ECUMASTER ADU-5/ADU-7

User Manual

(9.04.2020, version 1.117)

Contents

Ecumaster ADU

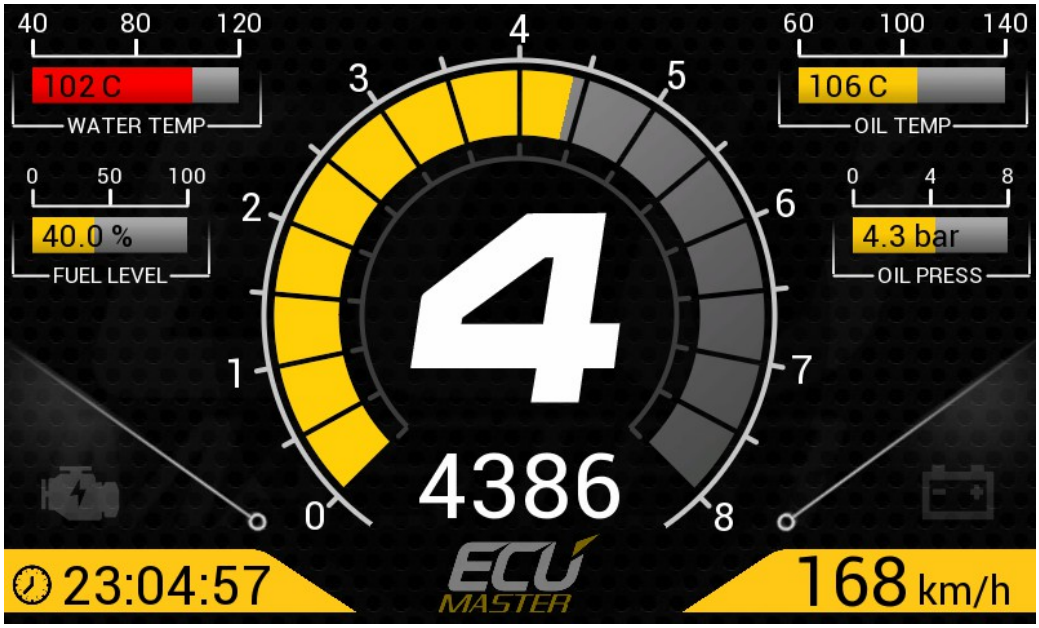
ECUMASTER ADU (*Advanced Display Unit)* is a universal display designed for motorsports. Unlike similar devices on the market, the Ecumaster ADU offers a high degree of configurability of the displayed information and remarkable flexibility for configuring inputs. Equipped with two CAN buses, the display can easily communicate with other devices (e.g. ECU, GPS, ABS, etc.). Additionally, up to 8 analogue inputs (e.g. pressure sensors, temperature sensors) and 8 digital inputs (signals from frequency sensors, beacon etc.) may be connected and configured.

A secondary method of relaying information to the driver is a set of 15 RGB LEDs. These LEDs are useful for relaying warnings (such as low oil pressure) and as a progressive shift light.

To ensure user comfort in various lighting conditions, a high-quality LCD display was chosen, with a brightness of 600 cd/m2 for the ADU5 display and 1000 cd/m2 for the ADU7 display. In order to reduce reflections, the display features an anti-glare coating. The front of the enclosure features a light sensor that automatically adjusts the brightness of the display to suit current conditions.

The ADU may also be used as a central data logger. All information collected by the display can be saved on an USB storage device (flash drive, pen drive) recorded at up to 500 Hz per channel. The ADU features a real-time clock, so all data is stored with the date and time of the recording.

The ADU is a powerful tool for lap timing and driver training. Lap and sector times may be recorded using an external GPS module, and the driver may be coached in real time using predictive lap timing. Timing information may be reviewed from logged data after the fact and analyzed.

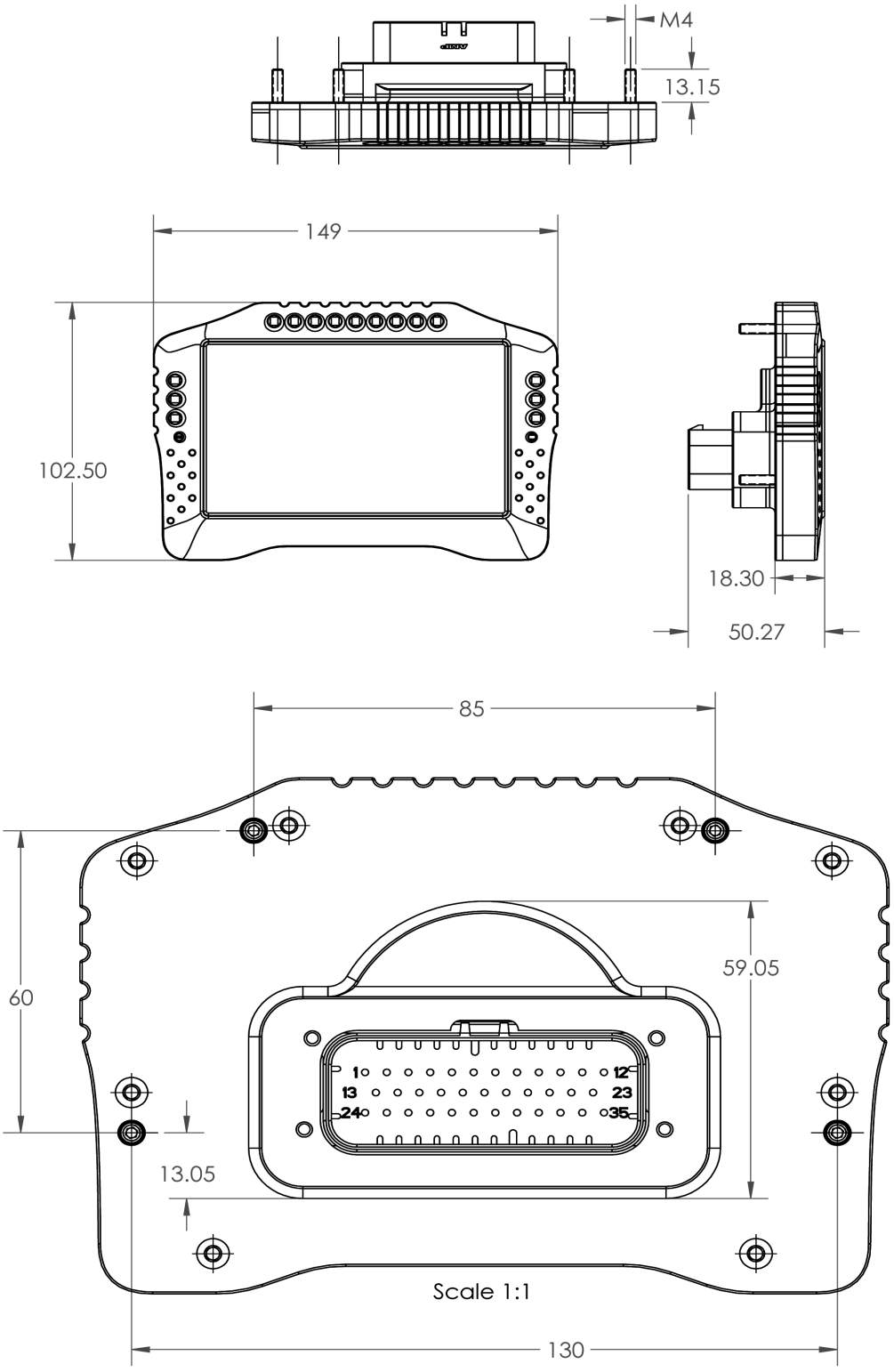


Characteristics

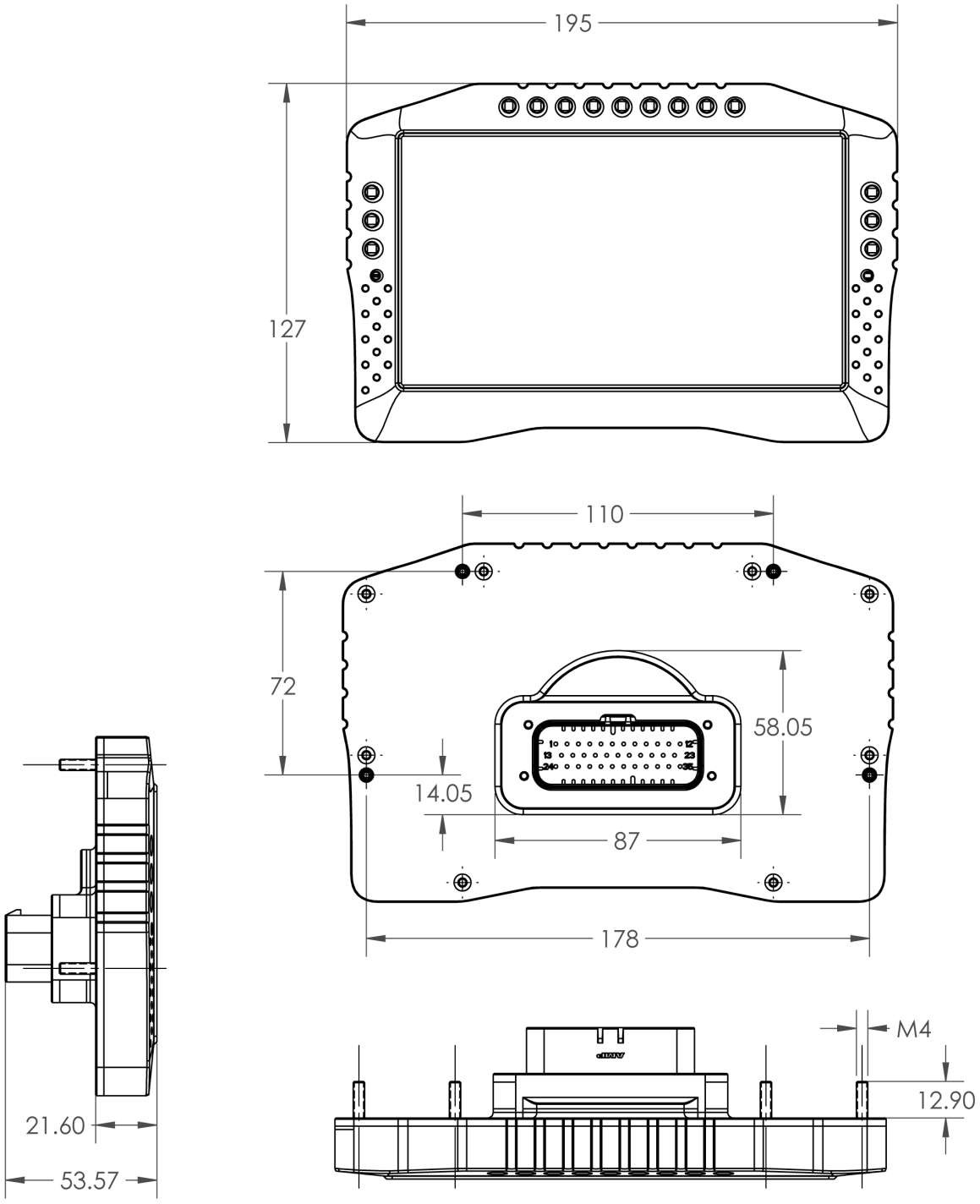
General	
Working temperature range	ACEQ100 (-40 – 85 C)
CPU	32 bits, automotive, 90 MIPS
Reverse polarity protection	Yes, internal
Working voltage range	6-22V, robust supply protection compliant to ISO 7637
Housing	Anodized aluminium, CNC-machined
IP code	IP 60
Connector	1 x 35 position, AMP *automotive*
Communication with PC	CAN bus Ecumaster interface, Peak or Kvaser
Display type	TFT 800x600
Brightness of display	5” - 600 cd/m^2, 7” - 1000 cd/m^2
Inputs / Outputs	
Analogue inputs	8 inputs, 10 bits, 0-5 V, software controlled pull-up/pull-down 10K resistor. Al analog inputs can be used as a switches
Digital inputs	8 digital inputs, software controlled input sensitivity (VR, Hall), software controlled 4K7 pull-up resistors, used for engine speed sensors, Flex Fuel, wheel speeds, turbocharger shaft speed. All digital inputs can be used as a switches
Outputs	2 low side outputs (switch to ground), up to 2A
+ 5V output	Monitored 5V output for powering external sensors
Communication	
CAN Interface	2 x CAN2.0 A/B, 250, 500, 1000 Kbps
CAN streams	User-defined
Serial communication	RS232 Rx/Tx, AiM protocols, Ecumaster, Hondata Kpro, Autronic
USB	Used for logging to external USB memory
Others	
Light Emitting Diodes	15 ultra bright RGB LEDs
Accelerometer/gyroscope	3D accelerometer + 3D gyroscope for the analysis of vehicle dynamics
Real-time clock	Yes, battery powered
Light sensor	Yes, for automatic correction of brightness
Temperature sensor	Yes, for monitoring device temperature

Technical drawing

ADU 5 Drawing (all dimensions in mm):

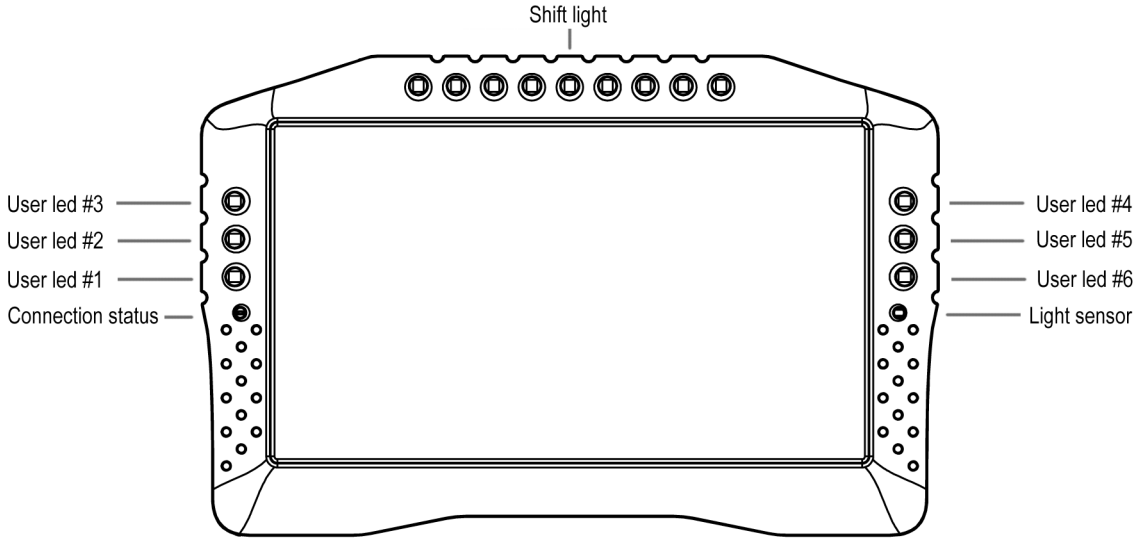


ADU 7 Drawing (all dimensions in mm):



Device description

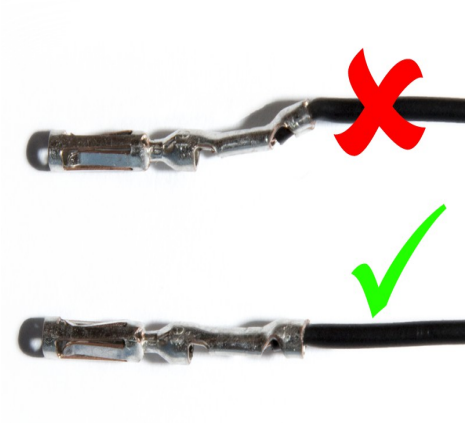
Front view



Position	Description
Connection status	LED indicating communication with PC. Flashes green when online
Light sensor	Light sensor is used for automatic control of the display and light-emitting diodes' brightness
User led #1- #6	RGB LEDs that can be controlled by user functions (e.g. Alarms, indicators, etc.)
Shift light	Gear change indicator (user configurable)

Connector

A single 35 position AMPSEAL connector on the rear of the display is used to connect the power supply, CAN buses and additional sensors or buttons.



A connector and terminals are included with the device. In order to crimp the terminals, use an appropriate crimping tool. We do not recommend soldering the wire to the terminal! If replacement terminals are required, the part number is AMP 770520-1.

It is critical that terminals are crimped correctly. This type of connector is very sensitive to the straightness of the terminal. If excessive force or improper tooling is used, the terminal will deform and will be difficult to install or remove. The portion of the crimp that supports the insulation must be circular and of a diameter equal to or smaller than the terminal.

In order to insert or remove terminals, the red terminal lock must be released to the halfway position, but not removed completely. To eject the red terminal lock, pry the two black latches using a sharp tool and gently pull the lock. The lock should extend by about 0.5 cm. The teeth prevent total removal of the red lock from the connector housing. In this position the connector housing is ready to have terminals inserted or removed.

Terminals should be inserted from the back side of the connector. The mat seal is designed to allow for the insertion of terminals. Do not attempt to disassemble the back of the connector housing.

Insert the terminal until you hear a click. Take care to only insert the terminal far enough to click. If the terminal is inserted too far (until it touches the front of the red terminal lock) the lock will be unable to return to its locked position.

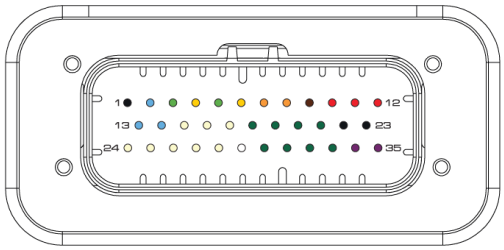
After all terminals have been inserted, push the red terminal lock back to its locked position. If excessive resistance is encountered, check to ensure that no terminals are inserted too far forward.

In order to remove a terminal, move the red terminal lock to the halfway position as described before. Grasp the wire near the connector, and rotate it left and right over a half turn each way to release the locking tabs, then pull the terminal out of the connector housing.

A video showing the proper assembly and disassembly of this connector can be found here:

https://www.youtube.com/watch?v=uXTkm_XV2OY

Connector - description



1	USB.GND	13	USB.DM	24	Analog in 8
2	USB.VBUS	14	USB.DP	25	Analog in 7
3	CAN1.H	15	Analog in 5	26	Analog in 6
4	CAN1.L	16	Analog in 3	27	Analog in 4
5	CAN2.H	17	Analog in 1	28	Analog in 2
6	CAN2.L	18	Frequency/ digital in 8	29	Analog output
7	RS232.RXD	19	Frequency/ digital in 6	30	Frequency/ digital in 7
8	RS232.TXD	20	Frequency/ digital in 4	31	Frequency/ digital in 5
9	Sensor ground	21	Frequency/ digital in 2	32	Frequency/ digital in 3
10	+5V output	22	Power ground	33	Frequency/ digital in 1
11	Switched 12V	23	Ground	34	Aux 1
12	Battery 12V			35	Aux 2

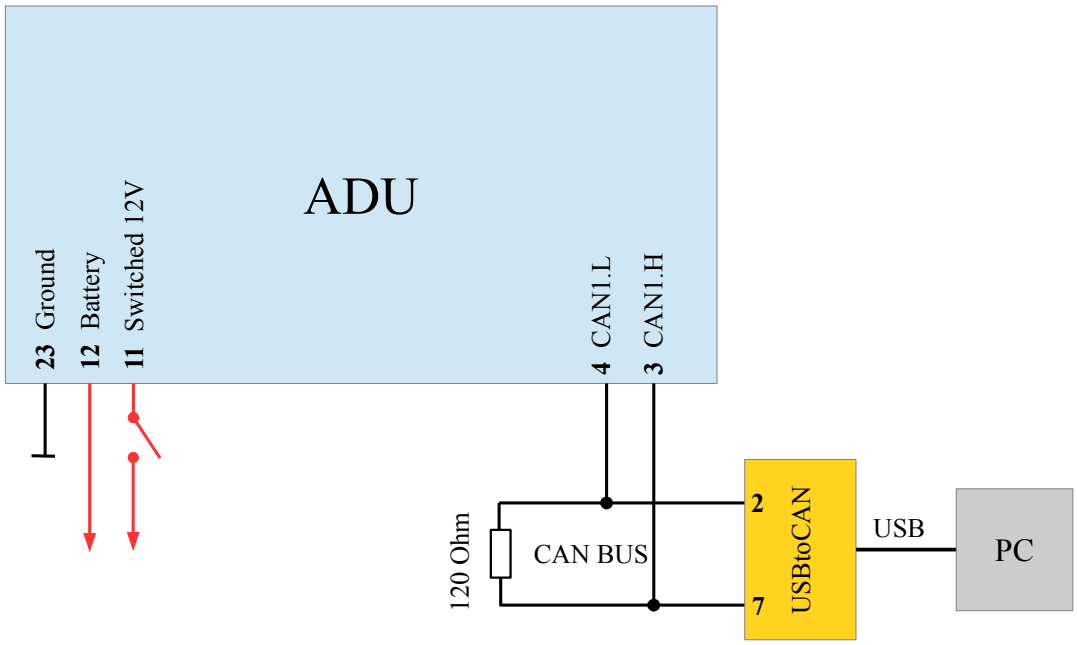
Terminal	Description
1. USB.GND	Ground for the USB port
2. USB.VBUS	VBUS signal for the USB port
3. CAN1.H	CAN H signal for CAN BUS 1
4. CAN1.L	CAN L signal for CAN BUS 1
5. CAN2.H	CAN H signal for CAN BUS 2
6. CAN2.L	CAN L signal for CAN BUS 2
7. RS232.RXD	RXD (receiving) signal for RS232 serial communication. Used for connection to EMU, Classic, Hondata, Autronic SM4 and AIM compatible ECUs.
8. RS232.TXD	TDX signal (transmitting) for serial RS232
9. Ground sensor	Ground for external sensors (e.g. Oil pressure sensor)
10. +5V output	+5 power supply for external sensors. Maximum load 400mA
11. Switched 12V	+12V signal to switch on the device. The device is internally powered by the 12 terminal (Battery 12V).

12. Battery 12V	Power supply and backup for the real-time clock when the device is turned off (when no +12V signal at terminal 11). In the case that there is no 12V battery power, the real-time clock is powered by an internal battery.
13. USB.DM	D- signal to the USB port
14. USB.DP	D+ signal to the USB port
15. Analog in 5	Analogue input 5. Measuring range 0-5V
16. Analog in 3	Analogue input 3. Measuring range 0-5V
17. Analog in 1	Analogue input 3. Measuring range 0-5V
18. Digital in 8	Digital input 8
19. Digital in 6	Digital input 6
20. Digital in 4	Digital input 4
21. Digital in 2	Digital input 2. The only input that can be used by a Flex fuel sensor
22. Power ground	Device ground used by the AUX outputs and LEDs
23. Ground	Device ground
24. Analog in 8	Analogue input 8. Measuring range 0-5V
25. Analog in 7	Analogue input 7. Measuring range 0-5V
26. Analog in 6	Analogue input 6. Measuring range 0-5V
27. Analog in 4	Analogue input 4. Measuring range 0-5V
28. Analog in 2	Analogue input 2. Measuring range 0-5V
29. Analog out	Analogue output 0-5V
30. Digital in 7	Digital input 7
31. Digital in 5	Digital input 5
32. Digital in 3	Digital input 3 .This is the only input that will read an AIM beacon
33. Digital in 1	Digital input 1. This is the only input that will support an RPM sensor
34. Aux 1	Low side output. Maximum load 2A
35. Aux 2	Low side output. Maximum load 2A

Installation

To start the device and communicate with a PC, connect the device's power supply and the USB2CAN interface to CAN1.

This bus has a constant speed of 1Mbps and one of its functions is communication with a PC.



The above figure shows the minimum connections required to power the device and enable communication with a PC.

The ADU is programmed through a USB to CAN adapter. Any of these three devices may be used to enable communication between PC and ADU:

- Ecumaster USBtoCAN (*www.ecumaster.com*)
- Peak Systems PCAN USB (*www.peak-system.com*)
- Kvaser USBcan (www.kvaser.com)

All of these interfaces are equipped with DB9 connectors, where CANL and CANH signals are on terminals No. 2 and No. 7 respectively.

The diagram also includes a 120Ohm terminator, which is necessary for the correct operation of the bus (for more information about the terminators see the CAN-BUS section).

IMPORTANT !

Do not connect the +5V output from the CAN interface to +5V ADU!

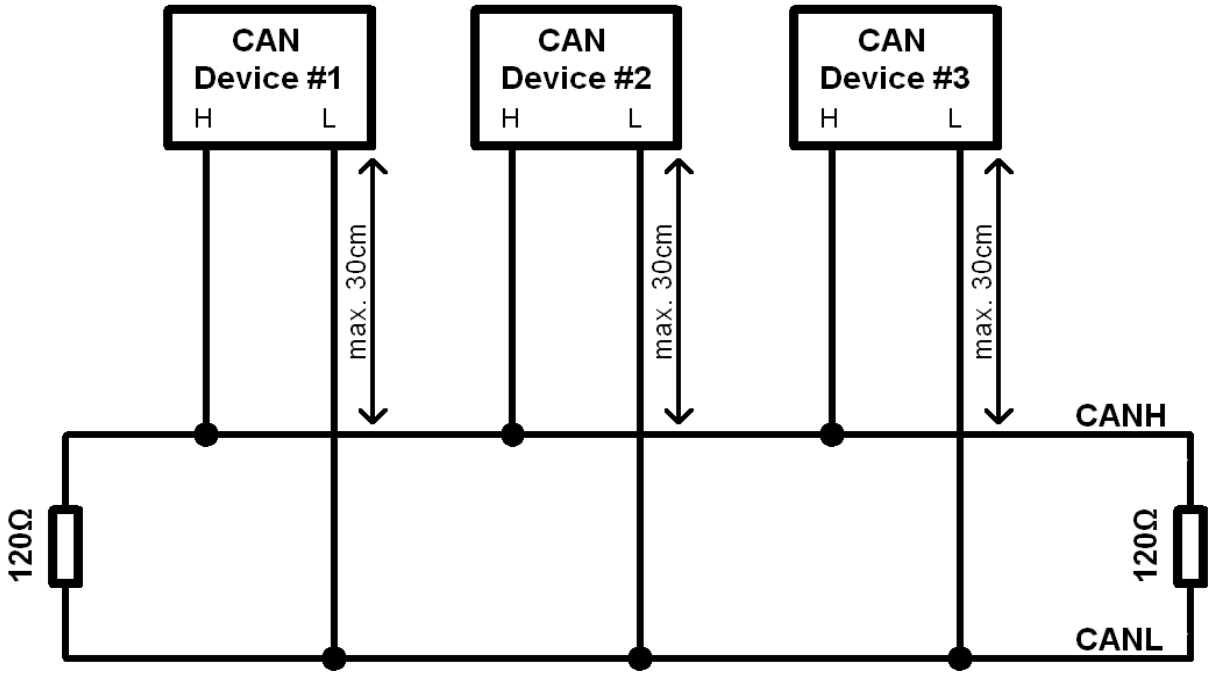
It is recommended to use an interface with galvanic isolation. The CAN bus is a differential signal bus and in most cases there is no need to connect the interface ground to the vehicle/ADU ground. If you want to connect an interface ground, measure the potential difference of the interface and the vehicle. Too large a potential difference can damage the device.

CAN bus

The CAN (*Control Area Network*) bus was developed to communicate between devices in automotive environments. Its construction is very simple (only two wires) and its immunity to interference is very high. In a modern car, there may be dozens of different electronic modules communicating with the use of the CAN bus.

The ADU device has two CAN buses: the CAN1 bus is used for communication with a PC (requires an additional interface) and devices that support 1Mbps speed.

Data frames are sent on the network. The network topology should look like the following:



In automotive applications, typical data transmission speeds on the CAN bus are 1Mbps, 500 Kbps and 250 Kbps. Depending on the speed, the following conditions must be met:

For a speed of 1Mbps:

- the length of the connection cable between the bus and the node must not exceed 30 cm.
- the maximum bus length is 40 m
- the maximum number of nodes is 30

For a speed of 500kbps:

- the length of the connection cable between the bus and the node must not exceed 30 cm.
- the maximum bus length is 100m
- the maximum number of nodes is 30

Regardless of the speed, the CAN bus must have 120 Ohm termination resistors at both ends. Additionally, all connections within the bus must be made using twisted pair wires.

It is important that the data transfer speed on a bus is identical for all devices.

WARNING!

Failure to follow these rules will lead to a malfunctioning CAN bus and problems with communication.

The CAN frame consists of an identifier (ID), the number of transmitted bytes (DLC), and the data. Depending on the bus type, the identifier may be 11 bits (0x0-0x7ff) or 29 bit (0x0-0x1fffffff). The number of data bytes may range from 0 to 8

ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7

Below is a sample CAN frame from a CAN Switchboard device.

ID	**DLC**	**Byte 0**	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
0x666	8	*Analog#1(mV)*		*Analog#2 (mV)*		*CALPOT 1*	*CAL POT 2*	*Switch mask*	*Heartbeat*

Parameter	**Description**
Analog#1	The voltage for the analogue input #1 0-5000mV, big endian
Analog#2	The voltage for the analogue input #2 0-5000mV, big endian
Switch mask	Bitmap of the pressed buttons (1 means pressed)
CAL POT #1	Discrete value of the position of the rotary switch connected to analogue input #1
CAL POT #2	Discrete value of the position of the rotary switch connected to analogue input #2
Heartbeat	The counter increases its value by 1 after sending each frame

Connecting to ECU

To be able to display and log data from the engine management unit, connect the ADU to the CAN bus of the ECU or its serial port.

When using a CAN bus, you may connect the ECU to the CAN1 (where the ECU CAN bus speed is 1 Mbps) or to the CAN2 bus where you can define the speed of the CAN bus.

When connecting to an OEM ECU, the typical speed is 500 Kbps (units with a 250 Kbps bus are rare), which forces us to use a CAN2 bus connection.

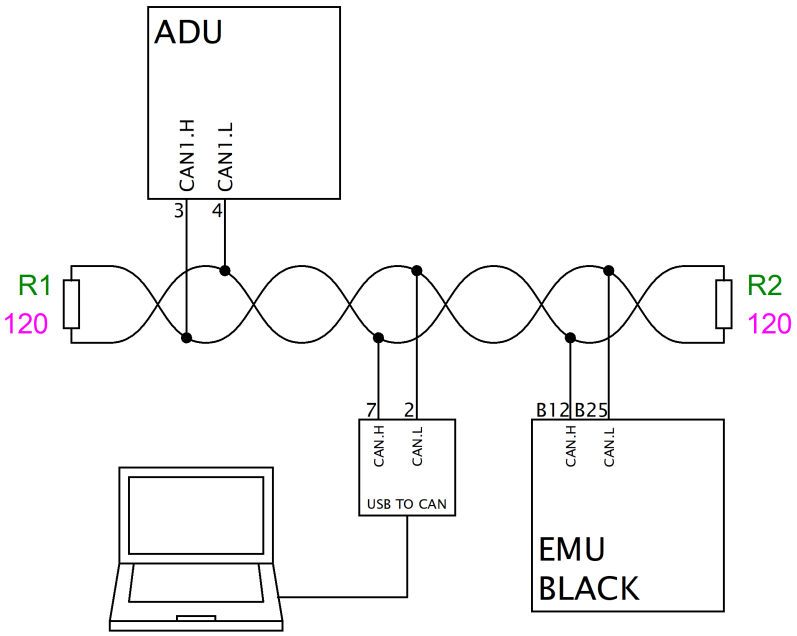
Some aftermarket engine management units used in motor sports do not have a CAN bus, but are equipped with a serial output. This is the case for the EMU, EMU CLASSIC, or Hondata. ADU supports the following serial formats: *AIM, Ecumaster serial protocol, Autronic SM4 and Hondata serial protocol.* For additional information, go to the **Serial communication** section.

In the case of factory controllers equipped with an OBD2 connector using the CAN BUS (all vehicles since 2008) it is possible to use the OBD connector to read basic engine operation parameters. For more information, see **OBD2** manual section.

External sensors may be connected to the ADU using the analogue and digital input channels (e.g. TPS, temperature and oil/fuel pressure sensors, crankshaft position sensor, etc.). As a result, you can monitor and log parameters that are not supported by the original engine control module.

Connecting to CAN bus

The following diagram shows an example connection of an ECU to the ADU using the CAN1 bus.



WARNING!

Engine control CAN bus driver speed must be at least 1Mbps. This is due to the fact that the ADU CAN1 bus supports only this communication speed.

IMPORTANT!

Please ensure the correct bus topology and its proper termination. For more information see the CAN BUS section.

If the CAN bus speed is different than 1Mbps or if you want to isolate the ECU from the ADU CAN1 bus, please use the CAN2 bus.

Detailed information on connecting specific ECU brands to ADU can be found in the application notes at www.ecumaster.com. Information about the channel configuration with CAN stream data can be found in the **CAN inputs** section.

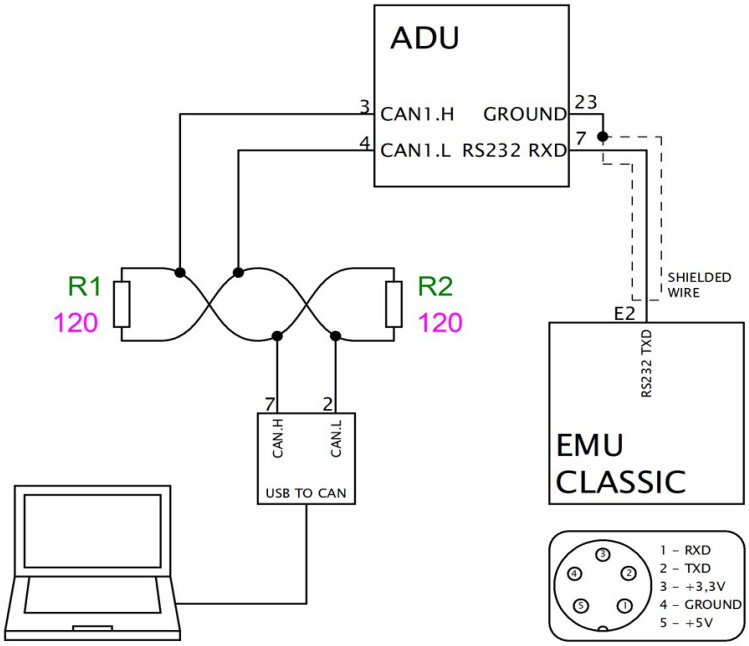
Connecting using RS232 serial communication

The ADU display has a built-in RS232 serial bus. In order to connect the ECU via a serial connection, connect the ECU output (*Tx*) to the ADU input (*Rx*) .

IMPORTANT!

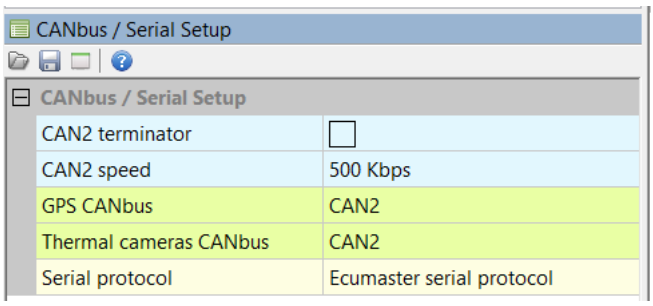
To transfer data via serial communication please use a shielded cable.

The diagram below shows an example of the connection.



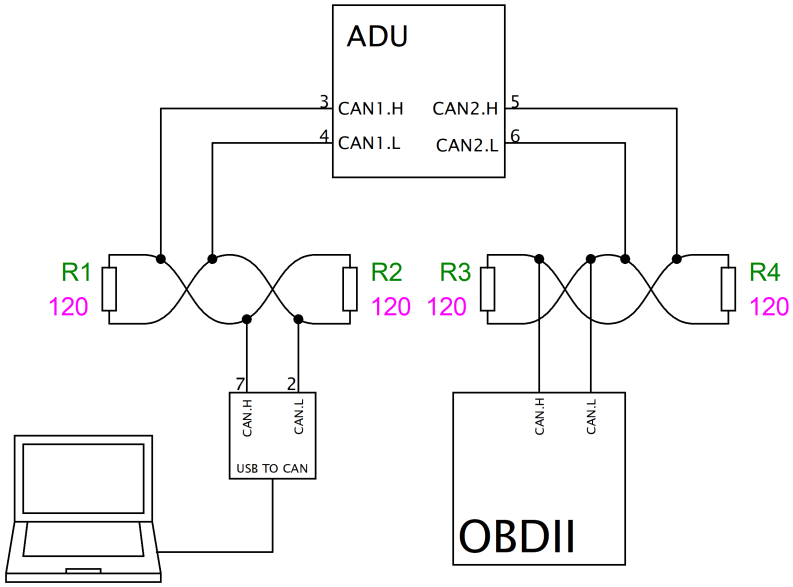
Detailed information on connecting specific ECU brands to ADU can be found in the application notes at www.ecumaster.com. www.ecumaster.com.

