition |

Same Condition for activation and deactivation

This is the simplest way for managing a Status variable: it becomes ON when a condition is verified, else it becomes OFF. In the following example, the Status variable AlarmWatertemp is TRUE when the water temperature increases above 100°C, and is reset to FALSE when the temperatures goes down 100°C.

| | (| Condition | | | | × |
|------------------------|---|---|--|--|---|---|
| Always TRUE | | | | | | |
| Water temp | 🗘 🦵 greater than | \$ | constant 🖌 | С | 100 | |
| TRUE after a time of 0 | sec in which it is verified | FALSE after a time | of 0 sec | in wh | ich it is no longer v | erified |
| | | | | | ОК | Cancel |
| | Always TRUE Water temp TRUE after a time of 0 | Always TRUE Always FALSE Water temp TRUE after a time of 0 sec in which it is verified | Condition Always TRUE Always FALSE Water temp Image: greater than TRUE after a time of 0 sec in which it is verified FALSE after a time of 0 sec in which it is verified | Condition Always TRUE Always FALSE Water temp Image: greater than constant Image: greater than TRUE after a time of Image: greater than Image: greater than TRUE after a time of Image: greater than Image: greater than | Condition Always TRUE Always FALSE Water temp Image: greater than constant C TRUE after a time of 0 sec in which it is verified FALSE after a time of 0 sec in which it is verified | Condition Always TRUE Always FALSE Water temp Image: greater than Image: constant C 100 TRUE after a time of 0 sec in which it is verified FALSE after a time of 0 sec in which it is no longer verified OK 0 0 sec in which it is no longer verified 0 sec in which it is no longer verified |

Different conditions for activation and deactivation

It may be useful to have two different conditions for activating and deactivating a Status variable. For example, we need to turn ON a Status variable ON when Water Temperature reaches 100°C and the RPM are higher than 2000, and we must turn it OFF when the Water Temperature goes below 80°C.



| 8 | Status Variable Settings | |
|--|--|--|
| | Name Alarm WaterTemp Store values at Frequency 10 Hz \$ | |
| E Distinct conditions for activation and deactivation | n 🗧 Work as Toggle 🗌 Generate Square Wave | Duration of statu Duration of statu |
| Adivation : set status to ON when follow Water Temp: greater than 100 [AND e] ECU.RPM greater than 20001 [Add] | king condition is verified for at least 0 sec C immediately pm immediately | Add Add |
| Add Deactivation: set status to OFF when follow Water Temp: less than .80 C immediat | wing condition is verified for at least 0 sec | Add |

It is possible to associate a LABEL to Status Variable value:

| Bet status to | ON | when following condition is | verified | for at least | 0 | sec |
|---------------|-----|-----------------------------|--------------|----------------|---|-----|
| Set status to | OFF | when following condition is | not verified | d for at least | 0 | sec |

And use this label per every further control or indication in the display.

A Status variable may also be activated in two different special ways:

As Toggle: the Status variable is set to TRUE (1) the first time the condition swaps from FALSE to TRUE and remains TRUE till when the same condition swaps again from FALSE to TRUE.

| Toggle | |
|--------------------|--|
| condition | |
| Status variable | |

As Square Wave: The Status variable may generate a Square wave,

for which it is possible to set both ON time and OFF time, whenever the activation condition is valid.

Multiple output values each with its own condition

This is the only case in which the Status variable assumes more than 2 values. An example may be the management of a rotary switch, connected to an analog input, as shown in the following picture:



| 🔄 Status Varial | ble Settings | _ 🗆 🗙 |
|---|--------------|-------------|
| Name RotarySwitch | | |
| Store values 🔲 at Frequ | Jency 10 Hz | |
| Multiple output values each with its own condition | | |
| Set output value to 1 when following condition is verified for at least |) sec | Øn ↑ |
| AnalogRotary between values (0; 1000) mV immediately | Add | |
| Set output value to 2 when following condition is verified for at least (AnalogRotary between values (1001:2000) mV immediately | 0 sec | \$ |
| Set output value to 3 when following condition is verified for at least (7 AnalogRotary between values (2001; 3000) mV immediately | D sec Add | ©۲ |
| Set output value to 4 when following condition is verified for at least [7] |) sec | ¢ |
| AnalogRotary between values (3001 ; 4000) mV immediately | Add | |
| | | Save Cancel |

The Status Variable assumes, in this example, the values 1,2,3, 4.. in dependence upon a defined condition.

11.8 Trigger commands

The "Trigger Commands" execute some specific actions on your PDM32. The commands available up to now are:

- set next/previous page
- show Camera Input page
- reset alarms
- activate pushbutton 1-4

You may define the condition that activates a Trigger Command.

To add a new command:

- Press "+Add New Command" (1)
- The "Create new Output Command" panel appears
- Set the condition for activating the trigger command.

As an example, let us activate the mirror camera when the gear is in reverse. As you see, it is very simple:



| | | Trigger Command Settings |
|---------------|---------------|---|
| | | Name |
| | | Store values at Frequency 10 Hz 💠 |
| – Same co | ndition for a | ctivation and deactivation |
| et status to | ON | when following condition is verified for at least 0 sec |
| et status to | OFF | when following condition is not verified for at least 0 sec |
| | | |
| | ecute the fol | llowing command(s) |
| ien active ex | econe une ion | Alarmastiana in DDM22 |
| ien active ex | | Alarm actions in PDM32 |

11.9 Power Outputs configuration

Every Power Output may be configured in order to generate an output of three different shapes:

- Continuous
- PWM
- Square Wave



- A **Continuous Output** is a constant current generation, whose value depends upon the device connected and the limit set by the user, as indicated in the Power Output Chapter.
- A PWM output is an output in frequency (100 Hz for all but the HalfBridge outputs).where the duty cycle is depending upon some conditions.
 In this case too, the soft start and soft stop are available.
- The **square wave mode** offers the possibility to define the frequency and duty cycle of the output, and is used when the wave frequency is very low.



Soft Start and Soft Stop activation modes are available

A **Soft Start** prevents the sudden current flow in the circuit during the start. It is useful to protect the devices or electronic components from the damage caused by instantaneous high input current.

It is possible to define both the timings in which the current arises (or decreases) from 0 to 100% (and vice versa)

Power Output Activation and Deactivation

The conditions for activating and deactivating every output of the PDM 32 are completely configurable. First of all, it is possible to select one of the two modes:

Same condition for both activating and deactivating.

Different conditions for activating and for deactivating



- Same Condition. It means that the Output is turned OFF when the defined condition is not valid anymore. Example: Turn the fan ON when the water temperature reaches 100°C. In this case, the fan is turned OFF when the water temperature decreases and reaches 99.9°C
- **Distinct Conditions**. It means that the condition that turns the output OFF is to be specified. Example: Turn the fan ON when the water temperature reaches 100°C and turn it OFF when the water temperature reaches 80°C. In this case, the fan is turned OFF only when, after having reached 100°C, the water temperature decreases and reaches 80°C

Activation and deactivation conditions must be verified for a period set by the user:

| Set status to | ON | when following condition is | verified | for at least | 0 | sec |
|---------------|-----|-----------------------------|--------------|----------------|---|-----|
| Set status to | OFF | when following condition is | not verified | d for at least | 0 | sec |



| Example: Turn the fan ON when the water temperature reaches 100°C and turn | n the fan OFF |
|--|---------------|
| when the condition is not verified anymore | |
| - Same condition for activation and deactivation | |
| | |
| Set status to ON when following condition is verified for at least 0 sec | |
| Set status to OFF when following condition is not verified for at least 0 sec | |
| Condition | |
| Always TRUE Always FALSE | |
| WaterTemp | |
| TRUE after a time of 0 sec in which it is verified FALSE after a time of 0 sec in which it is no longer verified | |
| OK Cancel | |
| | |
| | |
| | |
| | |



11.10 Power Output related channels

Every Power Output has two associated channels:

The Status

The Instant Current drawing in it.



