



Display DDU 9

Manual

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1 Preparation

Use the DDU 9 only as intended in this manual. Any maintenance or repair must be performed by authorized and qualified personnel approved by Bosch Motorsport.

Operation of the DDU 9 is only certified with the combinations and accessories that are specified in this manual. The use of variant combinations, accessories, and other devices outside the scope of this manual are only permitted when they have been determined to be compliant from a performance and safety standpoint by a representative from Bosch Motorsport.

Read the manual carefully and follow the application hints step by step. Don't hesitate to contact us, contact data can be found on the last page of this document.

Disclaimer:

Due to continuous enhancements we reserve the rights to change any illustrations, photos and technical data within this manual.

Please retain this manual for your records.

In this document all screenshots are created by way of example for other displays.

Please consider this and replace the product names with the name of your product.

Notice

In this document all screenshots are created by way of example for other displays.

Please consider this and replace the product names with the name of your product.

2 Power Supply

Bosch Motorsport software is developed for Windows system software. Connect the Ethernet line to your computer and install the driver. Read the manual carefully and follow the application hints step by step.

Please ensure that you have a good ground installation. That means:

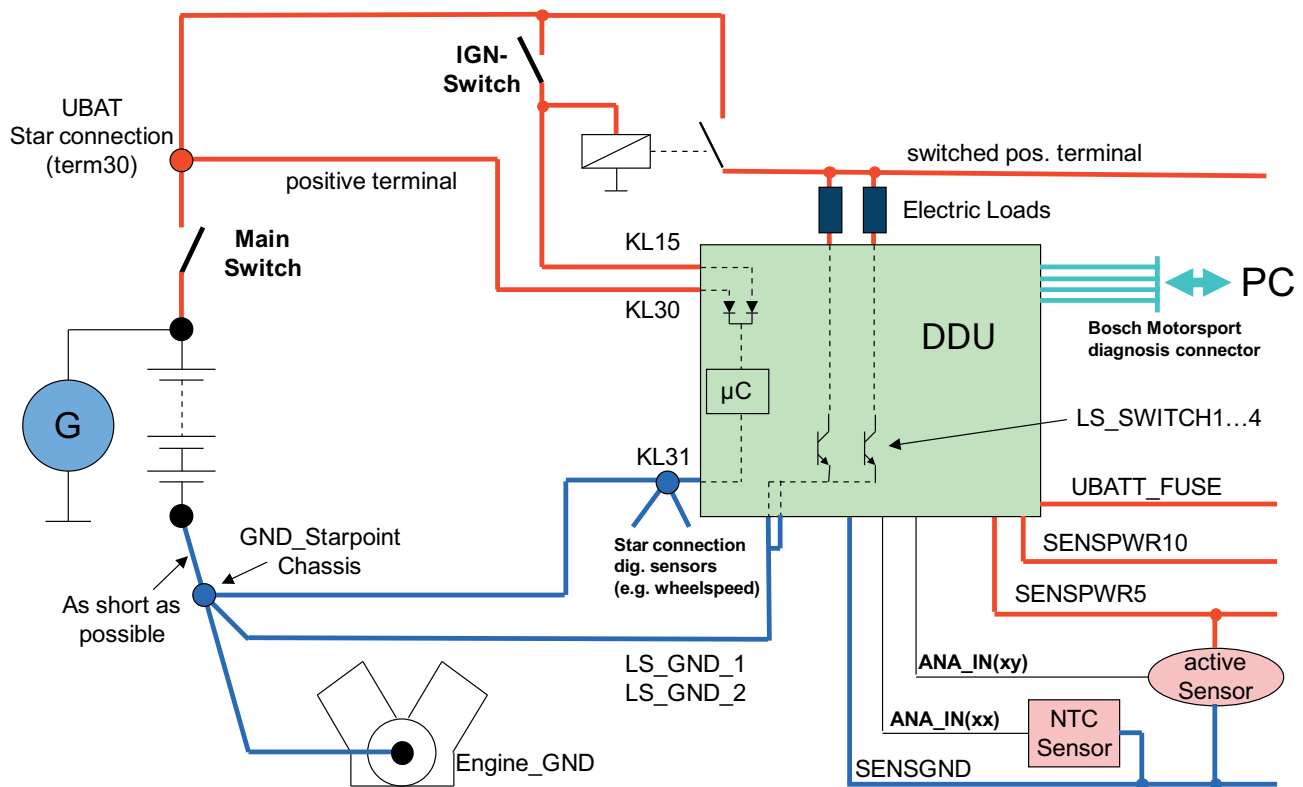
- A ground that has a solid, low resistance connection to the negative battery terminal
- Connection should be free from dirt, grease, paint, anodizing, etc..
- Use large diameter wire
- More metal-to-metal contact is better!

The following notations for power signals are used:

- KL 15 is a switched battery rail controlled by the IGN-switch
- KL 30 is an unswitched battery positive rail (same as battery positive terminal)
- KL 31 is an unswitched ground rail (same as battery negative terminal)

Be careful to observe current limits of wires and connector pins!

3 Onboard Network Concept



4 Technical Data



The display DDU 9 integrates a programmable full color dashboard display with a data logging system for motorsport applications for a very competitive price. Additional input devices can be connected via Ethernet and CAN buses.

Data Analysis Software WinDarab is available free of charge as “WinDarab V7 free” on our website. A basic logging function of 100 channels with recording of 50 ms (3 GB) is always included. The logger can be upgraded to full logging performance (max. 1 ms). In addition a 2nd logging partition of 1 GB (e.g. for long term recording) can be activated.

Customers can implement own graphics, pictures etc. on the 12 freely configurable display pages. For quick data transfer from the car e.g. during pit stop, data copy to a USB stick is available as an option. The stick is connected to the wiring harness for the DDU 9.

The device comes with 4 analogue and 4 speed inputs as standard; further 12 analogue inputs are available as optional upgrade.

Display	<ul style="list-style-type: none">▪ 5,7" graphic color display▪ 12 user configurable display pages▪ 10 multicolor freely configurable (RGB) LEDs
Resolution	640 x 480 pixel
Supported image file formats	Bmp, gif, jpg, png, tif
Processor	667 MHz Dual Core
Converters	8 kHz AD converters with digital low pass filter
Internal power source	Li/Ion capacitor

Configurable math channels	
User configurable CAN in/out messages	
Sampling rate	50 ms (standard), max. 1 ms (optional)
Online data compression	
Logging rate	Max. 600 kB/s
Recording channels	100 channels (standard), up to 1,040 in total (optional)
Logged data download speed	Max. 1,000 kB/s
Internal storage capacity	3 GB (standard), plus 1 GB (optional)
LTE Ethernet telemetry support, GSM telemetry support	
RS232 for GPS and telemetry	
CCP-Master, data acquisition from ECU that support CAN calibration protocol (optional)	

Communication

CAN interfaces	2
Ethernet 100BaseT	2
Laptrigger input	1
RS232	Telemetry, GPS
Configuration via RaceCon	Over Ethernet or MSA-Box II

Mechanical Data

Size	151 x 126 x 33.5 mm
Weight	540 g
Protection Classification	IP54 to DIN 40050, Section 9, Issue 2008
Operating temperature internal	-20 to 85°C
Operating temperature Display	-20 to 70°C
Max. vibration	Vibration profile 1 (see Appendix or www.bosch-motorsport.com)

Electrical Data

Supply voltage	5 to 18 V
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Inputs

Analog channels	4 standard, additional 12 optional
Input range	0 to 5 V
Resolution	12 bit
Switchable pull up resistor	For all ANA_IN
Wheel speed inputs	4 Hall-effect or DF11, switchable

Outputs

Sensor supply 5 V \pm 1 % (250 mA)	2
Sensor supply 10 V \pm 1 % (250 mA)	1
Sensor supply U_Bat 250 mA	1
Sensor ground	4

Environment

External switch for page selection, 12 steps	B 261 209 658-01
External switch for brightness adjustment or page selection, 6 steps	B 261 209 659-01
Optional Upgrades	
USB_DATA USB-Port unlocked (Rugged USB flash drive Bosch File System (BFS) format included, works with Bosch File System (BFS) preformatted USB Flash drive only)	F 02U V02 214-01
Adapter cable to USB-Port (included in Upgrade USB_DATA)	F 02U V01 343-01
Adapter for wiring harness (included in Upgrade USB_DATA)	F 02U 002 996-01
CCP_MASTER CCP-Master (ASAP2 file from ECU manufacturer required)	F 02U V02 213-01
ETHER_TELE LTE Ethernet Telemetry	F 02U V02 138-01
FULL_LOG_1 Enable full logging performance of 3 GB partition 1	F 02U V02 304-01
FULL_LOG_2 Enable full logging performance of 1 GB partition 2	F 02U V02 305-01
I_O EXTENS Enable additional 12 analog input channels	F 02U V02 205-01

Connectors and Wires

Motorsport connector on Display AS-216-35 PN	F 02U E01 659-01
Mating connector AS-616-35 SN	F 02U 000 466-01

Pin Configuration

Pin	Name	Comment	Status
1	KL_31		Incl.
2	KL_15		Incl.
3	KL_30		Incl.
4	Rev_In_3	Hall or DF11 switchable	Incl.
5	Rev_In_1	Hall or DF11 switchable	Incl.
6	KL_31		Incl.
7	CAN_2_L	CAN speed selectable	Incl.
8	Ethernet_2_TXP		Incl.
9	Ethernet_2_TXN		Incl.
10	Sens_Power_12V	over current protected	Incl.
11	Rev_In_4	Hall or DF11 switchable	Incl.
12	Rev_In_2	Hall or DF11 switchable	Incl.
13	Laptrigger_In		Incl.
14	CAN_2_H	CAN speed selectable	Incl.
15	CAN_1_H	CAN speed selectable	Incl.
16	Ethernet_2_RXP		Incl.
17	Sens_Gnd_4	fused	Incl.
18	Sens_Power 5V	over current protected	Incl.
19	ANA_IN_3	3.01 kOhm switchable	Incl.
20	ANA_IN_4	3.01 kOhm switchable	Incl.
21	Time_Sync	connection to Bosch ECU	Incl.
22	CAN_1_L	CAN speed selectable	Incl.
23	Ethernet_screen		Incl.
24	Ethernet_2_RXN		Incl.
25	Sens_Gnd_3	fused	Incl.
26	Sens_Power 5V	over current protected	Incl.
27	ANA_IN_7	3.01 kOhm switchable	Opt.
28	ANA_IN_1	3.01 kOhm switchable	Incl.
29	USB_Device_DP	to Bosch USB stick	Opt.
30	RS232_TX_Telemetry		Incl.
31	Ethernet_1_TXP		Incl.
32	Sens_Gnd_2	fused	Incl.
33	Sens_Power_10V	over current protected	Incl.
34	ANA_IN_8	3.01 kOhm switchable	Opt.
35	ANA_IN_10	3.01 kOhm switchable	Opt.
36	USB_Device_Gnd	to Bosch USB stick	Opt.
37	USB_Device_DN	to Bosch USB stick	Opt.

Pin	Name	Comment	Status
38	RS232_RX_Telemetry	e.g. GSM telemetry	Incl.
39	Ethernet_1_TXN		Incl.
40	Sens_Gnd_1	fused	Incl.
41	ANA_IN_11	3.01 kOhm switchable	Opt.
42	ANA_IN_9	3.01 kOhm switchable	Opt.
43	RS232_TX_GPS		Incl.
44	ANA_IN_16	3.01 kOhm switchable	Opt.
45	USB_Device_Power	to Bosch USB stick	Opt.
46	Ethernet_1_RXP		Incl.
47	ANA_IN_12	3.01 kOhm switchable	Opt.
48	ANA_IN_6	3.01 kOhm switchable	Opt.
49	ANA_IN_2	3.01 kOhm switchable	Incl.
50	ANA_IN_13	3.01 kOhm switchable	Opt.
51	ANA_IN_15	3.01 kOhm switchable	Opt.
52	Ethernet_1_RXN		Incl.
53	ANA_IN_5	3.01 kOhm switchable	Opt.
54	RS232_RX_GPS	for GPS sensor input	Incl.
55	ANA_IN_14	3.01 kOhm switchable	Opt.

5 Inputs and Outputs

5.1 Input channels

Analog inputs

The DDU 9 analog inputs accept an input signal of 0 to 5 V. A 3.01 kOhm pull-up resistor can be activated by software.

Digital inputs

The digital inputs of the DDU 9 accept 0 V to 5 V signals of Hall-effect sensors by default. Connect the output of the Hall-effect sensor to the REVn_P pin and leave the REVn_M pin open.

Display brightness switch

Pin 37 of the life connector is used as a dimmer switch for the display. The internal pull-up resistor is automatically activated. Different dim settings are selected by a connecting the pin to SENSGND with different resistor values over a 6 position switch. The individual brightness settings for LEDs and the display are defined by RaceCon.

Dim Level	Resistor Value
Level 1	43.9 Ohm
Level 2	142 Ohm
Level 3	264 Ohm
Level 4	409 Ohm
Level 5	609 Ohm
Level 6	846 Ohm

5.2 Output channels

Sensor power supply

The DDU 9 has four sensor power supplies: 2 x 5 V, 1 x 10 V and 1 x Ubat regulated voltage. They are short circuit protected to battery voltage and GND.

5.3 Communication channels

CAN bus

The DDU 9 has two CAN buses configurable as input and output. Different baud rates are selectable. Please note that the DDU 9 does not contain any CAN termination resistors. Thus the CAN termination resistors need to be integrated into the wiring loom.

Ethernet channels

The DDU 9 has two 100 MBit full duplex Ethernet communication ports. The ports are internally connected with an Ethernet switch. The Ethernet ports have 'cable auto crossover' functionality.