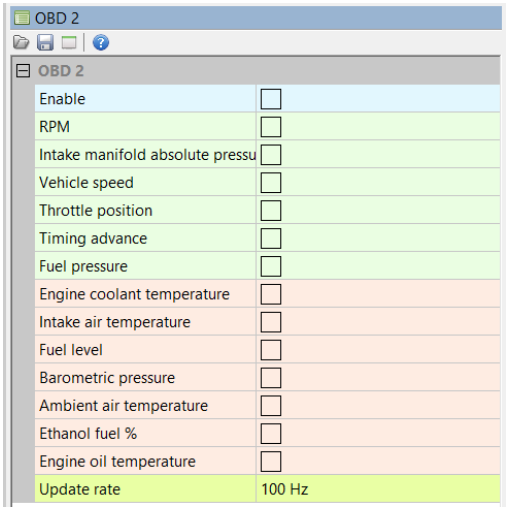
To configure the serial protocol (which depends on the ECU connected), select the appropriate protocol in the CAN Bus/Serial window (Ecumaster serial protocol, AIM, Hondata, Autronic SM4).



OBD 2

The following diagram shows the connection of the CAN2 bus to the OBD2 bus of the vehicle.





Set the correct CAN bus speed in the *CAN Bus/Serial* set-up window (it will usually be 500 Kbps). Then, select the desired channels in the OBD 2 window.

The channels are divided into two groups: quick (green) and slow (orange). Quick channels use 66% of the bandwidth (*update rate*) while the slow channels use 34%. This means that in the case of an Update rate equal to 100Hz (data is downloaded by OBD2 at 100Hz) and when the RPM channel is selected, it will be refreshed 66 times per second (66Hz). If you select an additional channel (e.g. *Throttle position*) the refresh rate for both channels will be 33Hz. It should be noted that not all ECUs are able to refresh the data at a frequency of 100 Hz. In such a case, lower the "*Update rate*" parameter.

IMPORTANT!

Not all channels found in the OBD2 window are available for different ECUs.

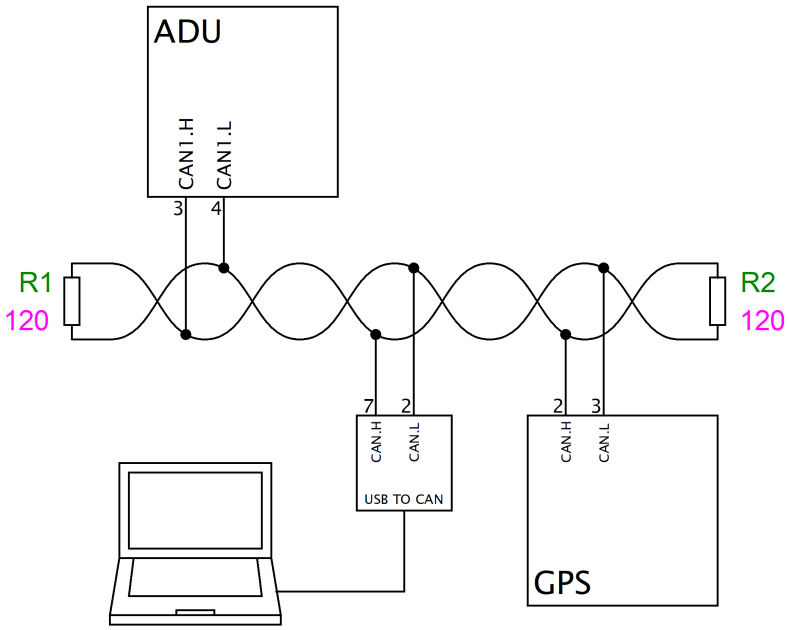
It is also possible to read a mix of parameters from an OEM ECU, e.g. throttle position and RPM can be read directly from the CAN bus and the remaining parameters from the OBD2 port. For further information go to **CAN inputs** section.

GPS module

The ADU display allows you to use the Ecumaster GPS module to measure lap times on track and allows data analysis based on the vehicle's position on the track.

To measure current position of the vehicle, the module uses information from GPS/Glonass satellites and a built-in accelerometer and gyroscope. The position is refreshed at a frequency of 20Hz.

By default, the GPS module speed is set to 1Mbps. Because of this, it is recommended to connect the GPS module to the CAN1 bus. A sample connection diagram is presented below:



After wiring the GPS module, it is necessary to configure the ADU. In the CAN bus/Serial setup options, select the CAN bus that the GPS module is connected to (GPS, CANBus).

The GPS module's channels are listed in the channel list, beginning with *gps*.

When using the GPS module, care must be taken to properly mount and calibrate the module. Due to the use of both a gyroscope and accelerometer for increased accuracy, the GPS module should be mounted using the supplied anti-vibration pads. The orientation of the module does not matter, but it must be calibrated after installation. The calibration happens automatically during the first few hundred meters of driving. Changing the location of the calibrated module should be followed by a short calibration drive.

For more information about measuring lap times with the GPS module, go to the **Lap times** section.

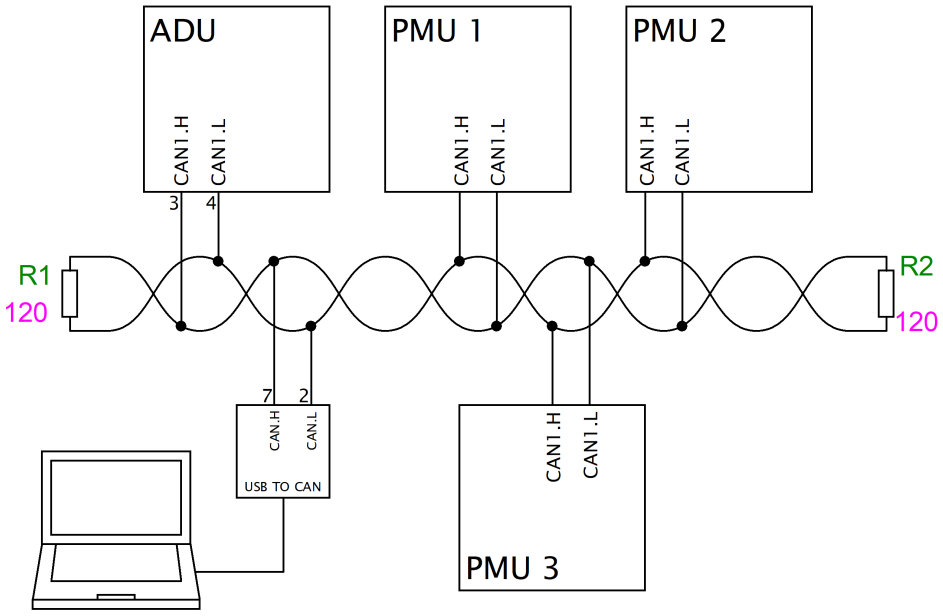
GPS channel list:

<table>
<tr><th>Channel</th><th>Description</th></tr>
<tr><td>gps.latitude</td><td>Latitude</td></tr>
<tr><td>gps.longitude</td><td>Longitude</td></tr>
<tr><td>gps.height</td><td>Height above sea level</td></tr>
<tr><td>gps.status</td><td>
<table>
<tr><td>0</td><td>Disconnected</td><td>no GPS module data (no connection)</td></tr>
<tr><td>1</td><td>No fix</td><td>unable to fix position</td></tr>
<tr><td>2</td><td>IMU</td><td>position is fixed using the built-in accelerometer and gyroscope</td></tr>
<tr><td>3</td><td>GPS 2d</td><td>position is fixed in 2D space using GPS/Glonass satellite data</td></tr>
<tr><td>4</td><td>GPS 3d</td><td>position is fixed in 2D space using data from GPS or Glonass satellites</td></tr>
<tr><td>5</td><td>GPS + IMU</td><td>position is fixed in 3D space and corrected using the built-in accelerometer (the highest accuracy)</td></tr>
</table>
</td></tr>
<tr><td>gps.fusionStatus</td><td>
<table>
<tr><td>0</td><td>Initialization</td><td>initialization and calibration of inertial sensors</td></tr>
<tr><td>1</td><td>Fusion</td><td>the device is using inertial sensors to correct the vehicle’s position</td></tr>
<tr><td>2</td><td>Suspend</td><td>temporary error of the inertial sensors</td></tr>
<tr><td>3</td><td>Disabled</td><td>error of the inertial sensors; they are not taken into account when determining the vehicle’s position</td></tr>
</table>
</td></tr>
<tr><td>gps.speed</td><td>Speed of the vehicle in km/h</td></tr>
<tr><td>gps.headingMotion</td><td>Direction of the vehicle motion. When the vehicle is skidding, the headingMotion value will be different from the headingVehicle value.</td></tr>
<tr><td>gps.headingVehicle</td><td>The direction in which the vehicle is heading. When the vehicle is skidding, the headingMotion value will be different from the headingVehicle value.</td></tr>
<tr><td>gps.accX</td><td>The longitudinal acceleration (longitudinal g)</td></tr>
<tr><td>gps.accY</td><td>The lateral acceleration (lateral g)</td></tr>
<tr><td>gps.accZ</td><td>The vertical acceleration (vertical g)</td></tr>
<tr><td>gps.gyroX</td><td>The angular velocity of the vehicle’s longitudinal axis</td></tr>
<tr><td>gps.gyroY</td><td>The angular velocity of the vehicle’s lateral axis</td></tr>
<tr><td>gps.gyroZ</td><td>The angular velocity of the vehicle’s vertical axis</td></tr>
<tr><td>gps.noise</td><td>The average noise level of the satellite signal. The lower the value the better</td></tr>
<tr><td>gps.numSatelites</td><td>The number of satellites used to fix position</td></tr>
</table>

Ecumaster PMU

If connecting the ADU to a system that includes a PMU, it is recommended to connect CAN1 of the PMU with the CAN1 bus of the ADu. This allows for easy communication with a PC and between the devices.

A sample connection diagram is presented below:

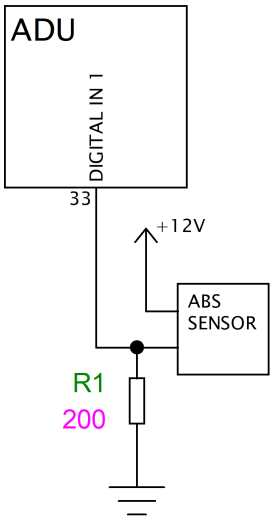


Digital inputs

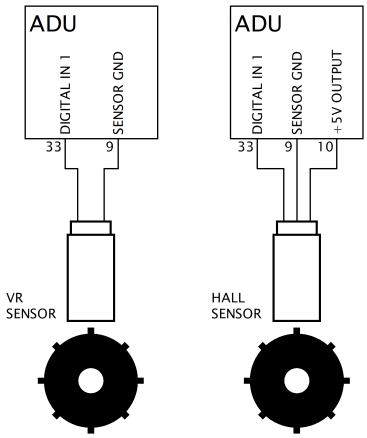
Digital inputs are used to process frequency signals (e.g. engine speed sensors, turbocharger speed sensors, Flex Fuel sensors) and beacons, as well as switches.

It is possible to read signals from inductive sensors (VR sensors), Hall effect sensors or optical sensors. The digital inputs have built-in switchable 2k2 pull-up resistors (pull-up to +5V), which may be used for Hall sensors or switches shorted to ground.

Magnetoresistive ABS sensor connection example

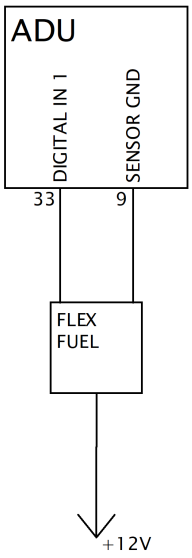


Connection example for crankshaft position sensor (Hall and VR sensor).

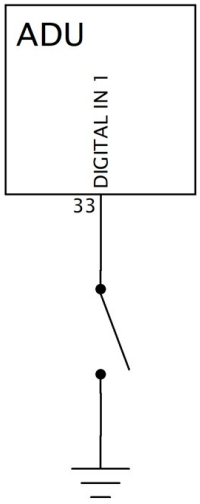


If an VR sensor is used, it is recommended to use shielded wires.

Flex Fuel sensor connection example



Example of switch connection



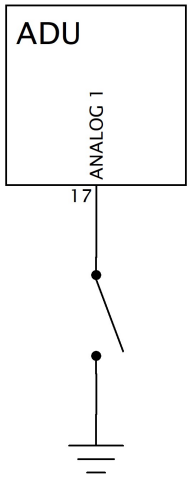
Analogue inputs

Analogue inputs are designed to measure signals from 0-5V (voltages above 5V are read as 5V) at a frequency of 500Hz.

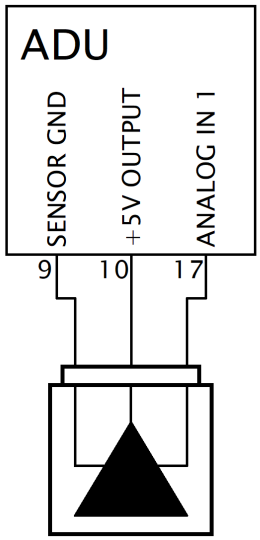
The primary use for these inputs is to display and log signals from analogue sensors such as pressure sensors (oil, fuel, water, etc.) or thermistors (e.g. oil temperature sensor, fuel level sensor.). These inputs can also used to connect switches.

The voltage of all analogue inputs may be transmitted to other devices (e.g. EMU, EMU BLACK) using the CAN bus.

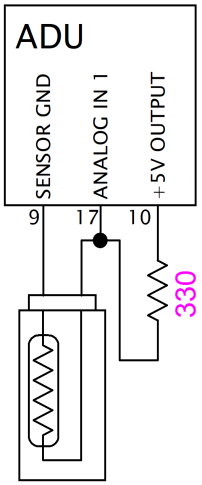
Switch connection to analogue input example



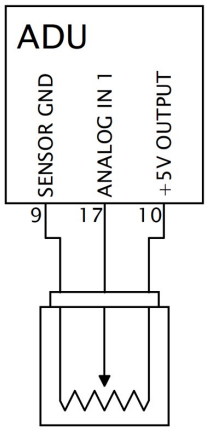
Oil pressure sensor connection example



Oil temperature sensor connection example



Potentiometer

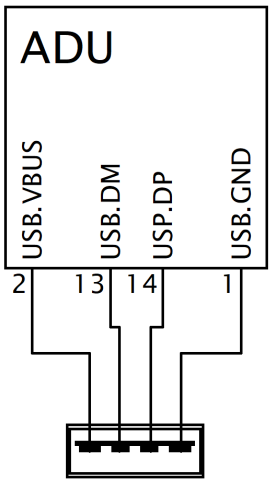


USB Flash drive (*pen drive*)

The ADU features the ability to log data to a commonly available USB flash drive. The built-in real time clock (battery powered) is used for recording the date and time to each file. The supported file system is FAT32. File size depends on the number of channels defined and the frequency with which they are stored. For more information on data logging see the **Logging** section.

It is recommended to use name brand flash memory sticks compatible with USB 3.0 (e.g. Sandisk Ultra, Sony USM8W3, USM16W3, USM32W3). Using USB flash drives with poor specifications can lead to data recording interruptions.

USB Connection Example

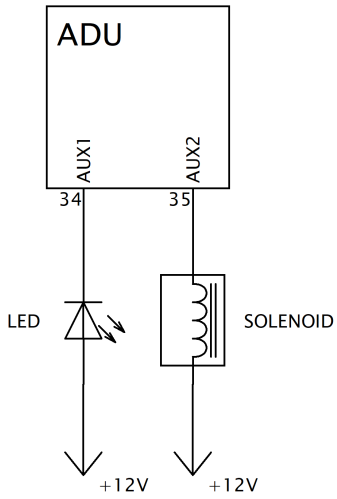


IMPORTANT!

Please note: **D+ and D- cables should be *twisted pair* wires and the cable must be shielded.**

Low side outputs

Built-in low side outputs (shorting to ground) may be used to control passive components (e.g. LEDs, solenoid valves, relays) according to user-defined parameters (e.g. radiator fan activation, signaling).



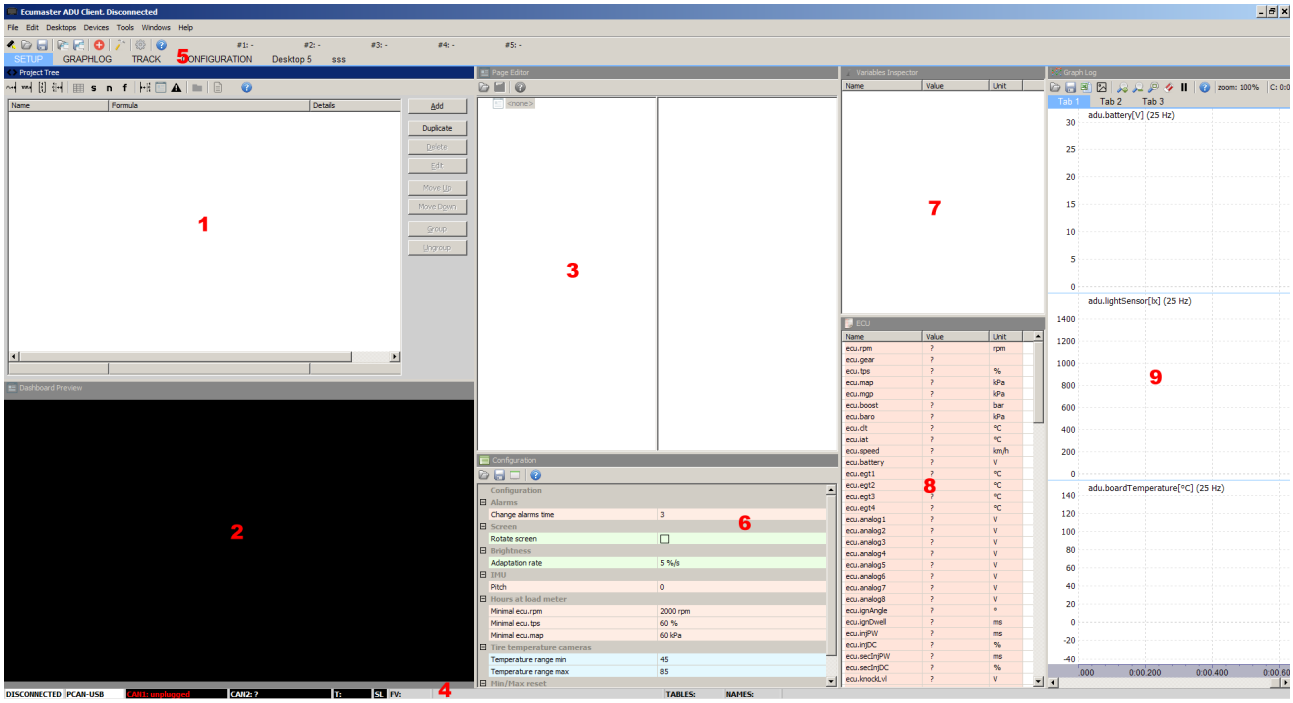
Windows software

Configuring the display requires the Windows based software available at www.ecumaster.com.

Hardware requirements to run the software:

- Windows XP, VISTA, 7, 8 and 10 (32 or 64 bit)
- Minimum screen resolution of 1366x768
- Open GL-supporting graphics card
- 2GB RAM
- A USB port

After installing and opening the software, you should see the following screen:



The primary window is the *Project tree (1)* pane. Use this pane to define all project items. Click *Add* to add a new item.

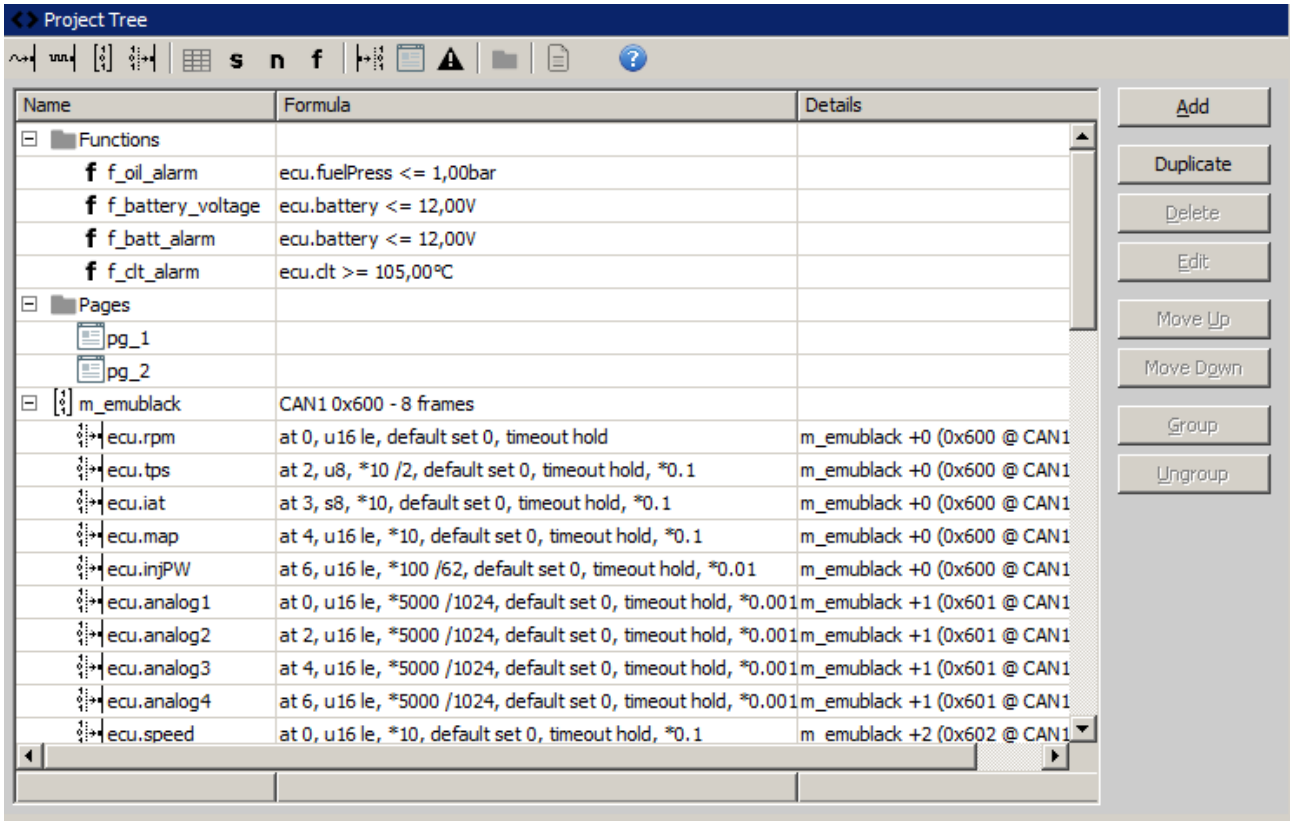
You may choose from:

- ***Analog input*** – an analog input, where parameters can be defined, such as the input channel, the name of the variable, the type (temperature, pressure), pullup etc.
- ***Digital input*** – a digital input whose properties can be defined, such as type, sensitivity, variable name, pullup, etc.

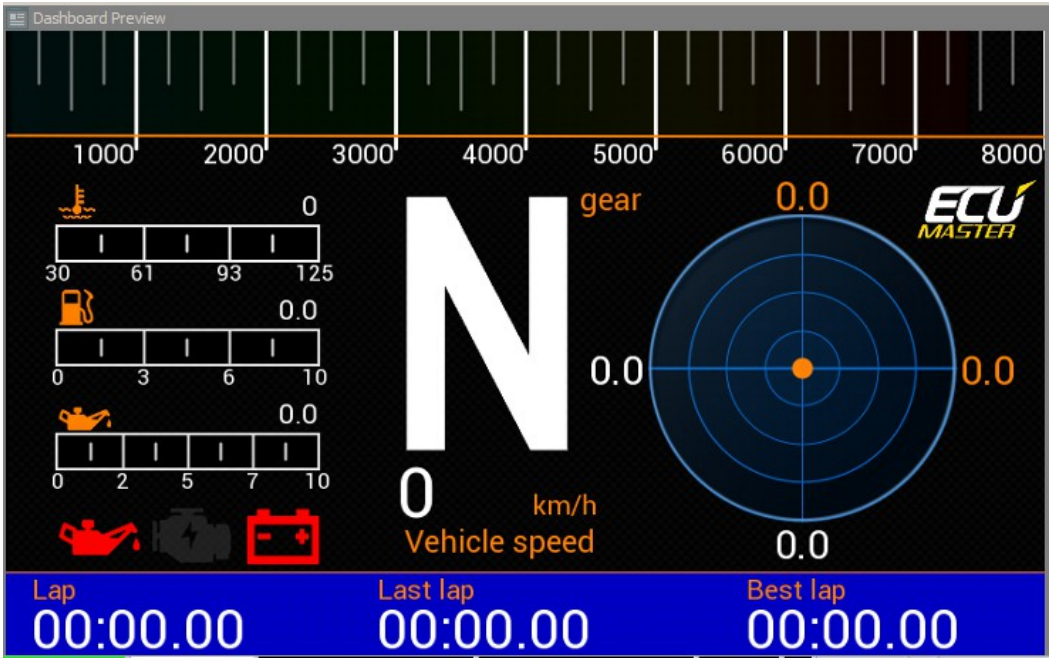
- ***CAN Bus message object*** – a CAN message, where individual CAN frames will be located. A CAN message object contains enough data for several individual messages.
- ***CAN Bus input*** – An input message used to receive and format data via CAN
- ***Table*** – a user definable table used to interpret data (e.g. transform an analog input voltage into temperature)
- ***Switch*** – a switch input
- ***Number*** – enables you to define a mathematical function to convert variable values (e.g. Converting a raw voltage from an analog input voltage to represent pressure)
- ***Function*** – enables you to create complex logic functions
- ***CAN Bus export*** - enables you to send CAN frames with variable and fixed values
- ***Page*** – a single page displaying data. If more pages are added, they can be switched on and off or cycled through using conditional functions (warning page when a temperature or pressure value is exceeded) or user switches (page up/down switches)
- ***Alarm*** - a display item showing any alarms, regardless of the current page
- ***Group*** – intended for grouping items. This allows for prioritization when working on larger or complex projects.
- ***Import .CANX*** file – this function is used for downloading predefined CAN streams for devices (e.g. EMU BLACK, MOTEC M1, etc.)

When adding items to a project take care to group them into logical categories. Attention should be paid to giving proper names to items and variables to facilitate managing a project in the future. You can also duplicate project items easily by means of the ***Duplicate*** button.

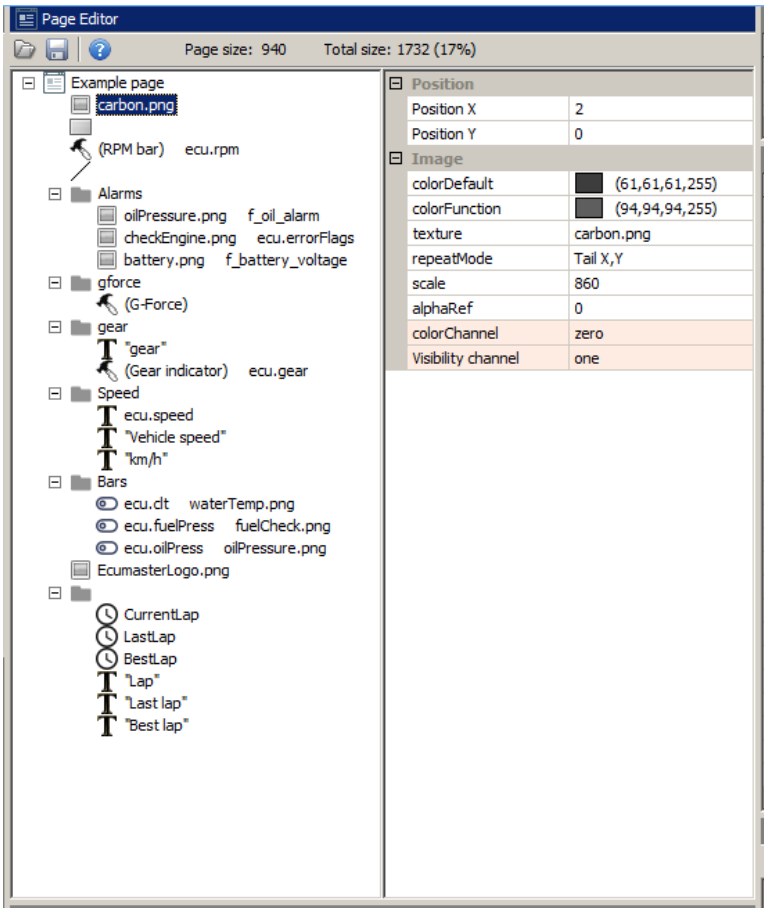
Example project shown below



The page preview screen (2) allows you to preview and edit the currently selected page. If your PC is connected to the ADU, all changes to a page are sent to the device in real time.



The preview screen works in conjunction with the page editor (3) which allows you to add and edit the graphic elements on a page. More information about pages is provided in the *Pages* chapter.



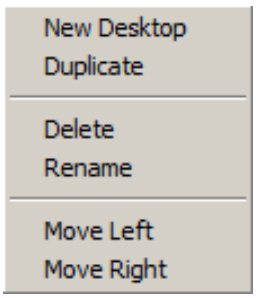
Another important element of the interface is the status bar (4), which contains important information on the status of a connected device.

Connection status	Specifies, whether a device is connected.
CAN interface	Shows the CAN to USB interface type. The following interface types are supported: - ***USBtoCAN*** - an interface by ECUMASTER - ***PCAN-USB*** - a interface by Peak System - ***Kvaser*** - an interface by Kvaser
CAN 1 status	The status of the CAN 1 bus from the USB to CAN interface
CAN 2 status	The status of the CAN 2 bus read from Can controller of the ADU display
Board temperature	Device temperature
FV Version	Internal firmware version
Device type	Device type - 5” or 7”
Used resources	The number of functions used
Tables	The memory available for 2D and 3D user maps
Names	The memory available for item names (can inputs, functions, etc.)

If the Can bus (1 or 2) status differs from OK, it means there are errors along the bus. The most frequent problems include:

1) A device on the CAN bus is the wrong speed
2) The device is not connected to the CAN bus
3) CANL and CANH are connected incorrectly
4) Incorrect or missing network termination
5) Bus damage (short circuit between CANL and CANH, or a short circuit along a GND or power cable)

Desktops are an important component of the interface. They enable you to create your own sets of panes, which speeds up the configuration process. Right click and the following menu will on a tab:

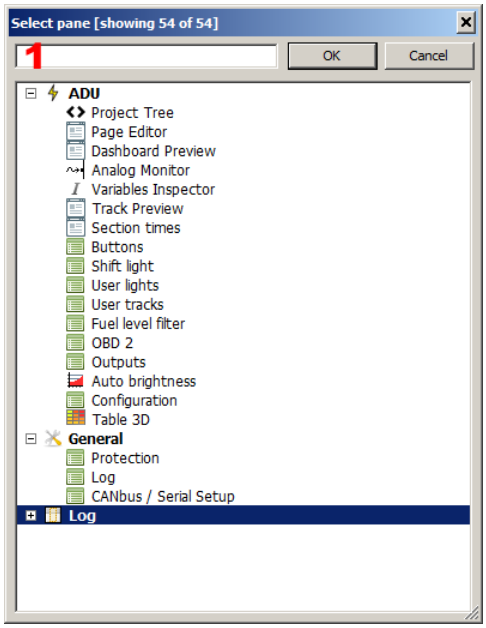


New desktop	Create new desktop. The new desktop will appear on the far right.
Duplicate	Duplicate a desktop. This option creates a new desktop copying the contents of the original desktop.
Delete	Delete a desktop.
Rename	This function enables you to change the name of a desktop.
Move Left	Moves a desktop to the left.
Move Right	Moves a desktop to the right.

To save the current desktops to your computer, press F2 (*Make permanent).* Desktops are also saved when the ADU application is closed. Desktops may also be saved as a file and used on another computer. To do this, click the ***Desktops/Save desktops template*** option. To return to the default settings select ***Desktops/Open desktop template*** and load *programDefault.adulayout* file.

Panes are an important element of the interface, containing all of the data and parameters you will be working with. All device configuration will be done in panes. Press F9 (or click the + icon on the toolbar) to add a new pane with parameters. A dialog box with all available panes will appear.

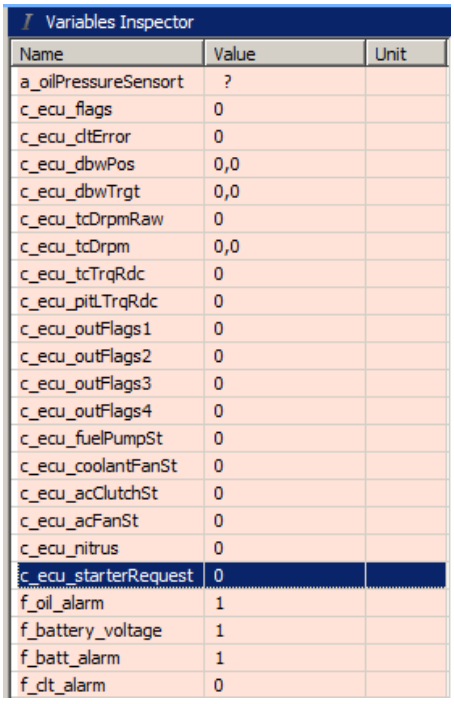
At this point you may manually locate the pane you want to add, or you can start typing in the search prompt at the top of the dialog box(1). The results will be filtered as you type, showing only the panes that contain your search term as a parameter. Double-clicking on a pane, or clicking it once and hitting 'Okay' will cause it to appear on the desktop. New panes always appear on the right-hand side. Panes may be moved by left-clicking on the title bar and dragging the pane to a new location. To remove a pane from the desktop, right click on its title bar and select '***Close Pane***' from the drop-down menu.



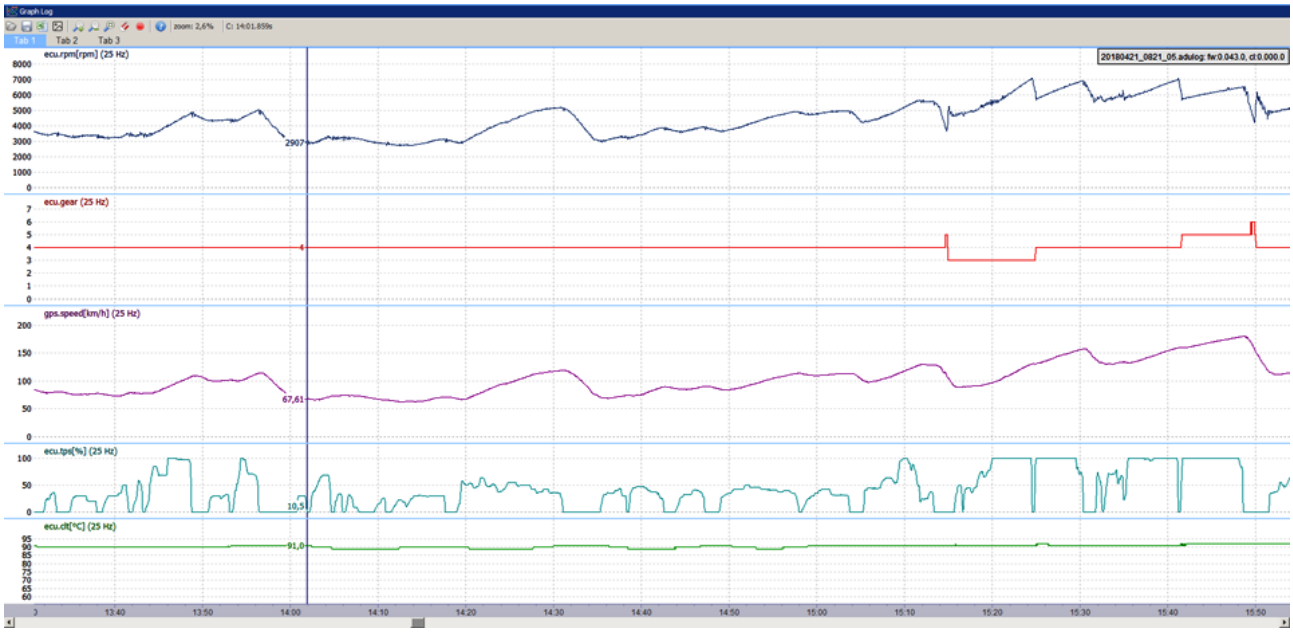
There are different pane types. Configuration panes contain settings. Another pane types are used for viewing data in real time, such as the ***Variables inspector*** *(7)*, the log channels preview *(8)* or the graphic log (9).