| 2 | | | Modify Ou | tput Signal | | | - 0 × |
|---|----------------------------------|-------------------|--------------|------------------|--------------|---------------|--------------|
| Mid PowerOut1 on Bi Name: MidPO1 Settings Related Chann | ack Connector (35 F | 'in Male) Pin: 2; | | | | | |
| Current of Power Output Unit: A | Name: Mi Display Preci | dPO1Current | Store Values | Frequency 10 Hz | 2 | | |
| Status of Power Output | Name: Mi | dPO1Status | Store Values | Frequency 10 Hz | 2 | | |
| Value | 0 | 1 | 2 | 4 | 8 | 16 | 32 |
| Label | ok | SC | open | htemp | ovcur | unvol | ovvol |
| Description | ok | short circuit | open circuit | high temperature | over current | under voltage | over voltage |

The Status of a Power Output may assume different values:

| ОК | |
|----------|------------------|
| SC | Short cut |
| OPEN | Open circuit |
| HTEMP | High temperature |
| OVERCUR | Over current |
| UNVOLT | Under voltage |
| OVERVOLT | Over voltage |

You may use the two associated channels as any other channel. For example, if you wish to turn an Icon ON on the display in case of a shortcut:

| Vame | LowbeanAlarm | | |
|--------------------|-----------------|---------------------|----------------|
| Show Ic when | | | |
| LowBeanStatus | 🜲 👓 == equal to | ¢ ok | ‡ [+ per |
| se show: select | | htemp ok open | select a value |
| | | ovcur | |

Here down an example shows how power out supervisor works.

At ON instant the output is activated. During the time T1, the output can source an inrush current higher than user set value: the PDM does not check the overcurrent but only the Short circuit.



The supervisor continuously checks the current value after T1. In case the current value is higher than user MAX Value selected, timer starts count. If timer value reaches the overcurrent Latch-off time selected (T2), the output is disabled.

After Retry Delay, if Number of retries is different from zero, the output will be enabled again, and supervisor starts current check again. This will be repeated in case of overcurrent until the Number of retries set by the user is reached. After that out will be disabled.

In case the output is disabled, PDM led indicator becomes red. The Output is re-enabled when the activating condition switches from ON to OFF and ON again.



As already stated, in order to check the Open Load Status, you have to:

- Define the minimum current, under which the Open Load Status is detected

- In case of L(ow) and M(medium) outputs, you may also set a flag for enabling the Check Open Load also in OFF state. If you enable this check, a very low current constantly flows through the output. Please note that, sometimes (LED lamps, for example), is enough for activating the connected device

11.11 PWM

Typical uses of PWM are:

- Fan speed control
- Water pump speed control (useful to maintain water temp close to ideal value)
- Led and Bulb Lamp dimming (i.e. DRL dimming related to low beam status)



The PWM functionality is managed in two different ways:

The Outputs LMH may manage a 100 HZ PWM

The Half Bridge High Power Outputs may manage configurable frequency PWM from 1 Hz to 10 KHz.

To configure a PWM output, with the duty cycle depending upon some conditions, please:

• Set the Power Output as PWM





between ON and OFF status of the output. The higher is the ratio, the higher is the energy that the output gives. If you connect a lamp or a fan to a PWM output, you may, changing the duty cycle, change the brightness (of the lamp) or the speed (of the fan).

• Define the logics that manage the different duty cycles

| U | Modify Output Signal | - 0 × |
|---|---|-------|
| High Power Out 2 on Black Connector (35 Pin Male) Pin: 12; 23; | | |
| Name: FAN | | |
| Settings Related Channels | | |
| Continuous PWM Square Wave | Maximum Value of Requested Load (up to 20,0 A) 20 A | |
| Soft Start in a time of 5 sec | Number of Retries | |
| Soft Stop in a time of 1 sec | Retry Detay 0.5 sec | |
| PWM based on frequency of 100 Hz | Minimum Current 0 A | |
| Set PM4 Duty Cycle to 10 % when following condition is verified for alles water temp: between values (70: 60) C immediately | ast 0 sec Add | © ,,, |
| Set PVM Duty Cycle to 50 % when following condition is verified for all los water temp. between values (80; 90) C. immediately | ast 0 sec | 0 |
| Set PVM Duty Cycle to 100 % when following condition is virified for alles | aat 0 sec | 0 |
| watertemp greater than 90 C immediately | Add | |
| | | 101 |

In this example, we correlate the duty cycle of the Power Output FAN to the Water temperature: In the range $70^{\circ}C - 80^{\circ}C$ the duty cycle is 10% In the range $80^{\circ}C - 90^{\circ}C$ the duty cycle is 50%

If the water temperature is higher than 90°C, the duty cycle is 100%.

The time for passing from one level to the next one is set at 5 seconds.





In case you use the Half Bridge / High Power outputs, you may also change the frequency, from 1 Hz to 10 KHz:



This possibility may be useful when a device absolutely requires a PWM output at a specific frequency for working properly.

11.12 Square Wave

The last way for managing the Power Output is the Square Wave, that may be useful for managing slow blinkings

| ettings F | elated Channel | Is | | |
|----------------|---------------------|----------|---------|--|
| Continu | ous O PWM | Squa | re Wave | |
| Duration of st | atus On (1) of the | wave 0.5 | sec | |
| Duration of st | atus Off (0) of the | wave 5 | sec | |





As shown in the above image, you may define the form of the wave, specifying how long the signal remains ON and how long it remains OFF.



12. ECU Connection and configuration

The PDM32 can be connected to your vehicle ECU, through CAN or RS232 connection. A wide database of more than 1500 protocols is available and documented in our web site:

https://www.aim-sportline.com/en/documentation-stock-ecu-connections.htm and https://www.aim-sportline.com/en/documentation-racing-ecu-connections.htm

for stock or racing ECUs.

In case you have a CAN based ECU, and its protocol is not in the database, you may anyway develop it, using the ECU Driver Builder function (see paragraph).

| | RaceStudio3 | 3 (64 bit) 3.50.11 - build 14 agosto 20. | 20 10:54 | |
|---|---|--|-------------------------------|---------|
| | | | | |
| All PDM32 01 % | | | | |
| Save Save As Close Transmit | | | | |
| Channels ECU Stream CAN2 Stream CAN Expansions Math Cha | annels Status Variables Parameters Shift Lights and A | Narms Trigger Commands Power | Outputs Icons Manager Display | SmartyC |
| | ECU: AUDI - R8_LMS (ver. 02.00.01) | | Change ECU 💲 🤇 | Ð |
| | | Enoble The | CAN Due 120 Ohm Desistor | |
| | Less C | | CAN BUS 120 ONIT RESISTOR | m |
| | 4 | Choose ECU Protocol | - | |
| | Manufacturer | Model | | |
| | None | CAN_PQ35_P5 | (v. 02.00.02) | (CAN) |
| | 2D | GROUP_2008 | (v. 02.00.01) | (CAN) |
| | A-RACER | R8_LMS | (v. 02.00.01) | (CAN) |
| | ABIT | R8_LMS_GT3_038 | (v. 00.01.02.) | (CAN) |
| | ADAPTRONIC | R8_LMS_GT3_SMC | (v. 02.00.01) | (CAN) |
| | AEM | TTCUP_CAN1_2016 | (v. 00.01.02.) | (CAN) |
| | AIM (CUSTOM CAN) | - | | |
| | ALFAROMEO | | | |
| | APRILIA | | | |
| | ARCTIC_CAT | | | |
| | ASTON_MARTIN | | | |
| | AUDI | | | |
| | AURION | | | |
| | AUTRONIC | | | |
| | BENTLEY | | | |
| | BLACK_BOX | | | |
| | BMW | | | |
| | | M | | |
| | | | | |
| | | | OK | Cancel |

There are two parameters that need to be set:

- **"Enable the CAN Bus 120 Ohm Resistor**": the CAN Bus needs two 120-ohm resistors at its two extremes. In case your PDM is the only device connected to the ECU, the 120 Ohm should be enabled, else, very easily, in the existing network it is already present, and should be disabled.
- "Silent on CAN Bus": Usually, the ECU expects an Acknowledge signal when transmits a message, and, as default, the PDM transmits this signal. Sometimes, and particularly when there are other devices in the network, the PDM should not transmit it: in this case, please, enable this flag, to make the PDM remain completely silent.