RS232 ports

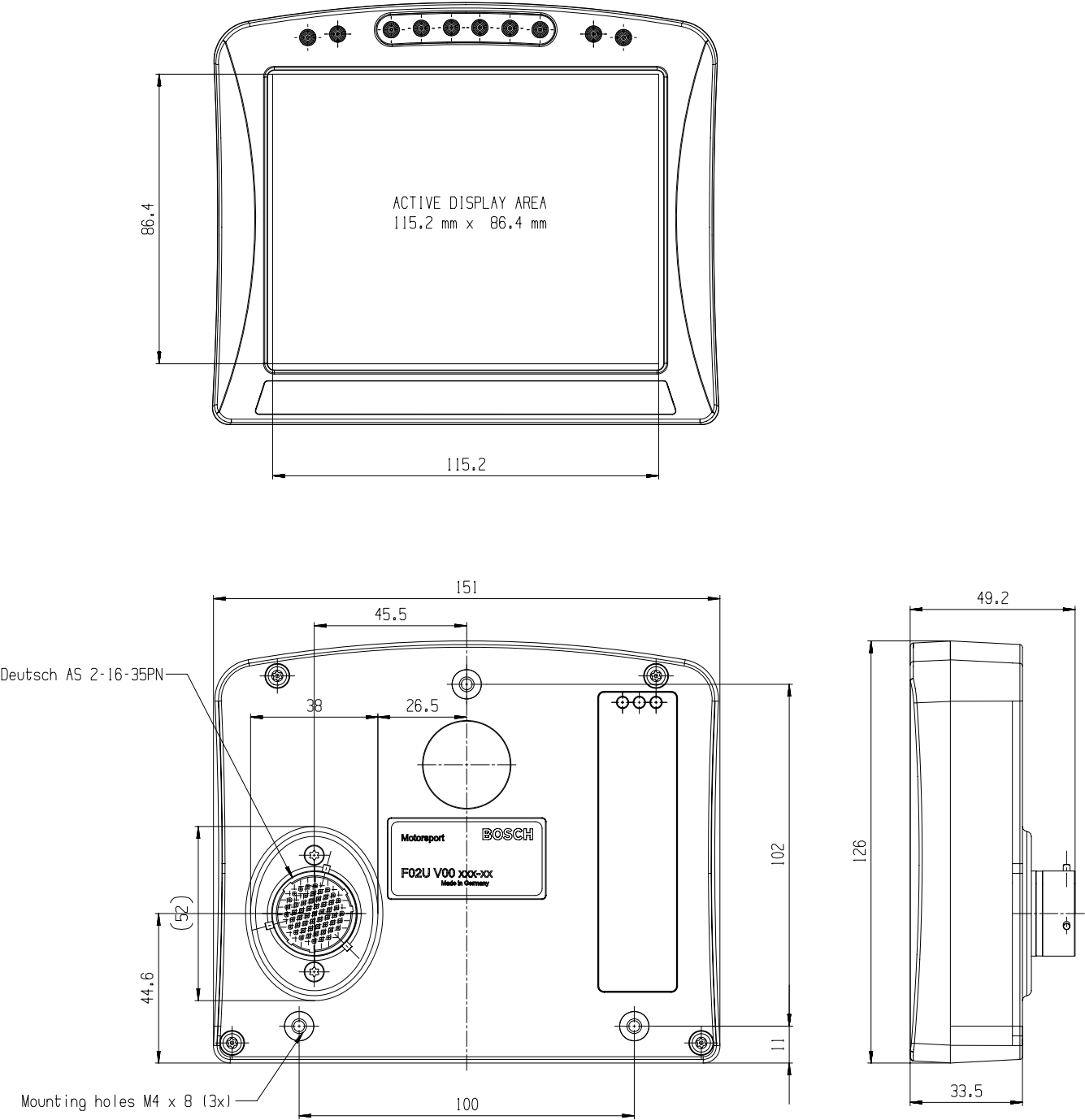
The DDU 9 has two RS232 serial ports. Baud rate for both ports is programmable. RS232 port 1 is reserved for online telemetry, port 2 can be used for reception of data from a serial GPS receiver.

Vehicle diagnosis connector

The Bosch Motorsport vehicle diagnosis connector is used as a standard interface to connect the vehicle to a PC e.g. via a MSA-Box II. Loom connector: AS 0-12-35SN

Pin	Name	Description	Used for DDU 9
Pin 1	Terminal 30	Permanent positive	+
Pin 2	Terminal 15	Switched positive	+
Pin 3	Terminal 31	GND	+
Pin 4	CAN High	Diagnostic CAN bus	
Pin 16	CAN Low	Diagnostic CAN bus	
Pin 10	K-Line	ECU diagnosis	
Pin 8	Ethernet RxD +	Ethernet interface	+
Pin 9	Ethernet RxD -	Ethernet interface	+
Pin 11	Ethernet TxD +	Ethernet interface	+
Pin 12	Ethernet TxD -	Ethernet interface	+
Pin 22	Screen	Cable screen	+

6 Mechanical Drawing



7 Starting up

7.1 Before starting

Install the software required DDU 9 operation. It is developed for Windows system software. Following software versions are used in this manual:

- DDU 9 setup, configuration and calibration: RaceCon
- Measurement data analysis: WinDarab V7

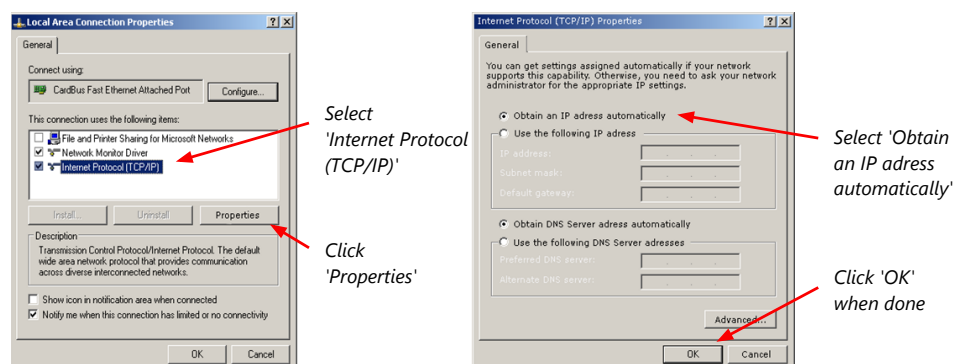
Set up the 100 Mbit Ethernet connection to the DDU 9.

- The Ethernet port has 'cable auto crossover' functionality

7.1.1 Setting up the network interface

The DDU 9 contains a DHCP server, network addresses can be assigned automatically to the configuration PC. The IP address of DDU 9 is 10.10.0.208.

1. Switch off the PC's firewall.
2. Set up the PC's network interface as shown in the screenshots.



7.1.2 Starting the unit

The DDU 9 powers up by turning on the ignition of the car. At startup the DDU 9 will display a Bosch logo.



After a moment the DDU 9 shows a display element screen.

The 'Link LED' at the PC's network adapter will illuminate. If the LED is off, check the wiring harness.

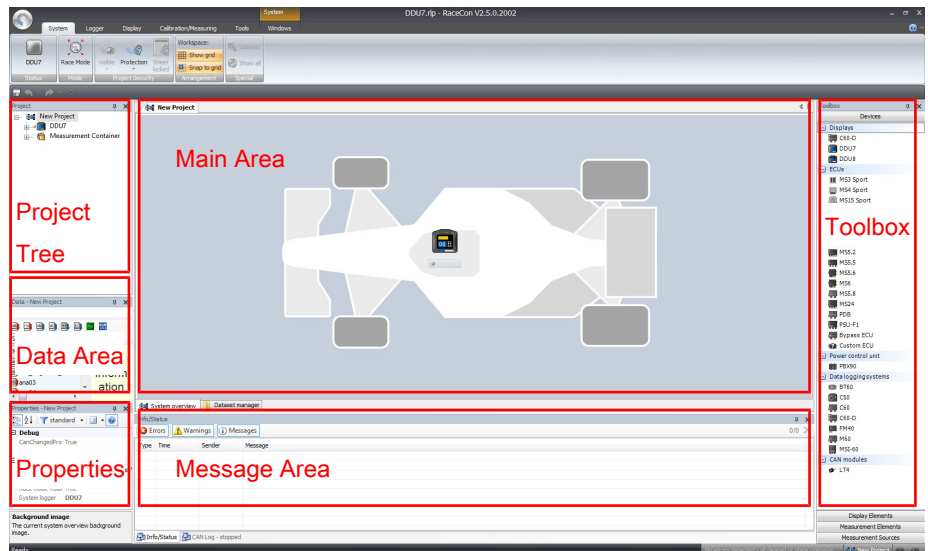
7.1.3 About RaceCon

RaceCon is an all integrated software tool for configuration and calibration of Bosch Motorsport hardware products. It is used to set up, configure and calibrate the DDU 9.

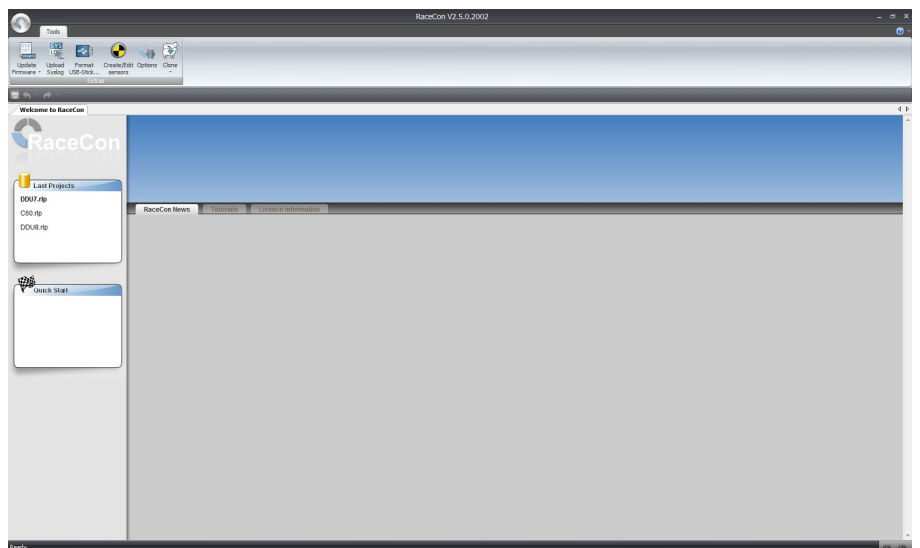
For better understanding, Bosch Motorsport offers a video tutorial that explains many functions of RaceCon. The video tutorial is available in the 'Software Download' section of www.bosch-motorsport.com.

7.1.4 Connecting the unit to RaceCon

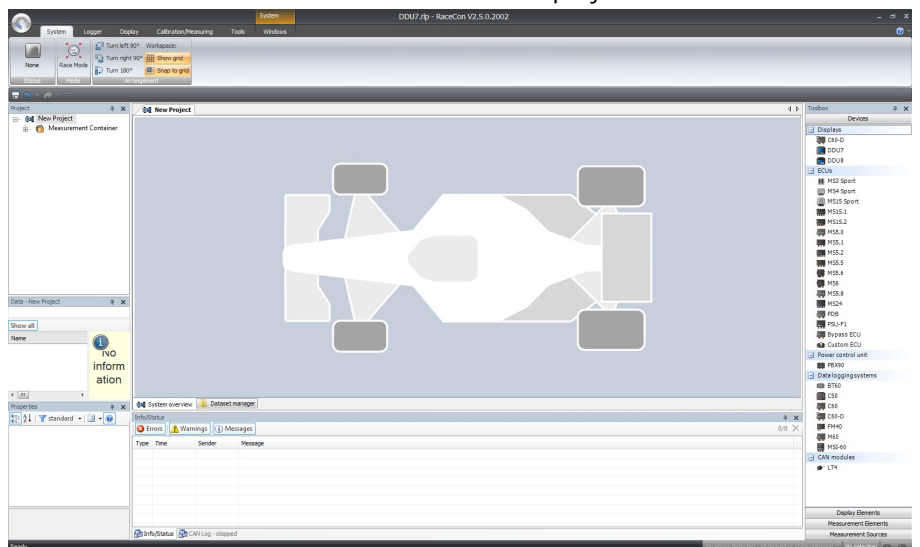
The following screenshot shows an overview of the RaceCon Main Screen with its areas. All (sub-) windows are resizable and dockable.



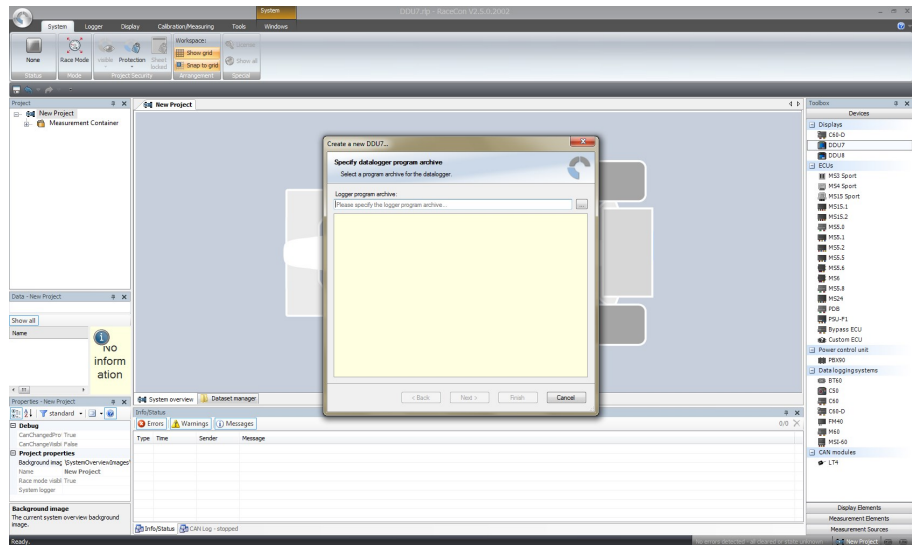
1. Start the RaceCon software.



2. In the 'File' menu select 'New' to create a new project.

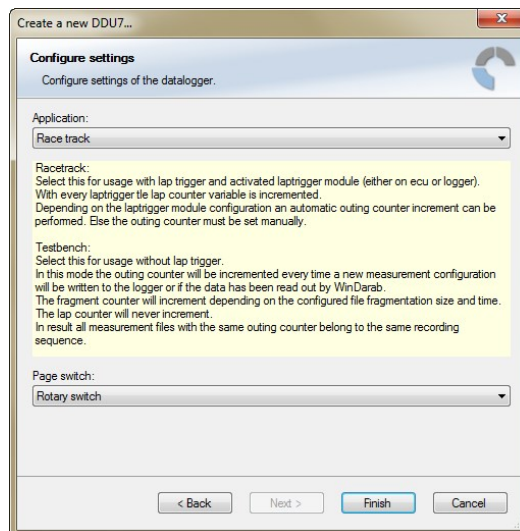


3. In the Toolbox select the DDU 9 and drag it into the Main Area. A pop up window to specify the DDU 9 program archive appears.

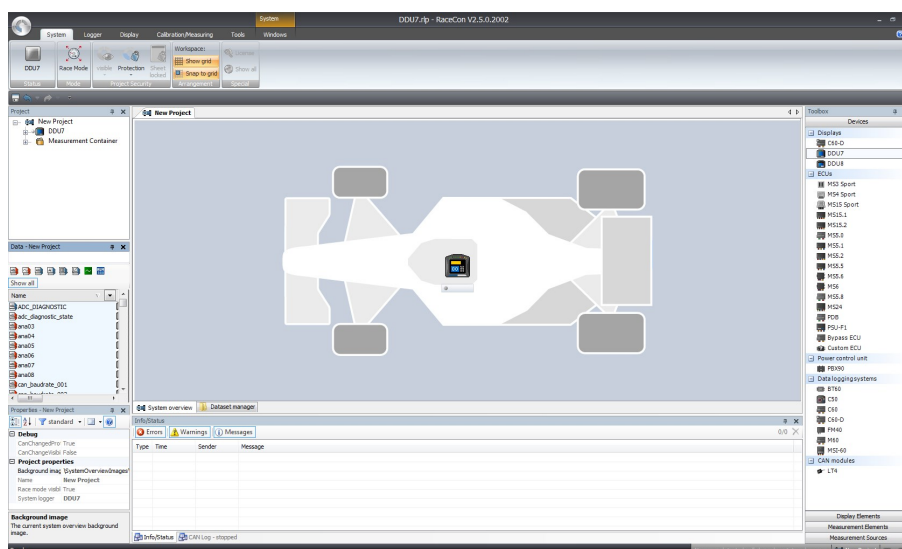


An information shows that the archive is valid or not.