The ***Variable Inspector*** pane is used for previewing values of the variables defined in a device. These variables include functions, numbers, Can (CAN) inputs, etc.

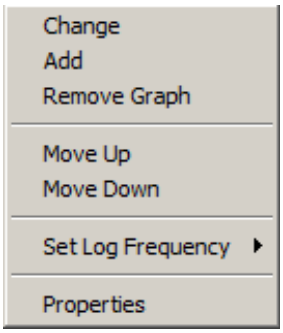
When a value displays the ***?*** Symbol instead of a numeric value, that means the log function for this channel is deactivated. To activate logging or change the log frequency of a given channel, right click on a given variable and select '***Set log frequency***' then choose the desired frequency from the drop down menu. There are several panes available that group common channels together, such as: ***Analog inputs*** (displays the analog input values), ***Digital inputs*** (displays digital input values), ***CAN BUS message objects***, ***CAN BUS inputs***, ***Tables*** (values from the tables), ***Numbers*** (mathematical function values) or ***Functions*** (logical function values).



Another pane type is the ***Graph log***. The ***Graph log*** displays values over time.



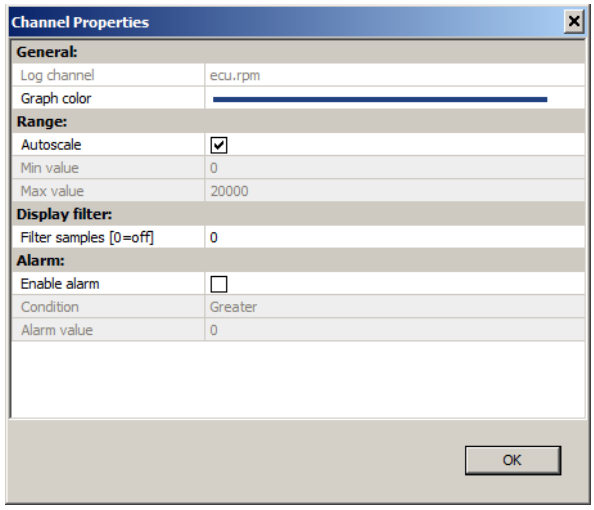
The following menu appears after right clicking on the log area:



Here you can add a new log channel (***Add***), remove an existing log channel (***Remove Graph***), change a log channel (***Change***), or relocate a channel (***Move Up, Move Down***). You may also change the log frequency (***Set log frequency***) and change the display settings for a given channel (***Properties***).

Just like the main desktop of the application, the log pane has tabs that are used for displaying different log channel groups (e.g. engine, track, etc.). These tabs work exactly the same way as the main desktop tabs.

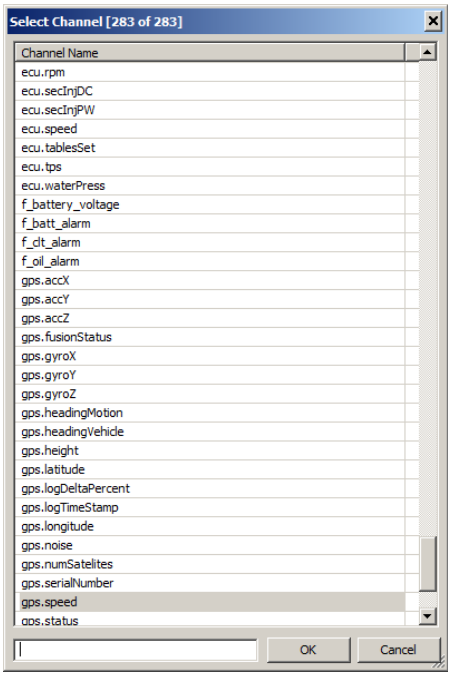
To alter settings for a logged channel, right click on the channel name and click 'Properties'. In this meny you may choose the colour (***Graph Colour***) and the range of values for the channel (*Min. and max. value).* The ***Autoscale*** option performs an automatic calculation of the display range based on logged data. In this menu you may also enable the ***Filter samples*** option, which defines the number of data samples that will be averaged to generate the displayed value. The 0 value means no filtering.



On the ***Graph Log*** toolbar there are icons that allow you to save or open a log file from your computer, save the displayed channels as a cvs file, save the currently displayed log as a png file, change the scale, and stop/resume a log. Keyboard shortcuts allow you to navigate the ***Graph Log*** pane without a mouse. The shortcut keys are as follows:

Right / left arrow	Move a log right or left. To move a log faster, hold the Shift key while pressing an arrow key
Up arrow or q	Zoom in
Down arrow or a	Zoom out
Z	Zoom all (scales entire log to fit in current window)
Mouse scroll	Scroll up- zoom in, scroll down, zoom out
Left mouse button	Click and drag to select an area
Middle mouse button	Move the log area

When changing or adding a channel, a channel selection pane appears on the graph. In order to search, enter the channel name in the search box to filter the available channels. e.g. entering the word 'gps' will cause only the channels containing the word 'gps' to be displayed.



Some functions are available in the application's menu. The following is a description of all available Menu functions

File	
Open project...	Open a previously saved project ***(CTRL + O)***
Save project	Save to a recently opened / saved file ***(CTRL + S)***
Save project as...	Save a project to a new file ***(CTRL + SHIFT + S)***
Import log...	Import a log from a pendrive ***(SHIFT + F4)***
Show full screen	Activate full screen mode to increase the available screen space for

	the application ***(CTRL + F)***
Upgrade firmware...	Update the internal software of the device
Restore to defaults	Restore a device to the default settings Deletes all settings
Make permanent	Saves changes to the Flash memory of a device Additionally, a file containing the current settings is saved to the *MyDocuments/ADU/DeviceName/QuickSave* catalogue **(*F2*)**
Exit	Exit the application. The desktop arrangement is saved upon exiting ***(ALT + X)***
Edit	
Undo	Undo the most recent operation ***(CTRL+Z)***
Redo	Redo a previously undone operation ***(CTRL+Y)***
Show undo list	Displays a pane with all operations performed
Toggle debug log	Displays the console logging the program operations ***(SHIFT + F9)***
Desktops	
Restore desktops	Reads desktops layout from *MyDocuments/ADU/Default/desktops.adulayout* file
Store desktops	Saves desktops layout to *MyDocuments/ADU/Default/desktops.adulayout* file
Open desktop templates...	Reads desktop configurations to a selected file. This allows to transfer configurations between computers
Save desktop templates...	Saves desktop configurations to a selected file. This allows to transfer configurations between computers
Add new pane	Adds a new pane to the desktop **(*F9)***
Switch to desktop	This option allows to switch between desktops
Previous desktop	Switch back to the previous desktop ***(CTRL+PGUP)***
Next desktop	Switch to the next desktop ***(CTRL+PGDWN)***
Devices	
Device selector	If one or more ADU devices are connected, a pane enabling switching between the devices will pop up. After switching to a device, the data between the PC and the device will be automatically synchronized. The names of particular devices are shown on the right hand side of the application toolbar. The currently connected device is shown in bold type
Set device #n	Automatic switching to the connected device no. #n. After switching to a device, the data between the PC and the device will be automatically synchronized. The names of particular devices are shown on the right hand side of the application's toolbar. The

	currently connected device is shown in bold type. ***(CTRL+SHIFT+1 do 5)***
Set device name	This function allows to give a name to a connected ADU device.
Reboot device	Reboots a connected device **(CTRL + SHIFT +R)**
Reconnect	Reconnects a device ***(CTRL + SHIFT + B)***
Receive log file	Read logs from USB memory connected to the PC ***(SHIFT+F4)***
Set real time clock	Setting the real-time clock of ADU according to the current PC time This time is used to date the files of a log saved into an external USB memory. It can also be displayed on the screen of a device
Generate pinout	This option generates an html file with a device port documentation (it shows the terminals in use and the functions assigned to them). It also generates CAN message objects for CAN and CAN2
Send data to ADU	Sends data to ADU and restarts all functions
Tools	
Texture manager dialogue	Displays a dialogue for managing the dashboard textures (graphics). You will find more information regarding texture management further in the manual
Customize keys	Changing the shortcut keys
Reset track data	Resets all times for a given track. It is possible to reset track data using an internal button connected to an ADU device
Logged channels	Display a dialogue with a list of all log channels and their frequency. Current size of the log data is visible at the bottom of the pane (number of channels and bites) ***(F8)***
Project tree	Displays the project pane ***(SHIFT+F7)***
Analogue monitor	Displays the analogue channel monitoring pane. ***(SHIFT + F10)***
Variables inspector	Displays the variables monitoring pane ***(SHIFT + F11)***
Options	Displays a dialogue with the application options ***2D tables colour*** – colour map 2D ***3D tables colour scheme –*** colour scheme for 3D maps ***Auto save logs –*** automatic saving of logs onto the disc ***Use mouse wheel to zoom on Graph log –*** activates the log scaling function by means of the mouse wheel

Pages

Pages represent what will be displayed on the ADU screen. The ADU software allows you to create multiple pages (the number allowed depends on their complexity and memory usage).

You can switch between pages by means of an external button or a function (e.g. a different page is displayed when the car is stationary than when it is moving).

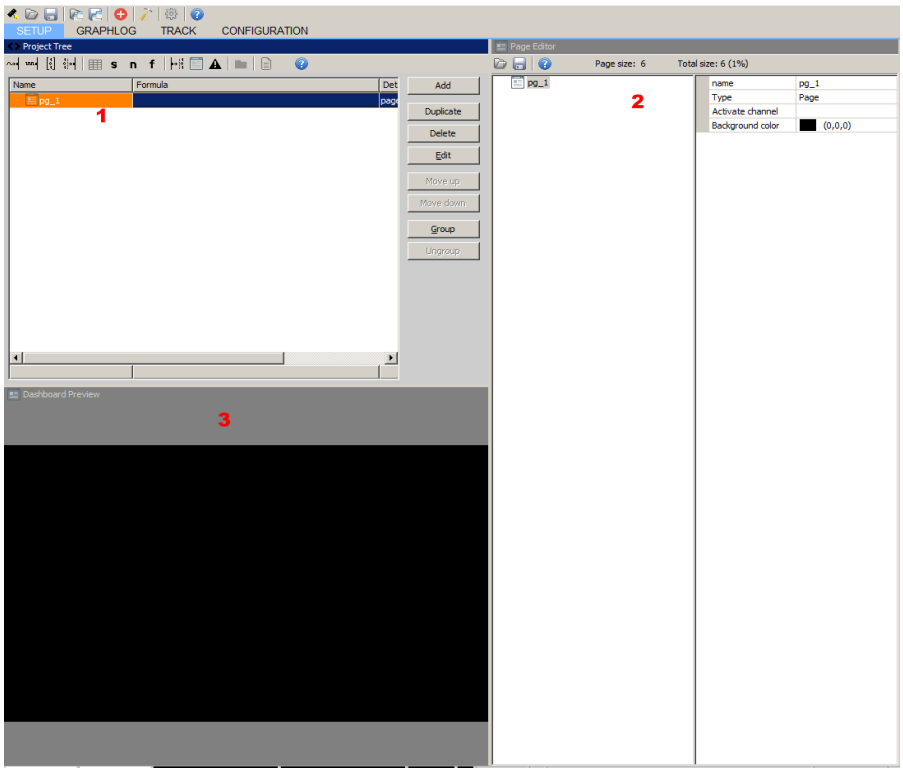
There are 3 types of pages:

- ***Page*** – a standard page
- ***Overlay*** – a page which can be overlaid on another page.
- ***Overlay with background*** – a page similar to the ***Overlay*** page, but with a non-transparent background

Additionally, an alert or warning can be displayed regardless of the current page (more information in the Alerts chapter*).*

Creating a page

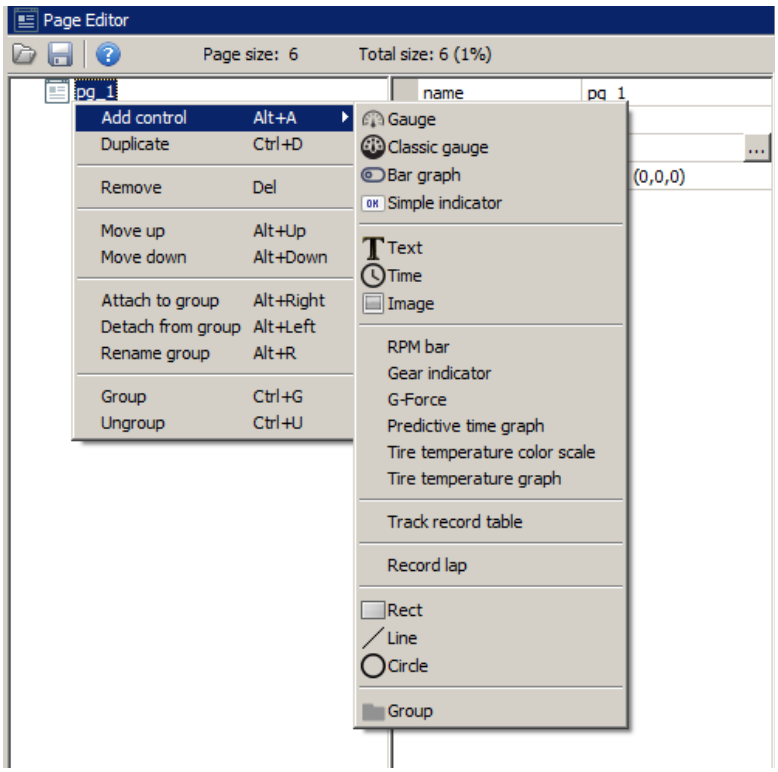
To create a page click ***Add*** in ***Project tree*** and select *Page*. A ***pg_1*** (1) page should appear in the project.



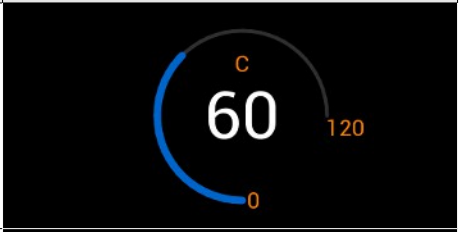
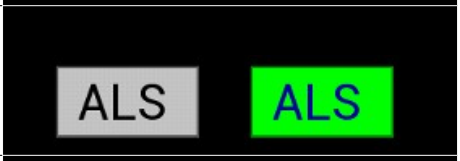
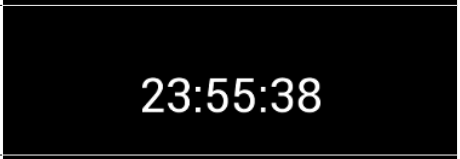
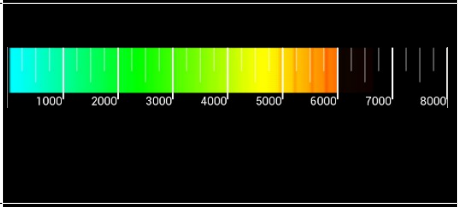
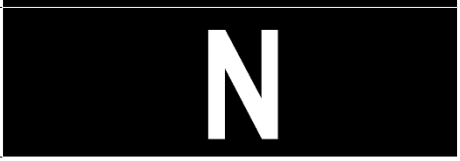
The currently selected page with its elements and configuration will appear in ***Page editor*** *(2).* At this point we don't have any elements defined for the page shown, but we can set the following page attributes:

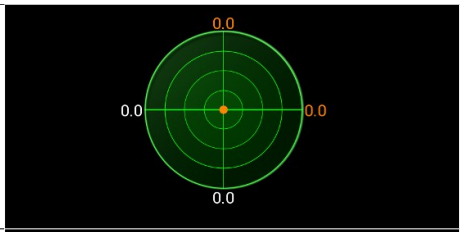
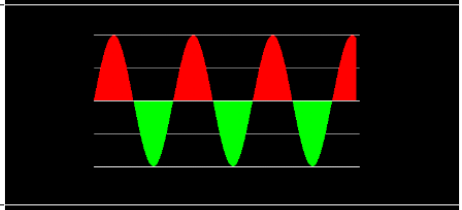
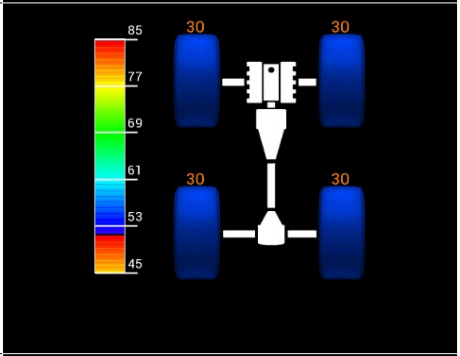
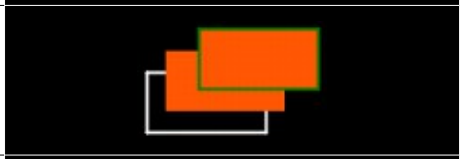
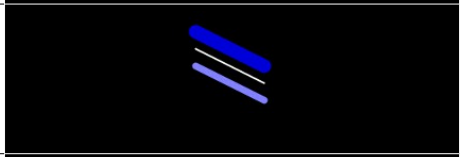
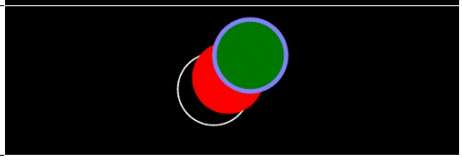
Attribute	Description
Name	Page name in the *Project view*
Type	Page type: - ***Page -*** *a* standard page - ***Overlay –*** a page than can be overlaid on another page - ***Overlay with background –*** a page similar to the ***Overlay*** page, but with a non-transparent background
Activation channel	Name of the channel or function that can automatically activate the page
Background style	**Solid color** – the background is a solid color defined by the ***Background Color field***, **Theme** – the background is a predefined graphic stored in the device
Background color	The colour of a page background

To add an element to a page, right-click the page name in the page editor, select ***Add control***, and choose the desired element from the menu. You may also open the menu by pressing ***Alt + A***.



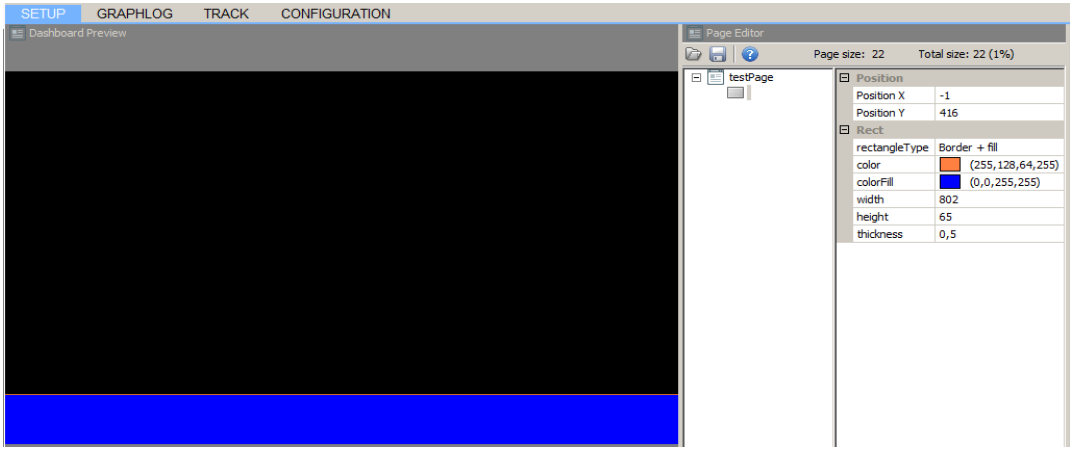
Page elements

Element	Description	Preview
Gauge	A round gauge displaying a numerical value, visualized with a circular segment.	
Classic gauge	A classic gauge resembling a car gauge. Visualized with a numerical value and a pointer with hashmarks.	
Bar graph	A numerical value visualized using a moving bar (horizontal or vertical). It is also possible to display an icon representing the measured value.	
Simple indicator	An icon using two texts in two different colour sets, switched using a log channel or function.	
Text	Displays text in different font sizes and colours. You can also attach a log channel (e.g. injection time, cooling liquid temperature, etc.) to the text.	
Time	Displays formatted time. You can choose from the following times: real time, lap time, last lap time, best time, and session time.	
Image	Displays one of the following graphic elements on the page: background, logo, icon. You may use the graphics available in the device or load one of your own from a file.	
RPM bar	This indicator is dedicated to displaying engine speed. There are three ways in which it can be displayed - a horizontal bar, a curved bar and a round gauge.	
Gear indicator	Indicates the current gear selected and uses a special, enlarged font.	

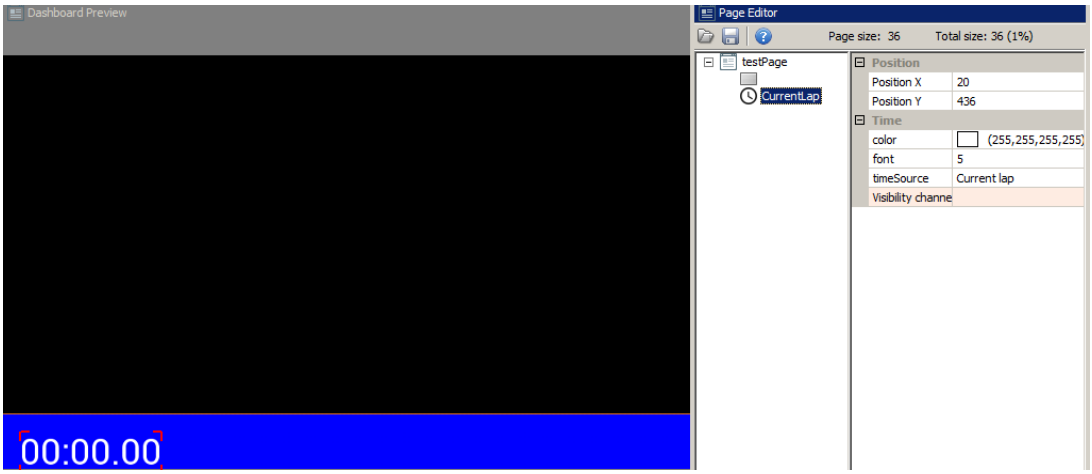
G-Force	The g-force indicator uses the internal accelerometer of the device.	
Predictive time graph	A graph displaying the current difference between a lap time and the best time. Green indicates a faster time, while red indicates slower.	
Tire temperature graph and tire temperature scale	Displays tire temperature from thermal imaging cameras and indicates their maximum temperature. This indicator can also display tire temperature in the form of horizontal bars with a temperature gradient (16 values for each tire).	
Track record table	Indicates 8 best times recorded on a given track. These times are saved in the device memory.	
Rect	Displays a rectangle in the form of a frame or a filled-in shape.	
Line	Displays a line of any colour or thickness as selected.	
Circle	Creates a circle of any colour, with or without a fill color.	

Adding page elements

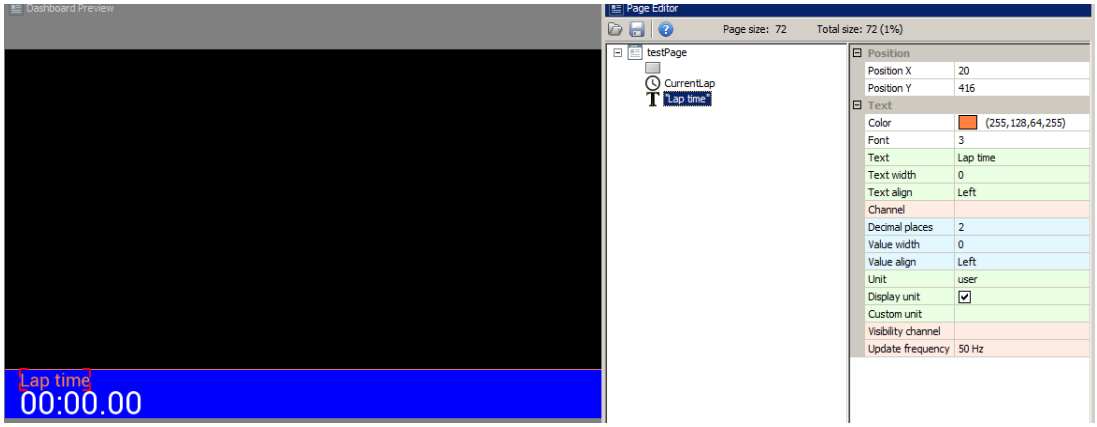
We will now create an example page. Let's start with placing a ***Rect*** item on it. You may position the item by left clicking and dragging it. If you are connected to your ADU device, the item will also move on the display. You can change the ***Rect*** item parameters in the ***Page editor.*** After entering the parameters shown below, the page will look as follows:



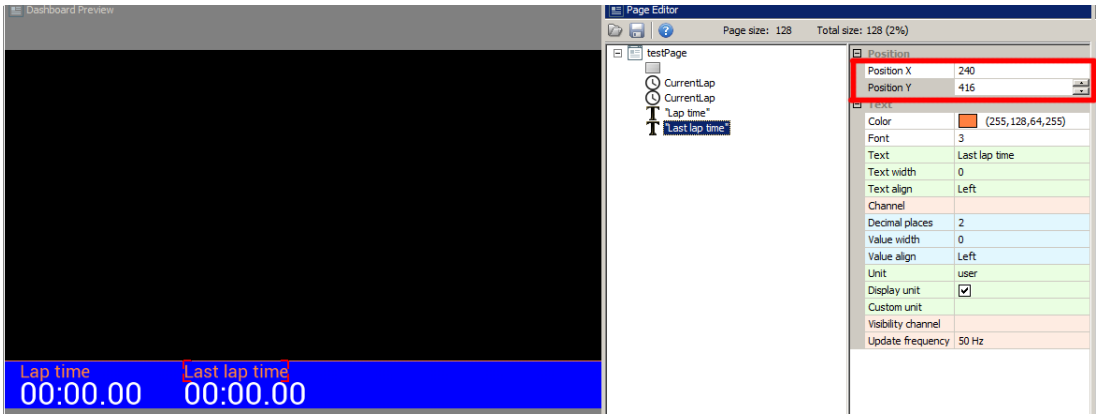
Now, we will add the current lap time. To do this, a **Time** item should be added.



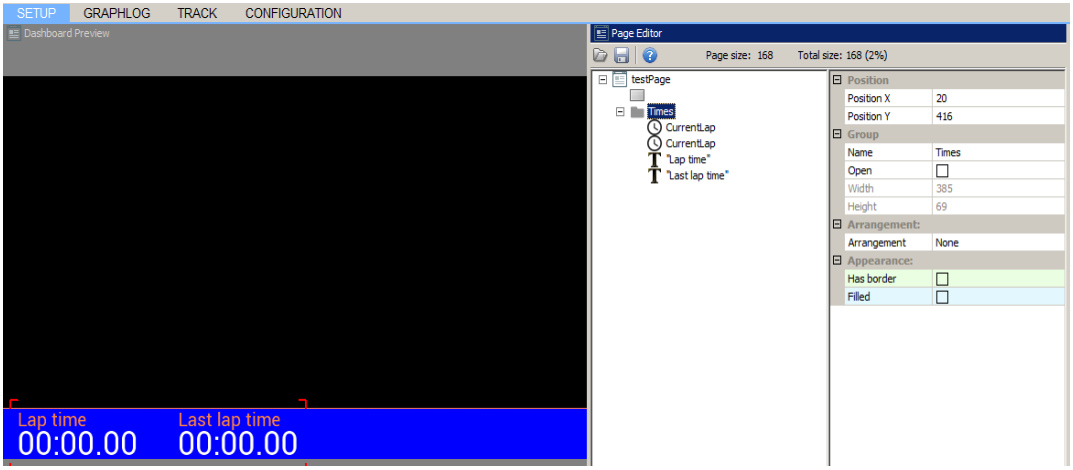
We will use a **Text** item to visually represent the time function we just created. In the ***Text*** field, type what you want to display, then choose the text colour. When creating a ***Text*** item, you may define both the static and dynamic elements of the displayed text. This will be discussed in more detail further in the chapter.



It is possible to duplicate items on the page. To do this, select an item in the ***Page editor*** and press CTRL+D. In this example we will duplicate the *Current lap* and the *Lap time* item to show the last lap time next to it.



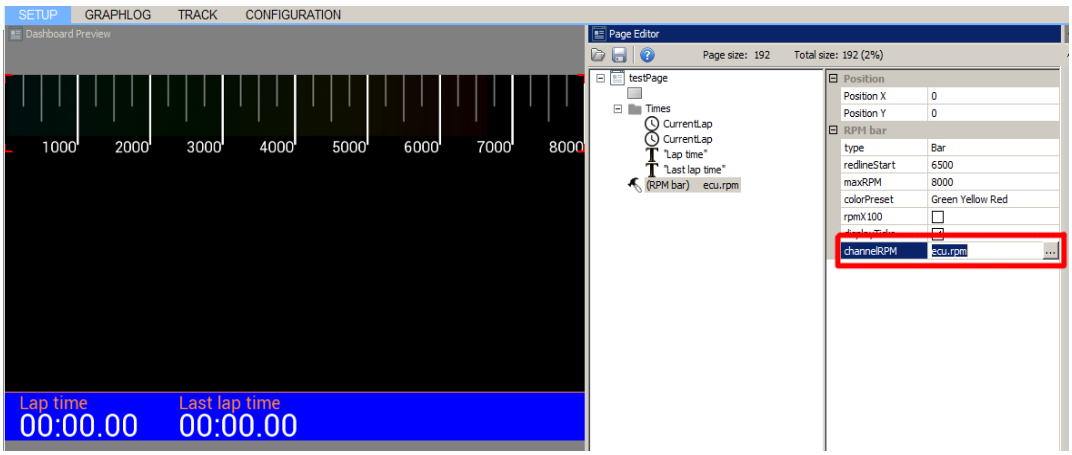
To accurately set an item's position on the page, you can enter values into the ***Position X*** and ***Position Y*** fields. Related items are best organized using the 'Grouping' function. This allows you to organize several functions and move them as a single group. You can also automatically arrange the position of items relative to one another (this will be discussed detail further on). To group items, select them in the editor and press *CTRL+G.* At this point you may name your group. In our example we have created a group for our text and time items and have named it *Times.*



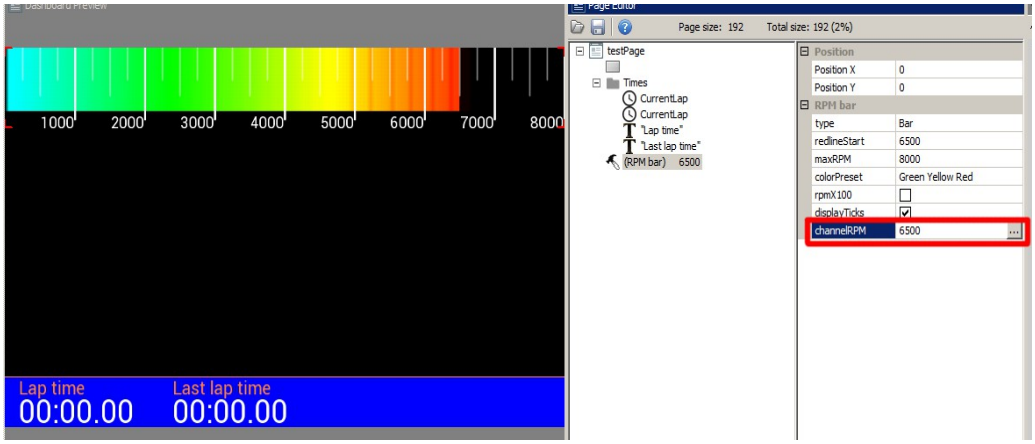
The next item we will add is an engine speed indicator. To do this, an ***RPM Bar*** item should be added to the page. When a page object displays a changing value, you must define the channel that drives the displayed value. This may be information from the CAN bus, a function, an analogue or digital input value, or a fixed value. For engine speed this information will usually come from the engine control unit via CAN bus or serial communication. A crankshaft position sensor may also be connected directly to *Digital Input 1*. Most ECUs on the market transmit common data via CAN (e.g. RPM, lambda, cooling liquid temperature, etc.) and this data is represented in the ADU software by the *ecu.** channels.

After loading the proper *CANX* file for the connected computer or configuring the serial connection, the *ecu.rpm* channel will display the value sent by the ECU. For information specific to your ecu, check the application notes files. Application notes also contain information about the available log channels. If the ECU sends specific channels not included in the *ecu.** channels, they are assigned unique names. These can be previewed in the ***Project tree*** or found in the application notes.

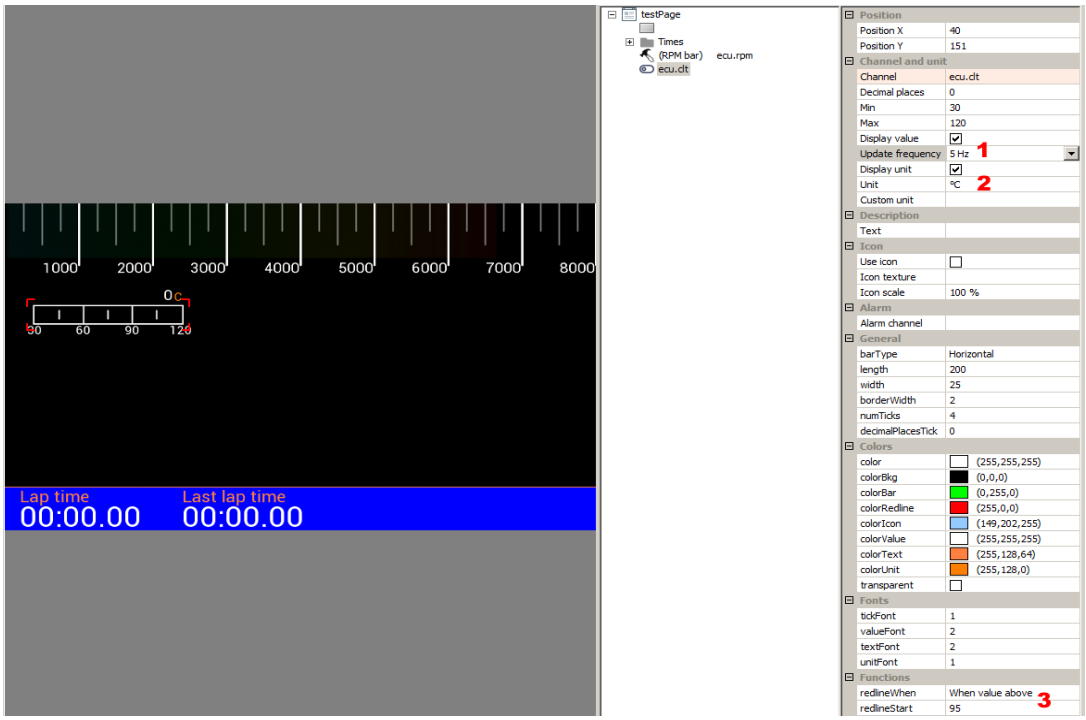
The pre-defined ECU channels are advantageous, as your page layouts can be used with any ecu without needing revision (revolutions will always be *ecu.rpm*, the cooling liquid temperature will be *ecu.clt*, etc.).