| Roces | tudio3 dev build lu | a 13 | | | | | | | | | | = 0 |
|-------|---------------------|---------------|----------------|-----------|-----------------------|-------------------|--------------------------|-----------------------|--------------------------|-------------|-------------------------------|-------|
| * | 20 FR | 3 6 | nta 46 | 会 | | | | | | | 4 | s 🥷 🧰 |
| AL M | (S 1.2 Strada > | | | ~ | | | | | | | | |
| Sa | re Save A | s Close | Transmit | | | | | | | | | |
| Chann | els ECU Strea | m CAN2 Stream | CAN Expansions | Math Chan | nels Statu ECU: FC | s Varia RD - N | bles Shift Lights and Al | arms Trigger Commands | Icons Mana Change ECU | ger Display | y SmartyCam Stream CAN Output | |
| | | | | | | | | Enable the CAN Bu | us 120 Ohm Re | sistor | | |
| | | | | | Enabled Cl | annels | (Max. 120) 35/35 | Silent on CAN Bus | | | | |
| | | | | | ID | • | Name | Function | Unit | Freq | | |
| | | | | | CC08 | • | RPM | Engine RPM | rpm | 10 Hz | * | |
| | | | | | CC09 | • | SpeedVeh | Vehicle Spd | km/h 0.1 | 10 Hz | | |
| | | | | | CC13 | • | SpeedFL | Wheel Spd | km/h 0.1 | 10 Hz | | |
| | | | | | CC14 | • | SpeedFR | Wheel Spd | km/h 0.1 | 10 Hz | | |
| | | | | | CC15 | • | SpeedRL | Wheel Spd | km/h 0.1 | 10 Hz 5 | = | |
| | | | | | CC16 | • | SpeedRR | Wheel Spd | km/h 0.1 | 10 Hz | | |
| | | | | | CC17 | • | Gear | Gear | gear | 10 Hz | | |
| | | | | | CC25 | • | WaterTemp | Water Temp | C 0.1 | 10 Hz | | |
| | | | | | CC04 | • | TurboBoost | Number | | 10 Hz | | |
| | | | | | CC21 | • | TCSBrakeEvent | Number | | 10 Hz | | |
| | | | | | CC22 | • | TCSEngEvent | Number | 2 | 10 Hz | | |
| | | | | | CC23 | • | StabCtrlTeltal | Number | | 10 Hz | | |
| | | | | | CC24 | ₽ | StabCtrIMTXT | Number | * | 10 Hz | | |
| | | | | | CC34 | • | TyreRvMile | Number | | 10 Hz | | |
| | | | | | CC31 | • | FuelLevelMean | Percent | % 0.01 | 10 Hz | | |
| | | | | | CC32 | • | FuelInst1 | Percent | % 0.01 | 10 Hz | | |
| | | | | | CC33 | ◄ | FuelInst2 | Percent | % 0.01 | 10 Hz | | |
| | | | | | CC35 | | AxleRatio | Number | | 10.67 | * | |

13. CAN2 Stream configuration

This page works exactly like ECU Stream one. Here you can find additional CAN modules. To load your additional module CAN protocol:

- enter "CAN2 Stream" tab
- press "Change protocol" button
- select "Manufacturer" and "Model" (in the example (MEGALINE/PADDLESHIFT)
- press OK

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|------------|------------------|-------------|----------------|--------------------------------|------------------------------------|--|----------------------------------|
| * | | S E | | 8 | | | ? |
| All MXS 1 | 2 Strada ≈ | | | | | | |
| Save | Save As | Close | Transmit | | | | |
| Channels | ECU Stream | CAN2 Stream | CAN Expansions | Math Channels Status Variables | Parameters Shift Lights and Alarms | Trigger Commands Icons Manager Dis | play SmartyCam Stream CAN Output |
| | | | | CAN2 Protocol: Click button | to select a CAN2 protocol | Change Protocol 🔹 | |
| | | | | | | | |
| | | | | Choose CAN2 Protocol | | | |
| | | | | Manufacturer | Model | | |
| | | | | None | PADDLESHIFT | | |
| | | | | BOSCH | | | |
| | | | | BRIGHTWATER | | | |
| | | | | HEWLAND | | | |
| | | | | KMP MECALINE | | | |
| | | | | NEMESIS | | | |
| | | | | SEAT Sport | | | |
| | | | | STACK | | | |
| | | | | TEVES | | | |
| | | | | TEXYS | | | |
| | | | | TIRE_WATCH | | | |
| | | | | WRELESS_MOTORSPORT | | | |
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14. CAN Expansions configuration

The PDM 32 can be connected to various AiM CAN expansions:

- LCU-One CAN
- Channel Expansions
- TC Hub
- Formula Steering wheel
- Expansion power Module

At the very first connection configuration this page shows up:

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|---|------------------|
| * * * * * * | ê 👙 🍿 |
| Ali MXS 1.2 Strada 20 | |
| Save Save As Close Transmit | |
| Channels ECU Stream CAN2 Stream CAN2 Stream CAN2 Stream CAN2 Stream Math Channels Status Variables Parameters Shift Lights and Alarms Trigger Commands kons Manager Display SmartyCam S | tream CAN Output |
| New Expansion | |
| | |
| | |
| Select an Expansion | |
| Expansion | |
| | |
| LCU-One CAN | |
| | |
| 10003 A | |
| Channel Expansion | |
| | |
| | |
| O Sime | |
| | |
| | |
| OK N Cancel | |
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Here you can select the CAN expansion you want to set. Select it and press OK. Each expansion needs to be set filling in the related panel.

Please note: for any further information about AiM Channel expansion refer to the related user manual you can download from AiM website www.aim-sportline.com documentation area, products section.



15. Icons manager configuration

The "Icon" is a set of images, each one of them to be shown on every page is desired, in dependence upon a certain condition that, when exists, triggers the proper image.



For example:

- the first image has to be shown when the signal TurnRight is TRUE
- the second when the signal Turnleft is TRUE
- the third when the signal Hazard is TRUE
- the fourth when no signal is TRUE

Not all the display pages offer the possibility to show Icons, but our technicians are working for offering more pages with this feature.

To configure an icon: press "Add New Icon" "Manage Icon" panel shows up press "Select" to see the panel showing all images select the image you want to set the software comes back to "Manage Icon" panel set the image conditions according to the channel they are related to

| ReceStudio] dev build yesterday 1826 |
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| II MXS 1.2 Strada ³² MXS 1.2 Strada 01 ³² |
| Save As Close Transmit |
| hannels ECU Stream CAN2 Stream CAN2 Stream CAN Expansions Math Channels Status Variables Shift Lights and Alarms Trigger Commands Icons Manager Display SmartyCam Stream CAN Output |
| Icons name Images |
| |
| Add New Kon still waikable kons: 37 Import Export Preview Area |
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| 🐿 Manage Kon 📃 💌 Select a licen to shoe |
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| show kon when · · · · · · · · · · · · · · · · · · · |
| select RPM ‡ / between values ¢ rpm 0 0 |
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| [★ ∧da new |
| |
| OK Cancel |
| 0.1 0000 |
| |

It is possible to use custom images pushing the "Add New" pushbutton. They must be 64x64 pixels png format.

Once all Icons set "Icons page" shows the icons summary and mousing over an Icon the related panel shows up on the right of the page as shown here below.

Here you can also edit and delete an icon using the related icons $\overset{\textcircled{}}{\sim}$







16. Display configuration

The PDM 32 may manage two different displays: The $6^{\prime\prime}$ and the 10".



You have to select which display you wish to connect through the proper software page:



Then you may proceed with the display configuration, in order to have a maximum of 8 pages available.





When the page has been selected two setting panels appears bottom of the page:

- on the left a panel that shows as many rows as the fields to be set
- on the right a panel shows the channels group you can set in that field and all the channels in it included; you can drag and drop the channel you want to set in the desired field or double click on it





17. Shift Lights and Alarms configuration

In this page you can set shift lights and set the alarm LEDs of your PDM dash, both 6" and 10".