4. Please find the firmware for the DDU 9 on www.bosch-motorsport.com/downloads/software.
5. Click 'Next'.

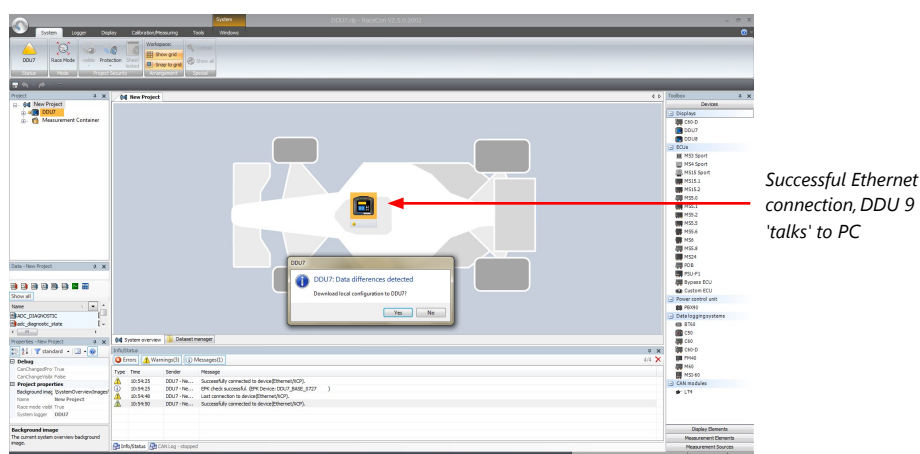


6. Select 'Race track'.
7. Click 'Finish'. The DDU 9 is inserted into the project and RaceCon tries to connect to the device.

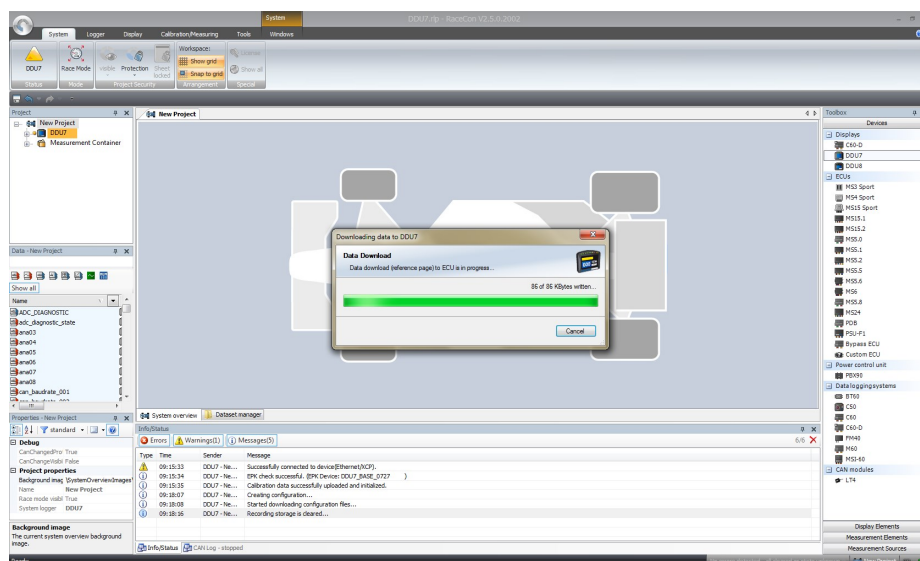


RaceCon detects configuration differences between the DDU 9 and the RaceCon project and asks for permission for data download.

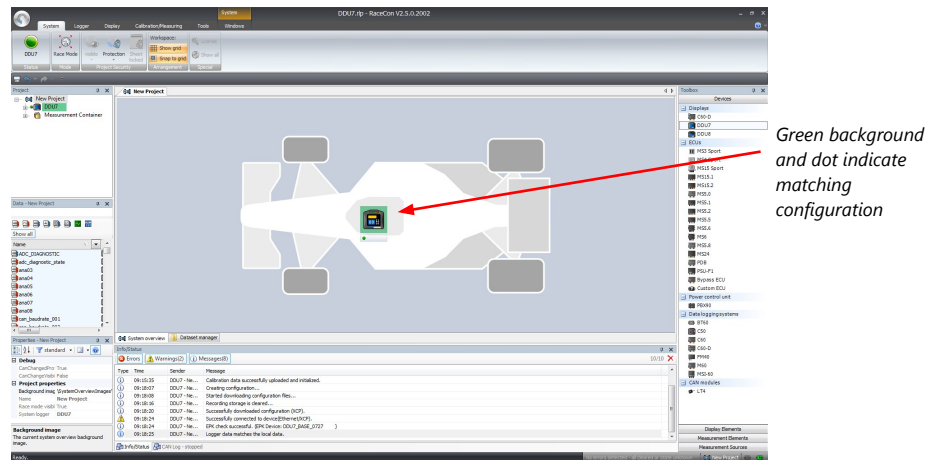
8. Click 'OK' to proceed.



The download starts and the DDU 9 carries out a reset.



After the reset RaceCon reconnects to the DDU 9. Local configuration on both the PC and DDU 9 match (indicated by green background and dot). The DDU 9 is now connected to RaceCon.

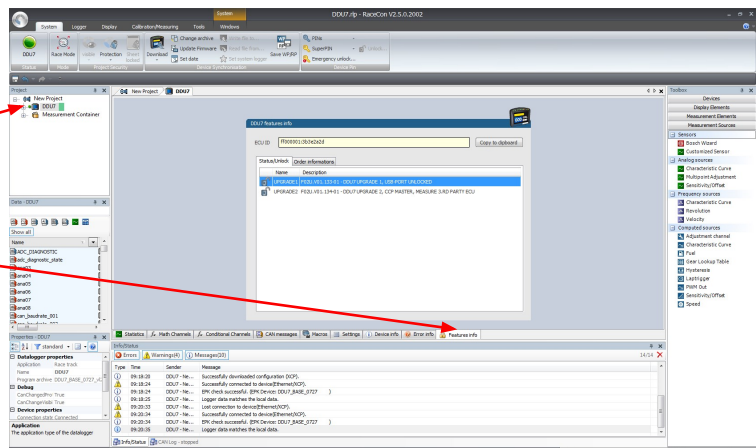


7.2 Feature activation

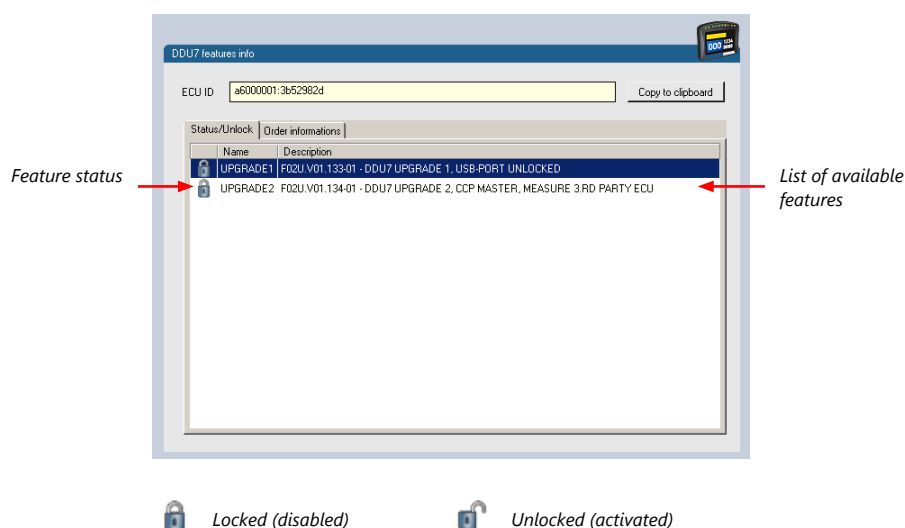
- Optional software feature packages are available for the DDU 9.
 - If you have purchased an optional software feature package, it must be activated before it becomes operational.
 - The feature activation status is stored permanently in the device and requires activating once only.
 - As the activation key is device specific, a key delivered with one DDU 9 does not work on any other DDU 9.
 - If you have not purchased an option package, the next steps can be skipped.
- To activate a feature, double-click on 'DDU 9' in the Project Tree and click on the 'Features info' tab in the Main Area.

1st: Double-click on DDU 9

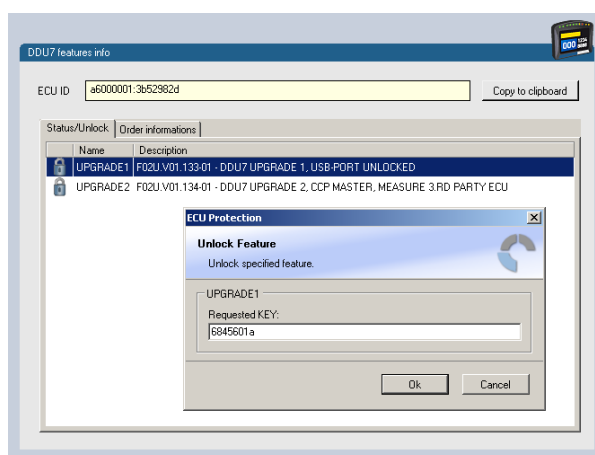
2nd: Click on 'Features Info'



The 'DDU 9 features info' window appears.

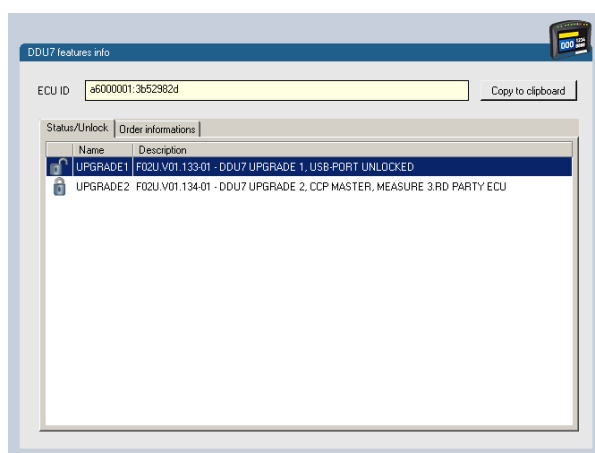


2. Double-click on the feature you want to activate. A feature unlock window appears.



3. Enter the activation key you received for this feature on this device and click 'OK' when done.

The feature's status changes to 'unlocked'.



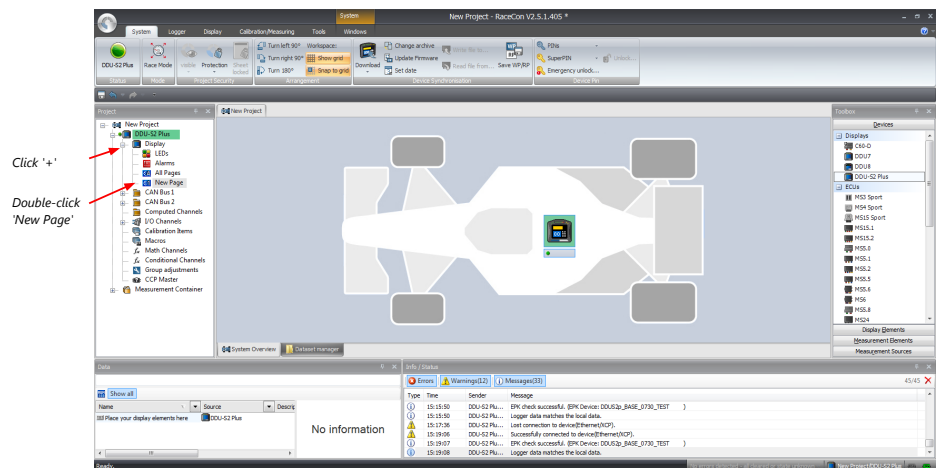
4. Perform these steps to activate other features you purchased.
5. Switch the car's ignition off and on again to cycle the power of DDU 9.

7.3 First display configuration (Quick Start)

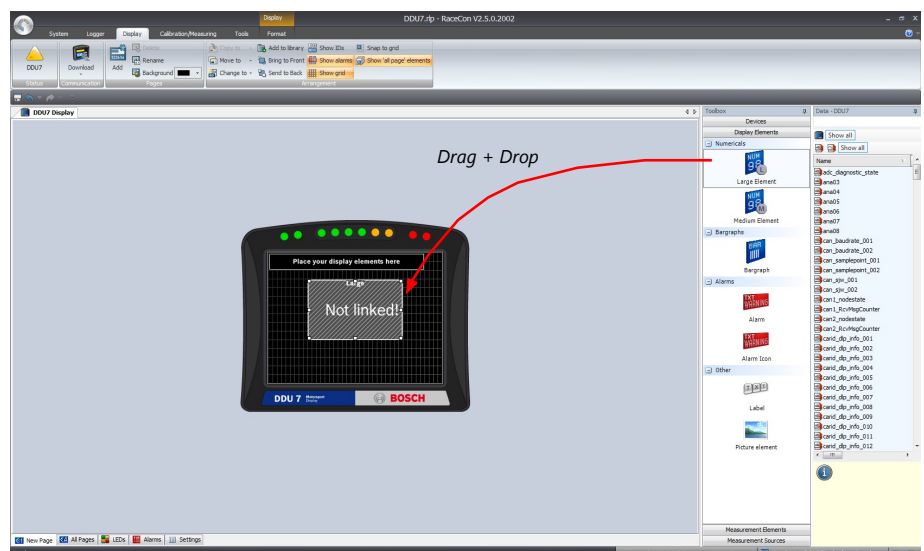
This chapter explains the configuration of a display element showing the battery voltage.

See chapter 'Display element configuration [▶ 30]' for a detailed instruction to configure display elements.

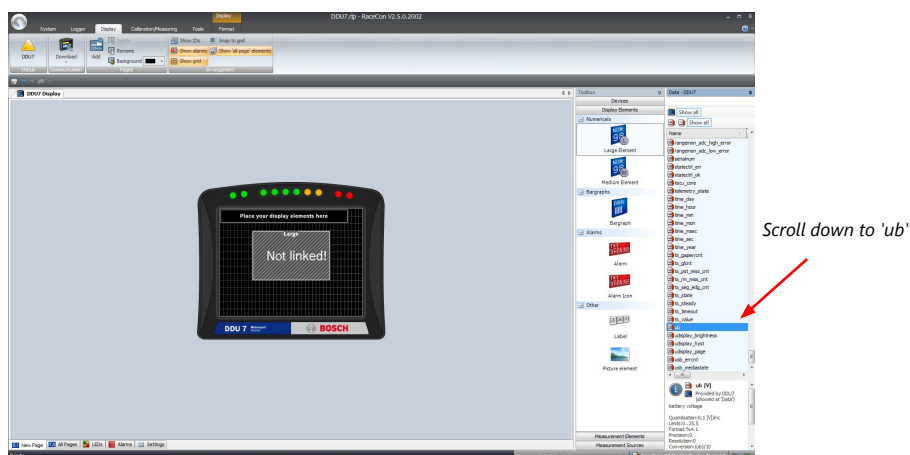
1. Expand the DDU 9 Project Tree by clicking '+'.
2. Click on '+' to expand 'Display'.
3. Double-click on 'New Page'. RaceCon changes to the page 'Display' to open the DDU 9 display configuration area.