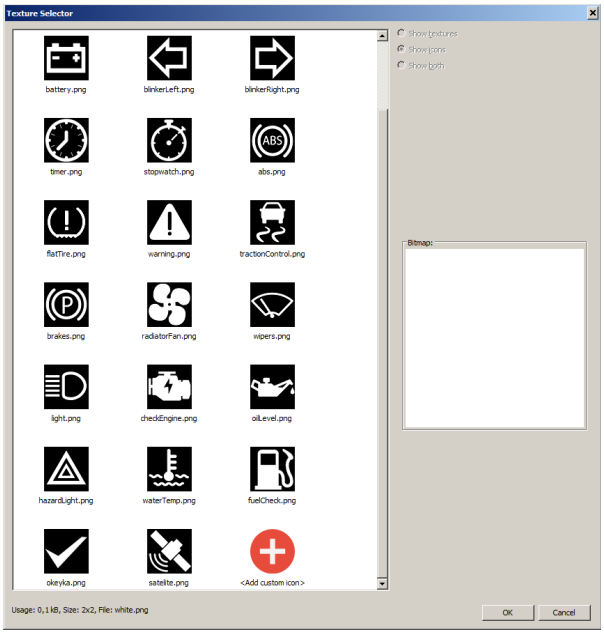
To test the operation of the indicator you can enter a numerical value (only integer values) in the ***Channel*** field. In the example below, we typed 6500 in the ***channelRPM*** field and the engine speed indicator appears.

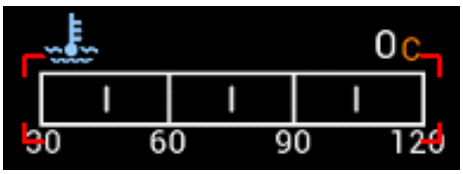


Next we will add a horizontal coolant temperature indicator to our page using a ***Bar graph*** indicator. Bar graph indicators have several configuration options. The first important parameter to consider is the ***Update frequency*** *(1)*. This parameter is the refresh rate of the displayed value. The ADU screen refreshes at a rate of 50Hz, so this is the max frequency for any value. Values with some degree of instability (e.g. oil or fuel pressure pulsation) are very difficult to read as they change rapidly. Limiting the update frequency acts as a filter. Measurement units are configurable. In our case, we want to the display temperature in degrees Celsius. If we change the unit to Fahrenheit in the ***Units*** field, the displayed value will immediately be converted accordingly. Another important function is the "redline" *(3)*, which changes the indicator appearance if the predetermined value is exceeded. In the ***redlineWhen*** field you may select the condition (i.e. warn when exceeds or warn when below), and in the ***redlineStart*** field you may enter value at which the indicator will change. The "redline" status will be indicated by the color selected in ***colorRedline***.

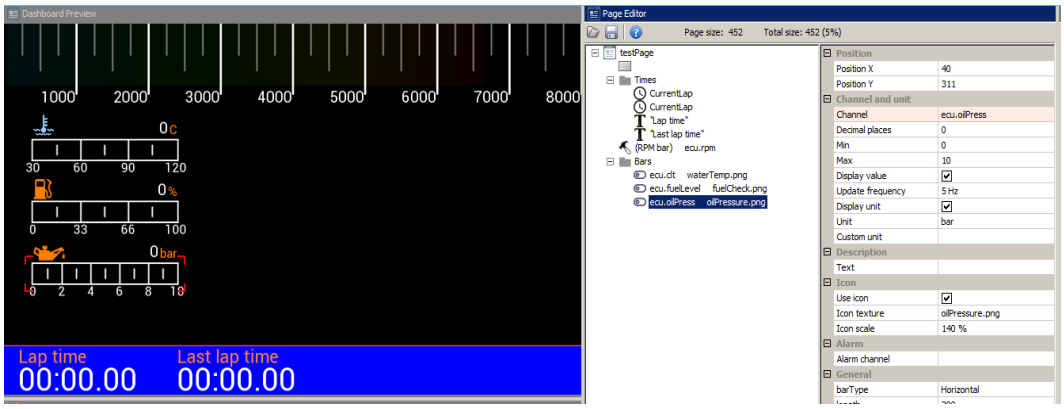


You may display an icon to identify a ***Bar graph*** indicator field. To apply an icon, select the *Use icon* option and select the desired icon from the *Icon texture* field (by left-clicking the '...' icon). A graphics selection pane will pop up. Select or load your own icon (you will find more information on icons further in the manual). After selecting the *waterTemp.png* icon, the indicator will look like the example below.

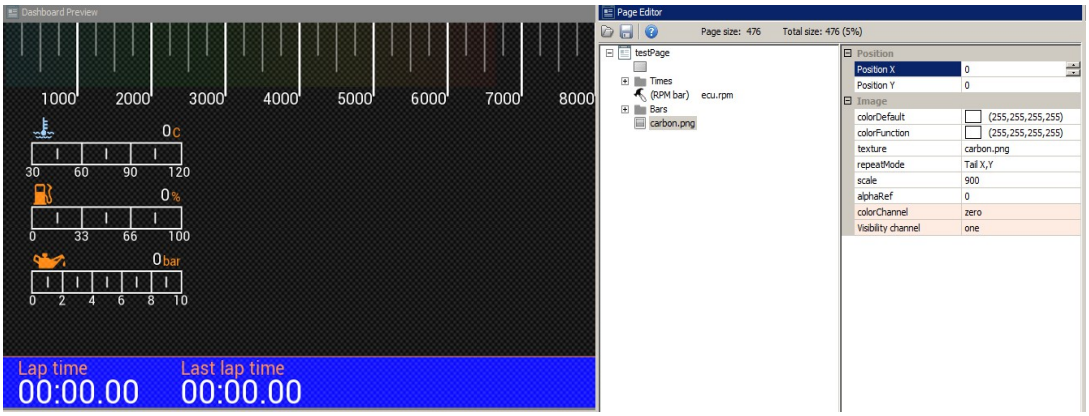




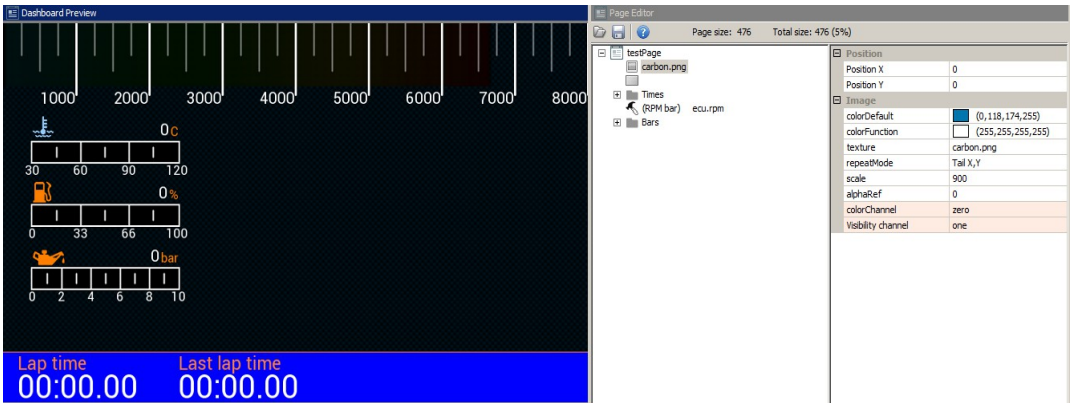
Next we will copy the created indicator twice in order to create a fuel level and oil pressure indicator. After copying, set their new position, select the appropriate icons and assign the appropriate channels in the ***Channel*** field. These will be *ecu.fuelLevel* for fuel level and *ecu.oilPress* for oil pressure, respectively. It is also worthwhile to group the indicators to facilitate their editing in the future. After copying the page your screen will look like the example below.



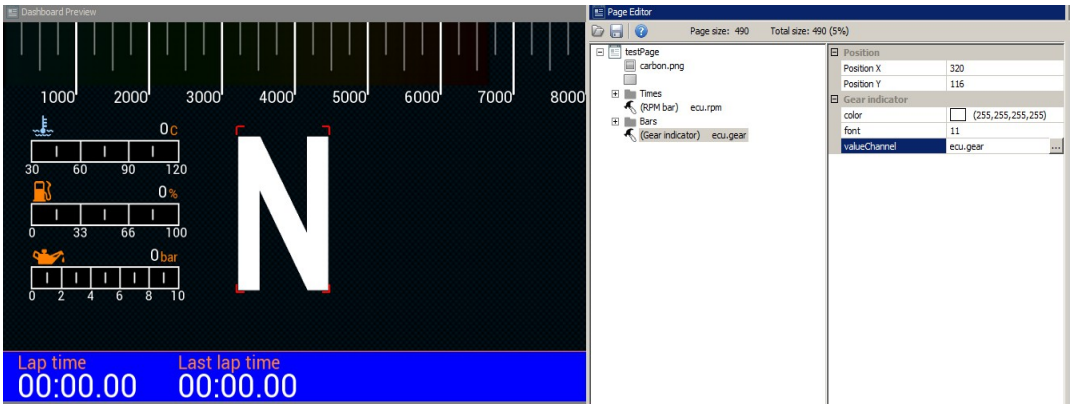
You may also add a background texture. For our example we will create a carbon fibre-style background. To do this, use the *Image* item and choose *carbon.png*. To cover the entire screen background, select *Repeat mode Tile X, Y* option and set *Scale* to 900%.



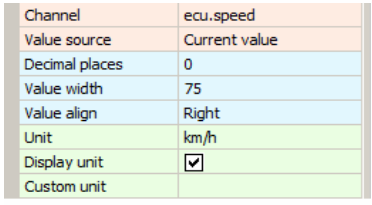
Note that our texture is displayed “over” the existing elements. To move it “underneath” we should rearrange it as the first element on the page. The order of application of elements is determined by their order on the list. To change their position on the list, select an element and move it by holding *ALT + up arrow* or *ALT + down arrow.* Let’s change the colour of our background to dark blue, too.

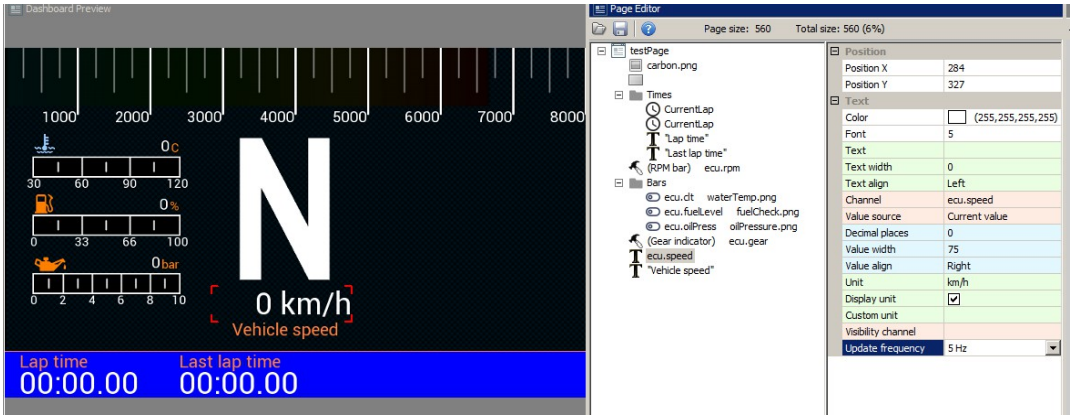


To insert an indicator for the current gear use *Gear indicator.* You should select a channel (*ecu.gear* in our case) and a font size. The indicator for the currently selected gear has a special font allowing to display large digits.

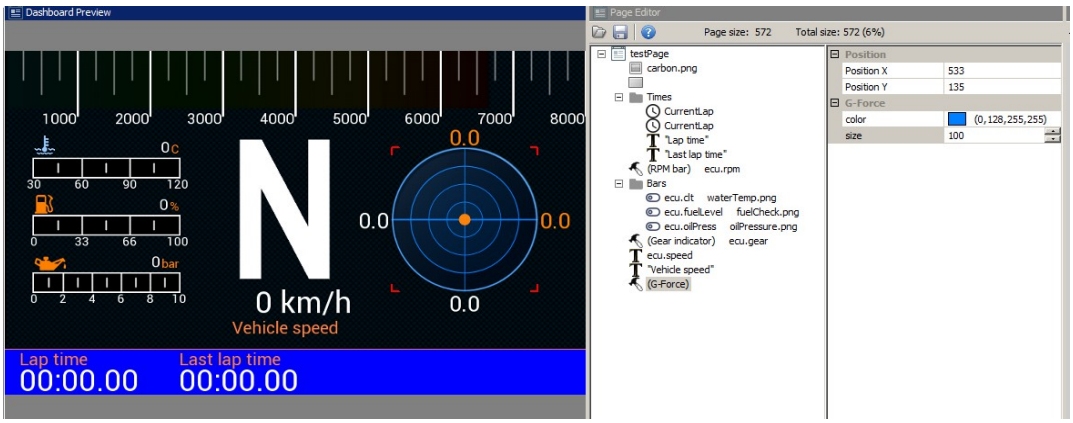


Under the gear indicator we will now display a numerical value representing the speed of the vehicle. We will use the ***Text*** indicator for this purpose. In addition to displaying static text, you may use a ***Text*** indicator to show values of channels and variables. Enter the name of a channel or variable in the ***Channel*** field. In addition to the current value of the channel, the measurement unit may also be displayed. Pay careful consideration to the width given to Text indicators. To prevent the text from shifting as the displayed value increases (e.g. From 7 km/h to 11km/h) we have set the text width at 75 pixels to allow for 2 and 3 digits to be displayed. To change the unit from km/h to mph choose your desired unit from the ***Unit*** field. Under speed we will also add a Text indicator showing “Vehicle Speed” as the channel description.



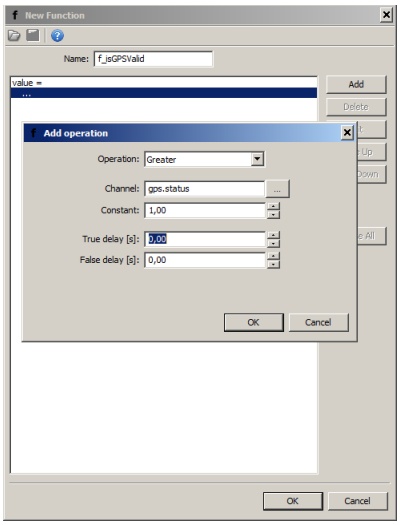


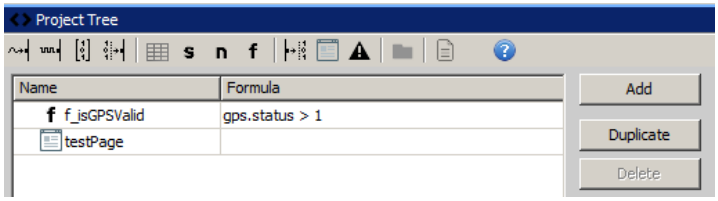
Next we will add a G-force indicator (*G-Force)*. This shows the current G-force acting on the vehicle. The ADU has a built-in accelerometer which may require calibration after the device is installed (setting the 0g point). You will find more information about the accelerometer later in the manual.



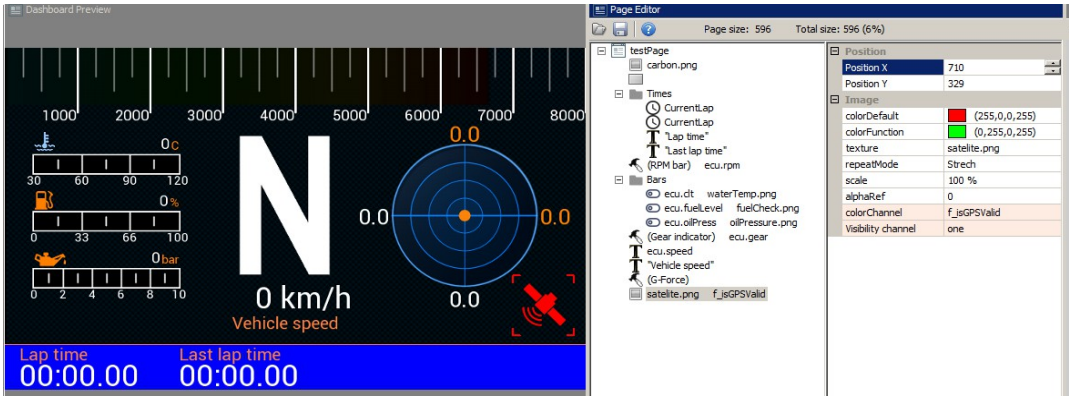
When using a GPS module, it is important that the user is able to see its status. To facilitate this, we will add a GPS status indicator. We will use two channels - *gps.status,* which shows us the GPS operation mode, and *gps.numSatelites* to show the number of satellites that the module is currently using.

The first step is to add a satellite icon (*satelite.png) to* the page using an ***Image*** indicator. The indicator color may be assigned to a channel or function. We set red as the default colour (GPS not working) changing to green when GPS is functioning properly. We also have to create a function driven by the *gps.status* channel. We will create a function that outputs 3 states: *0* - means that GPS is disconnected, *1* – means no synchronization with satellites, *2* - means that GPS is functioning and has fixed our position. Add the function in the ***Project tree*** *using* the ***Add*** *(function)* button. We will name the function f*_isGPSValid* and add a condition using the *Add* button. We will select *Greater* as *Operation, gps.status* as ***Channel*** and set the value for comparison (*Constant*) to 1. We have created the condition f_isGPSValid = gps.status > 1. You will find more information regarding the functions later in the manual.

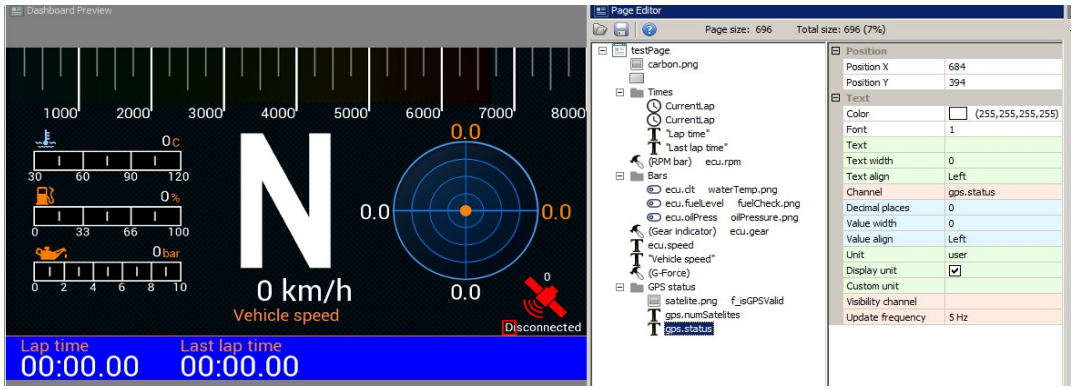




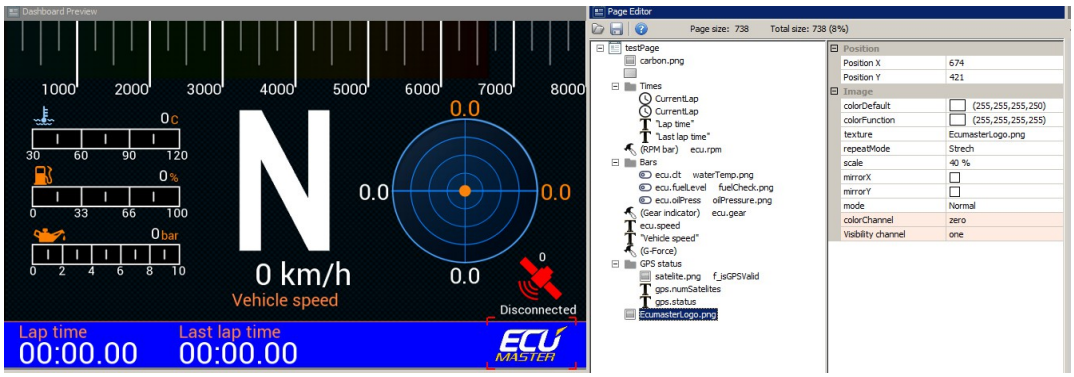
Enter *f_isGPSValid* in the ***ColorChannel*** field of our satellite icon. We can also test the colour change by manually entering 0 (basic colour) or 1 (alternative colour) in that field.



We will place two text fields over and under the icon. The upper field will indicate the number of satellites (*gps.numSatelites* channel), while the lower field will display the current GPS module status. For the *gps.status* channel, the text field will automatically transform the value into text (e.g. disconnected, gps 3D, etc.). We will group all elements of the indicators into a *GPS status* group.

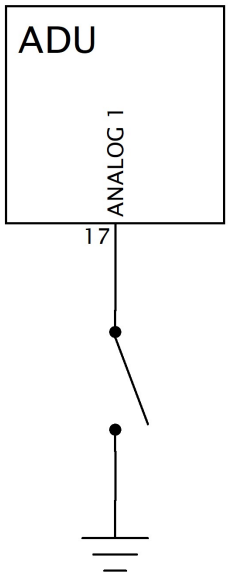


The last element to be added to the page will be the company logo. In this example we will use the logo of Ecumaster embedded in the device. However, you can add your own graphics and display the logo of your own company. You will find more information about this later in the manual. In order to add graphics, select the ***Image*** indicator and then the desired logo (in the ***Texture*** field).



Page switching

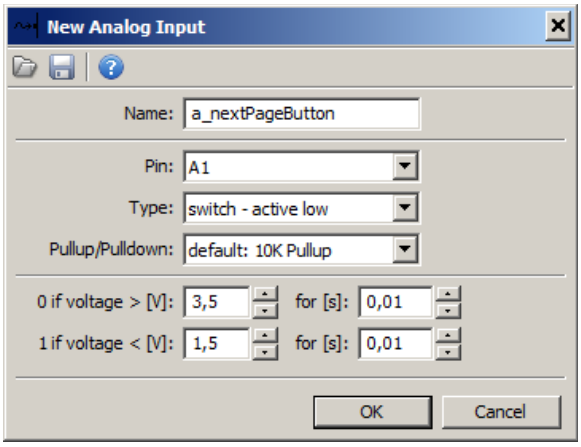
There are two methods of switching between pages. The first method is using a button connected directly to the ADU (by means of analogue or digital inputs) or to another device (e.g. a CAN switch board) and then sent to ADU via CAN bus. The button to be used for switching between the pages must be defined in the ***Buttons*** panel.



The following example shows how to connect and configure a page-switching button. The button is connected to the analogue input *Analog #1* and shorts to ground.

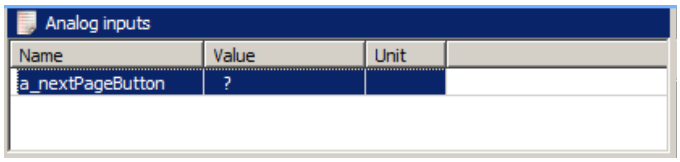
In the ***Project tree*** the button must be defined as an analogue input. To do this, press ***Add*** and then select ***Analog input***.

The following pane should pop up:

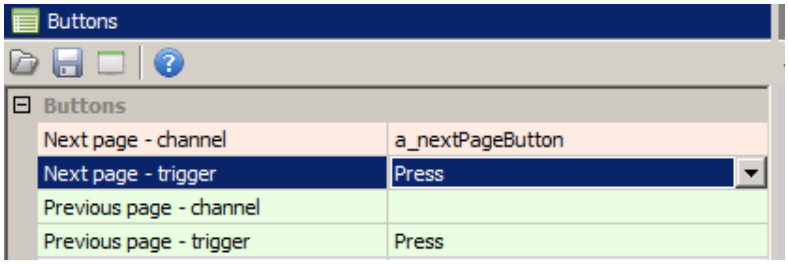


Name determines the name of the input that will be visible in the project. In the ***Pin*** field define the analogue input to which the button is connected (*Analog #1* in our case). Choose ***Switch - active low*** (which means that the button is activated at a low state). You also need to select a 10K pullup resistor.

To preview the button state, open the ***Analog inputs*** panel, in which you will be able to track all ***Analogue inputs***). The value of the button should equal 0 when not pressed and 1 when pressed.



Before a defined button can be used, it must be assigned in the *Buttons* panel for switching from one page to the next (***Next page - channel***). It should be noted that after pressing the button the last page switches to the first one. You can use the buttons only to switch between the *Page*-type pages. *Overlay* pages are ignored.



Similarly, you can connect another button and assign it to the function of switching to the previous page (*Previous page*)

Another method of switching between pages is to use the ***Activation channel*** page attribute. It is available after selecting a page in the ***Page editor*** together with the attributes such as the name, background colour or type.

The main use for this type of switching is ***Overlays***. They allow the application of an overlay (of another page) on the currently displayed page whenever an event occurs. To do this, a function that will activate the overlay needs to be created. It will be visible as long as the function result differs from 0.

Another method of switching between pages is to use a ***Rotary switch***. You can define a function and assign it to the ***Activation channel*** attribute for each of its positions.

Startup screen

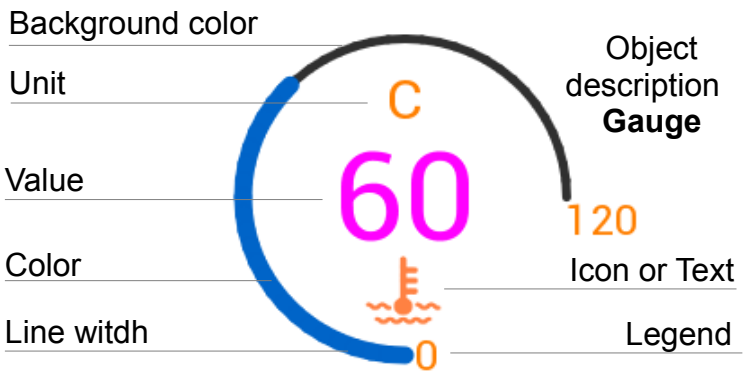
You can create a startup screen that will appear immediately after switching the device on and will be displayed for a defined time. To do this, configure the ***Startup Screen*** parameters in the ***Configuration*** pane.

Parameter	Description
Enable	Activates the startup screen
Texture	The texture that will be displayed on the startup screen (centred)
Scale	The scale of the displayed texture
Duration	The duration which the startup screen will be displayed
Color	The colour of the displayed texture
Background color	The colour of the background

Objects

Gauge

Gauge objects display data by means of a circular segment. You may further modify a gauge with a numerical value, a description, an icon and a unit in which the value is expressed.

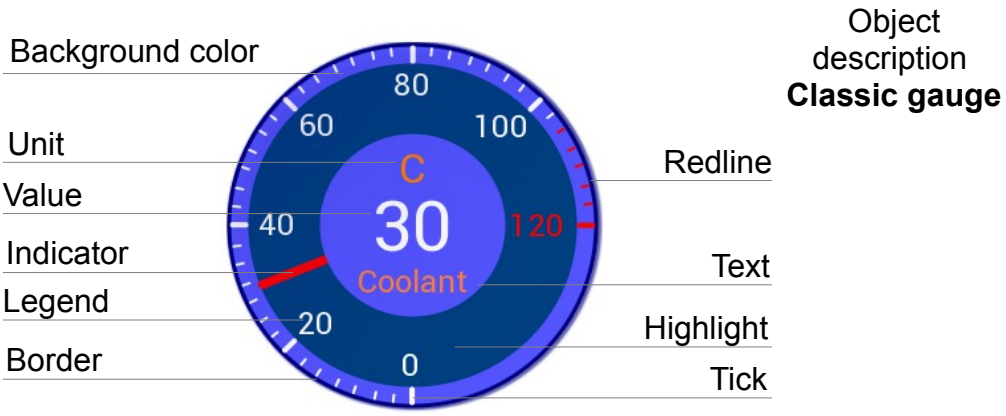


Parameter	Description
Position X,Y	Object position on the page. The reference point is the upper-left corner of a projected rectangular boundary around the gauge.
Channel	Name of a channel or a variable that will be displayed in the ***Value*** field and that will be represented on the gauge. Here you can also enter a numerical value without a decimal separator to test the operation of the gauge.
Decimal places	The number of decimal places displayed for the ***Value*** *and* ***Legend*** parameters
Min, Max	The minimum and maximum value displayed by the indicator
Display value	This option allows you to show or hide the displayed ***Value*** parameter
Update frequency	The update frequency on the ***Value*** parameter screen. The screen is updated 50 times per second (50Hz). Quickly changing variables are very difficult to read at this frequency. This parameter allows to decrease the frequency (e.g. to 5Hz), which makes the ***Value*** parameter easier to read.
Display unit	This option allows to display a unit *(**Unit***) A unit is displayed above the ***Value*** parameter.
Unit	Selection of a unit for displaying a value (e.g. kPa, Bar, Psi). You can define your own unit in the ***Custom unit*** field. To do this, select *User* in

	the ***Unit*** field.
Custom unit	This field is used for entering a user-defined measurement unit. To use it, select ***User*** in the Unit field.
Text	Defines the text displayed below the ***Value*** parameter.
Use icon	This parameter allows you to display an icon instead of text.
Icon texture	Allows you to select an icon from the texture menu. You can add a custom icon (more information about managing textures is provided further in the manual)
Icon scale	The icon size is automatically adapted to the indicator size. You may change its size using the ***Icon Scale*** parameter.
Alarm channel	A channel / function to change the indicator colour when its value differs from 0. The alarm colour is defined in the ***Alarm Color*** field.
Radius	The indicator diameter in pixels.
Line width	The indicator line width in pixels. Decimal values are possible.
Color	The indicator line colour
Value color	The displayed value colour
Text color	The text or icon colour
Unit color	The measurement unit colour
Alarm color	The colour to which the indicator and the displayed value will change if the value of the variable used in ***Alarm channel*** differs from 0.
Background color	The indicator background line colour
Value font	The size of the font used for displaying values
Text font	The size of the font used for displaying text
Unit font	The size of the font used for displaying measurement units
Legend font	The size of the legend font

Classic gauge

A ***Classic gauge*** allows you to display a numerical value similar to classic car gauges.
A numerical value is displayed in the center, along with a hand on the dial.



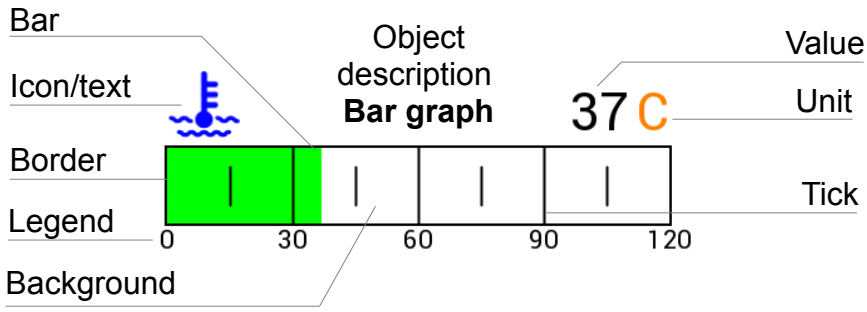
Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangular boundary around the object.
Channel	Name of a channel or a variable that will be displayed in the ***Value*** field and that will be represented on the gauge. Here you can also enter a numerical value without a decimal separator to test the operation of the gauge.
Decimal places	The number of decimal places displayed for ***Value*** *and* ***Legend***
Min, Max	The minimum and maximum value displayed by the indicator
Display value	This parameter allows you to hide the ***Value*** displayed in the gauge center
Update frequency	The update frequency on the ***Value*** parameter screen. The screen is updated 50 times per second (50Hz). Variables that change quickly are very difficult to read at this frequency. This parameter allows you to decrease the frequency (e.g. to 5Hz) to make the ***Value*** parameter easier to read.
Display unit	This option allows you to display a unit *(**Unit***) A unit is displayed above the ***Value*** parameter.
Unit	Selection of a unit to display (e.g. kPa, Bar, Psi). You can define your own unit in the ***Custom unit*** field. To this end, select ***User*** in the ***Unit*** field.
Custom unit	This field is used for entering a user-defined measurement unit. To use it, select *User* in the ***Unit*** field.

Text	Defines the text displayed below the ***Value*** parameter.
Use icon	This parameter allows to display an icon instead of a text.
Icon texture	Allows to select an icon from a texture menu. You can add a custom icon (more information about managing textures is provided further in the manual)
Icon scale	The icon size is automatically adapted to the indicator size. It is possible to change its size using the ***Icon Scale*** parameter.
Alarm channel	A channel / function allowing to change the indicator colour when its value differs from 0. The alarm colour is defined in the ***Alarm Color*** field.
Radius	The indicator diameter in pixels.
Border Size	The width of the line surrounding the indicator in pixels. Decimal values are possible.
Highlight percent	Indicates the part of the indicator that is to be filled with ***Highlight color***. 0 means that the entire indicator is filled with the ***Background color***
Num ticks	This value defines the number of parts into which the indicator area is to be divided. For each part a respective value and marker in the form of a section will be displayed.
Num subticks	This value defines the number of divisions between the main markers
Indicator width	The width of the hand showing the current value
Angle span	The range in degrees within which the indicator is to be divided (the example shows 270 degrees).
Angle offset	The initial angle of the first marker (0 in our example)
Color	The colour of the value, legend and markers displayed
Border color	The indicator frame colour
Highlight color	The “highlight” area colour
Indicator color	The “hand” colour
Background color	The background colour
Text color	The text or icon colour
Unit color	The measurement unit colour
Alarm color	The colour to which the indicator and the displayed value will change if the value of the variable used in ***Alarm channel*** differs from 0.
Tick font	The size of the font used for displaying the legend
Value font	The size of the font used for displaying the size of the font used for displaying values
Text font	The size of the font used for displaying the text
Unit font	The size of the font used for displaying the measurement units
Redline when	The condition for displaying the indicator in the “redline” mode.

	Never - never display in the “redline” mode, ***When value above*** – display the bar in ***Redline color*** when the ***Value*** parameter is greater than the ***Redline start value****,* ***When value below*** – display the bar in ***Redline color*** when the ***Value*** parameter is lower than the ***Redline start*** *value*
Redline start	This parameter defines the value for a condition defined by the ***Redline when*** parameter

Bar graph

This indicator allows to display values in the form of a moving bar (horizontal or vertical). It is also possible to display an icon symbolising the measured value.



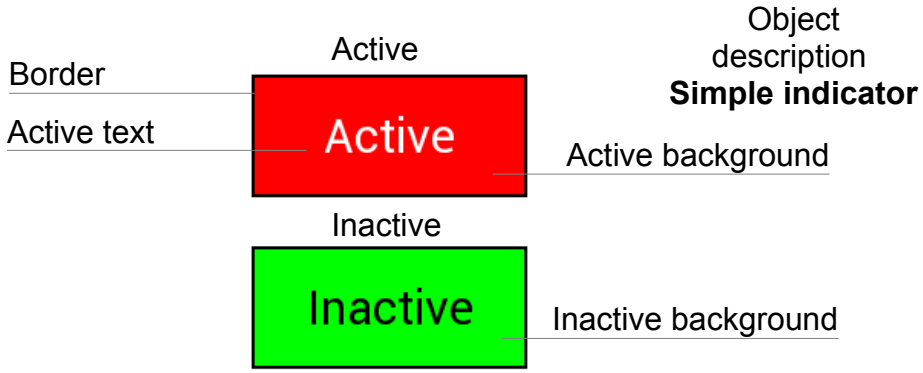
Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Channel	Name of a channel or a variable that will be displayed in the ***Value*** field and that will be represented on the gauge. Here you can also enter a numerical value without a decimal separator to test the operation of the gauge.
Decimal places	The number of decimal places displayed for ***Value*** *and* ***Legend***
Min, Max	The minimum and maximum value displayed by the indicator
Display value	This parameter allows to hide the ***Value*** displayed
Update frequency	The update frequency on the ***Value*** para meter screen. The screen is updated 50 times per second (50Hz). Quickly changing variables are very difficult to read at this frequency. This parameter allows to decrease the frequency (e.g. to 5Hz), which makes the ***Value*** parameter easier to read.
Display unit	This option allows to display a unit *(Unit*) A unit is displayed above the *Value* parameter.
Unit	Selection of a unit for displaying a value (e.g. kPa, Bar, Psi). You can define your own unit in the ***Custom unit*** field. To this end, select ***User*** in the ***Unit*** field.
Custom unit	This field is used for entering a user-defined measurement unit. To use it, select ***User*** in the ***Unit*** field.
Text	Defines the text (description) displayed along the indicator.
Use icon	This parameter allows to display an icon instead of a text.