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|---|
| |
| All MXS 1.2 Strada 🕅 |
| Save Save As Close Transmit |
| Channels ECU Stream CAN2 Stream CAN2 Stream CAN Expansions Math Channels Status Variables Parameters Shift Lights and Alarms Trigger Commands I kons Manager Display SmartyCam Stream CAN Output |
| Use for predictive time 💿 Use as gear shift lights |
| Gear Shift Light 1 2 3 4 5 6 7 8 9 10 All 8200 💽 8400 🚰 8600 🚰 8000 🚰 8000 🚰 9000 🥌 9000 💽 9000 💽 8000 🔂 |
| LED 1 LED 2 LED 2 LED 3 LED 3 LED 3 LED 3 LED 3 LED 3 LED 3 LED 4 LED 5 LED 5 LED 6 LED 6 LED 7 LED 7 |
| Add teen Alarm still available alarms: 37 Import Alarm Export Alarm |
| |
| |
| |
| |

17.1 Shift Lights

On top you can set your dash, both 6" and 10" shift lights working mode. Available options are:

- Shift Lights, for helping in changing gear
- and
- Predictive Time, for easily understanding if the actual lap is faster or slower than the reference lap.

Use as gear Shift Lights Click the icon (^(C)) for setting the parameters:

You may configure:

- At which RPM the single LED turns ON
- The sequence mode of the LEDs enabling the desired option:
 - a LED stays ON if its threshold is exceeded
 - o a LED stays ON until another LED with higher threshold turns on or
- Link the shift lights to the engaged gear enabling the related checkbox.

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|----------------------------|-----------------------------------|---|--|
| MXS 1.2 Strada H | e Transmi | | |
| inels ECU Stream CAN2 Stre | am CAN Expansions Math Channels S | atus Variables Parameters Shift Lights and Alarms Tri | gger Commands I Icons Manager Display SmartyCam Stream CAN Output |
| 0 | Use for predictive time | se as gear shilt lights | 🖝 Sont Lights Options |
| er Shift Light 1 2 | 3 4 8 6 | 7 5 5 10 | Choose a sequence mode of shift lights Export Shiftights Export Shiftights |
| 1 5200 🚺 5400 🚺 54 | 600 💽 8800 🏹 9000 🧑 9200 | 9400 🌄 9600 💽 960 💽 1000 🔽 🗘 – | # A LED stays on if it's threshold is exceeded |
| | | | C A LED stays on until another LED with higher threshold is turned on |
| | | | Choose the engine rpm channel |
| LHD | 1 2 2 4 | | |
| LED | | LED 5 | 🧭 Gear dependent shift lights Max gear number 6 |
| LED | 195 | 19.7 | Choose the gear channel. |
| | | 120 | Gear ShiftLight 1 2 3 4 5 6 7 8 9 10 |
| | an | | 6 8200 💽 8400 💽 8600 💽 8800 🦳 9000 💽 8200 🯹 9400 💽 9600 🜉 9600 🜉 10000 🜉 🛔 |
| | | | 5 8200 🔽 8400 🔽 8600 🔽 8000 🔽 8000 🔽 8200 🔽 9400 🔽 9600 🗾 9600 🗾 10000 🜉 🛔 |
| Francisco III | | | 4 8200 💽 8400 💽 8600 💽 8800 💽 9000 💽 9200 💽 9400 💽 9600 💽 9800 💽 10000 💽 🏨 |
| Le Add New Alarm | siti available alarms: 37 | mpon warm Export warm | 3 8200 🔽 8400 🖸 8600 🔽 8800 🔽 9600 🔽 9200 🔽 9400 🔽 9600 🜉 9600 🜉 10000 🜉 🛔 |
| | | | 2 8200 🔽 5400 🔽 8600 🔽 8600 🔽 800 🔽 8200 🖉 9400 🔽 9600 🗾 9600 🗾 10000 🜉 🎄 |
| | | | 1 8200 🔽 8400 🔽 8600 🔽 8800 🔽 9000 🔽 8200 🔽 9400 🔽 9600 🔤 9800 🜉 10000 🜉 🛔 |
| | | | |
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| | | | and and |



Use for predictive time. Click the icon (^(C)) for setting the parameters:

In this case the LEDs colours are fixed in:

Green, if the lap time is improving

RED, if the lap time is worse than in the reference lap.

You can define the threshold at which one LED is turned ON.

Assuming you fill in "0.10 sec" and your lap time is improving of 0.30 sec toward the reference lap, your MXS 1.2 Strada will switch on 3 LEDs green; if, on the contrary, your lap time is worsening the LEDs will switch on red.

Please note: this option only works if an optional GPS Module is connected.

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|---|--|---|------------------------|
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| All MXS 1.2 Strada ³⁶ | | | |
| Save Save As Close Transmit | | | |
| Channels ECU Stream CAN2 Stream CAN Expansions Math Cha | nels Status Variables Parameters Shift Lights | and Alarms Trigger Commands Icons Manager Display SmartyCan | n Stream CAN Output |
| Use for predictive time | 🔵 Use as gear shift lights | | |
| Channel for LED-bars | Incremental Time per LED | Predictive Time Bar Options | |
| +- Best Time | 0.10 sec | Choose a sequence mode of shift lights Import Set | ttings Export Settings |
| | | A LED stays on if it's threshold is exceeded | |
| | | C A LED stays on until another LED with higher threshold is turned on | |
| | LED 6 A C C C C C C C C C C C C C C C C C C C | Predictive Time increment per LED 01 (sec.) | OK Carrel |
| + Add New Alarm still available alarms: 37 | Import Alarm Export Alar | m | |
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17.2 Alarm LEDs configuration

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| Save Save As Close Transmit | |
| Channels ECU Stream CAN2 Stream CAN2 Stream CAN Expansions Math Channels Status Variables Parameters Shift Lights and Alarms Trigger C | commands Icons Manager Display SmartyCam Stream CAN Output |
| Use for predictive time Use as gear shift lights | Create New Alarm |
| Cear Shift Light (2 3 4 5 6 7 8 9 10 - - 1 6000 - | Description Import Export If All ¢ of the following conditions are true: |
| | Speed t t t t t t t t t t t t t t t t t t |
| | Lives Condition no longer met |
| Let Add York Alarm diff andalde alarma 37 Import Alarm Export Alarm | |
| | Save Cancel |

To set the new alarm:

- Define the Alarm name (**1**)
- You may use a combination of conditions for setting an Alarm and choose if the conditions are to be ALL valid, or just one of them.
- decide which action is to be trigged (5) among displaying a message or a timed popup message, display a measure, switch a LED on or activate an output signal (CAN output page, see the related paragraph)
- decide the alarm ending condition ("Untill" 6) among: condition no longer met, the device is turned off, a button is pushed, or data are downloaded
- "+" buttons you find right of the panel are to add new alarms (the top one) or to add new actions to an alarm (bottom one)



• when all operations have been performed press "Save" in "Create New Alarm Panel and you will come back to "Shift Lights and Alarm" page

| Image: Start Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start Image: Start Start Start Start | Use as gear shift lights | nds. Kons Manager Deptay SmartyCam Stream CAN Output | <u></u> |
|---|--------------------------|---|---------|
| XS 12 Strole ¹¹ Good 20L ¹¹ ¹² Credit Kolom ¹³ Credit Kolom ¹⁴ Credit Kolom ¹⁵ Credit Kolom | Use as gear shift lights | nds kons Manager Display SmartyCam Stream CAN Output | |
| e Sim As Cope Transmit **Cease New Joint **Cease New Joint Description Video Alam **Cease New Joint Description **Cease New Joint **Cease | Use as gear shift lights | nds kons Manager Display SmartyCam Stream CAN Output | |
| Constructions and Constructions and Constructions and Constructions Constru | Use as gear shift lights | nds Icons Manager Display SmartyCam Stream CAN Output | |
| | Use as gear shift lights | | |
| Description Water Alarm I import Export If 2 All 2 of the following conditions are true: All | Source | | |
| If 2 All c of the following conditions are true: | Source | | |
| All | Source | | |
| | | Channel | |
| Any | - CAN 2 | * Water Temp Alarm | |
| | Lap Channels | | |
| Speed1 3 🗘 📜 less than 🗘 km/h 0.0 | GPS | | |
| Τ | A/D Channels | | |
| then trigger the following action(s): | Accelerometer | | |
| Marrana A Insart marrana last | Gyro | | |
| | Magnetometer | | |
| Popup Message timed | Odometer | | |
| Display Measure | Internal | | |
| | Channel Exp. | | |
| LED , | TC-HUB Exp. | | |
| Output Signal | Water Temp Alarm | | |
| | - Water Temp Adarm | | |
| Until: 👩 🖣 condition no longer met 🛊 | | | |
| | | ок | Cance |
| Conduitor no longer met | | | |
| Or a holden is contract of | | | |
| DATA data is downloaded | | | |
| 4 data is dominidaded | | | |
| | | | |
| Save Cantel | | | |