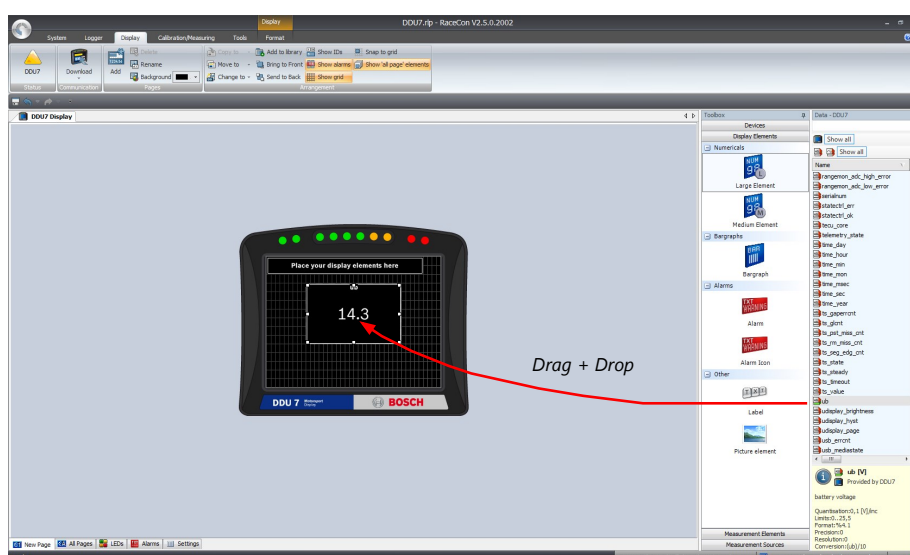
4. Drag a 'Large Element' from the Toolbox and drop it on the display page. A message in the 'Large Element' box shows that it is not linked to a measurement channel.



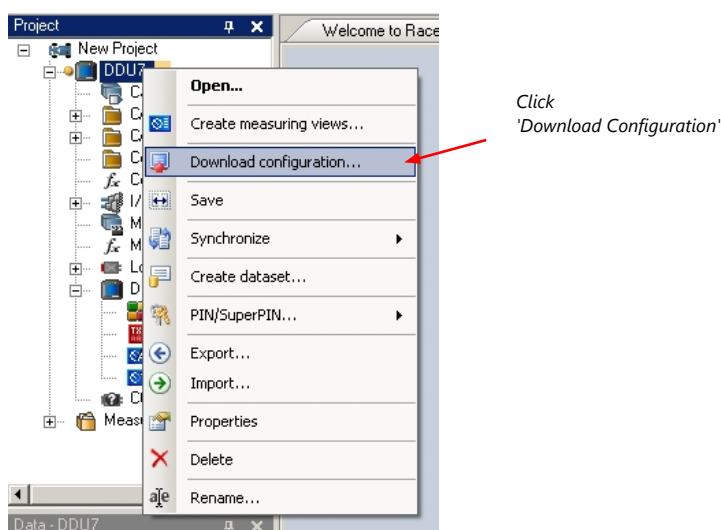
5. In the data window, scroll down to 'ub' (measurement channel for battery voltage).



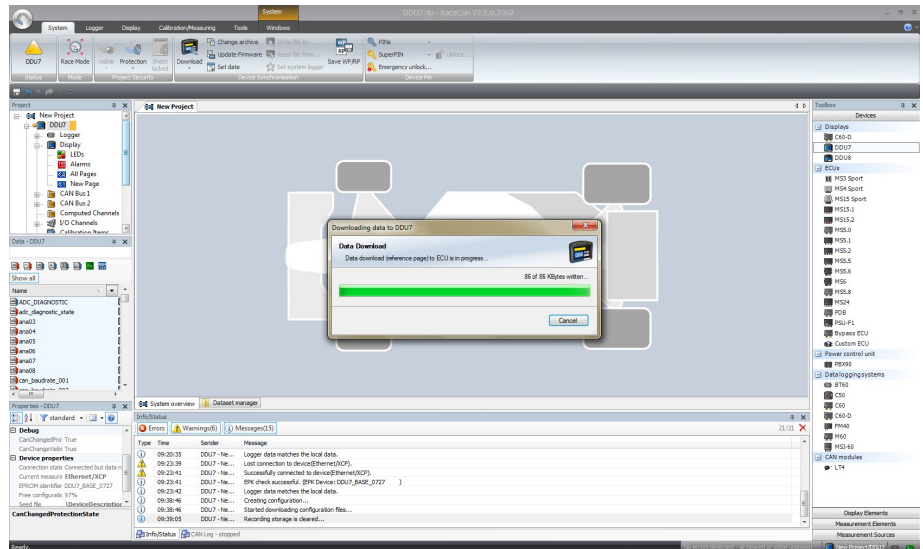
6. Drag the 'ub' measurement channel from the Data Area and drop it on the 'Large Element'.



7. To right-click on 'DDU 9' in the DDU 9 Project Tree, you have to change to page 'System'. Choose 'Download Configuration'.



The configurations download starts and the DDU 9 carries out a reset.



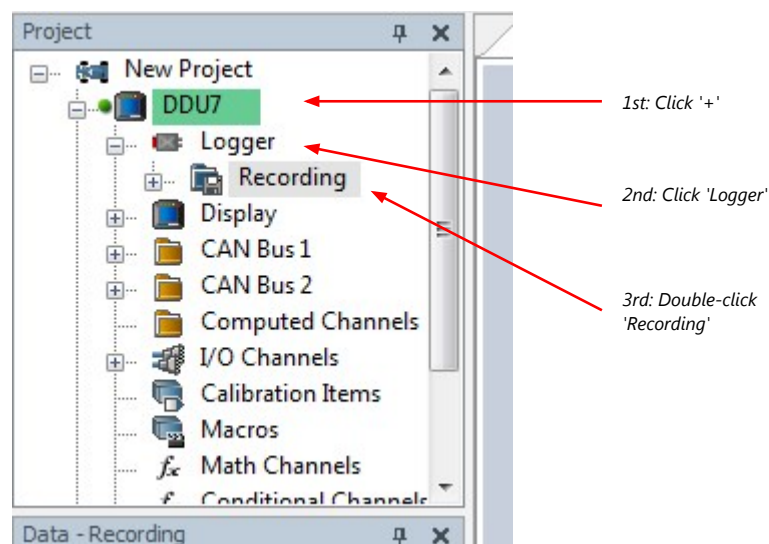
The value of the battery voltage is displayed on the DDU 9.

7.4 First recording (Quick Start)

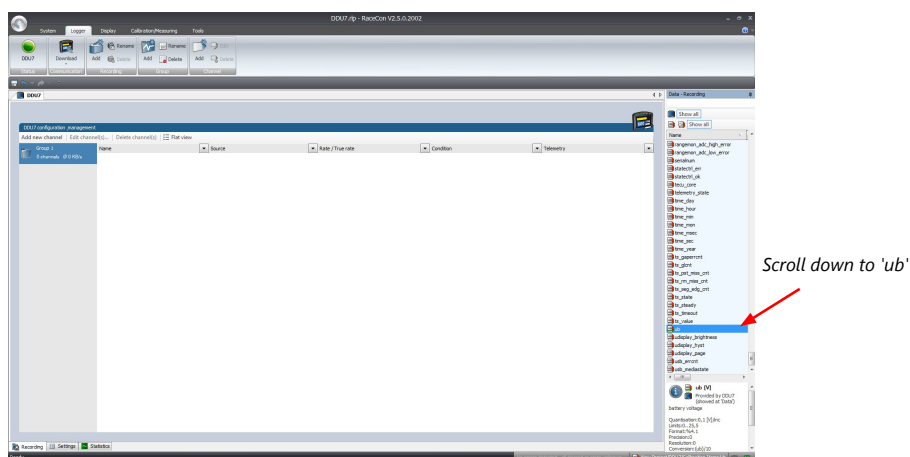
This chapter explains the configuration of the recording of the battery voltage channel. See chapter 'Recording [▶ 129]' for a detailed instruction to configure recordings.

1. Expand the DDU 9 Project Tree by clicking '+'.
2. Expand the Logger Tree by clicking '+'.
3. Double-click on 'Recording'.

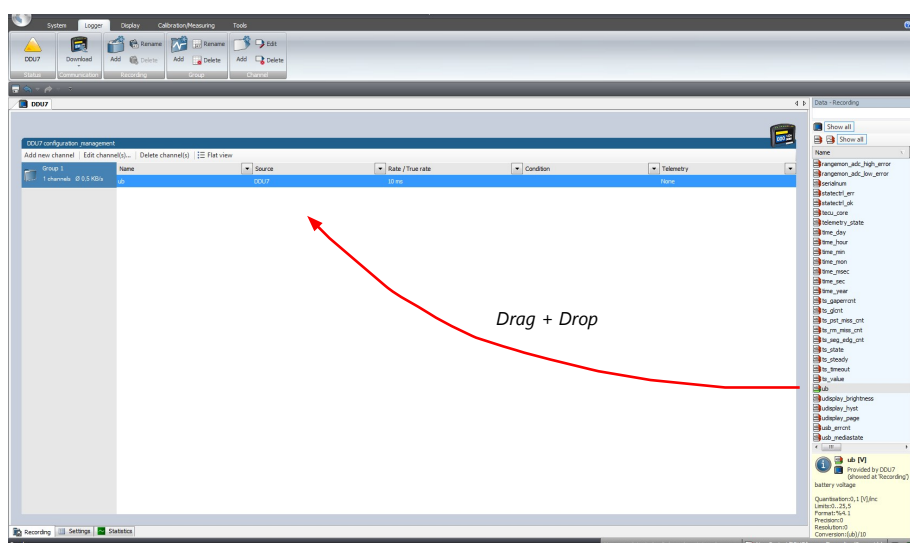
The DDU 9 recording configuration area opens. (RaceCon changes to the page 'Logger'.)



4. In the data window, scroll down to 'ub' (measurement channel for battery voltage).



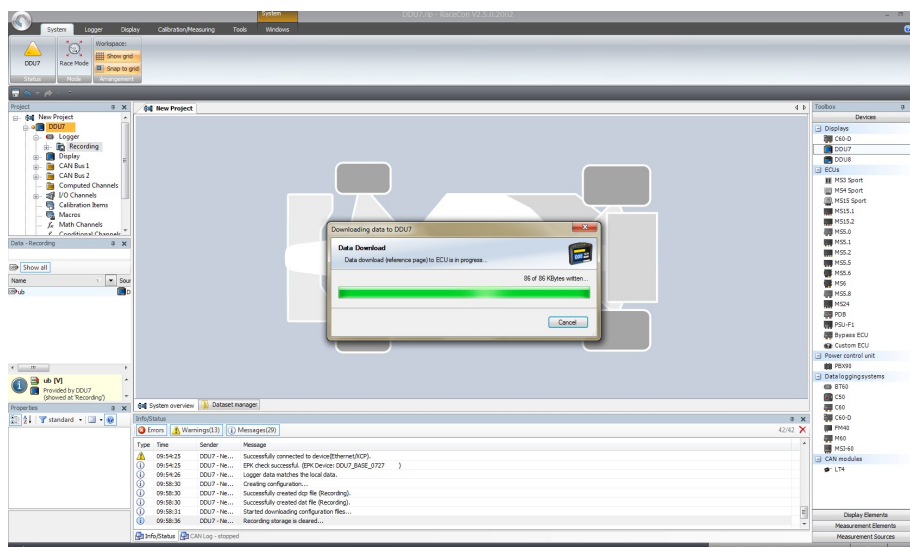
5. Drag + drop the 'ub' measurement channel into the recording area.



6. To right-click on 'DDU 9' in the DDU 9 Project Tree, you have to change to page 'System'. Choose 'Download Configuration'.

The configuration download starts and the DDU 9 carries out a reset.

The 'ub' measurement channel you can find now in the 'Data Area'.



As we did not define global start conditions, recording starts immediately.

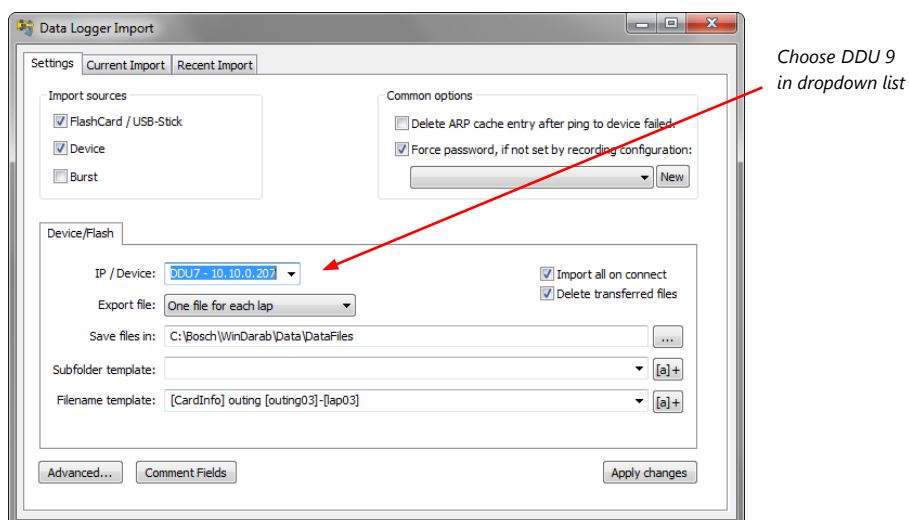
DDU 9 Manual



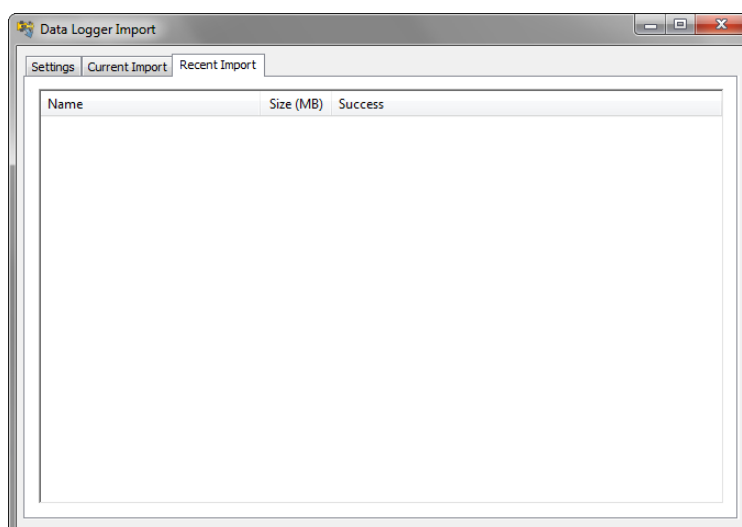
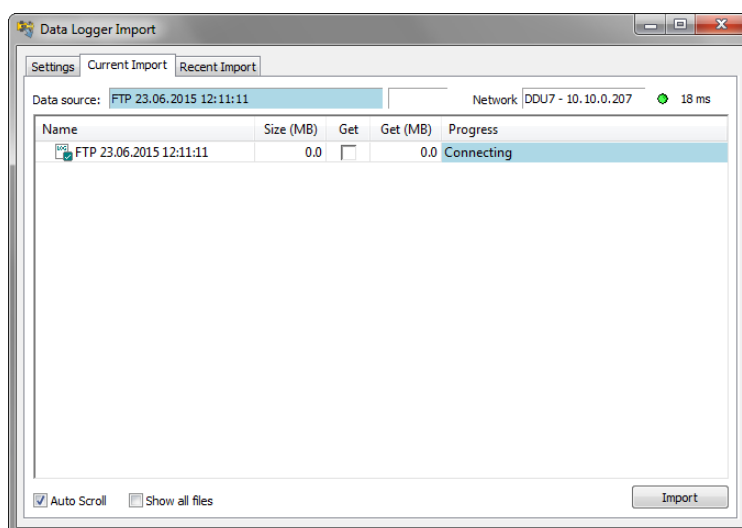
11. Click on 'Modify' button and select the base folder.
12. Choose 'FTP' as data transmission method.
13. Choose 'XXXXXXXXXX' in the Vehicle dropdown list.
14. Activate 'Auto save'.
15. Click 'Save' when done.