Icon texture	Allows to select an icon from a texture menu. You can add a custom icon (more information about managing textures is provided further in the manual)
Icon scale	The icon size is automatically adapted to the indicator size. It is possible to change its size by means of the ***Icon Scale*** parameter.
Alarm channel	A channel / function that changes the indicator colour when its value differs from 0. The alarm colour is defined in the ***Alarm Color*** field.
Bar type	Indicator type ***Horizontal***, ***Vertical***
Bar style	The graphical presentation of the bar
Length	Indicator length in pixels
Width	Indicator width in pixels
Border width	The width of the line surrounding the indicator in pixels
Num ticks	This value defines the number of parts into which the indicator area is to be divided. For each part a respective value and marker will be displayed. An additional section is drawn automatically between the markers.
Decimal places for tick	This value defines the number of decimal places drawn for the indicator description
Color	The indicator frame colour
Background color	The indicator background colour
Bar color	The indicator bar colour
Redline color	The indicator bar colour when the displayed value meets the *Redline* condition
Icon color	Icon colour
Value color	The displayed value colour
Text color	The text or icon colour
Unit color	The measurement unit colour
Alarm color	The colour to which the indicator will change if the value of the variable used in ***Alarm channel*** differs from 0.
Transparent	Decides if the indicator background is to be displayed
Tick font	The size of the font used for displaying the legend
Value font	The size of the font used for displaying the size of the font used for displaying values
Text font	The size of the font used for displaying the text
Unit font	The size of the font used for displaying the measurement units
Redline when	The condition for displaying the indicator in the “redline” mode. ***Never*** - never display in the “redline” mode, ***When value above*** – display the bar in *Redline color* when the *Value*

	parameter is greater than the *Redline start value,* ***When value below*** – displays the bar in *Redline color* when the *Value* parameter is lower than *Redline start*
Redline start	This parameter defines the value for a condition defined by the ***Redline when*** parameter

Simple indicator

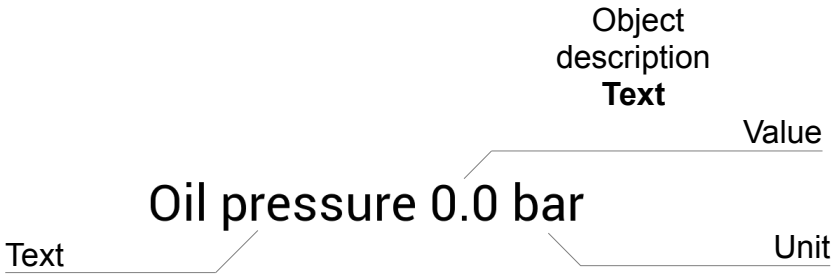
This indicator shows the current state of the assigned function (e.g. ALS). You may show two different texts in two different background colours depending on the state of the function assigned in the ***Channel active*** field



Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Channel	Name of a channel or a variable that will be displayed in the ***Value*** field and that will be represented on the gauge. You may also enter a numerical value without a decimal separator to test the operation of the gauge.
Width	Indicator width in pixels
Height	Indicator height in pixels
Border width	The width of the line surrounding the indicator in pixels
Background color default	Inactive indicator background colour
Background color active	Active indicator background colour
Default text color	The colour of the text displayed by the indicator when inactive
Active text color	The colour of the text displayed by the indicator when inactive
Border color	The indicator frame colour
Text	The text displayed by the indicator when inactive
Active text	The text displayed by the indicator when active
Text font	The size of the font used for displaying the text
Channel active	Channel/function/variable defining if the indicator is to be displayed in the inactive mode (0) or active mode (a value different from zero)

Text

This indicator allows you to display text with data from a log channel or function, along with a measurement unit. The user can also hide the object using a function or a log channel.



Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Channel	Name of a channel or a variable that will be displayed in the *Value* field and that will be represented on the gauge. Here you can also enter a numerical value without a decimal separator to test the operation of the gauge.
Color	Displayed text colour
Font	Displayed font size
Italic	Activates the italic mode
Two lines	Displays channel value in separate line
Second line font	Font size for secont text line
Text	A field containing the displayed text
Text width	The area width used by the *Text align* functions. For example, by entering 800 (screen width), setting the position X as 0 and selecting appropriate alignment, you can display the text to the left side of the screen, in the centre of the screen and to the right side of the screen.
Text align	Defines text alignment in the ***Text width*** area. ***Left*** – aligning the text to the left ***Center*** – center alignment, ***Right*** – aligning the text to the right
Channel	Name of a channel or a variable that will be displayed in the ***Value*** field and that will be represented on the gauge. Here you can also enter a numerical value without a decimal separator to test the operation of the

	gauge.
Value source	Determines the value that is to be displayed for the selected channel: ***Current –*** the current channel value ***Min value***- the minimum registered value ***Max value***- the maximum registered value
Decimal places	The number of decimal places displayed for the ***Value*** parameter
Value width	The width of the area of the displayed value used by the ***Value align*** function.
Value align	Defines text alignment in the ***Value width*** area. ***Left*** – aligning the text to the left ***Center*** – *centre alignment*, ***Right*** – aligning the text to the right
Display unit	This option allows you to display a unit *(Unit*) A unit is displayed above the ***Value*** parameter.
Unit	Selection of a unit for displaying a value (e.g. kPa, Bar, Psi). You can define your own unit in the ***Custom unit*** field. To do this, select ***User*** in the ***Unit*** field.
Custom unit	This field is used for entering a user-defined measurement unit. To use it, select ***User*** in the ***Unit*** field.
Visibility channel	Name of the channel or variable that will control the text visibility. 0 means that the text will be hidden, a value different from zero or no assigned channel means that the text is visible.
Update frequency	The update frequency on the ***Value*** parameter screen. The screen is updated 50 times per seconds (50Hz). Variables that change quickly are very difficult to read at this frequency. This parameter allows you to decrease the frequency (e.g. to 5Hz), which makes the ***Value*** parameter easier to read.

Time

This indicator allows you to display the built-in timers of the device, such as *Real Time*, *Lap Time*, *Best lap time* etc.

Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object
Color	The text colour displayed
Font	The font size displayed
Time source	***RTC*** – the device internal clock time. To set the RTC clock select the *Devices/Set real time clock* from the application menu ***Current lap*** - the current lap time ***Last lap*** - the last lap time ***Best lap*** – the best lap time **Session time** – an internal clock measuring the current session time. You can reset it using the external button ***Predictive time –*** predicted lap time based on the best lap time on a given track. It requires using a GPS module
Visibility channel	Name of the channel or variable that will control the text visibility. 0 means that the text will be hidden, a value different from zero or no assigned channel means that the text is visible.

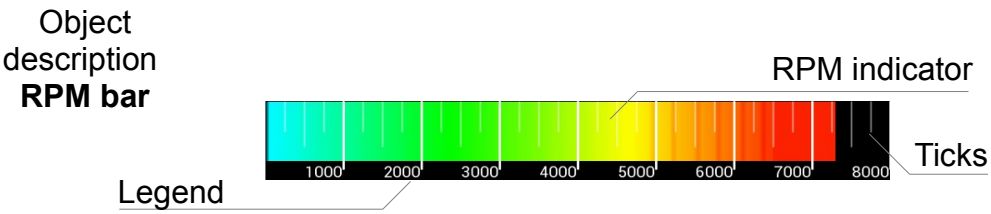
Image

This object allows you to display a texture (image) or an icon on the screen. You may scale it, choose the colour, mirror and tile. In addition to the textures contained in the device memory, you can upload your own textures / icons.

Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Default color	Displayed text colour
Function color	Displayed font size
Texture	Allows you to select a texture and an icon that will be displayed
Repeat mode	Texture repetition mode. ***Stretch*** – allows you to stretch the texture out (the scale parameter) ***Tile X*** – repeats a texture along the X axis ***Tile Y*** – repeats a texture along the Y axis ***Tile X,Y*** – repeats a texture along the Y axis In the case to the ***Tile*** modes, in order to duplicate a texture enter 200% in the ***Scale*** parameter, 400 % in order to quadruplicate it, etc.
Scale	This parameter determines the scale of a texture or the number of its copies for the ***Tile*** modes.
Mirror X/Y	It allows you to mirror image along the X and/or Y axis.
Mode	Texture drawing mode. In the ***Screen*** mode a texture is displayed by means of adding it to the current image. In the ***Normal*** mode a texture overwrites the current image, referencing the alpha channel (alpha channel is an image property defining transparency). You will find more information regarding textures further in the manual.
Color channel	Name of the channel or variable that will control the colour of the texture displayed. If the channel / function value is equal to 0, the colour defined in the ***Default color*** field is used. Otherwise the ***Function color*** will be used.
Visibility channel	Name of the channel or variable that will control the text visibility. 0 means that the text will be hidden, a value different from zero or no assigned channel means that the text is visible.

RPM Bar

This object allows you to display the engine speed in the form of a horizontal bar or a round indicator.



Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Type	The type of engine speed indicator displayed: ***Classic bar –*** displayed in the form of a “curved” bar **Bar –** displayed in the form of a horizontal bar (as shown in the above visualisation) **Round –** displayed in the form of a round gauge
Color	When using the ***Classic bar***, this determines the colour of the bar indicating the engine speed.
Color redline	When using the ***Classic bar***, this determines the colour of the indicator bar above the ***Redline start*** value
Redline start	A value specifying the beginning of the engine speed limit area .
Max rpm	The maximum engine speed value displayed on the indicator
Color preset	When using a ***Bar*** type indicator, this determines the colour gradient that will be used for
RPM x 1000	When using a ***Bar*** type indicator, this determines whether the engine speed is displayed in the legend in full or divided by one thousand
Display ticks	When using a ***Bar*** type indicator, this determines if additional division lines (*Ticks*) are to be displayed
Channel RPM	A channel or a function containing the current engine speed

Gear indicator

This object displays the currently selected gear. This indicator is unique in that it has a specially prepared, bigger font containing numbers and R marks (*Reverse)* and N marks (*Neutral*). The value of a displayed gear is -1 for the reverse gear, 0 for the neutral gear, 1 for the first gear, etc., respectively.

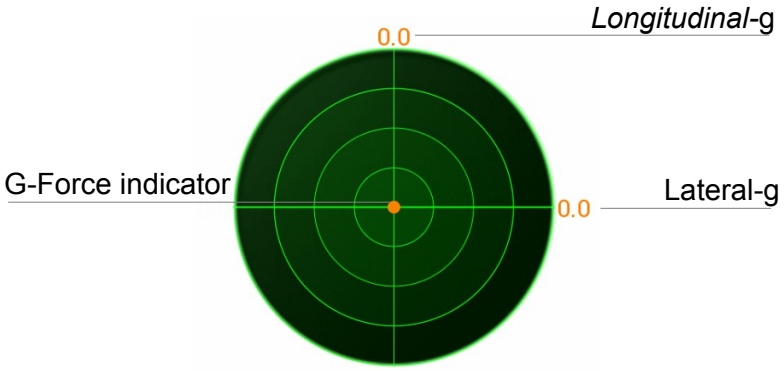
Object description
Gear indicator

Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Color	Displays gear colour
Font	Displays font size (maximum size is 15)
Value channel	A channel or a function containing the currently selected gear

G-Force

The ***G-Force*** object indicates the current G-force acting on the vehicle by means of an accelerometer built into the display The accelerometer requires calibration after installing the device.

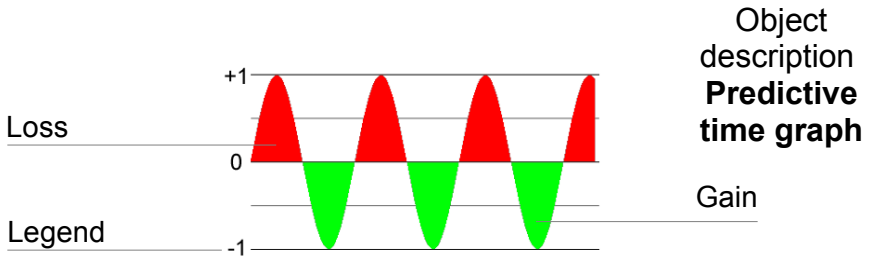
Object description **G-Force**



Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Color	Displays gear colour
Size	Indicator diameter

Predictive time graph

The ***Predictive time graph*** object indicates the time difference between the best reference lap and the current position on the track. This object requires a GPS module and a correct configuration of the racing track.

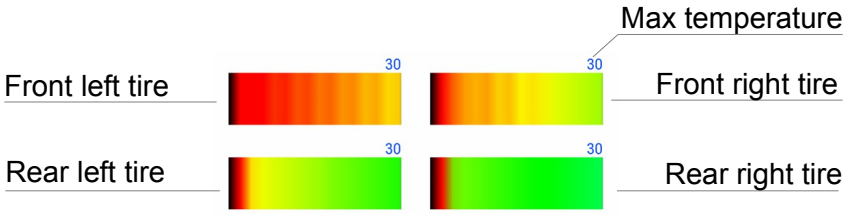


Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Width	Object width
Height	Object height
Gain color	The colour of the graph when the current time is faster than the reference time
Loss color	The colour of the graph when the current time is slower than the reference time
Lines color	The graph line colour
Font size	The font size

Tire temperature graph

The ***Tire temperature graph*** object displays the tire temperature gradient from thermal imaging cameras. The tire temperature can be presented as gradients or tires. Configuration of the measurement range of the cameras can be found in: ***ADU/Configuration/Tire temperature cameras***

Object description
Tire temperature graph

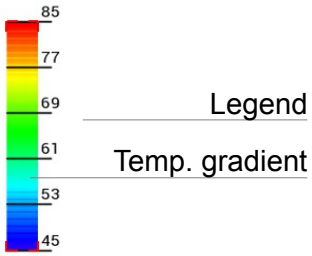


Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Style	***Tires*** – temperature displayed as tires ***Bar*** – temperature displayed as gradients
Width	Object width (available only for the *Bar* style)
Height	Object height (available only for the *Bar* style)
Spacing X	The distance on the horizontal axis between gradients representing tires (available only for the *Bar* style)
Spacing Y	The distance on the vertical axis between gradients representing tires (available only for the *Bar* style)
Scale	Object size (available only for the *Tires* style)

Tire temperature gradient

The ***Tire temperature gradient*** displays the temperature gradient and the temperature values assigned to a given colour. Configuration of the measurement range of the cameras is in the ***ADU/Configuration/Tire temperature cameras*** panel.

Object description
Tire temperature gradient

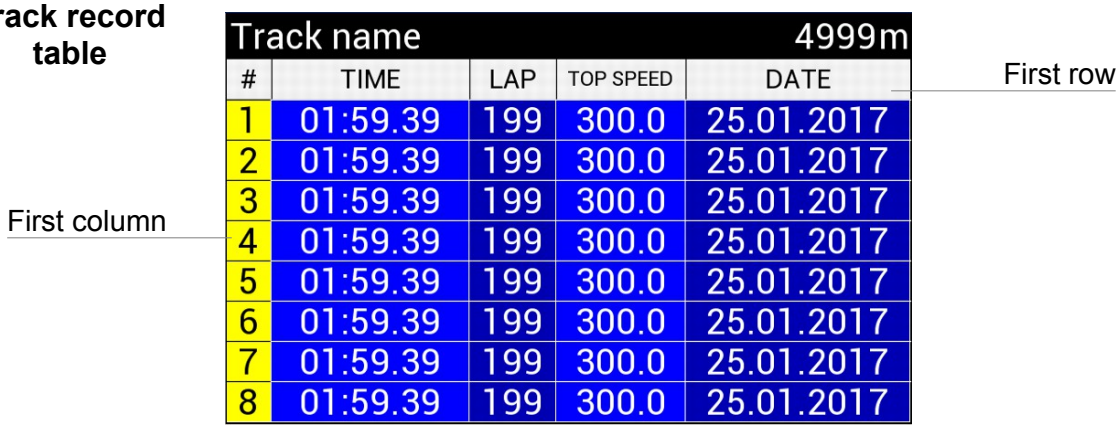


Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Scale	Defines the gradient size
Legend color	Defines the description colour

Track record table

The ***Track record table*** object allows to display the 8 best times for a given racing track. A track is recognized by means of GPS position. You will find more information regarding GPS further in the manual.

Object description
Track record table

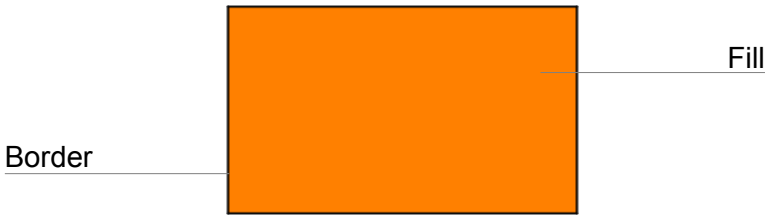


Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
First column bkgrd color	The first column background colour
First column Text color	The first column text colour
Table bkgrd color 1	The background colour for odd columns
Table bkgrd color 2	The background colour for even columns
Table text	The table text colour
First row bkgrd color	The first row background colour
First row tekst color	The first row text colour

Rectangle

The *Rectangle* object allows you to draw a rectangle on the page. You may define the width of the frame line and the fill colour.

Object description
Rectangle

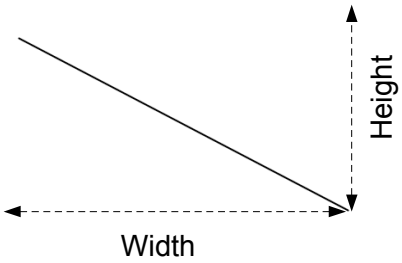


Parameter	Description
Position X,Y	Object position on the page. The reference point is the upper-left corner.
Rectangle type	The type rectangle displayed. ***Border –*** displays only the rectangle frame, ***Border + fill –*** displays the frame and its filling (*fill)* ***Only fill -*** displays only the fill (*fill)*
Color	The frame colour
Fill color	The fill colour
Width	The rectangle width
Height	The rectangle height
Thickness	The width of the frame in pixels

Line

The *Line* object allows you to draw lines on the page.

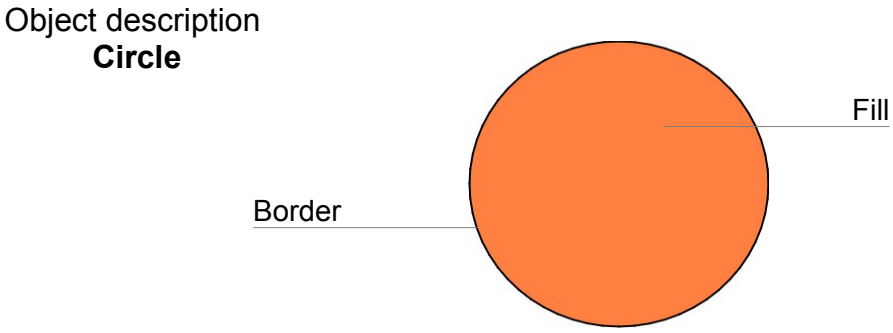
Object description
Line



Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of a rectangle around the object.
Color	The line colour
Width	The line width (the distance between the beginning and the end of the line along the X axis)
Height	The line height (the distance between the beginning and the end of the line along the Y axis)
Thickness	The width of the line in pixels

Circle

The *Circle* object allows you to draw a circle on the page. You may define the circle diameter, border width, and fill colour.

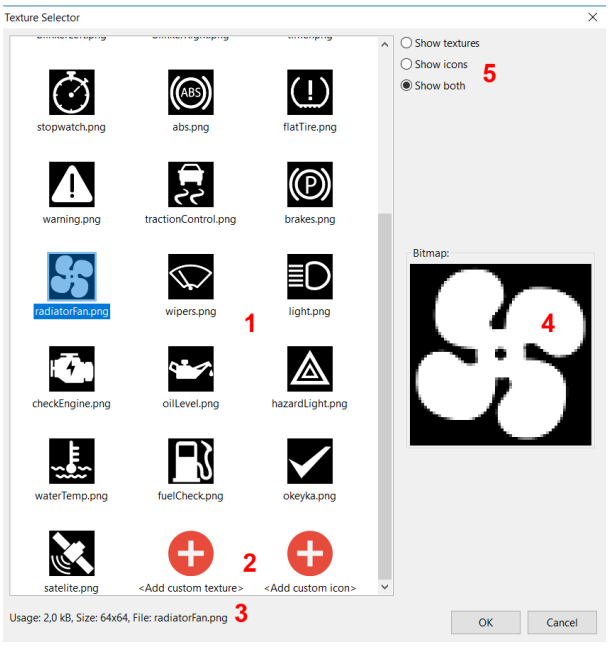


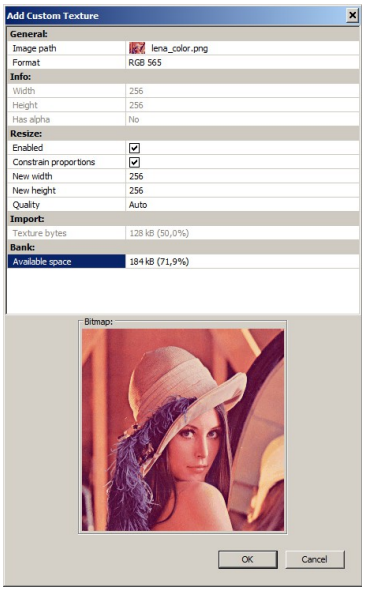
Parameter	Description
Position X,Y	Object position on the page The reference point is the upper-left corner of an rectangle around the object.
Circle type	The type of circle displayed. ***Border –*** displays only the rectangle frame, ***Border + fill –*** displays the frame and its fill (*fill)* ***Only fill -*** displays only the fill (*fill)*
Color	The frame colour
Fill color	The fill colour
Thickness	The width of the frame in pixels
Radius	The circle radius

Textures

Textures are bitmaps (images) that can be used as ***Image*** objects. The ADU device has built-in textures dedicated for displaying as icons or backgrounds. The user is also able to add their own textures (e.g. background, icon, etc.).

The textures are managed by means of the ***Texture Manager*** *(Menu/Tools/Texture manager dialogue*). This dialogue is displayed also when you select a texture for the objects that display it (e.g. ***Image***, ***Bar graph***, etc.) Using the ***Texture Manager*** you may preview the available textures. After selecting a texture in the lower part of the window, information about the selected image (*3*) will be displayed along with its preview (*4*). You can also use the filtering option to have only textures or icons (*5*) displayed. An icon differs from a texture in that it has to be 64x64 pixels. To add your own icon or texture, select *Add custom texture* or ***Add custom icon***. After selecting a file with a graphics (png, jpg and bmp formats are supported), a dialogue will be displayed that will enable you configure the texture.





Parameter	Description
Image path	File name on the disc
Format	The texture target format. The format influences the quality of the texture and the amount of the memory it takes up. Detailed information about the formats is presented on the next page.
Width, height	Information about the size of the source bitmap
Has alpha	Information whether the bit map has a separate alpha channel
Resize enabled	It activates the scaling of the source texture
Constrain proportions	When activated, this option automatically keeps the proportion of the texture during scaling
New width, height	The new width and height of the texture
Quality	The filtering that will be used during scaling. We suggest using the *Auto filtering* option.
Texture bytes	The size of the texture in the memory of the device.
Available space	The available free memory for textures

Format	Description	Preview
A1 (256x256) 8kB	1-bit format. A pixel of the texture can assume only 2 values. It takes up less memory	
A2 (256x256) 16kB	2-bit format. A pixel of the texture can assume 4 values.	
A4 (256x256) 32kB	4-bit format. A pixel of the texture can assume 16 values. This format is recommended for icons. It guarantees a good quality while using little memory	
A8 (256x256) 64kB	8-bit format. A pixel of the texture can assume 256 values	
Indexed RGBA8 (256x256) 64kB	An 8-bit colour format with an alpha channel. The texture is quantized to 256 unique colours. This format is suitable for coloured textures (e.g. a company logo). It uses little memory, however, it displays a low rendering efficiency and results in a visible quality deterioration in the case of tonal transitions	
RGB 565 (256x256) 128kB	A 16-bit colour format without an alpha channel. It has a very good quality and rendering efficiency. A downside of this format is that it uses twice the memory of an indexed format	
ARGB 1555 (256x256) 128kB	A 16-bit colour format with an alpha channel. It has a very good quality and rendering efficiency. A downside of this format is that it uses twice the memory of an indexed format	

Inputs

As we explained at the beginning of the manual, the ADU device is equipped with 8 analogue and 8 digital inputs.

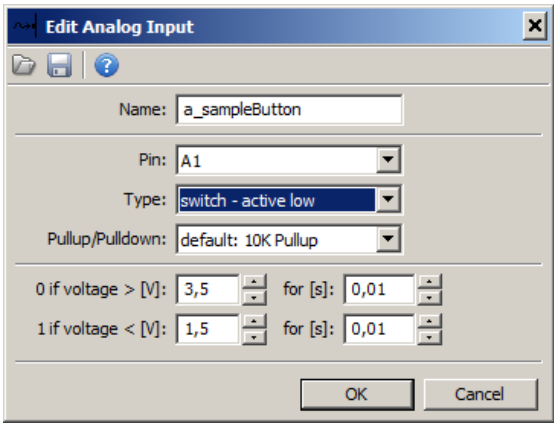
Analogue inputs

The analogue inputs are used for measuring sensor voltages (e.g. oil pressure sensor) or can be used as inputs for buttons or switches. To add an analogue input, add the ***Analog input*** object in the ***Project tree***. The configuration pane is comprised of the following options:

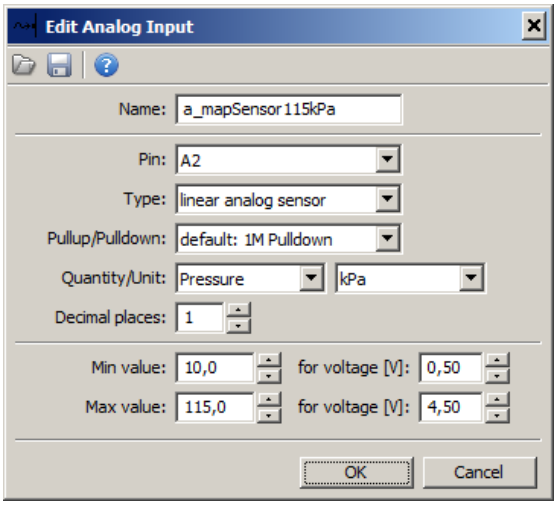
Parameter	Description
Name	The name of the analogue input that will be used as the channel name in the project
Pin	The number of the analogue input to which the configuration relates
Type	The function that the analogue input is to perform: ***Switch – active low*** – the analogue input will function as a switch (button) activated with a low state, ***Switch – active high*** – the analogue input will function as a switch (button) activated with a high state, ***Rotary switch –*** the input assumes a value consistent with the position of the ***Rotary switch***. The number of the positions of the rotary switch is defined as ***Min value / Max value***. ***Linear analog sensor –*** this type of input is used for measuring voltage (you select Voltage as a Unit) or any type of linear sensors (e.g. MAP sensor). ***Calibrated analog sensor*** – this type of input is used for measuring the values from sensors with a non-liner scale (e.g. temperature sensors NTC / PTC). A 2D map is used for defining the values.
Pullup / Pulldown	This function allows to activate the internal 10K resistor connected to the ground (*Pulldown)* or +5V (*Pullup*). These resistors are activated mainly when buttons are connected to the analogue inputs. In the case of a button activated with a low state, you should activate *Pullup 10K* and the button should connect the analogue input to ground. In the case of analogue sensors or in the case of measuring voltage, choose the *1M Pulldown* option.
Quantity / Unit	Defines the measured physical value and its unit for ***Linear*** and ***Calibrated analog sensor*** types
Decimal places	Defines the number of decimal places of the measured value for ***Linear*** and ***Calibrated analog sensor*** types

1 if voltage > [V]	Defines the voltage representing the value 1 for the ***Switch*** type. In order for this condition to be fulfilled, the voltage needs to be greater than that defined by the time from the field **for [s]**
0 if voltage < [V]	Defines the voltage representing the value 0 for the ***Switch*** type. In order for this condition to be fulfilled, the voltage needs to be smaller than that defined by the time from the field **for [s]**
Min value for voltage	This value defines the minimum sensor value for the defined ***Voltage*** when using a ***Linear analog sensor***
Max value for voltage	This value defines the maximum sensor value for the defined ***Voltage*** *when using a* ***Linear analog sensor***

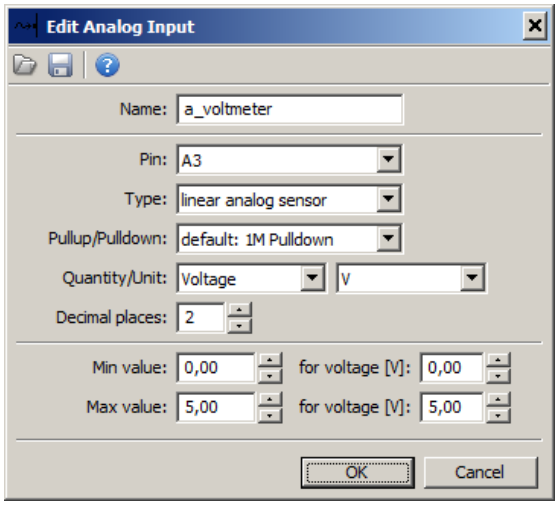
Example configurations:



A configuration for a button connected to ground and to analogue input 1. The value ***a_sampleButton*** will be 0 when the button is not pressed and 1 when it is.



Configuration for a pressure sensor in the intake manifold (MAP) connected to analogue input 2. The value ***a_mapSensor115kPa*** will assume values ranging from 10.0kPa to 115.0kPa

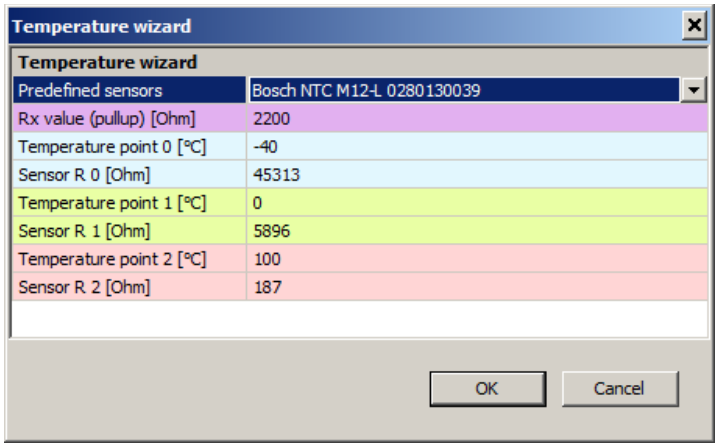


Configuration for measuring a voltage of 0-5V for a signal connected to analogue input 3.

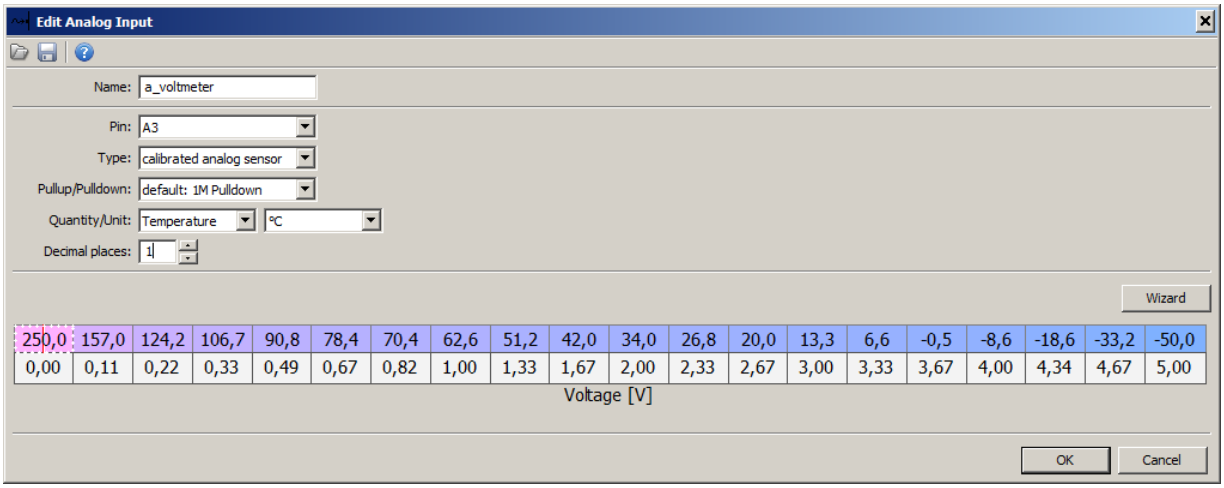
The value ***a_voltmeter*** will assume values ranging from 0.00V to 5.00V.

When using non-linear temperature sensors, the simplest method of calibration is to use the ***Wizard***. After pressing the ***Wizard*** button, a dialog window will pop up allowing you to define a sensor using 3 temperature values and the corresponding sensor resistance. You may select a calibration for common sensors in the ***Predefined sensor*** field.

The **Rx value** field means the value of the pullup resistor used when connecting the sensor.



If the sensor characterization data is correct, a 2D map describing the sensor characteristics will be generated automatically:



If you want to create a calibration map manually, you can input the values in the particular cells. To change the table size, right click on it and select one of the ***Modify bins*** options.

You can preview the analogue input values in the ***Analog monitor*** panel showing a channel value, voltage and information about the pullup resistor connected.

Digital inputs

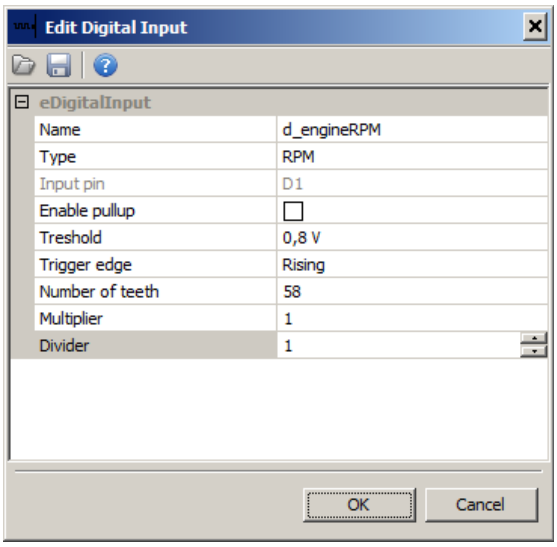
Digital inputs are used for reading digital signals such as signals from crankshaft position sensors, wheel speed sensors or an ethanol sensor *(FlexFuel).* They can also be used as inputs for buttons connected to ground.