18. SmartyCam stream setting

The PDM 32 can be connected to AiM SmartyCam to show the data you wish on SmartyCam video. To set each channel:

- click on it and a setting panel shows up
- it shows all channels and/or sensors that fits the selected function
- in case you do not find the channel or the sensor in the list enable "Enable all channels for functions" checkbox and all channels/sensors will be shown

| RaceStudio3 dev build lug 13 | | | | | - 0 - 23 |
|--|---------------------------------|-----------------------------------|---------|------------------------------|----------------|
| * 🐲 🖽 ዄ 🖆 📥 🄝 谷 | | | | | 🤶 😤 🐠 |
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| Save Save As Close Transmit | | | | | |
| Channels ECU Stream CAN2 Stream CAN Expansions Math Channels | Status Variables Shift Lights a | Ind Alarms Trigger Commands Icons | Manager | Display SmartyCam Stream CAN | Output |
| | Enable all channels for fu | unctions | | | |
| | SmartyCam Function | Channel | | | |
| | Engine RPM | RPM | \$ | Select Chappel | |
| | Speed | GPS Speed | \$ | Source | Channel |
| | Gear | Gear | \$ | 500 | A restartion A |
| | Water Temp | WaterTemp | \$ | CAN 2 | StabCtriTeital |
| | Head Temp | Not Set | \$ | Lap Channels | StabCtrIMTXT |
| | Exhaust Temp | Not Set | \$ | GPS | = TyreRvMile |
| | Oil Temp | OilTemperature | ÷ | A/D Channels | FuelLevelMean |
| | Oil Press | OIPressure | \$ | Odometer | Fuelnst1 |
| | Brake Press | BrakePres | ÷. | Channel Exp. | AveRatio |
| | Throttle Pos | ThrottlePotentio | ÷. | TC-HUB Exp. | PedalPosition |
| | Brake Pos | PedalPosition | = | LCILOne CAN Em | * VaxOato * |
| | Clutch Pos | Not Set | \$ | | OK Carro |
| | Steering Pos | SWAngle | \$ | | GALCO |
| | Lambda | OLCC_Lambda | \$ | | |
| | Fuel Level | FuelLevel | \$ | | |
| | Battery Voltage | Battery | ¢ | | |
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19. Managing a track with Race Studio 3

A huge database with more than 4500 tracks, constantly updated, is available. You may transmit them to your PDM32. Press "Tracks" icon.

Note: the GPS08 Module is needed.



The main page is divided in three columns. on the left:

- on top, the filters that allow to collect many tracks following customized criteria; by default, all tracks are shown (light blue "All Tracks" filter in the image below).
- bottom left, the connected devices (in the image, "MXS 1.2 Strada ID 5302808")

The column **in the middle** shows:

- on top a fast search bar, that allows to select the tracks which satisfy your personal research criteria; by pressing "?" a pop-up window explains research criteria (highlighted in red below), where:
 - \circ ~ long name is the name you see in bold in each track box ~
 - short name is the track name shown on the display of your MXS 1.2 Strada and is the name you find top right of each track box
 - \circ $\;$ track city is the name of the city the track is located in
- all the tracks listed in Race Studio 3 database. It automatically updates at start up if a connection to the Internet is available.

The column on the Right shows:

• the data sheet of the selected track.





When your PDM is connected it is shown on the left bottom part of the page as said before. Clicking on it all the tracks it contains are shown in the right column of the page.

| 📴 RaceStudio3 dev build yesterday 18:10 | | | | | | | | | | |
|---|---|-----------|--|--------------|----------|--------|-------|------------|--|---------------------|
| * * * * * | | | | | | | | | | 🤶 🥐 <i>@</i> |
| 🕄 All Tracks (2848) | | New | mport Export | Receive | Transmit | Delete | | | Tracks | |
| | 0 | | | | | | Traci | MXS 1.2 St | ada ID 5302808 | |
| Nations | | | | | | | R | efresh | Delete All | Save All Load Saved |
| Smart Collections | | | | | | | | | | |
| Manual Collections | | | Argent | ina | | | ш | 0.1 | | |
| | | | | | | | | 1/18 | Atlanta Motorsports Park | AMP GA |
| | - | 0 | Aeroclub 25 de Mayo | | 25 De N | lavo | 1 | \vee | 2,0 km Race Track Paved | |
| | | | 25 De Mayo, Buenos Aires | s, Argentina | | | | 0 | Arizona Motoreporte Park | AMP 47 |
| | 1 | \square | 776 m Off Road Dirt | | | | | _ <i>₩</i> | Litchfield Park, Arizona, United States | |
| | | \square | Auto Moto Nautico Lapr | ida | Lap | prida | 2 | T | 3,6 km Race Track Paved | |
| | 2 | 2) | Laprida, Argentina 800 m Kart Track Dirt | | | | _ | R- | Atlanta Motorsports Park Main | AMP Main GA |
| | - | | | | | | | 18 | Dawsonville, Georgia, United States | |
| $\sim \lambda$ | | \sim | Autodromo Ciudad de C Concordia Argentina | Concordia | CiuConco | ordia | 3 | 2 | 2,9 Km Race Track Paved | |
| | 3 | ~ | 934 m Kart Track Paved | | | | | 16 | Pista Santa Venera Acireale | Acireale |
| | | n | Autodromo Ciudad de F | lolores | Dok | | 4 | 0 | Kart Track Paved | |
| | |) | Dolores, Argentina | | | | | | 1.42. | |
| | 4 | 0 | 1,5 km Kart Track Paved | | | _ | | | Italy | Adria |
| Connected Devices | | ß | Autodromo Ciudad de D | olores2 | Dolor | res2 | 5 | | | User |
| MXS 1.2 Strada ID 5302808 | | | Dolores, Argentina 1.5 km Kart Track Dirt | | | | _ | A | Adria | Adria |
| 7 1 1 1 1 1 1 1 1 1 1 | | 0 | no an tort from out | | | User | ш | dl. | Adria (RO), Italy | |
| | | 1/0 | Autodromo Ciudad de P | arana | Pa | irana | 6 | -07 | 2,7 km Race Track Paved | |
| | 6 | V. | 4,1 km Race Track Paved | | | | | R | Adria Karting Raceway | Adria Kart |
| | | - 0 | Autodromo Cludad do S | an Martin | 6H | | 7 | 60 | Adria (RO), Italy 1.3 km Kart Track Paved | |
| | | | San Martin, Argentina | ran martin | Santia | | · ' | | | |
| | 7 | ھرپے | 1,1 km Kart Track Paved | | | | | 161 | Pista dell'Adriatico Cappelle sul Tavo, PE, Italy | Adriatico |
| | _ | 0 | Autodromo Concepcion | del Urugua | y Concep | cion | 8 | | 730 m Kart Track Paved | |
| Trash | | L IL | Concepcion del Uruguay, | Argentina | | | | | Autodromo Gianni De Luca | Aireda |

The page keyboards are used to manage the tracks.