11. Click on 'Modify' button and select the base folder.
12. Choose 'FTP' as data transmission method.
13. Choose 'XXXXXXXXXX' in the Vehicle dropdown list.
14. Activate 'Auto save'.
15. Click 'Save' when done.



16. Connect the DDU 9 network cable. Data transmission from the DDU 9 starts automatically. Measurement files are stored automatically in the base folder.

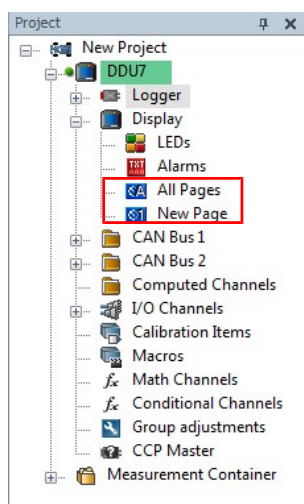


17. Click on 'Close' when transmission has finished.
 18. Click on the Start button and choose 'Open measurement file'.
 19. Select the measurement files from the storage folder.

8 Display Configuration

8.1 Display page setup

8.1.1 Organizing display pages



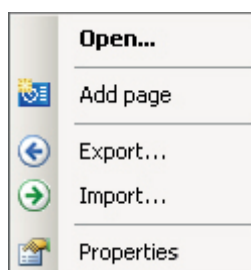
- All Pages: Display elements placed on this page are displayed on all pages. Recommended for 'Alarm' display elements.
- Single Page: Display elements placed on this page are displayed only on this page.

The priority of display elements placed on 'All Pages' is higher than the priority of display elements placed on single pages.

Example: An Alarm placed on 'All Pages' is displayed on all display pages and is always in front of other display elements.

8.1.2 Adding a new display page

Right-click on 'Display' and click 'Add Page' in the menu.

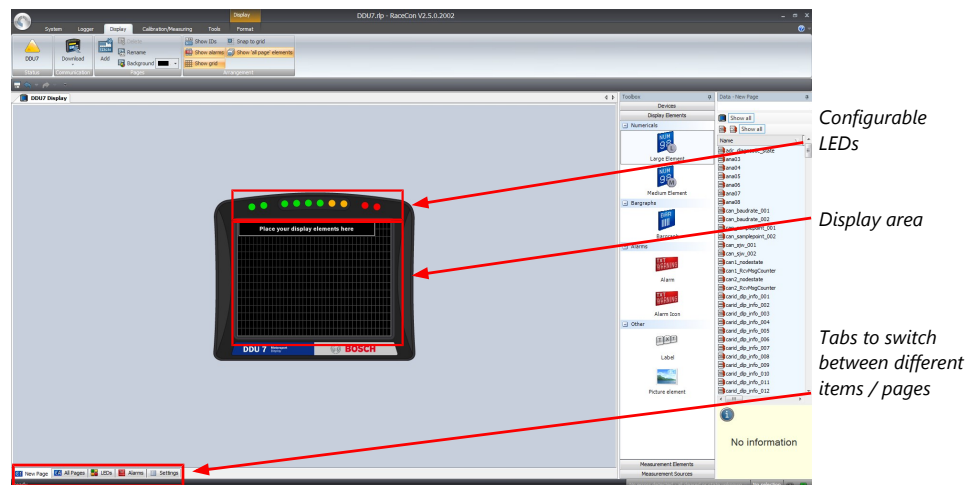


A new empty page opens.

8.1.3 Selecting display pages

Click on 'DDU 9' in the DDU 9 Project Tree, then on 'Display' and double-click on the page you want to select (example: 'New Page').

In the Main Area, a representation of the DDU 9 opens.



8.2 Display element configuration

8.2.1 Numeric display element

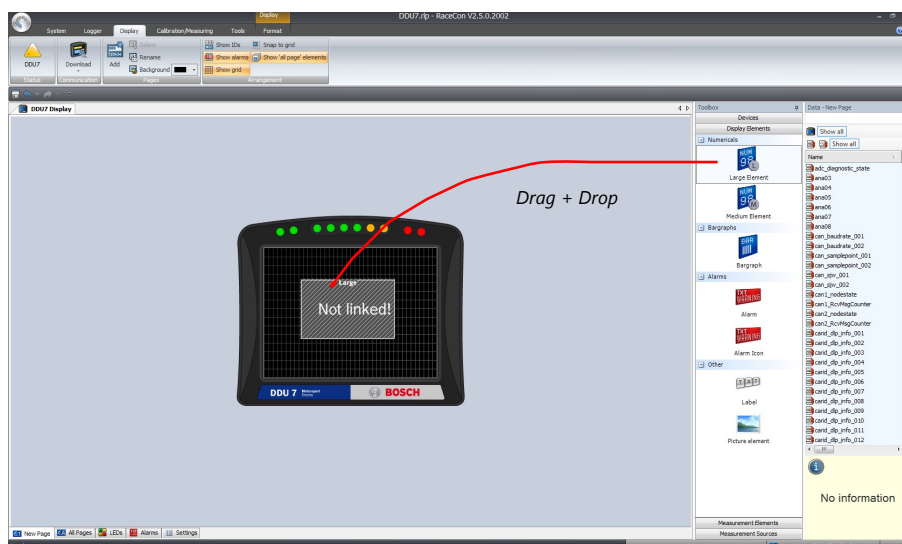
Adding a numeric display element to display page

The 'Large Element' and the 'Medium Element' numeric display elements differ in element and font size. The element and font size can be changed using the Numeric Wizard.

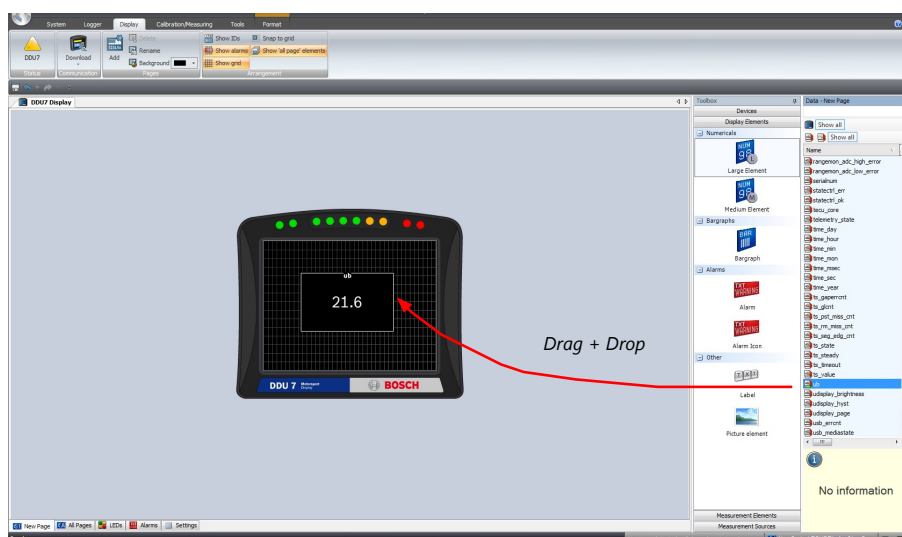
Notice

In this view the displayed values are random values and do not show the real values of the measurement channels.

1. Drag a numeric display element from the Toolbox and drop it on the display page. A message in the numeric element box shows that it is not linked to a measurement channel.



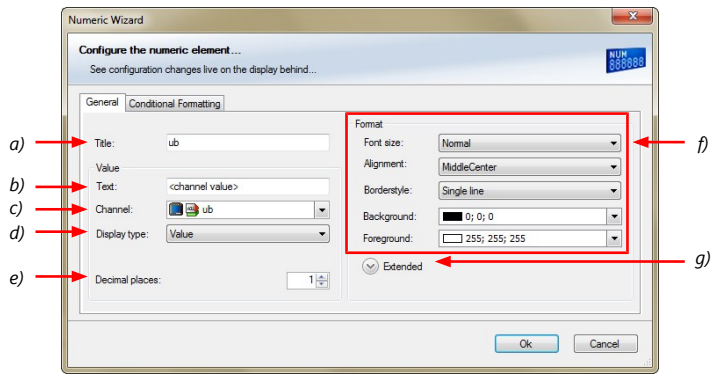
2. Drag a measurement channel from the Data Area and drop it on the numeric display element.



The measurement channel is linked to the numeric display element.

Configuring a numeric display element

1. Double-click on the numeric display element.
The Numeric Wizard window opens.



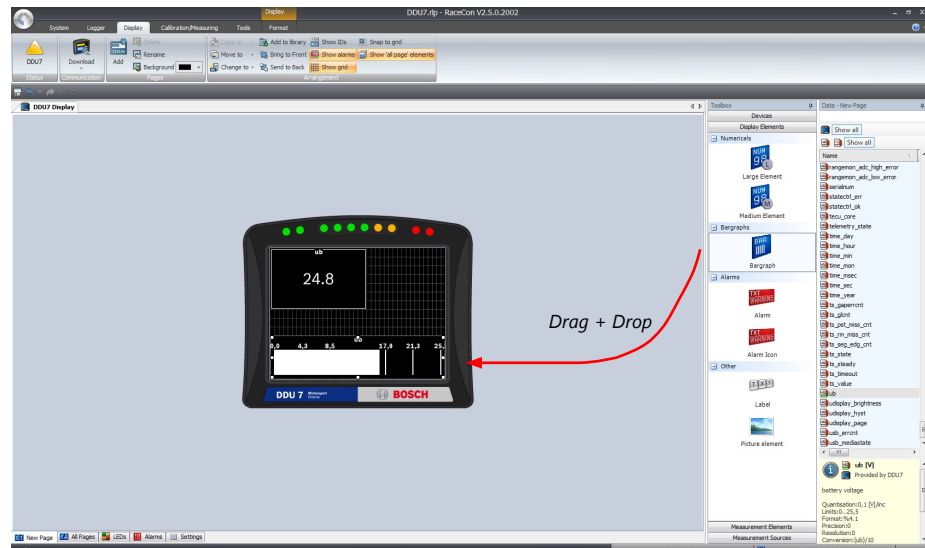
- a) Enter the title displayed on top of the numeric display element.
 b) Enter the text displayed in the middle of the numeric display element. The variable <channel value> displays the value of the measurement channel.
 c) Choose the measurement channel.
 d) Choose the type of input data:
 - Value
 - Gear
 - Time (in different formats)
 e) Enter the number of decimal places of the measurement channel.
 f) Choose the font size, alignment, borderstyle, background and foreground color of the numeric display element.
 g) Click the Extended button to show further options to change the color of the title, border and text individually.

2. Click 'OK' when done.

8.2.2 'Bargraph' display element

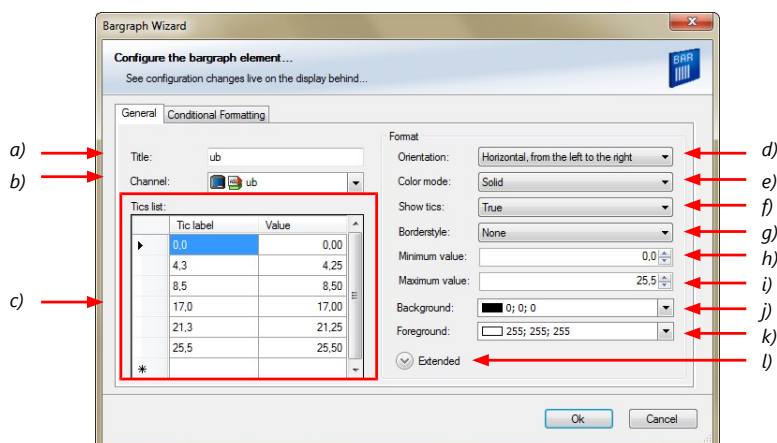
Bargraph display element

Drag the 'Bargraph' display element from the Toolbox and drop it on the display page.



Configuring a 'Bargraph' display element

1. Double-click on the 'Bargraph' display element. The Bargraph Wizard window opens.



- a) Enter the title displayed on top of the 'Bargraph' display element.
 b) Choose the measurement channel.
 c) Define the tick text corresponding with the physical value. You can add more tick labels by entering values in the row labeled with *.
 d) Choose the orientation of the Bargraph (horizontal or vertical).
 e) Choose the color mode of the Bargraph:
 - Solid: The whole Bargraph and tics are colored in one color
 - Stacked: The Bargraph is subdivided in segments with different colors. The colors are set in the tab 'Conditional Formatting'. For details, see chapter 'Conditional Formatting'.
 f) Define if ticks and numbers are shown.
 g) Choose the style of the border lines.
 h) Enter the physical value where the Bargraph begins.
 i) Enter the physical value where the Bargraph ends.
 j) Choose the background color of the Bargraph.
 k) Choose the foreground color of the Bargraph.
 l) Click the Extended button to show further options to change the color of the title, border and text individually.

2. Click 'OK' when done.

Notice

The tab 'Conditional Formatting' is explained in chapter 'Conditional formatting [▶ 38]'.

8.2.3 'Alarm' display element

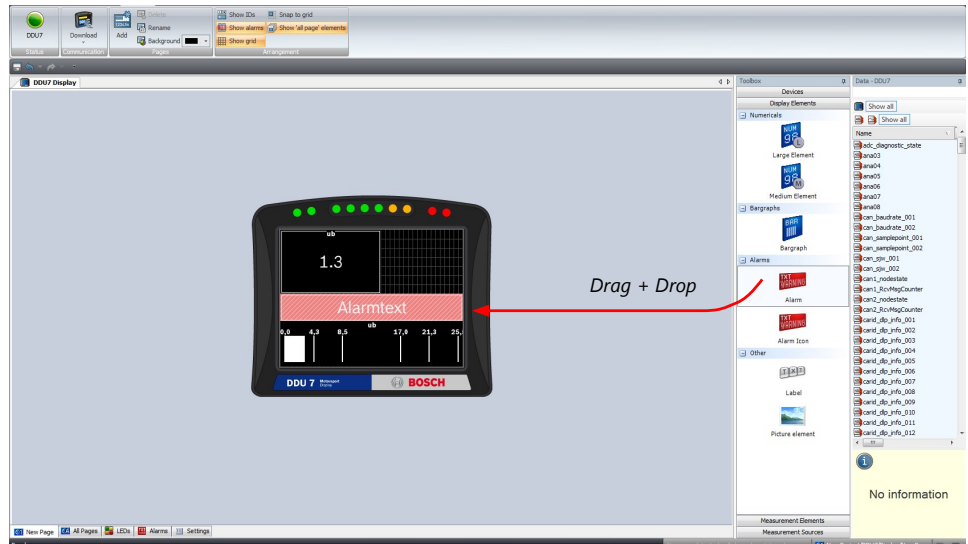
The 'Alarm' display element displays a warning message in case of a defined condition becoming 'true'. In case of a condition becoming 'false', the 'Alarm' display element is not shown.