To add an digital input, add the ***Digital input*** object in ***Project tree***. The configuration pane is comprised of the following options:

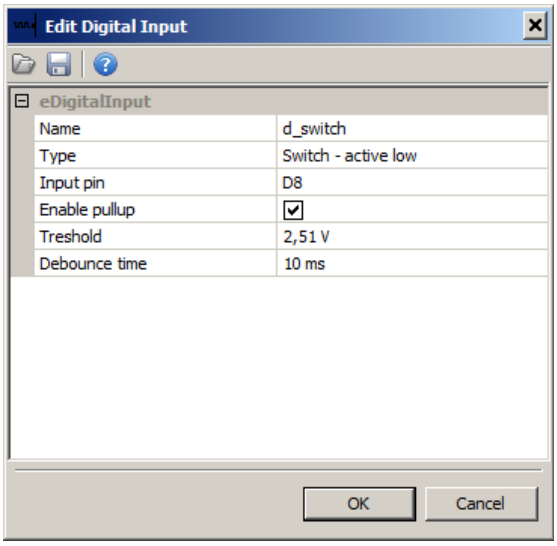
Parameter	Description
Name	The name of the digital input that will be used as the channel name in the project
Input pin	The number of the analogue input to which the configuration relates
Type	The function that the analogue input is to perform: ***Switch – active low*** – the digital input will function as a switch (button) activated with a low state, ***Switch – active high*** – the digital input will function as a switch (button) activated with a high state, ***Frequency –*** the digital input will measure the signal frequency **RPM –** the digital input will decode the signal from the crankshaft /camshaft position sensor in order to measure the vehicle engine speed. Only **D1** input can be used to measure the engine speed. **Flex Fuel –** a digital input used for reading the content of ethanol in fuel and the fuel temperature from the FlexFuel sensor. Only the **D2** input can cooperate with the FlexFuel sensor. The values read from the sensor are stored in the following channels: *adu.ff.ethanolContent*, *adu.ff.fuelTemperature, adu.ff.sensorStatus* ***Beacon*** - a digital input used for decoding the signal from an AIM Beacon. The **D2** input is compatible with an AIM beacon.
Enable pullup	Activates an internal pullup resistor for a given input.
Threshold	A reference voltage which, when exceeded, results in a change of the input state from 0 to 1 (and the other way around). When using VR sensors this value will be smaller than 1V. When using the Hall effect / optical sensors this value will equal 2.5V.
Debounce time	When using a ***Switch***-type input, this parameter determines the time needed to stabilize the switch contacts
Trigger edge	The signal edge to be used when reading a signal
Number of teeth	When using an RMP signal - a physical number of teeth on a toothed wheel

	used by the crankshaft/ camshaft position sensor. For a 60-2 toothed wheel the number will be 58, for a 12+1 wheel - 13, etc.
Multiplier	The value by which the input frequency (*Frequency)* or the engine speed (*RPM)* will be multiplied. This allows you to calibrate values such as turbocharger speed or vehicle speed.
Divider	The value by which the input frequency (*Frequency) or the engine speed (RPM)* will be divided. This allows for the calibration of values such as turbocharger speed or vehicle speed.
Timeout	Time to reset freqency if there is no incoming signal pulse

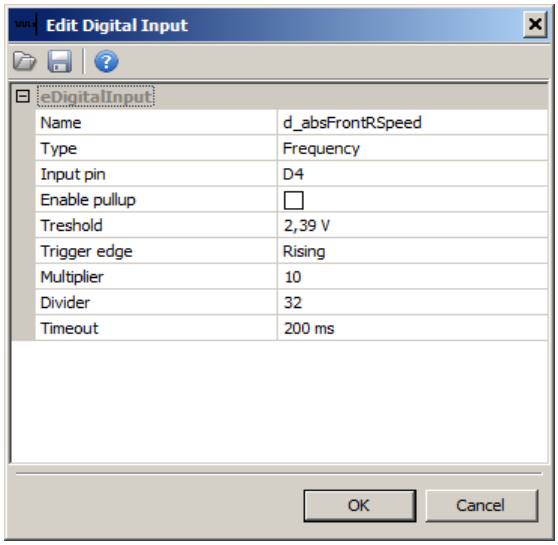
Example configurations:



Engine speed (RPM) read-out configuration from an inductive crankshaft position sensor and a 60-2 trigger wheel. When using the engine speed read-out, the sensor must be connected to ***Digital Input 1***



Configuration of the status read-out of the button connected to ***Digital Input 8***. The button must connect the signal to ground. The ***d_switch*** variable assumes a value of 0 when the button is not pressed and 1 when it is.



Configuration of a wheel speed read-out from an ABS sensor connected to ***Digital Input 4***. The ***d_absFrontRSpeed*** variable value equals the input frequency multiplied by 10 and divided by 32 (*multiplier, divider*).

Outputs

The ADU device is equipped with two low-side outputs rated at 2A each. Additionally, an analogue output with a signal ranging from 0 to 5V is available, which can be used to send a voltage signal to another device.

Low side output

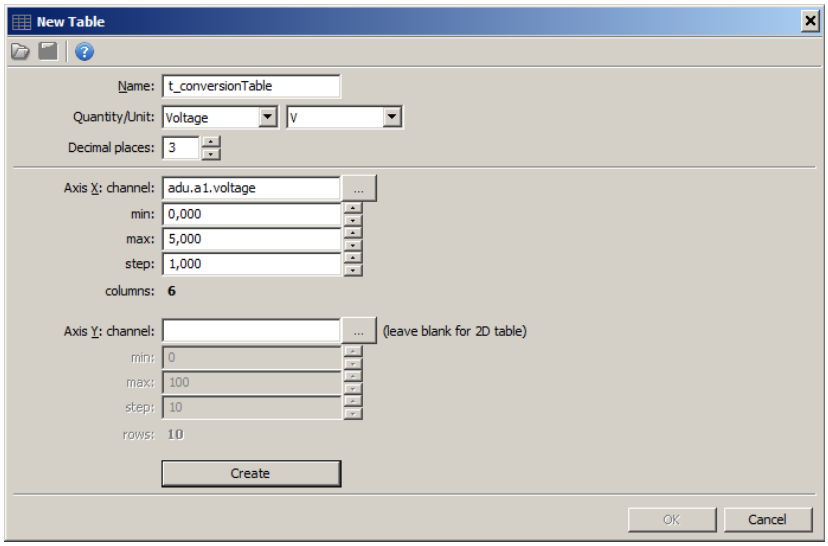
Configuration of low side outputs is available in the ***Outputs*** panel. You can choose between two output channels ***Aux1.channel*** and ***Aux2.channel***, where you can define the variables/functions that will control the output. When their value equals 0, a given output is inactive (open), when the value differs from 0, the output is active (connected to ground)

Analogue output

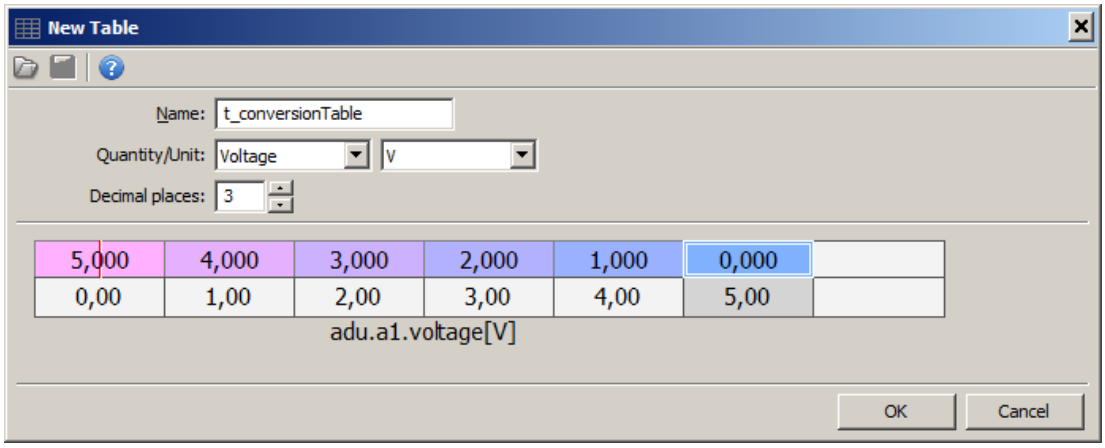
The analogue output control channel is available in the ***Outputs*** panel as ***AOut.channel.*** It should be assigned a variable representing a value in V with a 0.001V accuracy, resulting in the actual value ranging from 0 to 5000 (0-5V).

The following example shows how to change a signal from the 0-5V analogue input to a 5-0V signal and how to set the voltage at the ***Analog output***.

We will use a 2D map for this purpose. In order to create it in the project, select the ***Add*** button and then ***Table***. The configuration dialogue should look as follows:



A ***2D Table*** will be created after pressing the ***Create*** button. The table should be modified so that 0V from the table is 5V, and for 5V - 0V.



The value of the ***t_conversionTable*** should be assigned to the ***AOut.channel*** field in the ***Outputs*** panel.

User lights

The ***User lights*** functions allow to control the LEDs on both sides of the device. This way they can be assigned their own functions (e.g. Indicators, alarms).

Parameter	Description
Master brightness	The LED brightness scale. Each LED can be a assigned a brightness ranging from 0-100%. The ***Master brightness*** parameter influences the brightness of all LEDs.
Led 1 function	Selection of a function for LED no. 1. ***User LED1 –*** LED no. 1 behaves like the other LEDs and can be assigned a user function ***USB logger state still –*** LED no. 1 displays the state of logging into the memory connected to the USB port. ***USB logger state flashing -*** LED no. 1 displays the state of logging into the memory connected to the USB port.
Type	We can select the control method for each LED: ***On/Off –*** the simplest control where an LED assumes two states: off (if the value of the variable assigned in the *Channel* field equals 0) or on (if the value of the variable in the *Channel* field differs from 0). If a LED is on, its colour is defined as *Color 1* ***Choose*** – an LED assumes two states whose colour is defined in the *Color 1 and Color 2 fields.* The state depends on the value of the variable in the *Channel field.* ***Choose* + override** – an LED can assume three states whose colour is defined in the *Color 1, Color 2 and Color 3 fields.* The two first states are controlled the same way as in the *Choose* type. The third state is controlled by means of a variable assigned to the *Channel 3 field.* When this variable assumes a value different from zero, the LED colour will change to the value from the *Color 3 fields* irrespective of the value of the variable in the *Channel field*
Channel	A variable defining the state of a given LED.

Color 1	When using the ***On/Off*** type, it defines the colour when the variable in the *Channel* field assumes a value different from zero, When using the ***Choose and Choose + override*** type, it defines the colour when the variable in the ***Channel*** field equals zero
Color 2	When using the ***Choose and Choose + override*** type, it defines the colour when the variable in the ***Channel*** field differs from zero
Channel 3	A variable defining the third state When using the **Choose + override** type
Color 3	When using the ***Choose + override*** type, it defines the colour when the variable in the ***Channel 3*** field differs from zero
Brightness	The brightness of individual LEDs

User tracks

The ADU device has a built-in set of popular car racing tracks worldwide. This set continues to grow with each new version of the software. The currently available tracks are listed in Appendix no.1 hereto. If a track is not available or if a track configuration differs from that assumed by us, you can define a track yourself. You should enter the coordinates (latitude and longitude) of the centre of the start/finish line.

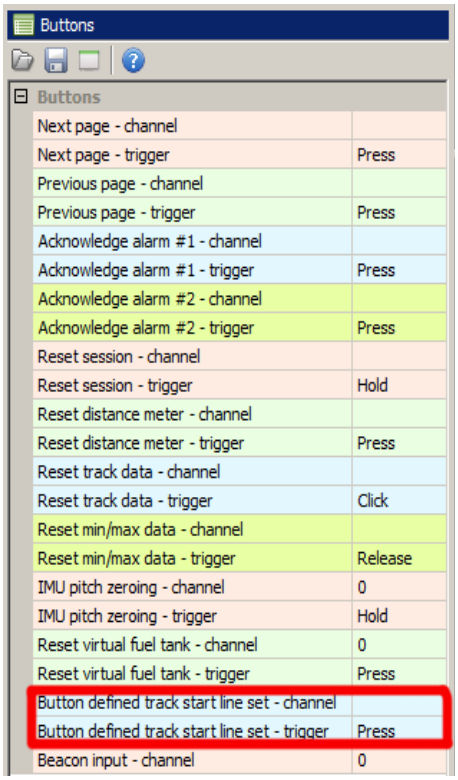
You can define up to 5 tracks of your own. If the track area coincides with a track area defined in the device, the one defined by the user will have the priority.

Parameter	Description
Enable	Enables a given track
Name	Track name
Latitude	The latitude of the centre of the start/finish line
Longitude	The longitude of the centre of the start/finish line
Track length	The track length in meters
Track width	The track width
Track radius	The radius of a circle defining the track area. The centre of the circle is defined as the centre of the start/finish line

The following drawings are a graphical representation of the track in Poznań.


Rzemieślnicza
Poznań: Tor samochodowy
Tor Poznań
Radius
500,00 m
697,73 m
Bukowska
Bukowska
307
307
307
Bukowska

User track defined by the button



It is possible to define the track using an external button connected to the ADU. The button needs to be defined in the "Buttons" window. When the driver presses the button first time, the actual GPS position is acquired. The driver needs to finish the whole lap to finish creation of the track. If the driver presses the button again during the track defining phase the track will be deleted. To inform the driver about the status of the button defined track, there is a template for an overlay page available. To load the template, the user needs to create a new page, press the open file icon on the page window and the load the ov_buttonDefinedTrackOverlay.aduepg.

This page will appear when the driver presses the button for the first time and automatically dissapear when the track definition is finished (the full lap is driven). The name of the track is "Button defined track" and can be displayed using $(TRACK) directive in the Text control.

The picture below shows the predefined overlay:

This overlay uses the channel *adu.track.userButtonDefinedTrackAcquiring* as a display condition. The ADU supports 3 types of the track definitions. The first one is the tracks defined in the device internal software (built in tracks), the second type is user track (5 available) that can be defined using the ADU software and the user tracks window. The third type is button defined track.

The order (priority) of the tracks is:

1) Button defined track

2) User tracks

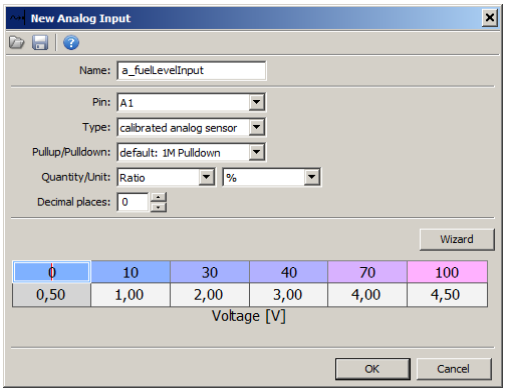
3) Built in tracks

Fuel level filter

The ***Fuel level filter*** function is used for filtering the signal from the fuel level sensor in the fuel tank.

The value produced by this function is output to the ***ecu.fuelLevel***. channel.

Parameter	Description
Fuel level mode	***One fuel level sensor –*** use one fuel level sensor, the result is stored in *ecu.fuelLevel* channel, ***Two fuel level sensors (average) –*** use two fuel level sensors, the result is avarage value of both sensors, and it is stored in *ecu.fuelLevel* channel, ***Two fuel level sensors (separate levels) –*** use two fuel level sensors, and results are stored in *ecu.fuelLevel* and *ecu.fuelLevel2* channel
Fuel level 1 - Source channel	A channel/variable determining the amount of fuel in the tank. Usually, a 2D table with calibration is used for this purpose.
Fuel level 2 - Source channel	A channel/variable determining the amount of fuel in the tank. Usually, a 2D table with calibration is used for this purpose.
Maximum step change	The maximum allowed fuel level change during one second.
Filter time	The time based on which samples are to be averaged. The longer the time, the greater the filtering.



In a typical car the fuel level sensor is a potentiometer that requires an additional pullup resistor (these are usually small values ranging between 100 and 200 Ohms). Connect this signal to an analogue input and select ***Calibrated analog sensor.*** This will allow you to calibrate the amount of fuel for a given voltage in the table.

If you need to resize the table, right click on the table cells and select ***Modify Bins/Insert cell*** (to add a cell) or ***Modify Bins/ Delete cell*** (do delete a cell).

Then enter the name of your channel (***a_fuelLevelInput***) in the ***Source*** field. After filtering, the value is available in the ***ecu.fuelLevel*** channel.

OBD 2

The OBD 2 panel is used for configuring communication using the OBD 2 communication protocol. The read channels are divided into two groups. The fast ones (such as RPM, TPS) are marked green, while the slow ones (such as CLT and Fuel Level) are marked pink. The more channels that are used from a given group, the lower their logging frequency. The read channels are mapped to ***ecu.**** channels. It should be pointed out that not every ECU allows you to read all of the following channels.

Parameter	Description
Enable	Activates support for the OBD 2 protocol over CAN BUS 2
RPM	The engine speed readout. Shown in the log as ***ecu.rpm***
Intake manifold absolute pressure	The absolute pressure in the intake manifold. Shown in the log as ***ecu.map***
Vehicle speed	The vehicle speed. Shown in the log as ***ecu.speed***
Throttle position	The throttle position. Shown in the log as ***ecu.tps***
Timing advance	The ignition timing angle. Shown in the log as ***ecu.ignAngle***
Fuel pressure	The fuel pressure. Shown in the log as ***ecu.fuelPress***
Engine coolant temperature	The engine coolant temperature. Shown in the log as ***ecu.clt***
Intake air temperature	The temperature in the intake manifold. Shown in the log as ***ecu.iat***
Fuel level	The fuel level. Shown in the log as ***ecu.fuelLevel***
Barometric pressure	The barometric pressure. Shown in the log as ***ecu.baro***
Ambient air temperature	The temperature outside the vehicle. Shown in the log as ***ecu.ambientAirTemp***
Ethanol fuel %	The content of ethanol in the fuel. Shown in the log as ***ecu.ethanolContent***
Engine oil temperature	The engine oil temperature. Shown in the log as ***ecu.oilTemp***
Update rate	A parameter determining the frequency of sending inquiries to the engine control unit. The higher the frequency, the higher the frequency of logging you can obtain. Unfortunately, not all control units are capable of responding with the frequency of 100Hz and may require a lower frequency.

Outputs

The ***Outputs*** panel is used for the configuration of controlling the ADU outputs (*AUX1, AUX2, Analog out*).

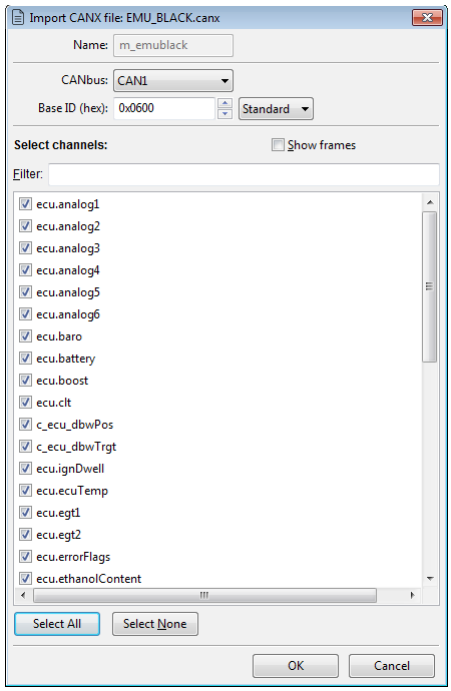
Parameter	Description
Aux1.channel	A channel/variable controlling the AUX 1 output. A value of 0 means an inactive output, a value of 1 means an output connected to ground
Aux2.channel	A channel/variable controlling the AUX 2 output. A value of 0 means an inactive output, a value of 1 means an output connected to ground
AOut.channel	A channel / variable controlling the AUX2 output. A value of 0 corresponds to 0V, while a value of 5000 corresponds to 5V (on the mV scale)

Working with CAN buses in ADU

Using pre-defined streams from CANX files.

The simplest way of working with a CAN bus is to use pre-formatted templates in the ADU Client. These templates are available as files with a CANX extension.

Open the ***Project tree / Add / Import CANX*** dialog and select a file with a CANX extension, then a pane with import settings will open. For starters, choose the CAN bus from which you will receive data. The ADU device has two CAN buses - CAN1 and CAN2. Next select the channels to be imported.



You can use a filter to select only particular channels. You can also select all using the '***Select all'*** button.

You should remember that the ADU device supports up to 100 CAN channels on both buses.

After confirming with the OK button, the selected channels will be added to the ***Project Tree***. In addition, one or more ***CANbus Massage Objects*** responsible for receiving frame groups will be created.

Custom CAN streams - CANbus Message Object

Access to a CAN bus in the ADU device is completely open. You can create your own streams or modify the existing ones supplied together with the package.

Configuration begins with the creation of a **CANbus Message Object** (Mob) element in the **Project tree.** Each mob receives 1, 2, 4 or 8 CAN frames. After choosing a CAN bus you should select a base ID (*Base ID*), as well as the type (*Type*) and the number of received frames (the *Size* parameter. If the device in connected, a preview of the stream in real time (*Live Capture*) will be shown, which facilitates diagnostics and accelerates work.

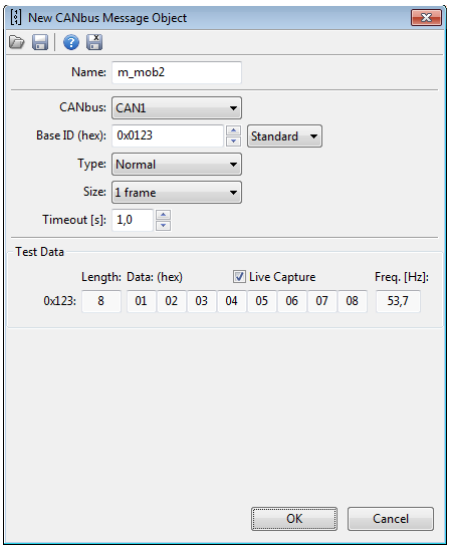
IMPORTANT!

Active logging is required for Live Capture to work properly. In other words, logging cannot be in the pause mode.

IMPORTANT!

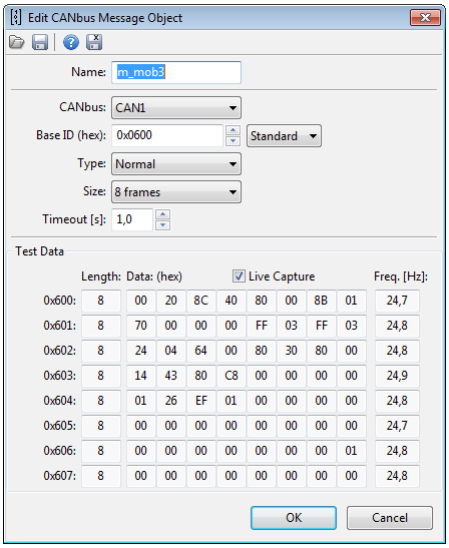
Frame CAN IDs in the ADU Client are always presented in hexadecimal notation (they usually begin with the *0x* prefix, which is a symbol of hexadecimal notation).

Receiving 1 frame ID 0x123 Standard



- **Base ID:** 0x123 Standard
- **Type:** Normal
- **Size:** 1 frame

Receiving 8 frames from the range of ID 0x600 - 0x607 Standard.



- **Base ID:** 0x600 Standard
- **Type:** Normal
- **Size:** 8 frames

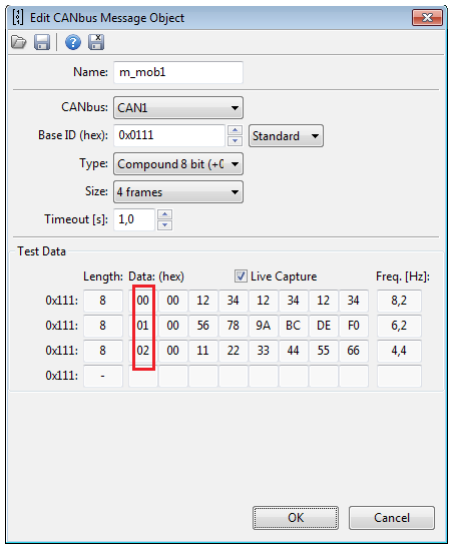
Remember that for regular frames (Type: Normal), the Base ID must be divisible by Size without a remainder. For example, you can receive 8 frames from the range of 0x600..607 using one mob. However, it is not permitted to receive frames from the range of 0x601..608 using one mob. If this is the case, this should be divided into two mobs of 0x600..607 and 0x608.

To check if the Base ID is suitable, pay attention to the last digit in the hexadecimal notation:

- If the number is 0 or 8, then it is divisible by 8 (Size: 8)
- If the number is 0, 4, 8, C, then it is divisible by 4 (Size: 4)
- If the number is 0, 2, 4, 6, 8, A, C, E, then it is divisible by 2 (Size: 2)
- Each number is divisible by 1 (Size: 1)

Receiving 3 Compound 8 bit frames from ID 0x111 Standard.

- **Base ID:** 0x111 Standard
- **Type:** Compound 8 bit (+0)
- **Size: 4** frames



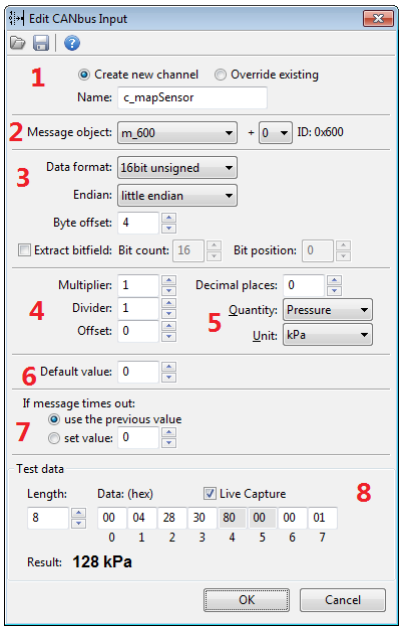
When using Compound frames the Base ID address doesn't have to be divisible by the Size. This results from the fact that the communication takes place using only one CAN ID.

Compound frames are characterized by containing an index on the first 4, 8 or 16 bits (for the Compound types 4 bit, 8 bit and 16 bit, respectively). In the dialogue pane nearby you can see the first byte in a sequence 00, 01, 02.

Custom Can streams - CANbus Message Input

After a ***Can Message Object*** has been created, you can start defining ***CANbus Input*** channels.

(1) For starters, decide whether you will be creating a new channel (option: ***Create new channel***) or whether you will be overriding an existing channel (option: ***Override existing***).



When creating a new channel, you should choose a unique name so that it can be identified.

When overriding, you must choose an existing channel from the "*ecu.*" group. (e.g. *ecu.rpm*). Additionally, you should match the decimal places and a unit to such selected channel.

(2) Next, select the prepared mob and select offset in frames from the list marked '+'. The scope of this parameter depends on the selected Size in the parameters of the used Message object.

(3) The next step is setting the Byte offset parameter. It marks the location of our values in the CAN frame (0-7).

You should select the interpretation of the number:

- ***signed/unsigned*** – ***signed*** is a number with a sign (it can receive positive and negative values, as well as zero). An example of such value is the value from the cooling liquid temperature sensor. ***Unsigned*** – numbers zero and above. For example engine speed (RPM)
- ***8 bit / 16 bit*** - number width in bits; 1 byte / 2 bytes, respectively
  - signed 8 bit - scope of numbers -128..127
  - signed 8 bit - scope of numbers 0..255
  - signed 16 bit– scope of numbers -32768..32767
  - unsigned 16 bit– scope of numbers 0..65535
- ***big endian / little endian*** - i.e. the "sequence" of bytes for 16-digit numbers. It shows how a number stored in two consecutive bytes is to be interpreted. E.g. numbers 0x12, 0x13 can be interpreted as 0x1234 for the *big endian* or 0x3412 for the *little endian.*

- You can also define ***"Extract bitfield"***, i.e. take only a part of an 8- or 16-bit number. For example, to check the setting of a bit of a 0x80 mask the following settings should be used: Bit count: 1, Bit position: 7.

(4) Next scaling / moving values, decimal places.

„***Raw***" (*raw*) value interpreted in item (3) may be scaled.

For example, Lambda in the EMU stream is saved as the value 0..255, where:

- raw value 0 means Lambda=0.0,

- raw value 128 means Lambda=1.0,

- raw value 255 means Lambda= app. 2.0,

Hence, such value should be scaled. You can use ***Multiplier=1000, Divider=128*** and move the decimal places using ***Decimal places*** = 3. This way, you will add the end value of 1.000 to the raw value of 128.

(5) Selection of a physical value and the unit.

You can choose from typical units from the SI system, as well as those applied in the automotive industry. If a unit is not on the list, you can also use the ***User unit***.

(6) Choosing a default value.

A default value is used from starting the device until receiving the first frame containing the channel.

IMPORTANT!

You should take into account decimal places in this constant. For example, if ***Decimal places*** = 2 has been selected, and the default value is to be 1.0, enter the value 100 into the field. The same requirement relates to the following fields: ***Offset*** and ***Timeout value***.

(7) Defining behaviour in the case of a loss of frame reception in the CAN bus.

If a given frame cannot be received for a time longer than that defined in *Message Object* (*Timeout* parameter in seconds), two options are available:

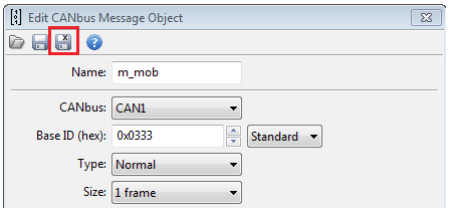
a) the last value can stay (alternatively, the default value, if a frame has never been received)

b) a specific value can be set

(8) The last element of the CANbus input defining window are ***Test data*** fields. These fields are used only during editing. You can observe a received frame in real time (active ***Live capture***) or enter test data (***Live capture*** deactivated). In both cases the calculated final value is visible, which accelerates configuration.

Custom CAN streams - saving to a .CANX file

A configured ***Message Object*** together with all CANbus input channels can be saved into a .CANX file using a toolbar button.

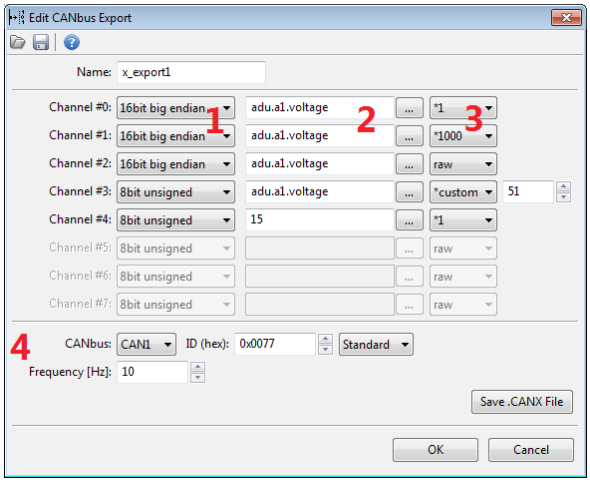


Sending frames by means of the CAN bus (CANbus export)

Access to the CAN bus in the ADU device is completely open, and allows sending any available channel of the device. You can send frames of any CAN ID into one of two CAN buses.

The CANbus Export configuration pane is comprised of the following sections:

(1) Selection of the type of the data sent



There are four options available:

- ***8bit unsigned*** - the value of the channel is limited to a range of 0..255 and sent as a single byte in a frame
- ***8bit signed*** - the value of the channel is limited to a range of -128..127 and sent as a single byte in a frame
- ***16bit big endian*** - the value is sent with the most significant byte first, and least significant byte second (for example the value 0x1234 will be sent as two consecutive bytes 0x12, 0x34)
- **16bit little endian** - the value is sent with the least significant byte first and most significant byte second (for example the value 0x1234 will be sent as two consecutive bytes 0x34, 0x12)

(2) Selected channels or constants

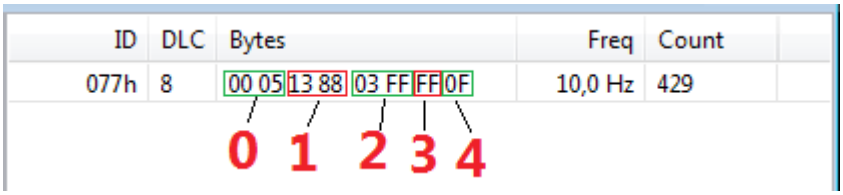
You should select a channel from the list or enter a constant. In addition to the decimal notation, a constant can also be saved in hexadecimal notation. For this, the prefix 0x should be used (e.g. 0xE3 or 0xe3).

(3) Selection of a multiplier or a raw value

It is possible to multiply the real values by a constant from the range of 1..1000 or, alternatively, to send a raw value. For example - from the above figure:

- ***Channel #0*** - voltage value at input A1 will be sent as one from the range of 0, 1, 2, 3, 4, 5 (i.e. in volts, but without the fractional part).
- ***Channel #1*** - voltage value at input 1A will be sent as a number from the range 0..5000 (i.e. in milivolts)
- ***Channel #2*** -voltage value at input 1 A will be sent as a raw value from the ADC converter, a number from the range ..1023
- ***Channel #3*** - voltage value at input 1A will be sent as a number from the range 0..255
- ***Channel #4*** – a constant value will be sent - 15 decimal

Below is a frame preview as seen in the *ECUMASTER Light Client* application. At the A1 analogue input the voltage is exactly 5V. Channel #0 - Channel #5, respectively, as in the above example:



- ***Channel #0*** - value 0x0005, i.e. 5 [V]
- ***Channel #1*** - value 0x1388, i.e. 5000 [mV]
- ***Channel #2*** - value 0x03FF, i.e. 1023 [adc]
- ***Channel #3*** - value 0xFF, i.e. 255
- ***Channel #4*** - value 0x0F, i.e. 15

(4) Selection of a bus, CAN ID, sending frequency.

Select a sending frequency ranging from 1..100 Hz.

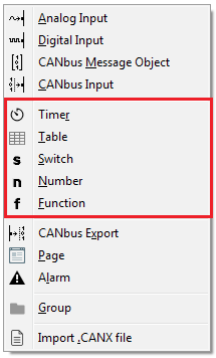
Select a CAN ID. Make sure you don't collide with other communications in the network.

WARNING!

It is not permitted for two devices in the CAN network to send frames of the same CAN ID !

Processing information in the ADU

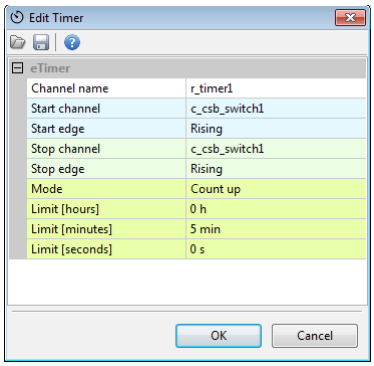
ADU has 5 information processing elements:



1. ***Timers*** - counting time
2. ***Tables*** - lookup tables
3. ***Switches*** - virtual switches, counters
4. ***Numbers*** - mathematical channels
5. ***Functions*** - logic functions

These elements are processed the same way as all elements in the ADU at 500 Hz (every 2 ms). These elements are processed in the listed above order (***Timers*** first, then ***Tables***, and so on).

Timers



Timers are used for counting time. It is possible to count time from zero to a predefined value (*Count up*) or down from predefined value to zero (*Count down).*

Timers can store time up to 200 hours with an accuracy of up to 0.01 seconds.

Timers are started by means of a channel defined by ***Start Channel*** and an edge defined by ***Start edge*** *(Rising* or *Falling*).

Similarly, Timers are stopped by means of a channel defined by ***Stop Channel*** and an edge defined by ***Stop edge*** *(Rising* or *Falling*).

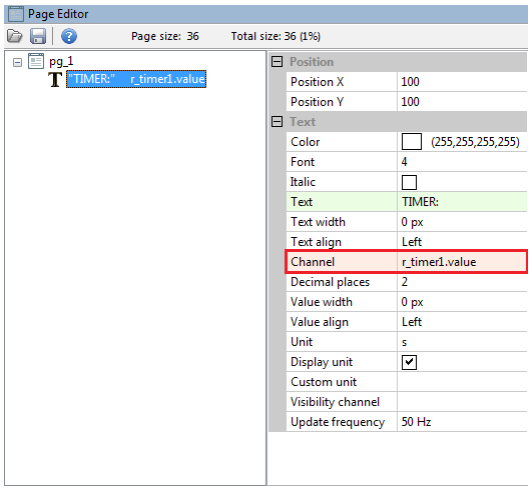
When a timer is stopped, the starting edge appearing in the ***Start Channel*** will always result in moving to the initial value. When a timer is already started, the starting edge is ignored. A timer will react to a starting edge only after stopping or counting to the end. This allows starting and stopping by means of the same channel and edge.

Each created timer has 3 subchannels:

- ***.value*** - value of time in seconds (up to 0.01 seconds)
- ***.elapsed*** - has a value of “1” when the time has elapsed; it will change to “0” after another start.
- ***.running*** - has a value of “1” when a timer is counting time

A timer can be used on a page in the ***Text*** indicator. Use the *.value* subchannel for this purpose.

Time can be formatted using ***Unit*** e.g. using the *hh:mm:ss* format. You can change the accuracy by means of the ***Decimal places*** parameter.