The keyboard you find above the central column allows you to:



- New: create a new track
- Import: import one or more tracks you stored in your MXS 1.2 Strada or in another external device
- **Export**: export one or more tracks to a specific PC folder or to another peripheral device
- **Receive:** receive from your connected MXS 1.2 Strada the tracks you created (if no device is connected the button is disabled)
- Transmit: transmit one or more tracks form the PC to your connected MXS 1.2 Strada (if no device is connected the button is disabled)
- Delete: delete one or more tracks from Race Studio 3 Database

The keyboard you find above the right column allows you to:

| Refresh | Delete | Delete All | Save All | Load Saved |
|---------|--------|------------|----------|------------|
|---------|--------|------------|----------|------------|

- Refresh: refresh the track list stored in your connected PDM 32
- **Delete**: delete one or more tracks from your PDM 32 memory
- Delete All: delete all tracks stored in your PDM 32 memory
- Save all: save all the tracks stored in your connected PDM 32; it creates a zip file you can load to another AiM device
- Load Saved: load the tracks you previously saved in your connected PDM 32 memory



20. ECU Driver builder 🔤

In case your vehicle ECU is not included in Race Studio 3 software, you can use CAN Driver builder to create your own CAN protocol.

You may use the CAN Driver Builder for producing a protocol that may be managed both on CAN 1 and on CAN2.

In order to activate the DriverBuilder, press the following pushbutton:



The main page is shown:

| | | RaceStudio3 3 | 12.01 build yesterday 1 | 7.21 | | | | |
|--------------------|------|---------------|-------------------------|-------------------|--------------|----------------|----------------------------|-----|
| | | New Cline | troore | Farrort | Depeter | Authorizations | Custom CAN Protocols | an |
| * All Custom CAN | C. | | | - Alter | Sec. 1 | | | 9.0 |
| | | Manufacturer | Model | CAN Device | Bus Speed | Date | File | |
| Manual Collections | 0 | SUPERECU | ECUPro | ECU | 1 Mbit/sec | ott 12 | 20160928_133347_003965 xc1 | |
| | | SUPERECU | EightCyl | ECU | 500 Kbit/sec | set 22 | 20160922_170809_003600.xc1 | |
| | | | | | | | | |
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| Trash | - | | | | | | | |
| | 1000 | AND AND A | | 100 | | | Destop · C · · · · · · | |

and the following pushbuttons are available:

New Clone Import Export Delete Authorizations

Press "NEW" for creating a new protocol.

This window appears:



| Select a Manufacturer | | Edit New Model Name | |
|-----------------------|---|---------------------|-------|
| None | ^ | | |
| 2D | | 1 | |
| ABIT | | | |
| ADAPTRONIC | | | |
| AEM | | CAN Device Type | |
| AIM | | ECU | \$ |
| ALFA ROMEO | | | |
| APRILIA | | | |
| ASTON_MARTIN | | | |
| AUDI | | CAN Bus Speed | |
| AURION | | 125 Kbit/sec | ± |
| AUTRONIC | | | |
| BENTLEY | | | |
| BLACK_BOX | | | |
| BMW | ~ | | |
| | | | |
| Add Manufacturer | | | |
| | | | |
| | | | |
| | | OK C | ancel |

Here you can set:

the Device manufacturer and the Model name, for then being able to select the new protocol, that you will find in the Protocols Database. In case the Device Manufacturer is not in the list, you can add it.
the Device Type: it can be ECU (in this case it can be managed only in CAN1 of the Aim Loggers/dashes) or Another CAN device (in this case it can be managed both in CAN1 and in CAN2)
the CAN bus speed

After having set the proper fields, this page appears:

| EC | | unerSn | ort × | \$ | | | 4 |
|----|------------|--------|-------|-------|---------|---------|---|
| L | Add New | CAN St | ream | Clos | e | | |
| | CAN Protoc | :ol: | SU | PEREC | CU - Su | perSpor | |

You have two pushbuttons:

Add New can Stream
 CLOSE

After having eventually defined the Password and the License Code, you can start creating the Protocol. Click on "ADD NEW CAN STREAM" and the new window appears:



| CAN ID | Stream Byte Order | | |
|--------------------|-------------------|--------------------------|----|
| 0x0 | Low to High | (Little Endian or Intel) | \$ |
| Enable Row Counter | | | |
| | | | |

The fields to be set are:

- CAN ID

- Stream Byte Order. This last can be Little or Big Endian, in dependence upon the processor of the device. Here an example of the different formats:

| | 89 | AB | CD | EF |
|----------------|-------|-------------|----------|----|
| Address | 0 | 1 | 2 | 3 |
| ittle-endian (| x86 f | amily | 0 | |
| ittle-endian (| x86 f | amily CD | /) AB | 89 |

- Row Counter Enable: This field is used when we have to define a multiplexed stream, that is to say a stream where the format depends upon a field, called Row Counter.

| CAN ID | Stream Byte Ord | ler | | |
|--------------------|-----------------|----------------------|---------------|--------------|
| 0x0 | Low | to High (Little Endi | ian or Intel) | \$ |
| Enable Row Counter | Row Counter | RC Start Bit | RC Nur | nber of Bits |
| | 0x0 | 0 | 1 | |
| | | | OK | Cancel |

If you enable the Row Counter, you must specify its Start Bit, its Number of bits and the Value for every single row to be defined.

After having set the different parameters, you click OK and a new window appears:



| CAN ID | | CAN Me | easure Setting | S | | | | | | | | 2 |
|----------------|-------------------|----------------------|---------------------|--------|------------|--------|---------|-----------|----------|-------|------|-----|
| | Byte Order | | | | | | | | | | | |
| 0x10 | Low to High (Litt | tle Endian or Intel) | | | | | | | | | | |
| —— Meas | ure Stream Data | | | | | | | | | | | _ |
| Start Bit | 12 | Number of Bits | 16 | | 7 | 6 | 5 | 4 | oit 3 | 2 | 1 | 0 |
| Name | Watertemp | | | Byte 0 | Thro | ttlePo | sit (Th | irot) | | | | |
| Short Name | temp1 | | | Dyte t | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Function | | Temperature | \$ | Byte 1 | Wate 15 | rtemp | (tem | p1) 12 | 11 | 10 | 9 | 8 |
| | | | | Byte 2 | Wate | rtemp | (tem | p1) | | | | |
| | 50 Hz | Unit | C . | 5,6 2 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| wax. Trequency | | | | Byte 3 | 24 | 20 | 20 | 20 | Wate | rtemp | (tem | p1) |
| Stepped Values | Prote | cted by License code | ✓ | | 31 | 30 | 29 | 20 | 21 | 20 | 25 | 24 |
| | | | | Byte 4 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 |
| Signed Data | | Unsigned | \$ | Byte 5 | | | | | | | | |
| Convertion | Gain 1 | O Encoding | | | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 |
| | Offset 0 | Set Encodin | ig Values | Byte 6 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 |
| | | | | Byte 7 | | | | | | | | 50 |
| | | | | | 63 | 62 | 61 | 60 | 59 | 58 | 57 | 56 |

This page is used for defining a single channel.

You have to define:

- Start Bit
- Number of Bits
- Name to be used in Analysis
- Short Name to be used on the display
- Function
- Max Acquisition Frequency
- Unit of Measure

- Protection (in this case, the License Code you have previously set is used

- Stepped Value - this field is used in Analysis: if a value is Stepped, it is not interpolated (for example, the Gear Number, that is to be shown at fixed values).

- Conversion : for every channel you can define a Gain and an Offset (Output = Input Value x Gain + Offset) or an Encoding. In this case, a conversion table is to be defined per every value of the field:

| Input Format | Decimal | O Exadeci | mal |
|---------------|-----------|-----------|--------|
| Value (input) | Label (ou | rtput) | |
| 1 | | | [+ |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | OK | Cancel |



After having set all the parameters, the data stream is shown:

| UPro 🕺 | | | | | |
|---------------|------------|------------------------|----------------|-----------------|---------------|
| Save | Close | Password Label: prova1 | Protection Key | Label: EightCyl | Sort Measures |
| CAN Protocol: | SU ream | PERECU - ECUPro | | | |
| CAN Protocol: | SU ream | PERECU - ECUPro | | 2000 | |

Five pushbuttons are available:

1) SAVE

2) CLOSE

3) Password: for changing the password associated to the protocol

4) Protection key: for managing the protection key used for crypting and hiding some fields of the protocol5) Sort Measures: used for changing the order in which you will see the fields in the final protocol, that will be available in the protocol database and used like any other protocol

For adding a channel, please double click in the desired position of the stream.

For modifying a channel, click on it.