Two types of 'Alarm' display elements are available:

- Alarm: An alarm displaying a defined text
- Alarm Icon: An alarm displaying a defined image (e.g. a warning triangle)

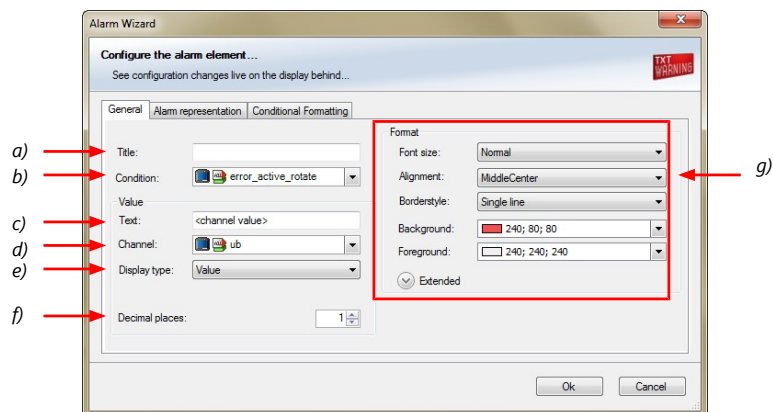
Adding an 'Alarm' display element to display page

Drag an 'Alarm' element from the Toolbox and drop it on the display page.



Configuring an 'Alarm' (text) display element

1. Double-click on the 'Alarm' display element. The Alarm Wizard window opens.



a) Enter the title displayed on top of the 'Alarm' display element.

b) Choose the condition when the alarm will be activated:

- Create a condition using the Condition Creator. For more information see chapter 'Creating a new condition channel'

- Choose an existing condition.

The Alarm is displayed if function is 'TRUE', i.e. result of the calculation is >0.

c) Enter the alarm message displayed in the middle of the 'Alarm' display element. Enter the variable <channel value> to display the value of the measurement channel.

d) Choose the measurement channel.

e) Choose the type of input data:

- Value

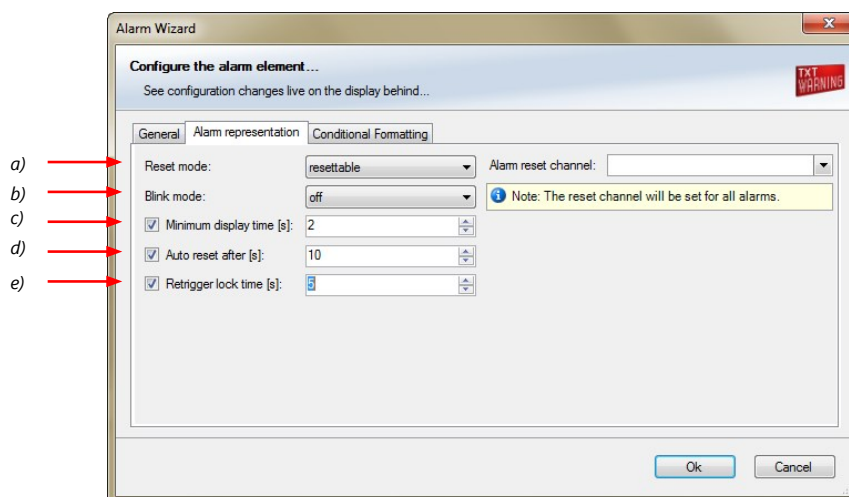
- Gear

- Time (in different formats)

f) Enter the number of decimal places of the measurement channel.

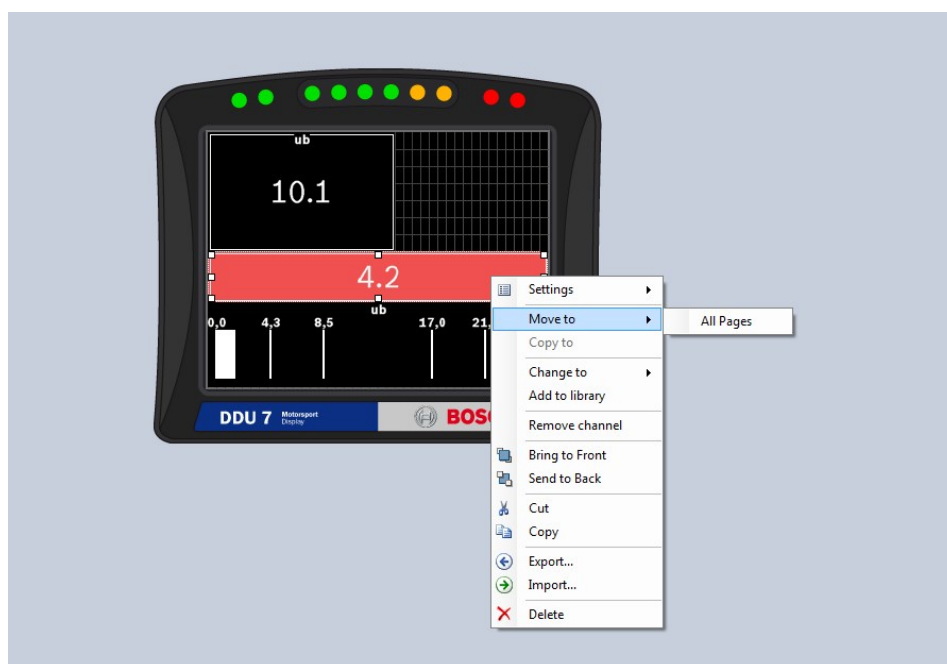
g) Choose the font size, alignment, borderstyle, background and foreground color of the 'Alarm' display element.

2. Switch to the tab 'Alarm representation'.



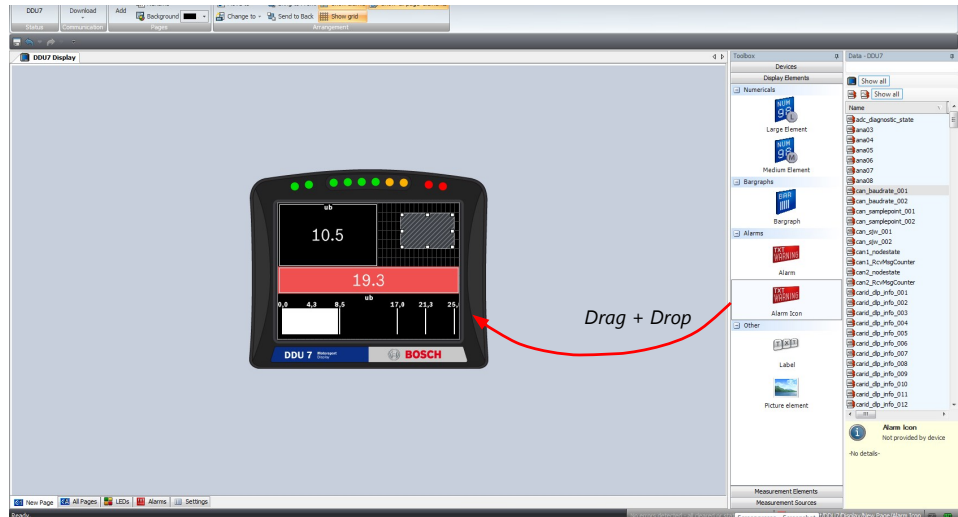
- a) Choose if the alarm can be reset or not.
 b) Choose if the alarm blinks slowly, fast or does not blink.
 c) Enter the minimum time the Alarm display element is displayed if an alarm is triggered.
 d) Enter the time until the Alarm resets automatically after the minimum display time entered in c). Only possible if Alarm is resettable.
 e) Enter the time until the Alarm can appear again after a reset.

3. Click 'OK' when done.
4. Copy alarm to all display pages by clicking 'Move to' -> 'All Pages'.

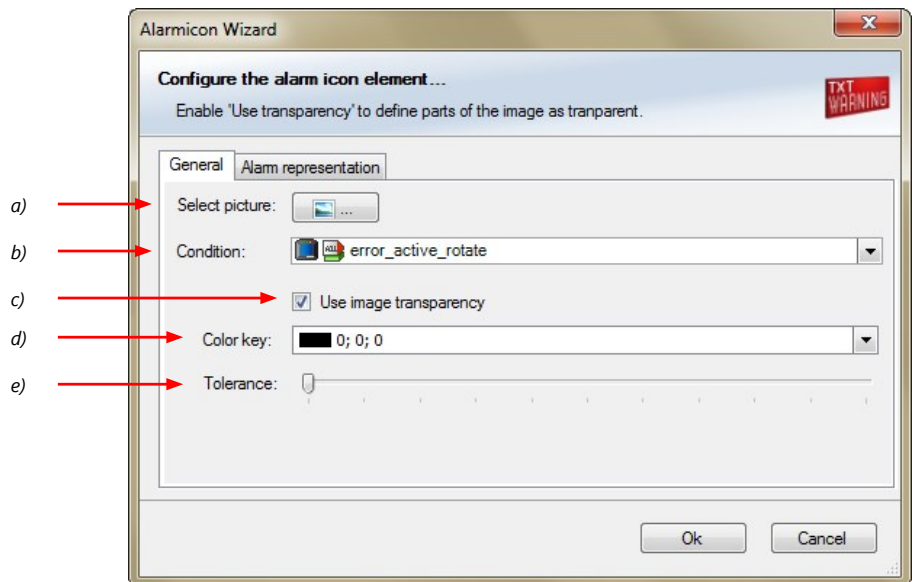


Configuring an 'Alarm Icon' (image) display element

1. Double-click on the 'Alarm Icon' display element.
 The Alarm Icon Wizard window opens.



2. Switch to the tab 'Alarm representation'. It is configured in the same way as the 'Alarm' text display element.



- a) Select the image from the hard drive that is shown in case of an alarm.
- b) Choose the condition when the alarm will be activated:
 - Create a condition using the Condition Creator. For more information see chapter 'Creating a new condition channel'
 - Choose an existing condition
- The 'Alarm Icon' is displayed if function is 'TRUE'; i.e. result of the calculation is >0.
- c) Enable the checkbox if you want to define parts of the image as transparent.
- d) Select the basic transparent color key. This means that any pixel of the image near (depending of the tolerance value) to this color gets transparent.
- e) Select a tolerance in percent to define parts of the image as transparent.

3. Click 'OK' when done.

Notice

If several active alarms in the display overlap, each alarm is in the foreground for 2 seconds.

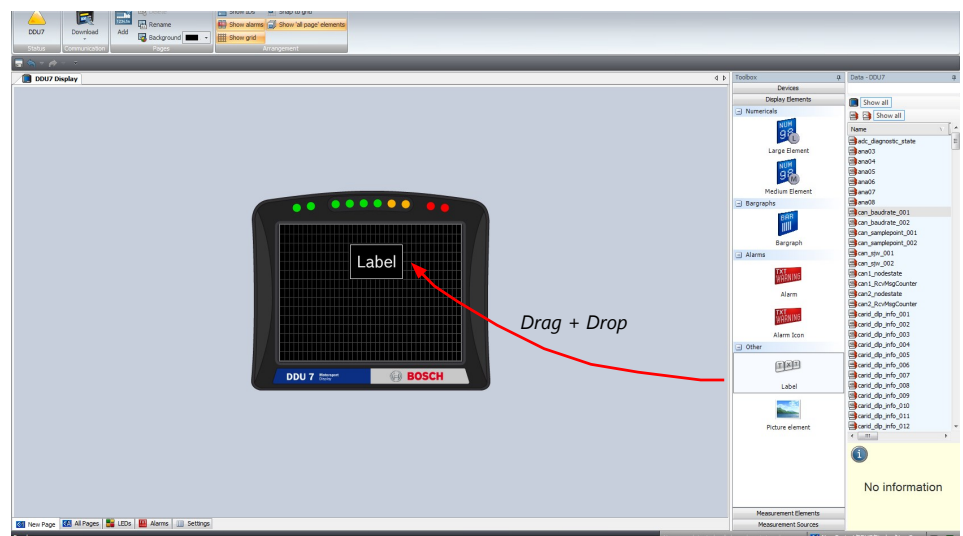
8.2.4 Other display elements

Two types of other display elements are available:

- Label: A label displaying a specified text
- Picture element: An element displaying a static picture (e.g. temperature warning)

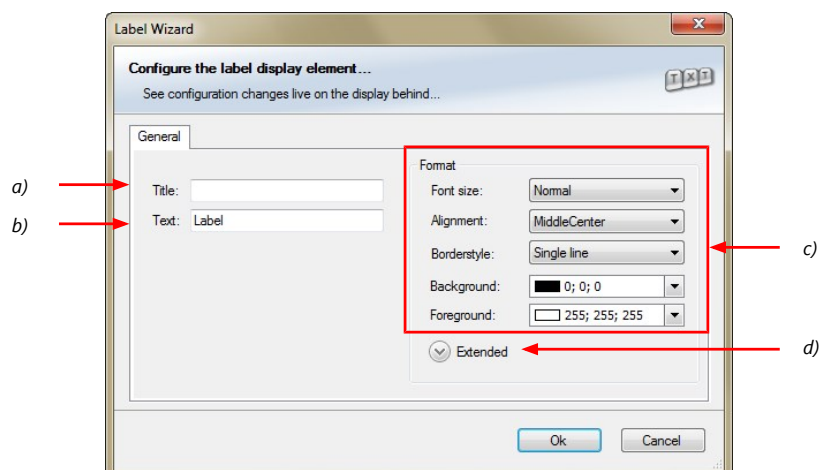
Adding a Label or picture display element to display page

Drag the Label or picture display element from the Toolbox and drop it on the display page.



Configuring a Label display element

1. Double-click on the Label display element. The Label Wizard window opens.

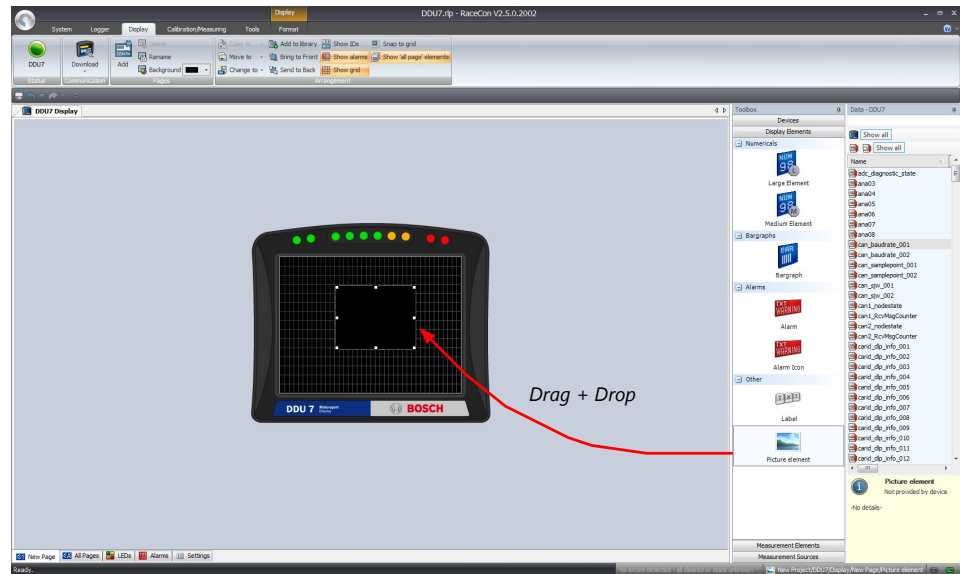


- a) Enter the title displayed on top of the Label display element.
- b) Enter the text displayed in the middle of the Label display element.
- c) Choose the font size, alignment, borderstyle, background and foreground color of the Label display element.
- d) Click the Extended button to show further options to change the color of the title, border and text individually.