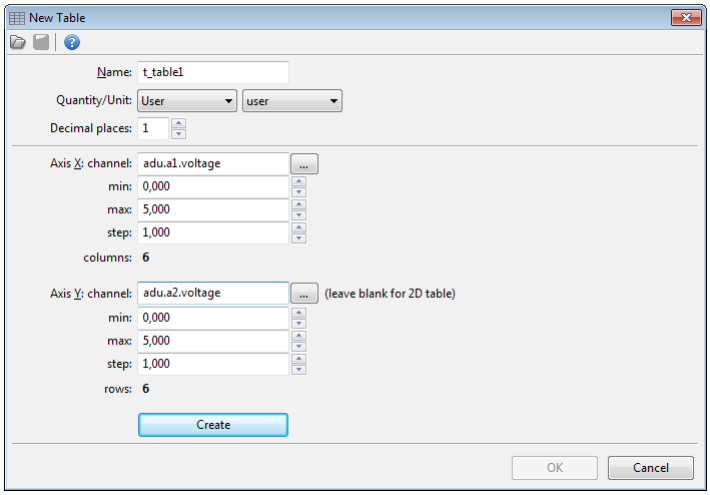


Tables - lookup tables

Configuration of a table starts by defining the channels representing axes. If a table is to be two-dimensional, leave the ***Axis Y: channel*** empty.

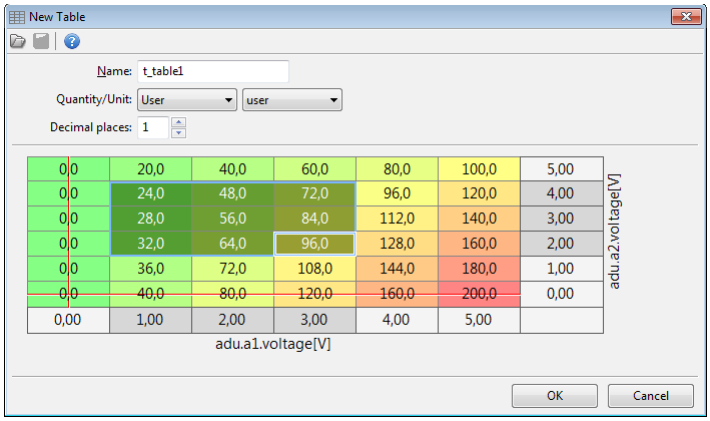
You should also define the axis scope - *min* and *max* To change the number of elements in a table, change the *step* parameter which defines the step.

Table size can range from 2x2 to 21x21.

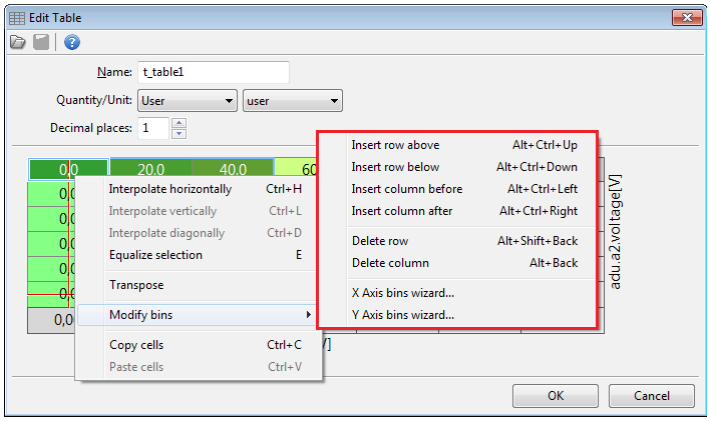


Next, fill the cells and axes with values. The values defined on axes are independent for each table.

You can select several cells by means of the *Shift* key. Use *Ctrl + arrows* to copy the content into the neighbouring cells. You will also find the horizontal and vertical interpolation commands helpful.



A table size (number of columns and rows) can be changed any time by means of a popup menu opened by right-clicking.



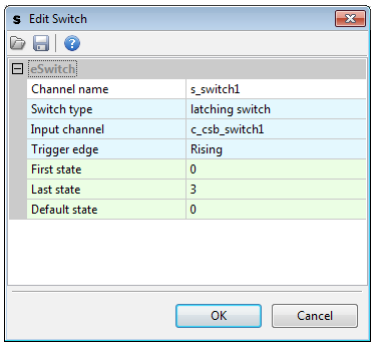
Description of the commands in the popup menu:

Command	Shortcut key:	Description:
Interpolate horizontally	*Ctrl+H*	Horizontal interpolation: the value of the cells inside the selection is calculated as a linear interpolation of cells on the left and right selection edge.
Interpolate vertically	*Ctrl+L*	Vertical interpolation: the value of the cells inside the selection is calculated as a linear interpolation of cells on the upper and lower selection edge.
Interpolate diagonally	*Ctrl+D*	Interpolation between apexes. You should define 4 corner points in the selection, and the remaining cells will be calculated as a double linear interpolation. It combines two commands - first the horizontal and then vertical interpolation.
Equalize selection	*E*	Smoothing out the selected cells
Insert row above	*Alt+Ctrl+Up*	Inserting a row above the selected cell
Insert row below	*Alt+Ctrl+Down*	Inserting a row below the selected cell
Insert column before	*Alt+Ctrl+Left*	Inserting a column to the left of the selected cell
Insert column after	*Alt+Ctrl+Right*	Inserting a column to the right of the selected cell
Delete row...	*Alt+Shift+Back*	Deleting a row containing the selected cell
Delete column...	*Alt+Back*	Deleting a column containing the selected cell
X Axis bins wizard		Starting the creator for the X axis allowing to define a new number of columns and to generate the Y axis cells according to the selected interpolation type.
Y Axis bins wizard		Starting the creator for the Y axis allowing to define a new number of columns and to generate the Y axis cells according to the selected interpolation type.

Switches - virtual switches, counters

The main task of this element is to convert a *Momentary switch / Non-latching switch* available as an *analogue* or *CAN input* into a *Latching switch.*

You should define the range using the ***First*** *state* and ***Last state*** parameters, as well as the *default value* by means of the ***Default state*** parameter.



This element will operate as a counter. After each appearance of a***Trigger edge*** in the ***Input channel*** the element will increase the value by 1. If the element already has a value equal to *Last state* and a***Trigger edge*** appears, the value will “roll back” and assume the value of the ***First state***.

Numbers - mathematical channels

The mathematical channels are used for calculating functions using mathematical operations. In the simplest form, a number is calculated by means of a sum of products (sum of multiplications).

RESULT = (A * B * ... * C) + ... + (D * E * ... * F)

e.g. RESULT = (A * B)

RESULT = (A * B) + (C * D) + E

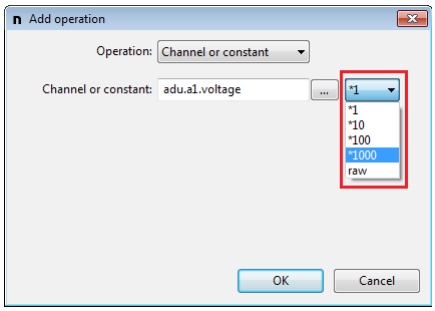
You can also use integer division ("/" symbol) or a division remainder ("*mod*" symbol)

e.g. RESULT = (A * B/ C)

RESULT = (A mod B) + (C * D * F)

Channel value modifiers.

Channels used for mathematical operations may be scaled before the operation is defined. You may mulitply by 1, 10, 100 or 1000 (the fractional part is rejected). You may also choose to use the *raw* value with no modification. *Raw* applies to the voltage from analogue inputs, for example, where it is a value from an ADC converter with a range of [0..1023].



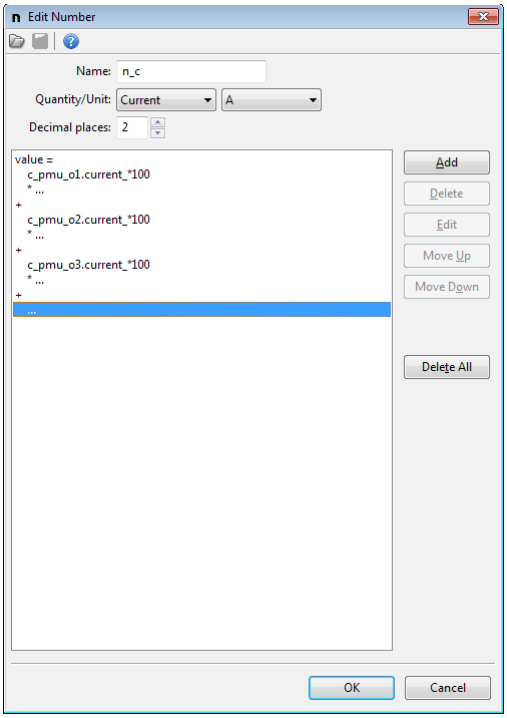
Calculating the sum of currents of 3 PMU current outputs

Three channels are given: *c_pmu_o1.current*, *c_pmu_o2.current*, *c_pmu_o3.current*. Each channel contains the current usage of a PMU output, and these messages are sent from the PMU.

Let's assume that we want to a have a result with an accuracy of up to 0.01 A.

The following formula should be used:

n_c = (o1.current*100 + o2.current*100 + o3.current*100) where the point should be "moved" by two decimal places to the left.



Decimal places

Each mathematical channel can store raw values within the range of [-32768, +32767].

You can additionally define decimal places by “moving” the point by 0, 1, 2 or three places. For example, when decimal places are set to 1, the channel can store real values within the range of [-3276,8, +3276,7].

Values are calculated in the raw value based on integers and then the point is “moved” by a defined number of decimal places.

Indirect calculations are performed using a broader range of numbers (app. $\pm 2*10^9$). For example, calculations can be performed for the following values 1000*1000 / 123. In the end, the result is limited (*clamped*) to a range of [-32768, +32767].

Calculating the average speed of the rear axle

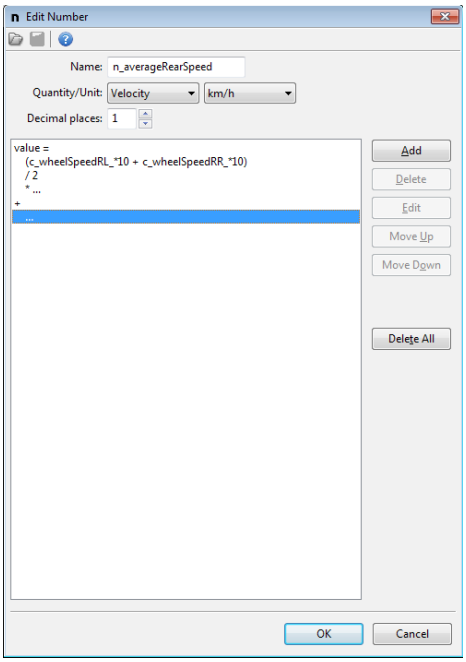
Two channels are given: *c_speedRL* and *c_speedRR* containing speed in km/h.

Let’s assume that we want a result with an accuracy of 0.1 km/h.

The following formula should be input:

n_averageRearSpeed = (c_speedRL*10 + c_speedRR*10) / 2

You should remember to “move” the point by 1 decimal place to the left. The “*/*” operation means integer division.



List of operations available for mathematical channels.

FACTOR is a single multiplier in the A*B*C notation

RESULT is the calculated result of previous multiplications or divisions / division reminders

Operation	Parameter	Pseudocode
Channel or constant	Result[1]	FACTOR = *Result*
Constant	Result[2]	FACTOR = *Result*
Choose	Condtion channel Result if true Result if false	if *Condition_channel* ≠ 0 then FACTOR = *Result_if_true* else FACTOR = *Result_if_false*
Divide	Value	RESULT := RESULT DIV *Value* (DIV – integer division; eg.: 9 DIV 2 = 4)
Modulo	Value	RESULT := RESULT MOD *Value* (MOD - division reminder; eg.: 9 MOD 5 = 4)
Addition	Value 1 Value 2	FACTOR = *Value_1* + *Value_2*
Subtraction	Value 1 Value 2	FACTOR = *Value_1* - *Value_2*
Min	Value 1 Value 2	if *Value_1* < *Value_2* then FACTOR = *Value_1* else FACTOR = *Value_2*
Max	Value 1 Value 2	if *Value_1* > *Value_2* then FACTOR = *Value_1* else FACTOR = *Value_2*
Clamp	Input Min Max	if *Input* < *Min* then FACTOR = *Min* else if *Input* > *Max* then FACTOR = *Max* else FACTOR = *Input*
Lookup2	Channel First index Value[A], Value[B]	if *Channel* ≤ *First_index* then FACTOR = *Value[A]* else FACTOR = *Value[B]*
Lookup3	Channel First index Value[A], Value[B] Value[C]	if *Channel* ≤ *First_index* then FACTOR = *Value[A]* else if *Channel* = *First_index+1* then FACTOR = *Value[B]* else FACTOR = *Value[C]*
Lookup4	Channel First index Value[A], Value[B] Value[C], Value[D]	if *Channel* ≤ *First_index* then FACTOR = *Value[A]* else if *Channel* = *First_index+1* then FACTOR = *Value[B]* else if *Channel* = *First_index+2* then FACTOR = *Value[C]* else FACTOR = *Value[D]*

[1] - Constant value for ***Chanel or constant*** operation is in range [-16384, +16383]

[2] - Constant value for ***Constant*** operation is in range [-32768, +32767]

Functions

Logic functions are used to define an extended behaviour of the display depending on the channel input values.

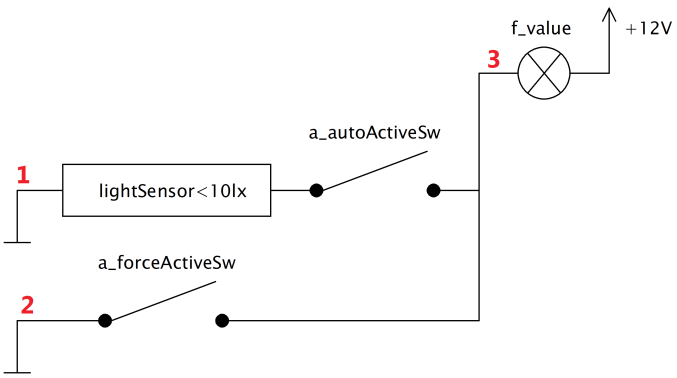
Example #1: Controlling a dome light using a light sensor.

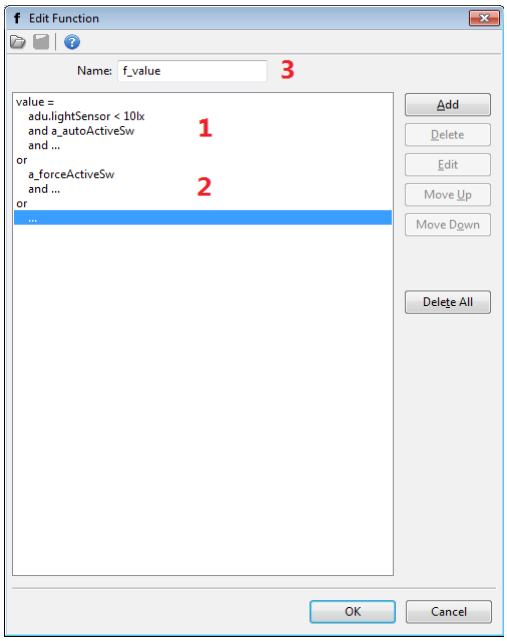
The dome light will turn on when at least one of the conditions is met:

- when it is dark and automatic mode is active (the *a_autoActiveSw* switch is on)
- when manual lighting mode is active (the *a_forceActiveSw* switch is on)

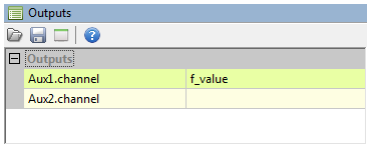
Both switches are connected to analogue inputs of the device.

An analogy comparing a logic function to an electrical diagram is shown below. A logic function will be true if at least one of the branches is true. A branch, in turn, is true when all operations in its branch are true.





Now that the logic is done, assign the *Aux1* output so that it can be controlled with *f_value*:



List of operations available for logic functions.

Operations for logic functions can be divided into two groups: *simple* and *special*.

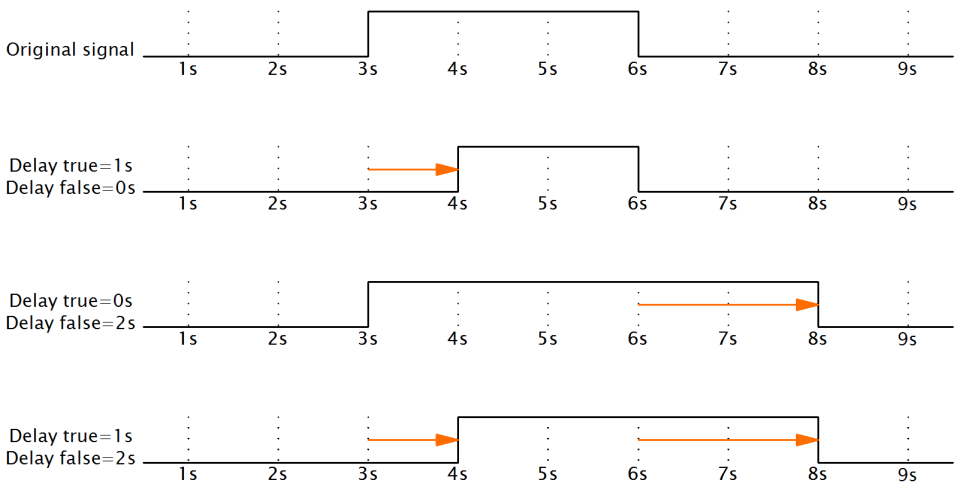
1. Simple ones are those whose result depends on the input state (alternatively, a delay can be used for this result)

   Simple operations include: testing (*Is False*, *Is True*), comparing (=,≠,<,≤,>,≥) and logic operations (*And*,*Or*, *Xor*)

IMPORTANT!
 The following description contains **false** and **true** notions. **False** is understood to mean a value of "**0**" (zero) **True** is understood to mean any value **other** than zero (e.g. "**1**").

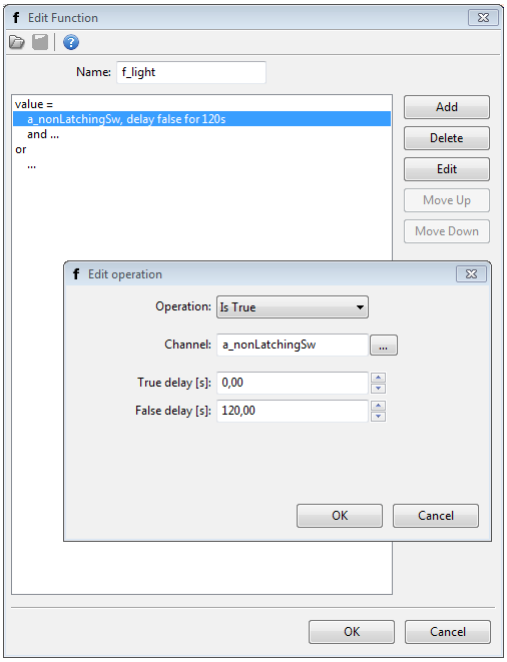
Testing operations:	
Is True	Returns **1** when the *Channel* value is **true** (non-zero), returns **0** otherwise
Is False	Returns **1** when the *Channel* value is **false** (zero), returns **0** otherwise (In electronics this operation represented by the NOT gate).
Comparing operations:	
Equal	Returns **1** when the *Channel* value **=** *Constant*, returns **0** otherwise
Not Equal	Returns **1** when the *Channel value* **≠** *Constant*, returns **0** otherwise
Less	Returns **1** when the *Channel value* **<** *Constant*, returns **0** otherwise
Less or Equal	Returns **1** when the *Channel value* **≤** *Constant*, returns **0** otherwise
Greater	Returns **1** when the *Channel value* **>** *Constant*, returns **0** otherwise
Greater or Equal	Returns **1** when the *Channel value* **≥** *Constant*, returns **0** otherwise
Logical operations	
And	Returns **1** when the values of both *Channel #1* and *Channel #2* are **true** (non-zero), returns **0** otherwise
Or	Returns **1** when at least one of the channels, i.e. *Channel #1* or *Channel #2* is **true** (non-zero), returns **0** otherwise
Xor	(Exclusive Or) Returns **1** only when exactly one of the channels, Channel #1 or Channel #2, has a value of **true** (non-zero), returns **0** otherwise

All simple operations may be used with a delay to activate (*Delay true*) and deactivate (*Delay false*). The figure below shows the original signal. Next, it is shown how the setting of the *Delay true* and *Delay false* parameters affects this signal.



The bulb goes on following a button press and remains on for another 120 s after releasing the button.

This functionality can be achieved by means of the *Is True* operation with the parameter *Delay false* = 120s.



2. Special operations.

<table>
<tr><td colspan="2">Signal generation</td></tr>
<tr><td>Flash</td><td>This operation generates a pulsing signal as long as the Channel is true (non-zero). When the Channel value is false (zero), the operation returns the value 0.
When a high state appears (a non-zero value) in the Channel, the Flash operation begins to cyclically switch between the value 1 (Time on) and the value 0 (Time off).
When the Channel value is false (zero), the operation will immediately return 0, thus stopping the cycle.</td></tr>
<tr><td>Pulse</td><td>This operation generates N impulses following the appearance of a trigger edge._
After a selected edge appears (Rising or Falling) in the Channel, pulse generation begins. The number of pulses is determined by the Count parameter. Each pulse has an active phase (when the operation returns 1) and a non-active phase (the operation returns 0).
The Retrigger parameter defines whether the appearance of a trigger edge during pulse generation will cause the process to restart or if it will be ignored.</td></tr>
<tr><td colspan="2">State storing operations</td></tr>
<tr><td>Toggle</td><td>Changes the state between 0 and 1 each time a selected edge appears in the Channel (Rising or Falling)
The initial value of this operation at device startup may be defined by means of the Default State.</td></tr>
<tr><td>Set-Reset Latch</td><td>This operation sets a new value or returns a previous value according to the settings of two input channels: Set Channel and Reset Channel:
<table>
<tr><th>Set channel value:</th><th>Reset channel value:</th><th>Operation value:</th></tr>
<tr><td>true (non-zero)</td><td>false (0)</td><td>1</td></tr>
<tr><td>false (0)</td><td>true (non-zero)</td><td>0</td></tr>
<tr><td>true (non-zero)</td><td>true (non-zero)</td><td>0</td></tr>
<tr><td>false (0)</td><td>false (0)</td><td>Previous value</td></tr>
</table>
This function mimics an SR latch, an electronic device.
https://en.wikipedia.org/wiki/Flip-flop_(electronics)
The initial value of this operation at device startup may be defined with the Default State parameter.</td></tr>
<tr><td colspan="2">Change detection</td></tr>
<tr><td>Changed</td><td>When the value of a Channel changes by a predefined Threshold, the operation will initiate an active state (it will return the value 1) for the next “Time on” seconds. If during this time the channel value changes again by a predefined threshold, the active state will be extended for another “Time on” seconds. Following the end of the active state, the operation will again return a value 0.</td></tr>
<tr><td colspan="2">Hysteresis</td></tr>
</table>

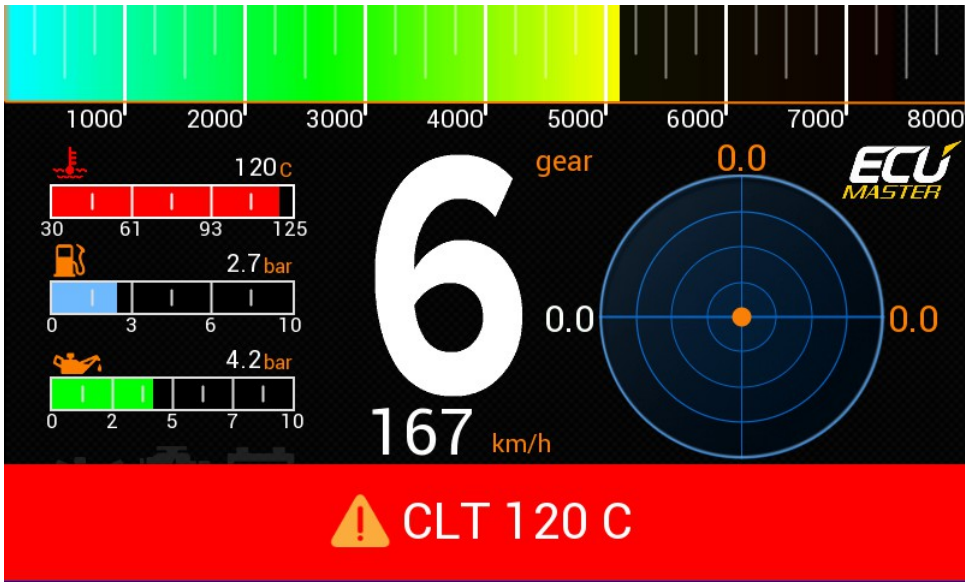
Hysteresis	a) For the *Polarity=Above* parameter If the value of the *Source channel* is greater than the predefined *Upper value* threshold, the value of the operation will be **1.** If it is *lower* than the *Lower value* threshold, the value of the operation will be **0.** If it falls between [*Lower value, Upper value*] the value of the operation will be the previous value. b) For the *Polarity=Below* parameter If the value of the *Source channel* is lower than the predefined *Lower value* threshold, the value of the operation will be **1.** If it is *greater* than the *Upper value* threshold, the value of the operation will be **0.** If it falls between [*Lower value, Upper value*] the value of the operation will be the previous value.

IMPORTANT!

For the *Pulse, Flash and Changed* operations, setting the *Time on* parameter to 0s will result in generation of an impulse of 2ms.

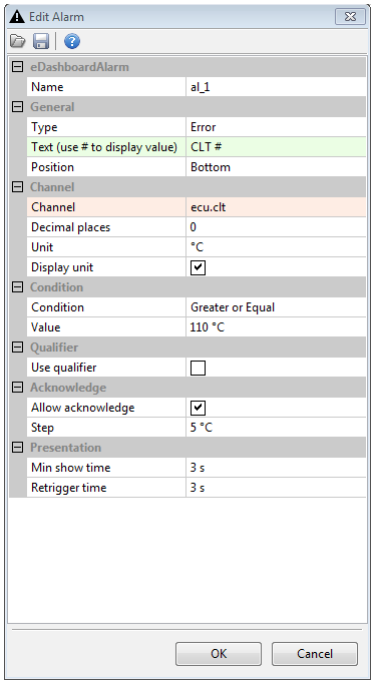
Alarms

Alarms provide information about emergency situations detected by the device.



Alarm example shown at bottom of page.

1. Basic configuration



Configuration consists of defining the ***Channel*** and the ***Condition / Value*** that will activate an alarm.

You should also define the text to display (*Text* parameter).

The alarm text may also show the current channel value. Use a pound sign (#) to show a value.

If you wish to display the pound sign, enter **##** (two **#** symbols).

2. *Qualifier*

You can additionally enter a precondition, called a ***Qualifier***. *For example, when an alarm should only be shown at higher engine speeds, you can use the following precondition: ecu.rpm > 4000.*

3. *Presentation*

To prevent an alarm from appearing and disappearing and thus causing confusion, you can define two additional parameters:

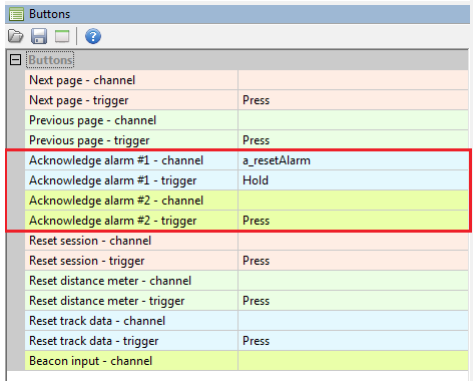
– ***Min show time*** defines the minimum amount of time in seconds that an alarm will be shown. An alarm will be visible during this time even if the alarm condition is no longer met.

– ***Retrigger time*** defines the minimum time before an alarm will be shown again.

4. *Acknowledge*

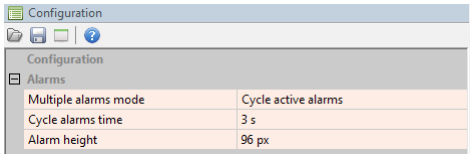
After reading an alarm message, the driver may confirm it (the ***Allow acknowledge*** option). The alarm will disappear and the threshold value will shift by a predefined ***Step***.

In the ***Buttons*** section of the ***Configuration pane*** you can define one or two alternative buttons for acknowledging an alarm.



5. Global settings

There may be a situation when two alarms appear simultaneously. Such situation can be handled in two ways, depending on the settings of the ***Multiple alarms mode***



a) ***Cycle active alarms*** will cause active alarms to appear one after another for the *Cycle alarms time*.

b) ***Only one active with highest priority*** *(last in Project tree)* will cause only one alarm to appear, the one with the highest priority. The highest priority is understood to mean the location in the *Project tree.* The alarm located at the end has the highest priority.

User Lights

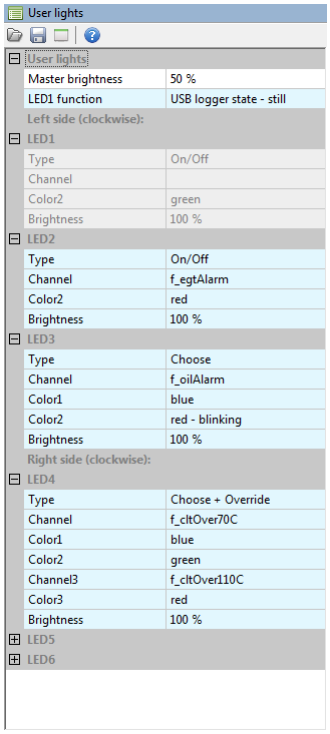
User lights are used for controlling the colour of the LED diodes located on the left and the right hand side of the device.

The diodes may be used to inform the driver of the condition of the vehicle or emergency situations.

The LED diodes are numbered clockwise LED1 to LED6 .

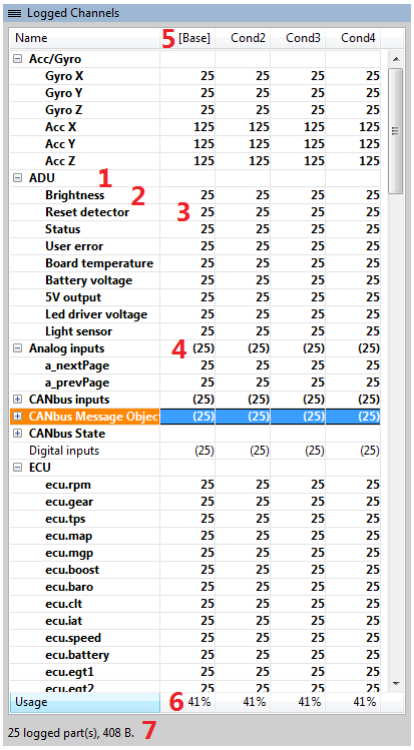
LED1 diode may be used as a USB log state indicator. This is explained in more detail in the USB Memory Logging chapter.

For each diode, you may define which channels will affect its colour, as well as which colour will be shown.



Operation name	Parameters	Description
On/Off	*Channel* *Color2*	When the *Channel* value is **true** (non-zero), the diode has the colour as defined by *Color2; otherwise it is off.*
Choose	*Channel* *Color1* *Color2*	When the *Channel* value is **true** (non-zero), the diode has the colour as defined by *Color2; otherwise it has the Color1.*
Choose + Override	*Channel* *Color1* *Color2* *Channel3* *Color3*	When the *Channel3* value is **true** (non-zero), the diode has the colour as defined by *Color3; otherwise it is off.* When the *Channel* value is **true** (non-zero), the diode has the colour as defined by *Color2; otherwise it has the Color1.*

Logging channels



The *Logged Channels* pane defines the logging frequencies for various channels. These values are expressed in Hz.

It is worth noting that the same frequencies are used for both logging to the USB memory and for logging directly to the ADU Client programme on your PC.

- ***Groups*** (1)

- ***Channels*** (2)

- ***Channel logging frequencies*** *(3)*

- ***Default logging frequencies for new elements****(4)*. When a new element is created (e.g. Analog Input), this frequency will be assigned to its channel.

- Selected ***Log condition*** (out of four available) *(5).*

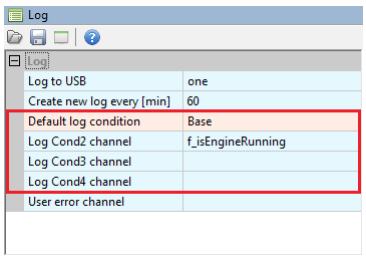
- The logging bandwidth budget used expressed in [%] for particular *Log conditions (6)*.

  – The logging bandwidth budget used expressed in bytes *(7)*

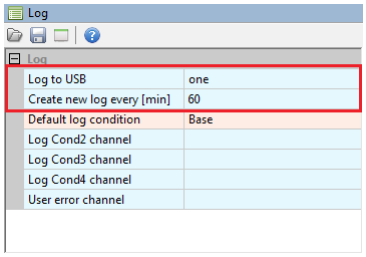
Logging configuration may be performed using a pop-up menu or by using the shortcut keys shown below. If the keyboard shortcut is used in a log group, it will change the frequency of all channels in the group. If the shortcut is used in a channel, it will change the frequency of just that channel. You can also change an individual ***Log condition*** or all of them, depending on the selected column.

Key	Logging frequency
Alt+~	Deactivation of channel/group logging
Alt+1	1 Hz
Alt+2	5 Hz
Alt+3	25 Hz
Alt+4	50 Hz
Alt+5	125 Hz
Alt+6	250 Hz
Alt+7	500 Hz

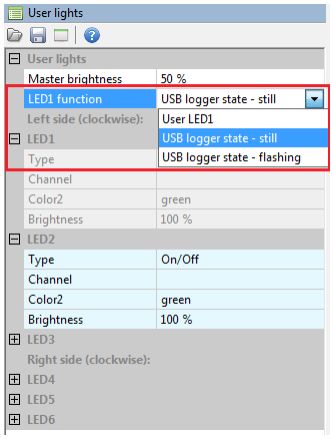
Selection of a given ***Log condition*** takes place 25 times per second. If the values of two channels are **true** (non-zero) (e.g. the one selected in the *Log Cond2 channel* field and the one selected in the *Log Cond3 channel* field) the first one will be selected.



Logging to USB memory



Logging to a USB memory stick is activated by default. Immediately after detecting a USB memory stick connected to the device, the ADU will record the log file in the ***.adulog*** format. This is the same format in which the ADU client saves logs. Files are created cyclically by a defined interval (1h by default, maximum 5h). Data analysis is easier if the files are relatively small.



Logging state can be shown by means of the LED1 diode. This is done using the *LED1 function* parameter, which has two options available:

-***User LED1*** *(the diode works just like the other User light LEDs)*

-***USB logger state*** - ***still*** (the green diode stays on constantly while logging)

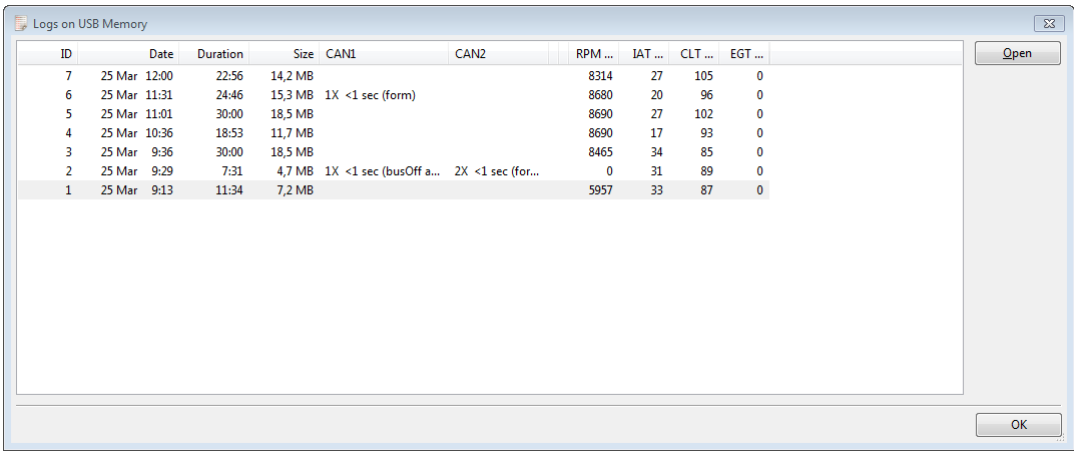
-***USB logger state - flashing*** (the green diode flashes each time a log is saved. Useful for diagnosis)

Colour	Description
● ***Blue***	USB memory is not connected to the ADU device
● ***Green***	USB memory is detected and the file system information is being loaded. This state usually lasts a few seconds.
● ***Green***	Log file saving in progress.
● ***Red***	Error, the USB memory is not compatible with the ADU device. This may result from the fact that a USB memory contains a system of exFAT files that are not supported by the device.
● ● ***Red and Green interchangeably.***	USB memory is full.
● ● ***Orange and blue interchangeably***	Poor quality USB memory. USB memory cannot record faster than the ADU generates logging data.