For adding another stream, click on the "+" at the right of the stream.

For Sorting the measures in the stream, please, push the pushbutton and the window will appear:

| CANID | rvame | Function | Unit | wax. rreq. |
|------------------|-------------|-------------------------|------|----------------|
| Move Up | Move Down | Move to Top | N | love to Bottom |
| ID:0x0 RC:0x0 | RPM | RPM | rpm | 10 Hz |
| ID:0x0 RC:0x0 | Throttle | Pct Throttle Load | % | 10 Hz |
| ID:0x0 RC:0x0 | Speed | Vehicle Spd | km/h | 10 Hz |
| ID:0x1 | Watertemp | Water Temp | с | 10 Hz |
| ID:0x1 | HeadTemp | Head Temp | с | 10 Hz |
| ID:0x1 | OilPressure | Oil Pressure | bar | 10 Hz |
| ID:0x2 | Brake | Pct Brake Load | % | 10 Hz |
| ID:0x2 | Lambda | Lambda of Engine Output | λ | 10 Hz |
| | | | | OK Canad |



You can click on a field and move it up and down, dragging and dropping it.

The last pushbutton is intended for managing the "Authorizations":



CAN Driver Builder offers TWO different Authorizations:

- **Protocol Password**: the password that you are supposed to have in your PC for EDITING the protocol

- **Measure Protection Key**: the key that you are supposed to have in your PC for using, seeing in online, downloading and seeing in Analysis the measures defined as "locked" in your protocol.

The "locked" measures cannot be shown on the display, but are recorded like any other measure. If you download the data into a PC with the Measure Protocol Key installed, the locked measures are completely visible, else they are hidden and crypted.

At the end, "Save" and exit. You will find the new protocol among all the others in the database.



21. The device window

| * 🐲 🖾 🖾 🐨 🛨 ' | *ô | | | | | | | ((• | e an |
|--|--|---|-------------|--------------------------------|----------------------|------|------------|------|------|
| MXS 1.2 Strada 180717 × All Configurations | | | | M | (S 1.2 Strada ID 530 | 2808 | | | |
| evices (4) anual Collections | Live Measures Properties Start Live Measures So Sort by C Sort Api Sort by | s Settings Track ted by Channel Ty Configuration habetically Channel Type | ks Counters | Logo Firmware ate mV Values | | | | | |
| | | | | | Master | | | | |
| | | | | | A/D channels | | | | |
| | RPM | 0 | rpm | Channel02 | -16 | mV | Channel06 | -14 | mV |
| | Speed1 | 0.0 | km/h | Channel03 | -15 | mV | Channel07 | -15 | mV |
| | Logger Temperature | 36.2 | с | Channel04 | -15 | mV | Channel08 | 1 | gear |
| | Channel01 | -15 | mV | Channel05 | -15 | mV | Luminosity | 0.85 | * |
| | | | | G | lculated channels | | | | |
| connected Devices | Lap Time | 0:59.980 (0) | | sGPS (No GPS) | 0,0 | km/h | | | |
| MXS 1.2 Strada ID 5302808 | • | | | | CAN 2 channels | | | | |
| | FLAG_ABS_OFF | | | POS_TCS_MAP | | # | I_DIF_PUMP | | A |
| ~ | POS_DIF_MAP | | 8 | TORQ_DIF_REF | | Nm | | | |

Clicking your PDM 32 bottom left of the software page you enter the device window and have these options:

- Live Measures: to check all PDM 32 channels; here you can:
 - o start live measures
 - sort the channel visualization as you prefer: as managed by the firmware (sort by configuration), alphabetically, by channel type (they will be shown by device then by channel type and at the end by measure type)
 - o calibrate sensors that need the calibration
 - o show the measure in Mv
- **Properties**: to name your device, fill in racer's and vehicle name or number, championship and venue type (generic or qualifying testing, warm up, race, test type)
- Settings to:
 - o set date
 - o enable/disable daylight time
 - o set time format and time zone
- Tracks: to manage the tracks stored in the device memory
- **Counters**: to set reset the device odometers
- Logo: transmit/receive the logo that shows up when switching MXS 1.2 Strada on; supported image format are JPEG or BMP; always use the most recent Windows[™] versions (Windows8 or Windows10) whose graphic libraries are more updated
- Firmware: to check or update your PDM 32 firmware version.

21.1 Online measure values forcing

In the Online Interface, it is possible to force the values of every channel:



| Non- | | | |
|-------------------|---|--|---------------------------------------|
| * | RaceSD | idio3 3,23.11 | |
| * * * ** | | | ? |
| Otilities | | MXm ID 5600203 | |
| Comment Davidson | Live Measures Download WiFi and Properties | Settings Tracks Counters Logo Firmware Device Expl | orer |
| Connected Devices | Stop Live Measures Sorted by Channel Type A | uto Calibrate mV Values | Start Recording Blink |
| • MAIM ID 5600203 | | Master | |
| | InlineAcc -0.38 g | PitchRate -1.8 deg/s | External Voltage 14.8 V |
| | LateralAcc -0.01 g | YawRate 0.3 deg/s | Luminosity 27 % |
| | VerticalAcc -0.92 g | RPM 0 rpm | |
| | RollRate -2.4 deg/s | Logger Temperature 34.4 C | |
| | | Calculated channels | |
| | Lap Time 0:38.200 (1) | iGPS (GPS Search) 0.0 | |
| | | | |
| . 🧿 🔛 🖬 🔛 🛤 | 😤 🤗 🛯 😢 🖬 🗱 | o 🔄 💿 💿 🔛 📟 | Descep ¹ - 1 12 P- 1A Line |

| Live Measures D | ownload WiFi and P | roperties Settings Tra | icks Counters Logo | Firmware Device Explore | er | | |
|--------------------|--------------------|------------------------|------------------------|-------------------------|--------|-----------------|----|
| Stop Live Measures | Sorted by Channe | el Type Auto Calibrate | mV Values | | | Start Recording | BI |
| | | м | aster | | | RPM | |
| nlineAcc | -0.38 g | PitchRate | -1.8 deg/s | External Voltage | 14.8 V | 0 rpm | 1 |
| LateralAcc | -0.01 g | YawRate | 0.3 deg/s | Luminosity | 26 % | | |
| /erticalAcc | -0.92 g | RPM | 0 rpm | | | | |
| RollRate | -2.4 deg/s | Logger Ten Can't sho | w other decimal places | | | | |
| | | C Force Ct | annel Value | | | | |
| .ap Time | 0.00.000 (0) | iGPS (No GPS | 0,0 | | | | |

If you select a channel, RPM, for example, and click on the right small icon that appears near the value, you may force the value of that channel.

| | | | MXm ID | 5600203 | | | |
|---|------------------|---|------------------------|---------------------------|--------|-----------------|-------|
| Live Measures Dow Stop Live Measures | Sorted by Channe | roperties Settings Tra H Type Auto Calibrate | e mV Values St | o Firmware Device Explore | er | Start Recording | Blink |
| | | м | aster | | | RPM | + |
| InlineAcc | -0.38 g | PitchRate | -1.9 deg/s | External Voltage | 14.8 V | 0 rpm | - |
| LateralAcc | -0.01 g | YawRate | 0.2 deg/s | Luminosity | 26 % | | |
| VerticalAcc | | Choose value | × | | | | |
| RollRate | RPM | Insert | a (float 16 bit) value | | | | |
| | 5000 | | | | | | |
| Lap Time | | OK | Cancel | | | | |
| | | ОК | Cancel | | | | |

The forced channels are shown surrounded by a red frame.