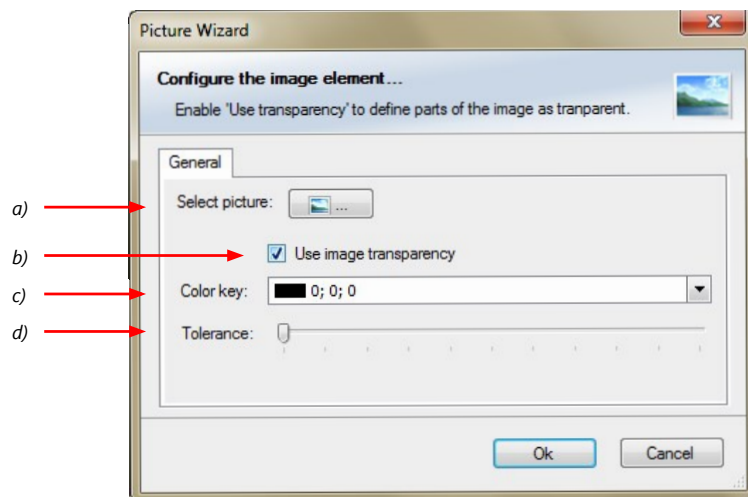
2. Click 'OK' when done.

Configuring a Picture display element

Supported image file formats are: bmp, jpg, gif, png, tif



1. Double-click on the Picture display element. The Picture Wizard window opens.



- a) Select the image from the hard drive.
- b) Enable the checkbox if you want to define parts of the image as transparent.
- c) Select the basic transparent color key. This means that any pixel of the image near (depending of the Tolerance value) to this color gets transparent.
- d) Select a tolerance in percent to define parts of the image as transparent.

2. Click 'OK' when done.

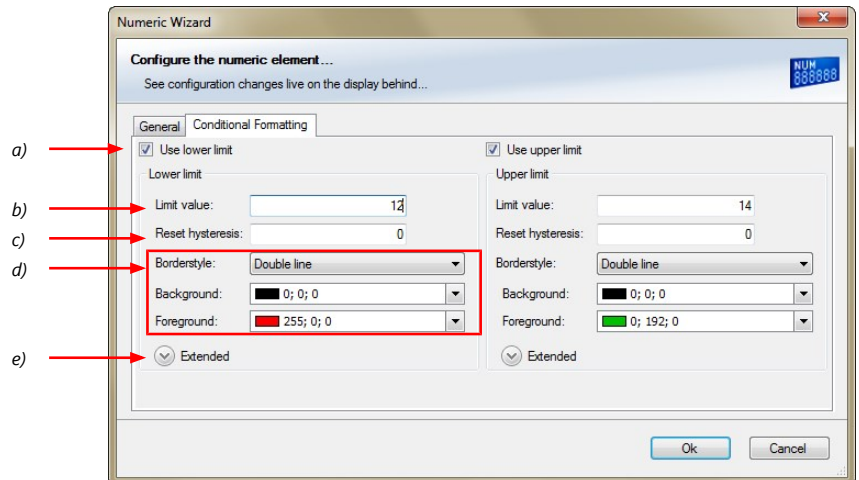
8.2.5 Conditional formatting

This function pigments the displayed values in dependence of a specified measurement channel value.

Example: The text color changes from white to red when the battery voltage is fewer than 12 V.

Conditional formatting is available at numeric, 'Bargraph' and 'Alarm' display element.

1. Double-click on the display element. The Numeric Wizard window opens.
2. Switch to the tab 'Conditional Formatting'.



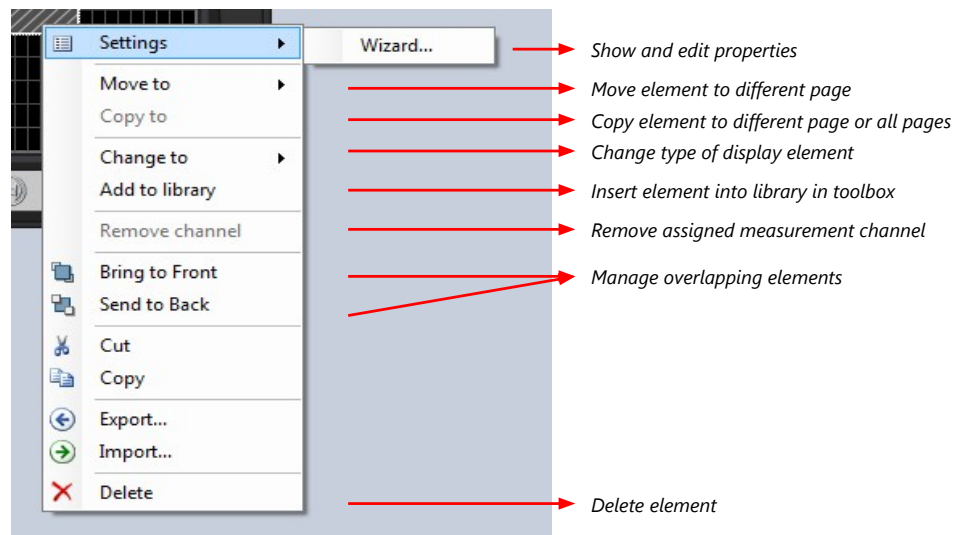
- a) Check the box to activate the formatting at a lower limit.
 b) Enter the limit value when the formatting is active.
 c) Enter the limit value when the reset hysteresis function is active. The reset hysteresis function avoids the high-frequent switchover of the measurement channel value.
 d) Choose the borderstyle, background and foreground color of the numeric display element.
 e) Click the Extended button to show further options to change the color of the title, the border and text individually. If a 'Bargraph' display element is used, its colors can also be changed.

The lower and the upper limits are configured in the same way.

3. Click 'OK' when done.

8.2.6 Context menu

The context menu appears by right-clicking on a display element.

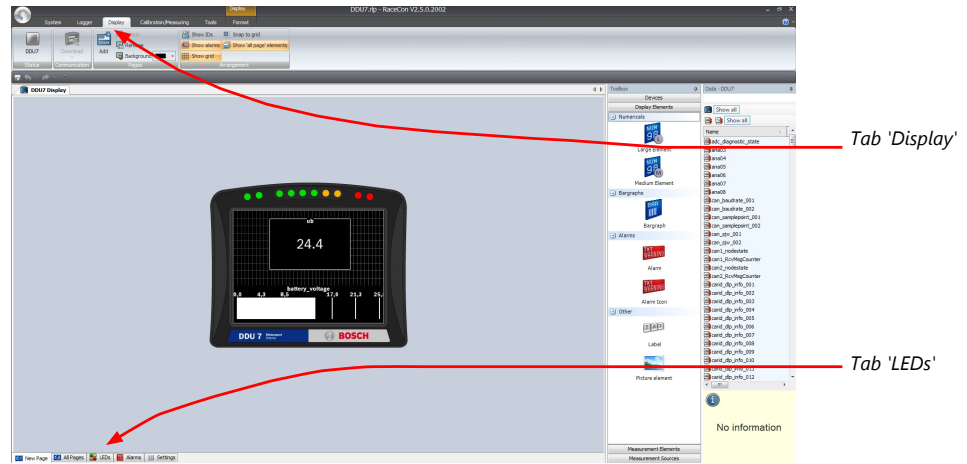


8.3 LEDs

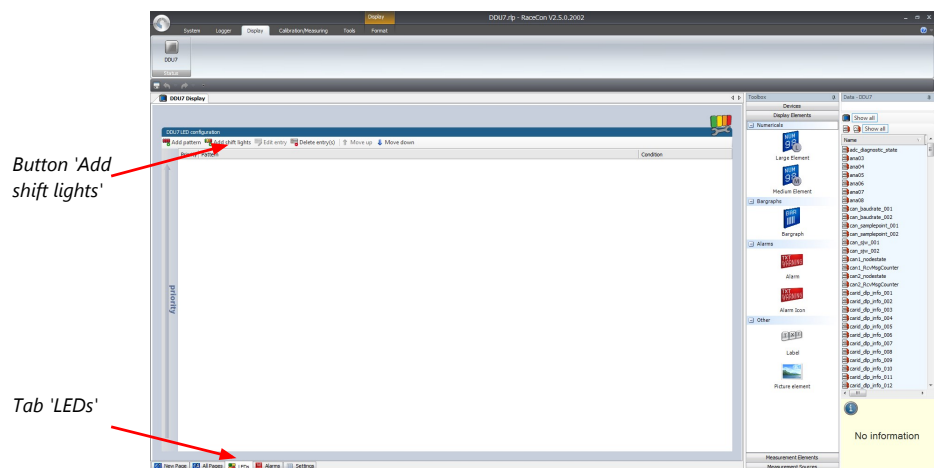
The LEDs are fully configurable to show the optimal shifting point. They can also be configured to flash in case of a customized condition becoming 'true'.

8.3.1 Configuring shift LEDs

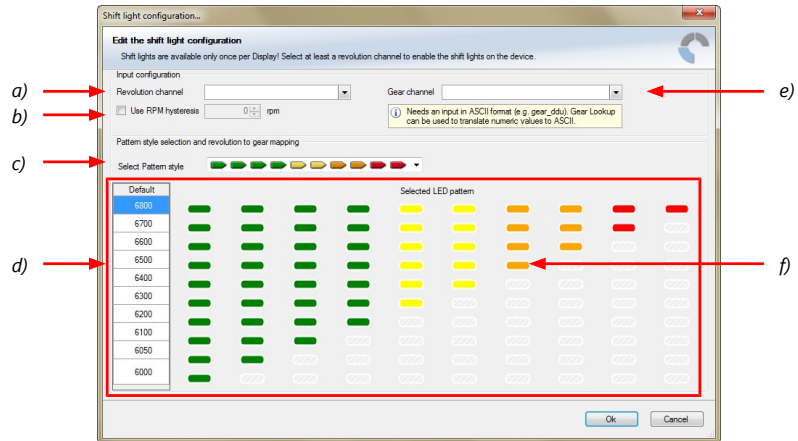
To use shift LEDs, RPM and gear measurement channels an ECU has to be loaded in RaceCon.



1. Click on the tab 'LEDs' in the display view.
2. Click on the button 'Add shift lights'.



3. The shift light configuration window appears. Set up the shifting lights using the following configuration possibilities:



a) Choose the measurement channel for 'Revolution'. Revolution must have 1/min quantization.
 b) Enter the limit value when the RPM hysteresis function is active. The RPM hysteresis function avoids the high-frequency switchover of the measurement channel value.
 c) Choose a predefined Pattern style.
 d) Define the gear (must be ASCII quantization). Only if gear channel is used.
 e) Choose the measurement channel for 'Gear'. Gear must have an ASCII quantization (1st gear='1' = 49, 2nd gear='2' = 50, ...). (ASCII quantization is standard for the 'gear' channel of Bosch ECUs.
 If you get the gear information of a different control unit as the Bosch ECU (e.g. a gearbox control unit), use the Gear Lookup Table to translate numeric values to ASCII format.
 For more information see chapter "Converting a gear channel to ASCII representation.)

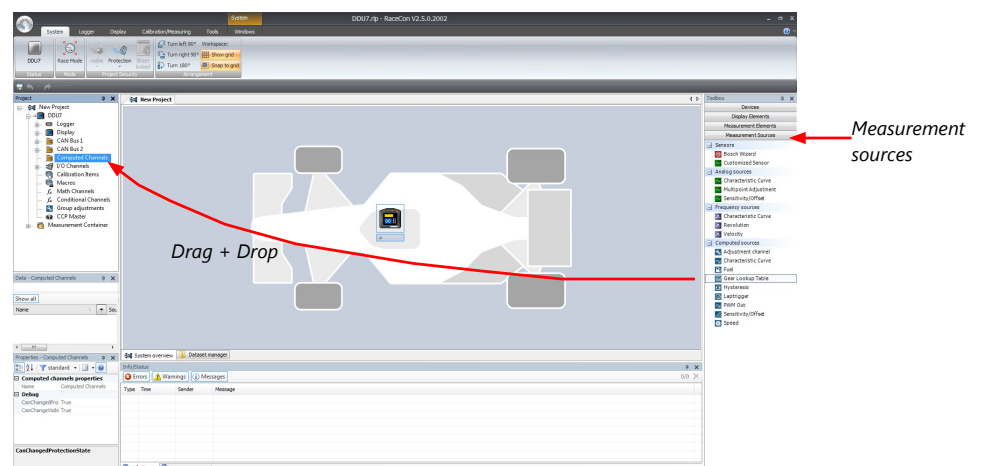
4. Click 'OK' when done.

The configuration is displayed in the DDU 9 LED Configuration window.

8.3.2 Converting a gear channel to ASCII representation

If you get the gear information of a different control unit as the Bosch ECU (e.g. a gearbox control unit), use the Gear Lookup Table to translate numeric values to ASCII format.

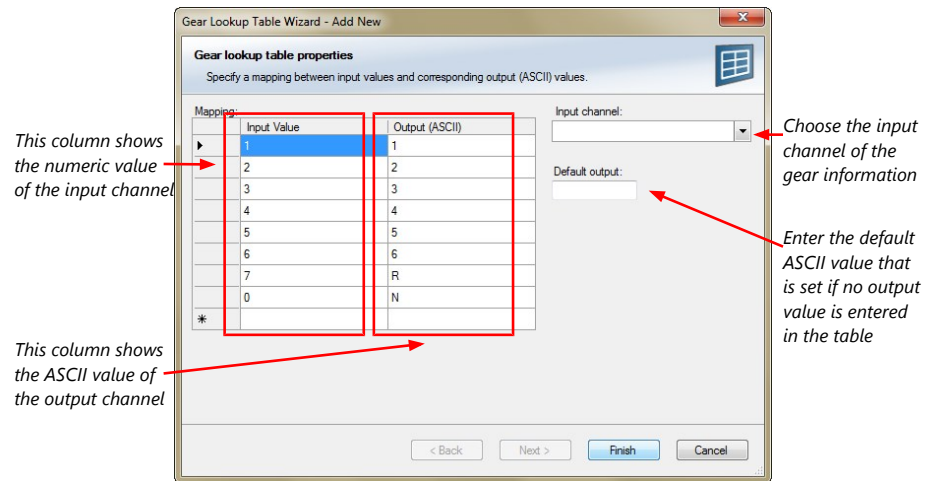
1. Click on the Measurement Sources button in the Toolbox.
2. Drag the 'Gear Lookup Table' symbol and drop it in the 'Computed Channels' folder.