IMPORTANT!

he *USB logger state - flashing may* be used to diagnose problems with poor-quality USB memory sticks. After starting a new log, the green diode will stay lit continuously for a few seconds, but during normal operation, the green colour should not stay on longer than 1 second. If the colour stays on longer than 1 second, this means that the memory stick is not able to record data at a fast enough rate.

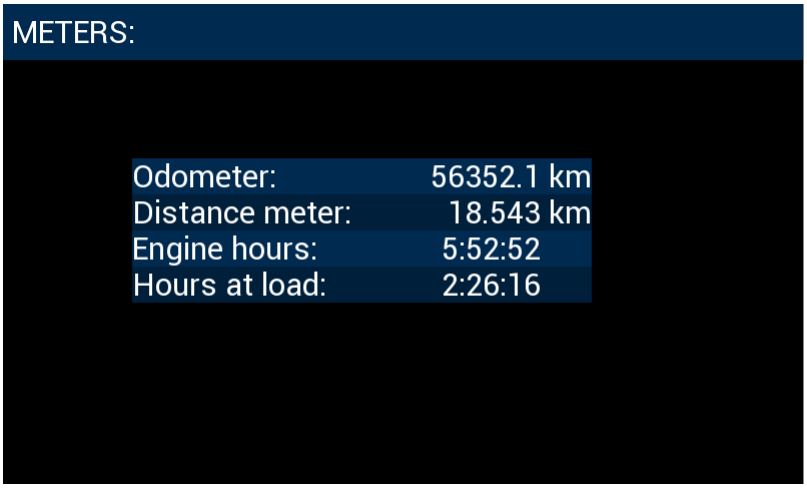
Once data has been recorded, the USB memory should be removed from the port connected to the ADU and connected to a PC. After connecting a USB memory stick to a PC, choose the ***Receive logs*** command from the Devices menu (Shift+F4) in the ADU client to view the stored logs.



Permanent meters

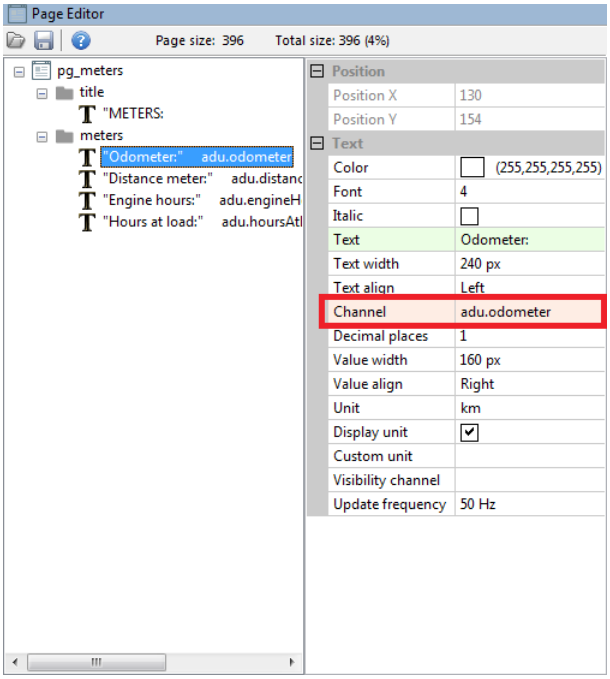
The ADU contains 4 permanent meters. That is, meters whose value is stored in memory even after switching the device off.

Meter name	Channel	Description
Odometer	*adu.odometer*	An odometer, a travel distance meter
Distance meter	*adu.distanceMeter*	An additional, resettable odometer. It can be reset by means of a button defined in the *Buttons* panel: *Reset distance meter - channel / trigger*
Engine hour meter	*adu.engineHours*	It measures the number of hours the engine has run. (*ecu.rpm* > 0 channel)
Hours at load meter	*adu.hoursAtLoad*	It measures the number of hours the engine has run under load. The parameters that define load can be configured in the *Configuration/Hours at load meter:* • *Minimal ecu.rpm* • *Minimal ecu.tps* • *Minimal ecu.map*



A screen containing meters with example values.

To place a meter on the page, insert the *Text* object and select a channel from the above table.



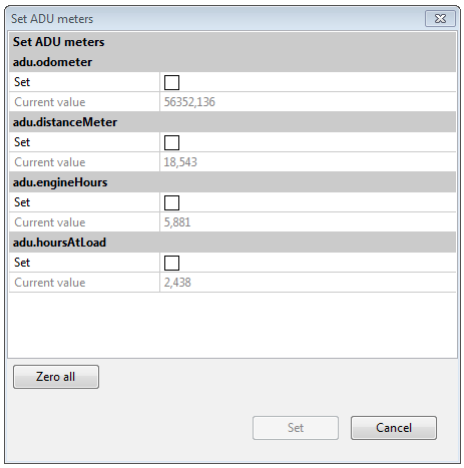
Resetting/changing meter status

Meters may be changed using the ADU Client program. It may be helpful to set the actual vehicle mileage as the initial odometer mileage.

This is done by means of a command from the ***Tools / Set meters*** menu

To set a given meter, check the ***Set*** selection field for the meter and enter the new value.

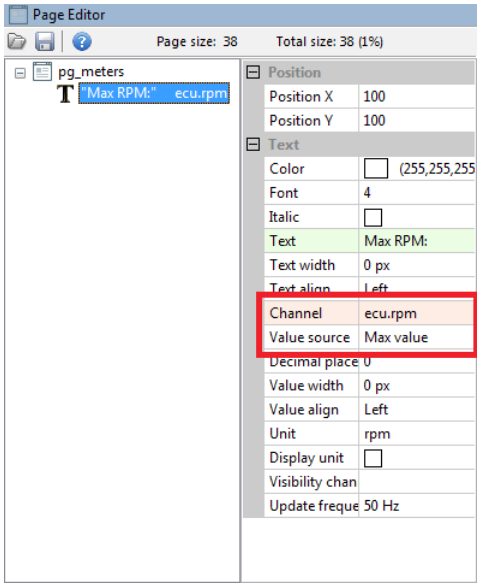
To set all values to zero, you can use the ***Zero all*** button.



After entering the desired values, accept them by means of the ***Set*** button at the bottom of the dialog box.

The min/max value for ECU channels

Each channel from the *ECU* group (e.g. ***Ecu.rpm****)* records a minimum and maximum value. These two extreme values may be displayed on the page using the ***Text*** object.



Choose the correct channel from the ECU group and set the *Value source* parameter to *Min value* or *Max value.*

The *Value source* parameter appears only for the the ECU group channels.

If a channel has not recorded any value yet (e.g. there is no CANbus Input element recording data in this channel), the *Text* object will display a "?" *(question mark).*

Just like the permanent meters, the min/max values of the ECU channels are recorded in the non-volatile memory of the device and remain in it even after the device is restarted.

However, you can decide when the process of recording the min/max values is reset (when these values are to be deleted). For this purpose, use the ***Reset min/max mode*** option in the ***Min/Max*** reset section of the ***Configuration*** menu. You can choose between two options:

a) ***Every firmware upgrade –*** resetting with each replacement of the device software.

b) ***Every power off –*** resetting each time the device is powered on.

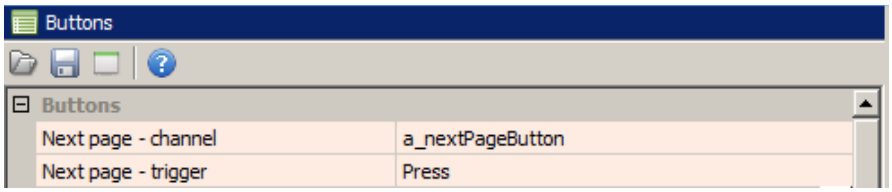
Irrespective of the above options, you can also define a manual reset button that may be accessed by the driver. The button can be defined in the ***Buttons*** panel: ***Reset min/max data - channel / trigger***

Panels

Panels contain additional device configurations not included in the main menu and the ***Project tree***.

Buttons

The ***Buttons*** panel allows you to assign buttons to different internal functions of the device, such as switching between pages, cancelling alarms, resetting times for a given track, etc.
A given function (e.g. next page) is configured by selecting a channel/function representing a button and the button interpretation method (*trigger).*



There are 4 channel interpretation types (*trigger):*

Press - a function is activated by pressing a button
Release - a function is activated by releasing a button
Click - a function is activated by quickly pressing and releasing a button
Hold - a function is activated by pressing and holding a button

Position	Description
Next page	Switching to the next page
Previous page	Switching to the previous page
Acknowledge alarm#1	Cancelling the alarm displayed on the screen
Acknowledge alarm#2	Cancelling the alarm displayed on the screen
Reset session	Cancelling the internal ***Session time*** clock
Reset distance meter	Cancelling the distance meter (the ***adu.distanceMeter*** channel)
Reset track data	Cancelling the list of the best times and the reference lap for the current racing track
Beacon input	A channel access from an external beacon. It informs the ADU about completion of another lap

Shift light

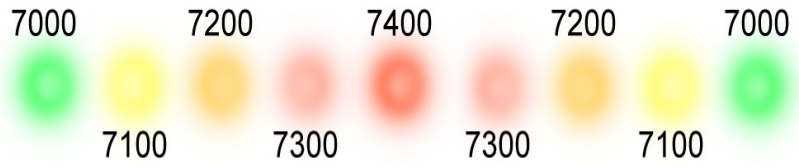
Shift light uses the LEDs at the top of the device to indicate the optimal gear change time. There are 3 possible ways to control the diodes. The first is the parametric method (***Parametric***) where for each gear you can define the moment when the first and last LED lights up. The second method involves a ***3D table*** where for each LED and a given gear, you can input the engine speed at which it will light up. The third method consists of sending information about the shift light status from the ECU via CAN, which results in the LEDs lighting up.

Parametric control

To activate the parametric shift light, select Parametric in the ***Control type*** field

Parameter	Description
Brightness	LED brightness
Maximum RPM	The maximum RPM at which all LEDs begin to blink red
Neutral and reverse	The RPM at which the first LED for the reverse and neutral gear lights up
1 to 8	The RPM at which the first LED for gears 1 to 8 lights up
RPM channel	The channel containing the current engine speed
Gear channel	The channel containing the current gear. If not defined, the neutral gear will be selected by default

Below you will find the RPM at which the individual LEDs will light up when the ***Maximum RPM*** is defined at 7400, and the initial RPM for a given gear at 7000. Above 7400 RPM all LEDs begin to blink red.



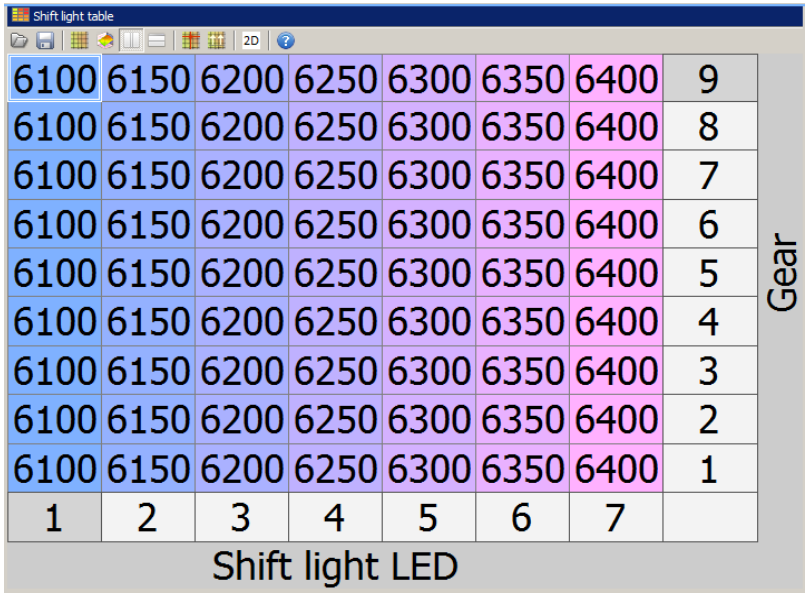
Control by means of a 3D map

To activate control by means of a 3D map, select Table 3D from the ***Control type*** field.

Parameter	Description
Brightness	LED brightness
RPM channel	A channel containing the current engine speed.
Gear channel	The channel containing the current gear. If not defined, the neutral gear will be selected by default

Shift light colour #n	The colour assigned to individual LEDs
Flash when all leds on	Selecting this option makes LEDs blink following all of them lighting up
Flash colour	Selecting the LED colour when blinking If you choose ***Use default colours***, the colour of the blinking LEDs will correspond to the colours assigned in the ***Shift light colour*** fields. Otherwise, the LEDs will change colour to the one selected in this field.

The following map lights up individual LEDs between 6000 and 6400 RPM with a 50 RPM step.



When using the reverse and neutral gears the values for first gear are used.

Control by means of an external channel (CAN-Bus)

To activate control by means of a channel/variable, select CAN BUS from the ***Control type*** field.

Parameter	Description
Brightness	LED brightness
Num states	The number of the shift light (4-6) states
Shift light channel	A channel containing information about the number of currently lit LEDs

This control lights up respective LEDs depending on the value of the variable assigned to the ***Shift light channel*** field.

Autobrightness

The ***Autobrightness*** table defines the brightness of the screen and the LEDs relative to ambient light.

The following is the method of calculating the brightness of the screen and the LEDs (all values range between 0% and 100%):

LCD brightness = Autobrightness

User led brightness = Autobrightness * User led master brightness * Led brightness

Shift light brightness = Autobrightness * Shift light master brightness

The automatic brightness is additionally controlled by a ***Configuration*** panel parameter named ***Adaptation rate***. This rate determines the maximum permitted brightness change per second.

Virtual fuel tank

Virtual fuel tank allows the user to calculate the remaining fuel in the fuel tank. Usually this is far more accurate way of determining of amount of fuel in tank than the float inside the tank. This strategy is based on the information from the ecu according the used fuel (ecu.usedFuel channel). It can also inform the driver about remaining fuel and the number of the circuits laps that can be finished based on the last lap or average consumption.

Strategy parameters

Parameter	Description
Fuel tank size	The size in litres of the fuel tank or base amount of fuel in a tank
Used fuel channel	The data channel that consist information about used fuel sent by ECU. By default it is ecu.usedFuel channel
Max used fuel change	The maximum allowable change in used fuel between updates. If the change is greater than this value it is ignored. It allows for proper work of the strategy even if the used fuel channel in ECU is reset
Fuel usage correction	The correction factor if there is a difference between real fuel consumption and consumption calculated by ECU. Must be set empirically

In addition to this in the Buttons window **Reset virtual fuel tank** button is defined. It is crucial for the whole strategy, because during refuelling, the driver needs to reset the strategy. Then the remaining fuel is reset to the fuel tank size, and all data is calculated from the beginning.
All parameters are stored in the ADU flash memory, allowing for the ADU to remember fuel level even when the dash is turned off. This functionality is available only when the ADU power is connected properly!

Logging channels

Channel	Description
Remaining fuel	Fuel that remains in the fuel tank
Remaining laps avg	The number of laps that can be driven on remaining fuel based on lap average fuel consumption (*Fuel used per lap avg*)
Remaining laps last	The number of laps that can be driven on remaining fuel based on last lap fuel consumption (*Fuel used per last lap*)
Fuel used per lap avg	The average fuel consumption based on laps driven from resetting fuel tank
Fuel used per last lap	The average fuel consumption during last lap
Used fuel from the last reset	The fuel consumed from the virtual fuel tank reset

Configuration

The ***Configuration*** panel contains the configuration parameters of elements such as the startup screen, thermal imaging cameras for measuring tire temperature, internal accelerometer calibration, screen rotation, etc.

Parameter	Description
Alarms	
Multiple alarm mode	The alarm system operation mode. In the case of more than one alarm going off simultaneously, this parameter determines their behaviour. ***Only one active with highest priority –*** only the highest-priority alarm will be displayed. The priority is determined based on the order of the alarms in the project. The lower an alarm is on the list, the higher its priority. ***Cycle active alarms*** – switching between all active alarms will be activated
Cycle alarm time	The time in seconds during which an alarm will be displayed if the ***Cycle active alarms*** parameter is set in the ***Multiple alarm mode*** parameter
Alarm height	The height of the rectangle displayed as an alarm background
Screen	
Rotate screen	This allows you to rotate the screen 180 degrees. This option is used if the screen is installed turned 180 degrees (with the shift light LEDs at the bottom)
Brightness	
Adaptation rate	This parameter handles the automatic brightness of the screen and the LEDs, determining the maximum allowed brightness change during one second
IMU	
Pitch	The display pitch calibration
Hours at load meter	
Minimal ecu.rpm	The minimum engine speed indicating that the engine is under load
Minimal ecu.tps	The minimum throttle opening angle indicating that the engine is under load
Minimal ecu.map	The minimum pressure in the intake manifold indicating that the engine is under load
Tire temperature cameras	
Temp. range min	The minimum tire temperature displayed on the graph in blue

Temp. range max	The maximum tire temperature displayed on the graph in red
Min/Max reset	
Reset min/max mode	This parameter defines the behaviour of the min/max values for the ecu channels*. **Every power off –** the min/max values are deleted each time the device is activated **Every firmware upgrade –** the min/max values are deleted when the internal device software is replaced
Startup screen	
Enable	Activates the startup screen
Texture	The texture that will be displayed on the startup screen (centred)
Scale	The scale of the displayed texture
Duration	The time during which the startup screen will be displayed
Color	The colour of the displayed texture
Background color	The colour of the background

Protection

The ***Protection*** panel contains options related to the password protection of the device. A password must be provided before any changes can be made to the device if protected. If no password is provided, the only way to remove the protection is by restoring the default settings.

Parameter	Description
Enable password protection	Activates the password protection of the device
Copyrights	The information displayed when attempting to connect to the device if protected
Contact info	Contact information (e-mail, telephone) displayed when attempting to connect to the device if protected

Log

The *Log* panel contains the logging configuration.

Parameter	Description
Log to USB	A channel / variable determining if the device is to log to a USB. The value one means that logging is to be active the whole time. This parameter defines the conditions when logging is active/inactive
Create new log every [min]	Determines the maximum size of a single file in minutes. When the size of the logged data exceeds the predefined time, a new file will be created
Default log condition	The ADU device allows you to create 4 logging profiles. These profiles are defined in ***Menu/Logged channels***. This allows you to record to a file different channels with different frequencies depending on the current condition. The ***Default log condition*** parameter defines the default profile that is to be used if none of the conditions for the profiles are met.
Log Cond2 channel	A channel/function activating the logging of the ***Cond 2*** profile
Log Cond3 channel	A channel/function activating the logging of the ***Cond 3*** profile
Log Cond4 channel	A channel/function activating the logging of the ***Cond 4*** profile

CAN Bus / Serial setup

The *CAN Bus / Serial setup* panel is used for configuring the CAN BUS and for the RS232 serial communication.

Parameter	Description
CAN 2 terminator	Activation of the terminator on the CAN 2 bus.
CAN 2 speed	The speed of the CAN 2 bus
GPS CAN Bus	Selection of the CAN bus to which the GPS module is connected.
Tire temp. cameras CAN Bus	Selection of the CAN bus to which the thermal imaging cameras measuring the tire temperature are connected
Tire temp. Cameras base ID	The base ID of the first thermal imaging camera (in the hexadecimal notation).
Serial protocol	Selection of a serial protocol: ***Ecumaster serial protocol –*** a serial protocol supported by the the EMU and EMU Black computers

	AIM serial – a serial protocol consistent with the AIM protocol **Hondata 9600 -** a serial protocol consistent with the Hondata PRO computer protocol (speed of 9600 bps). A signal inverter between the Hondata computer and the ADU is to be used. ***Hondata 115200 -*** a serial protocol consistent with the Hondata PRO computer protocol (speed of 115 kbps). A signal inverter between the Hondata computer and the ADU is to be used. ***Autronic SM 4***- a serial protocol consistent with the Autronic SM 4 computer protocol. This version refers to the SM 4 computer software version.

Lap timing

The ADU device may operate as a *Lap timer*, i.e. a device for measuring time on a racing track. The time can be measured by means of a GPS or a device called *beacon.* The device is placed near the start/finish line and sends an infra-red beam, which is registered by a receiver inside a car. The receiver “informs” the ADU of the crossing of the start/finish line.

In addition to measuring time, the GPS module allows to display the anticipated lap time (Predictive timing) and a change in the anticipated lap time in the form of a graph (*gain/loss).* Additionally, by logging the GPS and other data such as the sensor values or engine parameters to the external USB memory, this data can be analyzed further.

Configuration of time measurement with a beacon device

Depending on the beacon system in place, the output of the receiver should be connected to an analogue or digital input of the ADU device and an appropriate channel should be created.
The channel should be assigned in the ***Buttons*** panel in the ***Beacon input - channel*** field. When the channel value changes from 0 to 1, the last lap time counter (***last lap***) will assume the value of the lap time counter (***lap time***), which will be reset. If a lap time is better than the best lap time (***best lap***), it will be changed. Additionally, the ***adu.track.lap*** channel will be increased by 1. Use the ***Time*** object to display the above-mentioned times on the screen. To display the current lap number, use the ***Text*** object and enter the ***adu.track.lap*** channel in the ***Channel*** field. If a *beacon* system is in place, it is not possible to apply lap time prediction (*predictive timing).*

Configuration of time measurement with a GPS

A GPS module offers more possibilities than a *beacon* system. Based on GPS coordinates, the ADU automatically detects the track you are currently on. The list of automatically detected tracks is included in Appendix 1. If a track is not included in the list, you can add a track of your own (see the *Panels/User tracks* chapter).
The ADU memory can store data from 20 tracks. The 8 best times are recorded, including their date, time and maximum speed. You can display them using the ***Track record table*** object.
The best time from a given track is used as a reference time for the algorithm determining the predicted lap time. It works such that for a given place on the track the current lap time is taken, while for the remaining part of the track - the best lap time.
By displaying the ***Predictive time graph****,* you can check in real time if you have completed a given part of the track faster or slower than during your best lap.
To reset a given track data you can use the ***Tools / Reset track*** *data* menu or connect a button and assign it to the ***Reset track data channel*** function in the ***Buttons*** panel. We suggest that you use a ***Hold***-type trigger to prevent accidental data deletion.
To display the name of the track the car is currently on, use the ***Text*** object and enter *$(TRACK)* in the *text* field.

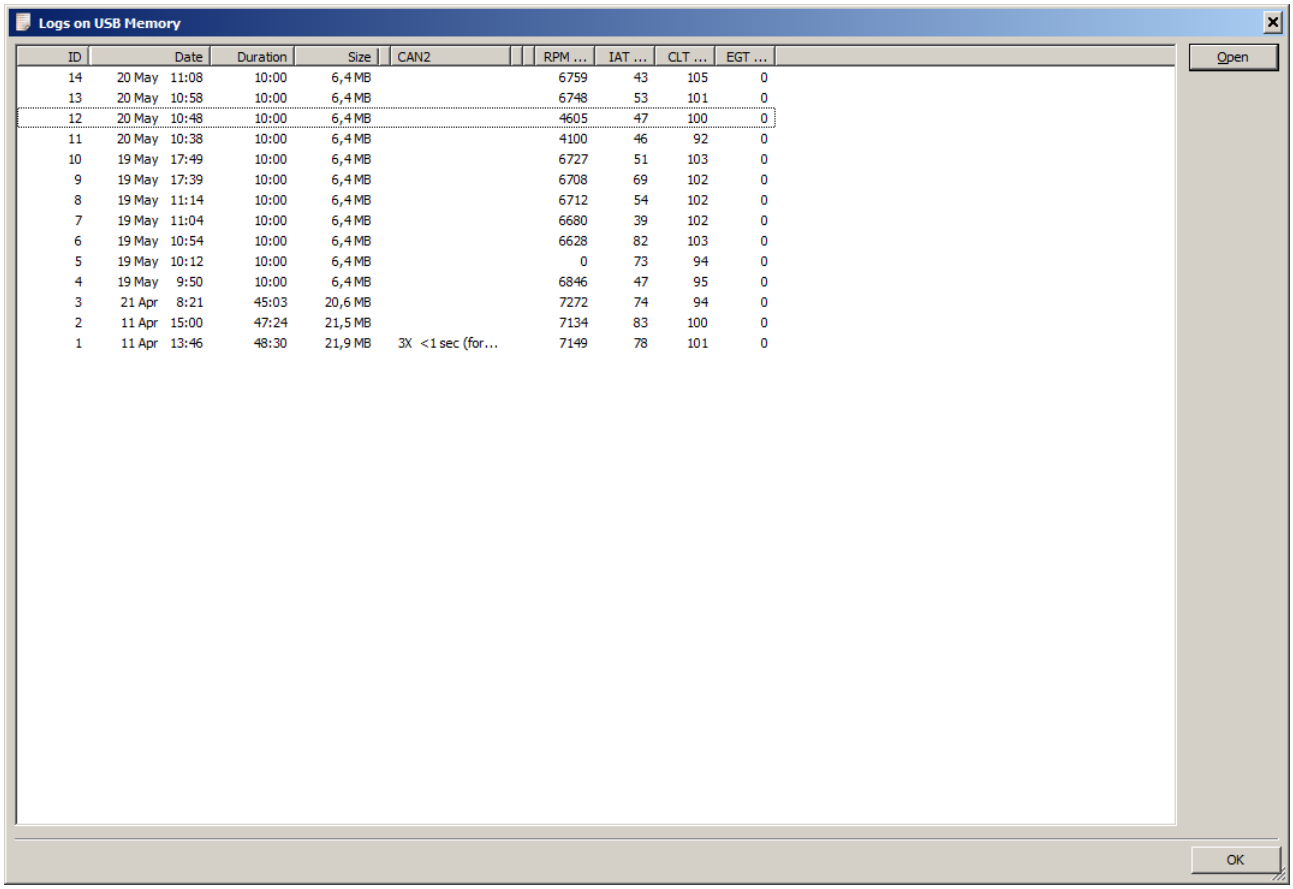
IMPORTANT!

A GPS module must be installed using the rubber ant-vibration pads supplied with it.

Data analysis

If you have racing track data saved on a pendrive, you can analyse it further using Windows software. After inserting a pendrive into a computer USB port, select an option from the ***Devices/Receive log file*** menu or use the **SHIFT+F4** shortcut.

A dialog window with a log files selection will appear.

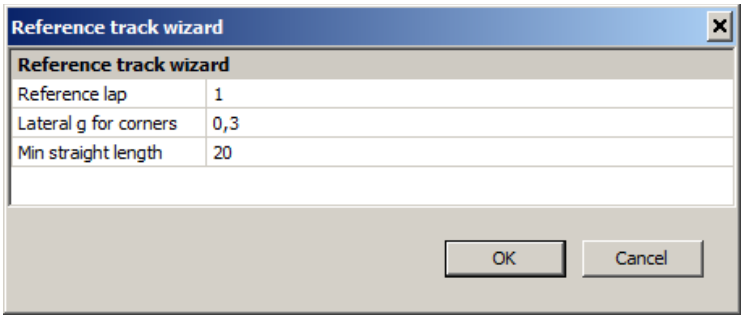


To upload the desired log, double click on it with the left button.

Then move on to the ***Track*** tab. The ***Track Preview*** pane should display the entire track covered by the car as saved in the file. Example shown below:

To analyse your run, you need to generate the track contour based on the collected data. To do this, press the *magic wand* icon in the tool bar of the track preview pane.

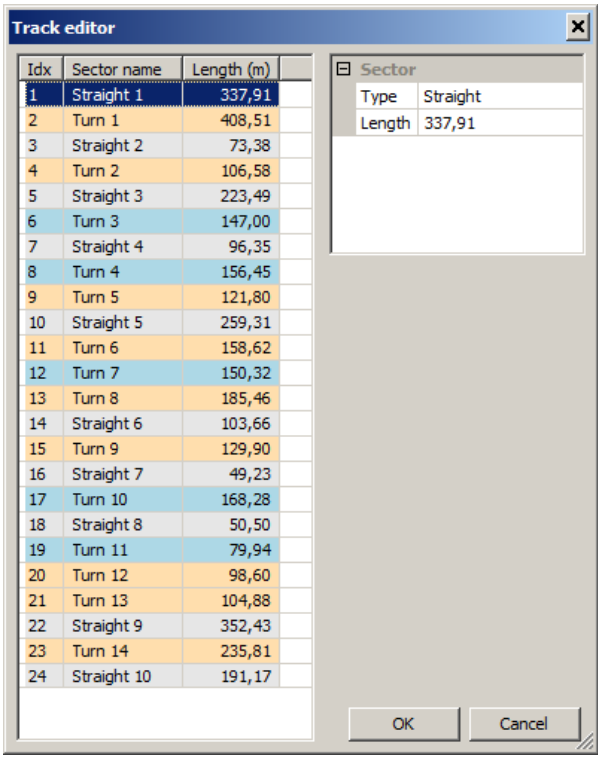
The following dialog should pop up:



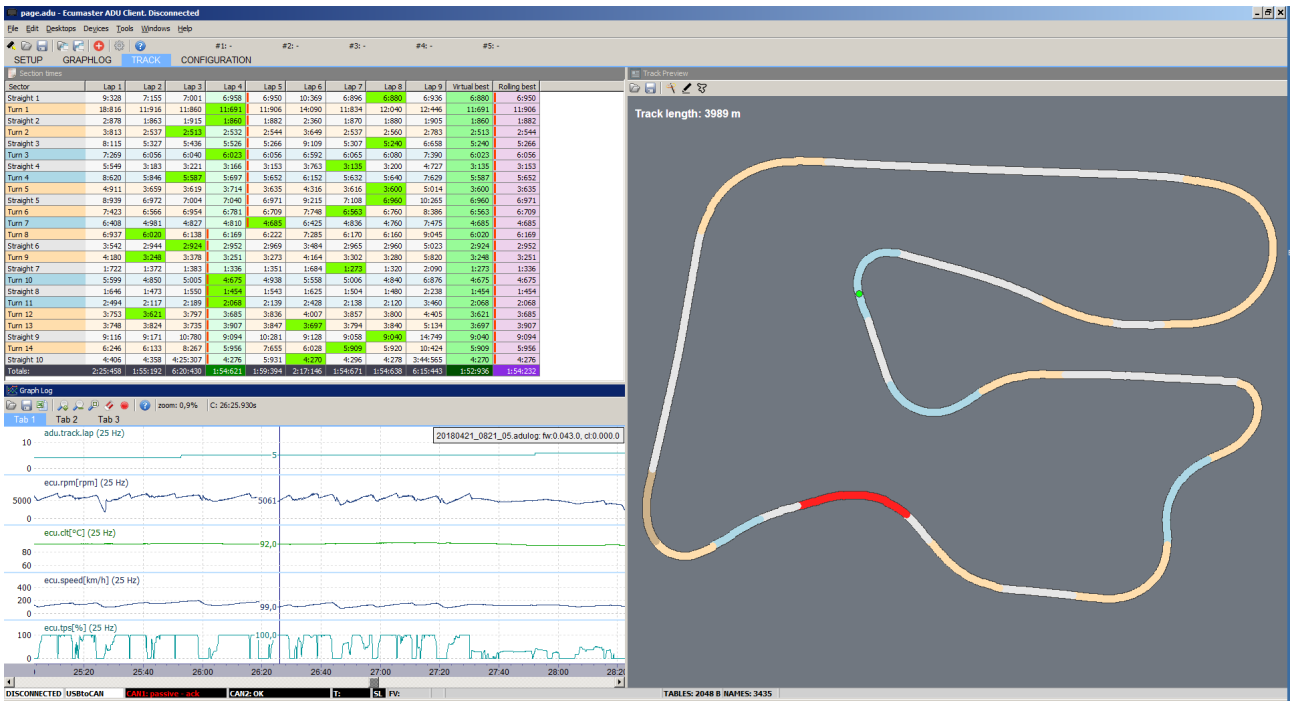
From the ***Reference lap*** field select the lap to be used for creating your reference track. As this lap changes in real time, the track contour will change, too. The ***Lateral g for corners*** parameter defines the lateral g-force above which a given track part is interpreted as a turn. The ***Min straight length*** parameter defines the minimum section of a track where the g-force was lower than ***Lateral g for corners*** for the distance to be considered a straight section.

Press OK to generate a reference track. To edit its sections, select the pencil icon from the tool bar.

A track editor pane will pop up. You can use it to delete sections, divide them, change their type and length (right click on the segments table). The selected section is automatically highlighted in the preview screen. Press OK after you finish editing. To save the track you created, press the disk icon. The last saved / read reference track will be loaded after you run the programme again.



After creating a reference track, the times in the sections should be automatically recalculated and the application screen should look as follows:



A green point on the reference track defines the car position for the position indicated in the log pane. This way, by moving along the log pane, you can see the set of parameters for particular car positions.

The ***Section times*** pane displays times in defined sections for all laps. The best times are marked green. Additionally, this pane has two columns: ***Virtual best*** and ***Rolling best.*** The ***Virtual best*** is the sum of the best times in individual sections, while ***Rolling best*** shows the best continuous time of a single lap. It is indicated by a red, vertical line and, in our example, it was scored in laps 3 and 4. This time is the feasible time that you can score.

The channels that may be helpful in analysing data:

Channel	Description
adu.track.lap	Displays the current lap
adu.track.lapTime	Displays the current lap time
adu.track.gainLoss	Displays the gain/loss relative to the best recorded lap
Adu.track.distance	Current lap distance
gps.speed	The vehicle speed read from the GPS
gps.status	The GPS module status In case of problems with the signal, the analysed data may be inaccurate.
ecu.rpm	The engine speed
ecu.tps	The throttle position
ecu.clt	The coolant temperature
ecu.map	The pressure in the intake manifold
ecu.oilPress	The engine oil pressure
ecu.oilTemp	The engine oil temperature

Appendix 1

Racing circuits stored in internal ADU memory (automatically detected)

Belgium

Circuit de Spa-Francorchamps, Circuit Zolder

Croatia

Rijeka Grobnik

Czech Republic

Automotodrom Brno

France

Circuit de Nevers Magny-Cours

Germany

Hockenheim, Eurospeedway Lausitzring, Nurburgring, Motorsport Arena Oschersleben, Schleiz

Hunagary

Pannonia Ring

Itally

Misano World Circuit, Fanciacorta International, Racalmuto, Autodromo Nazionale Monza, Imola, Mugello Circuit, ACI Vallelunga Circuit

Latvia

Bikernieki

Netherlands

Assen circuit, Aspen circuit, Circuit Zandvoort

Poland

Tor Poznań, Tor Słomczyn

Portugal

Autódromo Internacional do Algarve

Scotlan

Knockhill racing circuit

Slovakia

Slivakia ring

Spain

Circuito de Albacete, Ciudad del Motor de Aragón, Circuit de Barcelona-Catalunya, Circuito Permanente de Jerez, Circuito de Navarra, Circuit de la Comunitat Valenciana Ricardo Tormo

UK

Silverstone natl., Cadwell park, Anglesey International, Brands Hatch GP, Donington Park, Oulton park, Snetterton Circuit, Thruxton Motorsport Centre

USA

Circuit of the Amerikas, Barber Motorsport Park, Laguna Seca Raceway, Miller Motorsports Park, New Jersey Motorsport Park, Pittsburgh International Race Complex, Road America, Michelin Raceway Road Atlanta, Sears Point Raceway, Virginia International Raceway

QUATAR

Losail Circuit

Document history

1.115

Virtual fuel tank added

Button defined track added,

Updated built-in track list