Here, for example, RPM has been forced to the value 5000.



| Live Measures Download WiFi and Properties Settings Tracks Counters Logo Firmware Device Explorer stop Live Measures Sorted by Channel Type Auto Cationale mV Values Stop Forcing Start P Master InlineAcc -0.38 g PitchRate -1.9 deg/s External Voltage 14.8 V 5000 LateralAcc -0.01 g YawRate 0.2 deg/s Luminosity 26 % | Recording RPM |
|---|---------------|
| Stop Live Measures Sorted by Channel Type Auto Calibrate mV Values Stop Forcing Start F InlineAcc -0.38 g PitchRate -1.9 deg/s External Voltage 14.8 V 5000 LateralAcc -0.01 g YawRate 0.2 deg/s Luminosity 26 % | RPM |
| Master Master InlineAcc -0.38 g PitchRate -1.9 deg/s External Voltage 14.8 V 5000 LateralAcc -0.01 g YawRate 0.2 deg/s Luminosity 26 % | RPM 0 rpm |
| InlineAcc0.38.g PitchRate1.9.deg/s External Voltage14.8.V 500 | 0 rpm |
| LateralAcc -0.01 g YawRate 0.2 deg/s Luminosity 26 % | o ipin |
| | |
| VerticalAcc -0.92 g RPM 5000 rpm | |
| RollRate -2.4 deg/s Logger Temper 34.2 C | |
| Calculated channels | |
| Lap Time 0.37.540 (1) iGPS (GPS Sea 0.0 | |
| | |

Then, you may move it up and down using the pushbuttons "+" and "-".

This feature may be useful for testing, for example, Icons behavior, alarms, Power Outputs, harnesses.

| | | | MX | m ID 6500100 | | |
|---|------------------|-----------------------|---------------------------------|----------------|------|-----------------------|
| Live Measures Dow Stop Live Measures | sorted by Channe | operties Settings Tra | cks Counters Log mV Values S | top Forcing | prer | Start Recording Blink |
| VerticalAcc | -0.92 g | Oil Pressure | -2.65 bar | Wat AlarmCurr | A | Water temp - |
| RollRate | -0.4 deg/s | Logger Tempe | 33.7 C | Luminosity | 6 % | 103.6 C |
| PitchRate | 0.8 deg/s | Channel03 | -290.0 C | | | Wat Alarm |
| YawRate | 5.4 deg/s | Water temp | 103.6 C | | | 1 # |
| | | ECU cł | annels | | | |
| PedalPosition | % | ErrorCode4 | # | InletAirTemp | C | |
| ThrottlePosition | % | ErrorCode5 | # | EngineCoolantT | C | |
| Brake Switch | # | ErrorCode6 | # | EngineHour | ms | |
| AWDActivation | # | ErrorCodeSw | # | EPSInputForce | Nm | |
| Override SW | # | ManifoldAirPre | bar | EPSOuputForce | Nm | |
| ErrorCode1 | # | EngineSpeed | rpm | Battery | V | |
| ErrorCode2 | # | Vehicle Speed | km/h | EPSCurrent | A | |
| ErrorCode3 | # | EPSTemp | C | Gear | gear | |
| | | Calculated | i channels | | | |
| Oil Pr Ala | 1# | Wat Alarm | 1# | iGPS (GPS Go | 0,1 | |
| Oil Pres Status | 1 # | Lap Time | 0:00.000 (0) | | | |

In the above configuration, for example, a Power Output is turned ON when the Water temperature reaches 100°C. If you force its value at 100°C, and, using the "+" and "- "pushbuttons, you move this value up and down and you may see the alarm being turned ON and OFF.



22. CAN Output configuration

You may configure your device to transmit a CAN data stream, both on CAN1 and CAN2, containing the channels required.

To add a payload:

- press "+Add new Payload" and "Set CAN Header details" appears.
- fill in ID CAN (hex), available options are:
 - 11 bits (normal address)
 - 29 bits (extended address)
- select the payload max bytes number (DLC), from 1 to 8 bytes
- select the byte order according to the used processor, available options are:
 - Little endian for Intel compatible processor
 - o Big Endian for Motorola processor
- set the sampling frequency among 1,2, 5, 10 or 20 Hz

| Save | Save As Close Transmit | | | | | | | | |
|------------|----------------------------------|-----------------------------------|---|-----------------------------------|---------------------------------|----------------|------------------|---------------------|------------|
| hannels EC | U Stream CAN2 Stream CAN Expansi | ions Math Ch | annels Status Var | ables Parameters Shi | ft Lights and Alarms 1 | ngger Commands | kons Manager Dis | olay SmartyCam Stre | CAN Output |
| | Bit Rate Protocol (b8%) | -500K.06% | • //R12+1+ | a dad BCDJ protocol Texporeny (| must be aways \$500 little with | cent in chepts | Name | 1 | |
| | CAN ID (Res) | Byte 0 | Dyte 1 | Dyte 2 | Dyte 3 | Byte 4 | Byte S | Eyle 6 | Byte 7 |
| | + Add New Payload | | | | | | | Dent | Import |
| | | | | | 1 byte | | | | |
| | | | | | 3 bytes | | | | |
| | | set hexadecima It may have 111 | namber for CAN E pay its (normal address) or 2 | laad. 9 bits (otwoded eddress) | 4 bytes | | | | |
| | | | ID CAN (Nex) | N | 6 bytes | | | | |
| | | | | \$11.bb O223 | te 7 trytes | | | | |
| | | | DLC | 5 bytes | e B bytes | | | | |
| | | | Oyle Order | Big Endian | | | | | |
| | | | | Little Endlan | | | | | |
| | | | Frequency | .1 BC | 1 112 | | | | |
| | | | | | 2 Hz | | | | |
| | | | | ОК | ancel 10 Hz | | | | |
| | | | _ | | | | | | |



When all channels set your configuration is finished:

- press "Save" on the page top keyboard
- press "Transmit" to transmit the configuration to the PDM 32

| Save | Save As | Close | Transmit |
|------|---------|-------|----------|
| | | | |



Appendix A – Connectors and Pinout





| NIA | DESCRIPTION | NIA | DESCRIPTION |
|-----|----------------------------|-----|----------------------------|
| - | Half bridge power output 1 | 19 | Speed 2 input |
| 2 | Half bridge power output 1 | 20 | Speed 1 input |
| S | Low power output 9 | 21 | Channel input 9 |
| 4 | Mid power output 9 | 22 | Channel input 10 |
| 5 | Mid power output 10 | 23 | Ignition |
| 9 | Low power output 10 | 24 | Half bridge power output 3 |
| 7 | Low power output 11 | 25 | Half bridge power output 3 |
| 80 | Mid power output 11 | 26 | Channel input 1 |
| 6 | Mid power output 12 | 27 | Channel input 2 |
| 10 | Low power output 12 | 28 | Channel input 3 |
| 11 | Half bridge power output 2 | 29 | Channel input 4 |
| 12 | Half bridge power output 2 | 30 | Channel input 5 |
| 13 | P GND | 31 | Channel input 6 |
| 14 | P GND | 32 | Channel input 7 |
| 15 | LIN | 33 | Channel input 8 |
| 16 | +5V Analog Vreference | 34 | Half bridge power output 4 |
| 17 | +Vb output | 35 | Half bridge power output 4 |
| 18 | GND | | |
| | | | |

| PIN | DESCRIPTION | NIA | DESCRIPTION |
|------|---------------------|------|---------------------|
| - | High power output 1 | 19 | Low power output 6 |
| 2 | Mid power output 1 | 20 | Low power output 7 |
| e | Mid power output 2 | 21 | Low power output 8 |
| 4 | Mid power output 3 | 22 | CAN0 High |
| 5 | Mid power output 4 | 23 • | High power output 2 |
| 9 | Mid power output 5 | 24 🔵 | High power output 3 |
| 7 | Mid power output 6 | 25 • | High power output 3 |
| 8 | Mid power output 7 | 26 | Channel input 11 |
| 6 | Mid power output 8 | 27 | Channel input 12 |
| 10 | GND | 28 | CAN2 High |
| 7 | CAN0 Low | 29 | CAN2 Low |
| 12 • | High power output 2 | 30 | CAN1 High/RS232TX |
| 13 | High power output 1 | 31 | CAN1 Low/RS232RX |
| 14 | Low power output 1 | 32 | +Vb ext CAN |
| 15 | Low power output 2 | 33 | +Vb out CAN |
| 16 | Low power output 3 | 34 • | High power output 4 |
| 17 | Low power output 4 | 35 • | High power output 4 |
| 18 | Low power output 5 | | |

High Power Out 1 has internal serie diode
 High Power Outs (1,2,3,4) have internal freewheeling diode