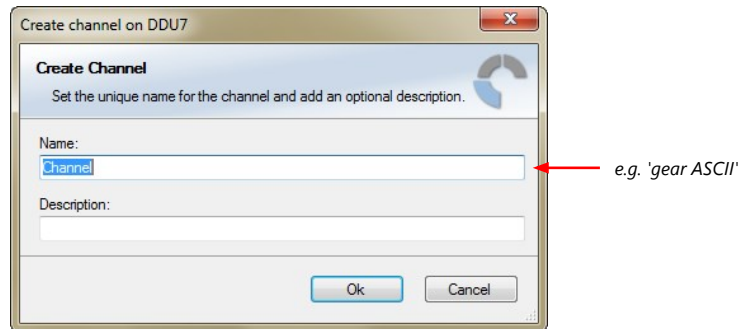
The Gear Lookup Table Wizard appears.

Gear Lookup Table Wizard

1. Set up the settings as shown in the screenshot.



- Click 'OK' when done.
The 'Create channel on DDU 9' window appears.
- Enter the name and an optional description of the translated ASCII measurement channel.

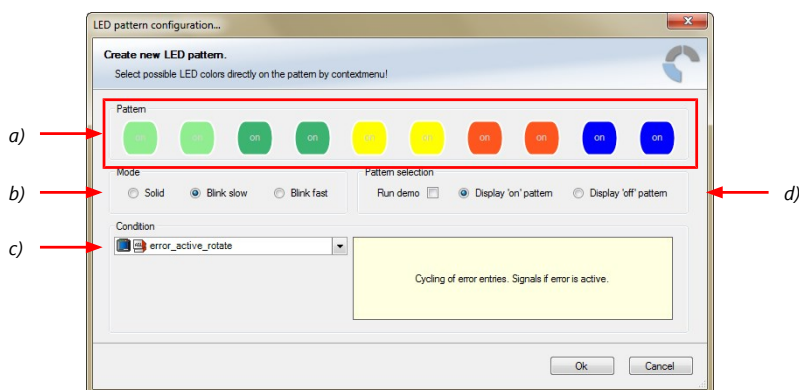


- Click 'Ok' when done.
A graphic shows the connection between the input and output channels. The measurement channel can now be used in the shift LED configuration.

8.3.3 Creating customized LED pattern

You can create your own LED pattern with an individually created condition. The LEDs flash if the condition becomes true.

- Click on the button 'Add pattern' in the display view. The LED pattern configuration window appears.



- a) Choose the number and color of the LEDs by right-clicking.
 b) Select if the LEDs blink or do not blink.
 c) Choose the condition when the LEDs will flash.
 - Create a condition using the Condition Creator. For more information see chapter "Creating a new condition channel".
 - Choose an existing condition.
 d) Check the box to show a demo of the LEDs. (Important to check blinking)
 To create a LED that alternately blinks in two different colors, choose 'Display "on" pattern' and define the LEDs in the one color. Then choose 'Display "off" pattern' and define the LEDs in the other color.

2. Click 'OK' when done.

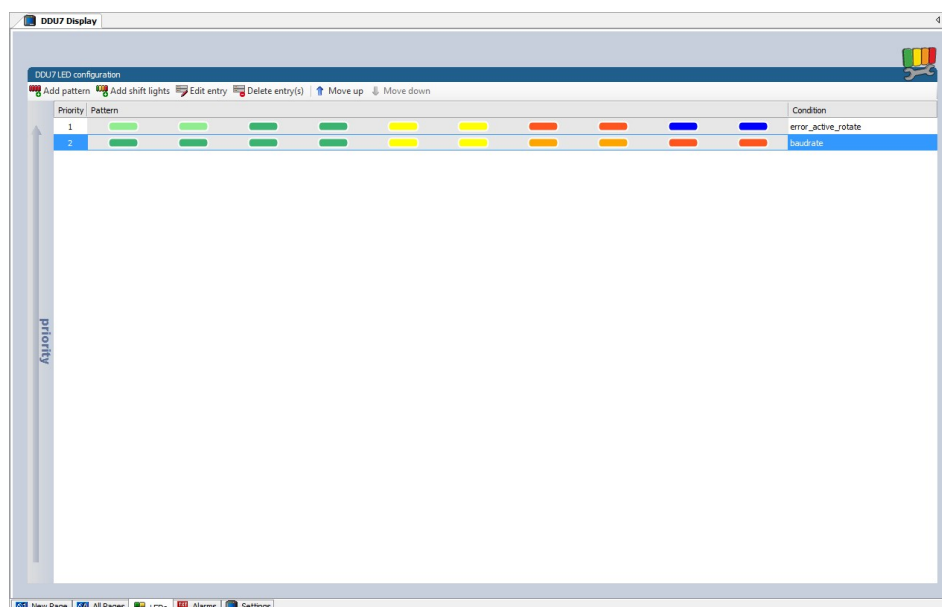
The configuration is displayed in the DDU 9 LED Configuration window.

8.3.4 Assigning display pattern priority

You can assign the priority of the created display pattern and shift lights.

The 1st display pattern is activated before all following pattern if its condition is 'true'. The 2nd display pattern is only activated if the condition of the 1st display pattern is 'false' or the LEDs of the 1st display pattern are transparent.

Change the priority by clicking the 'Move up' or 'Move down' button.

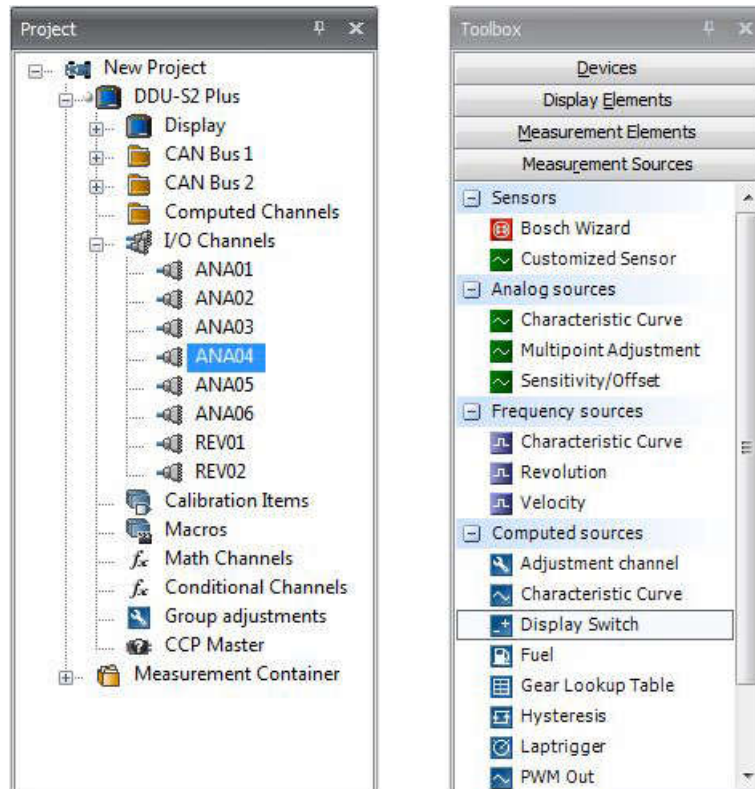


8.4 Page select

Any "event" can be used to change display brightness and/or page. This can be an input switch, a math channel etc..

8.4.1 Option 1: 12 position switch

1. Connect 12 position switch to one of analog input ANAxx and sensor GRD.
2. Select one of Analog input and then select Characteristic Curve.



3. Select "Pull-up value:" 3.01 kOhm and go Next.

Characteristic Curve Wizard - Add New

Pin Properties
Configure the analog pin properties.

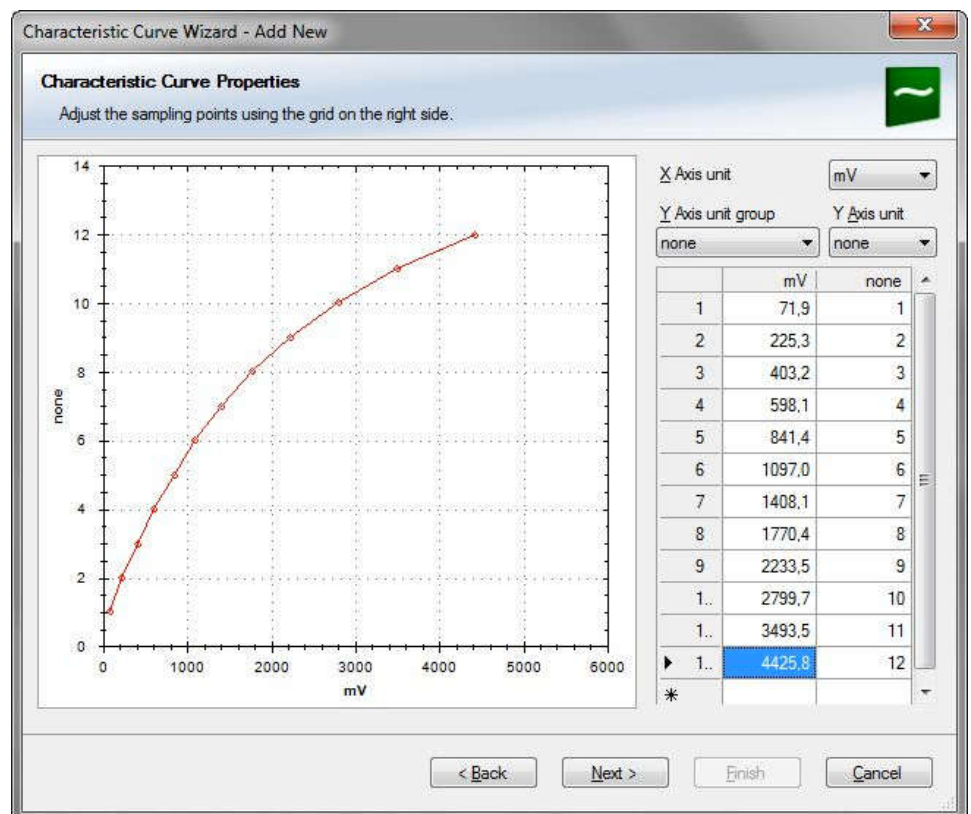
Pullup value: 3.01 kOhm

Pin Diagnosis & monitoring limits

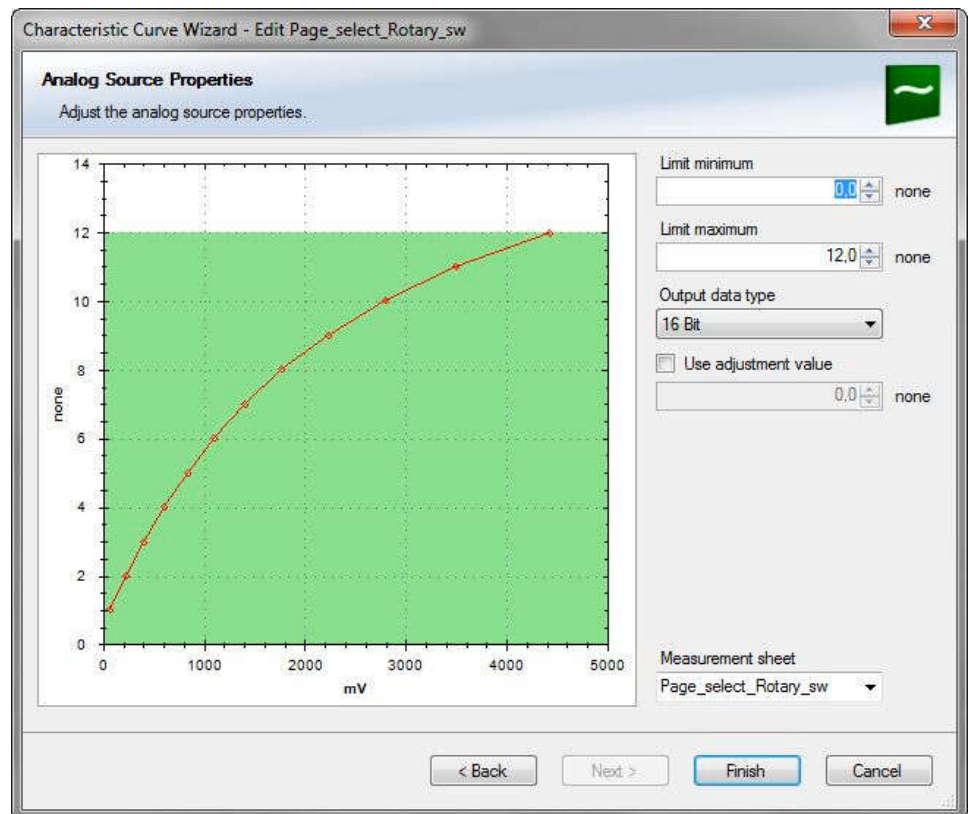
☐ Enabled Minimum: -5000 mV Maximum: 5000 mV

< Back Next > Finish Cancel

4. Input the relation between voltage and switch position and go 'Next'.
 Voltage = $5000 \times R / (R + 3010)$
 5000: Sensor supply (mV)
 R: Resister for each Rotary sw position (Ohm)
 3010: Pull-up resistor (Ohm)



5. Input minimum and maximum Limit.
 Select Output data type from 8, 16 or 32 Bit
 Do not check Use adjustment value.
 Input Measurement sheet and go 'Finish'.



6. Input Name and Description and go Ok.

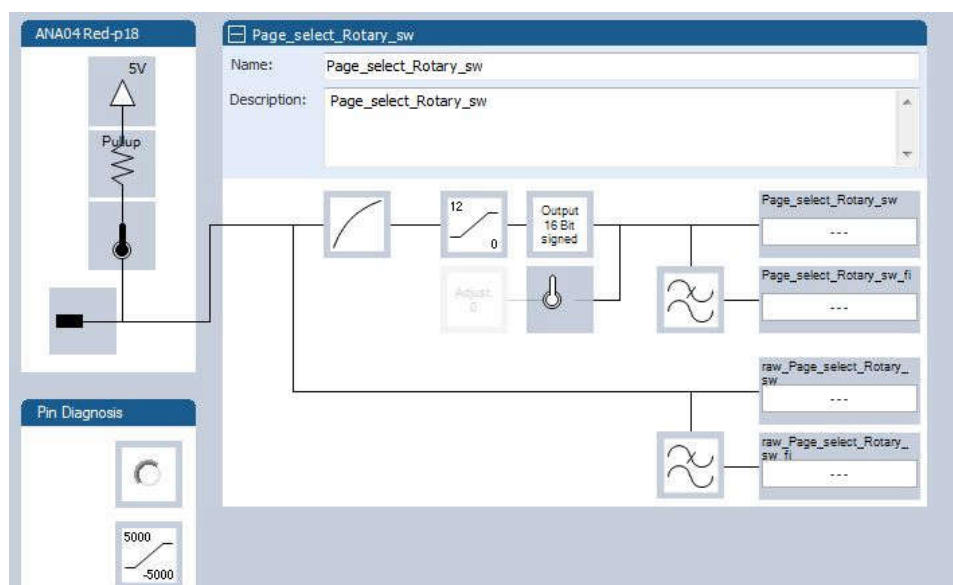
Create channel on DDU-S2 Plus

Create Channel
 Set the unique name for the channel and add an optional description.

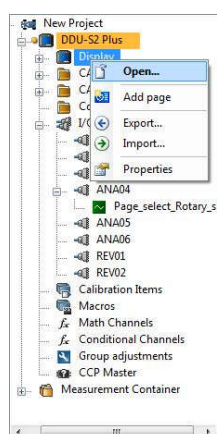
Name: Page_select_Rotary_sw

Description: Page_select_Rotary_sw

Buttons: Ok, Cancel



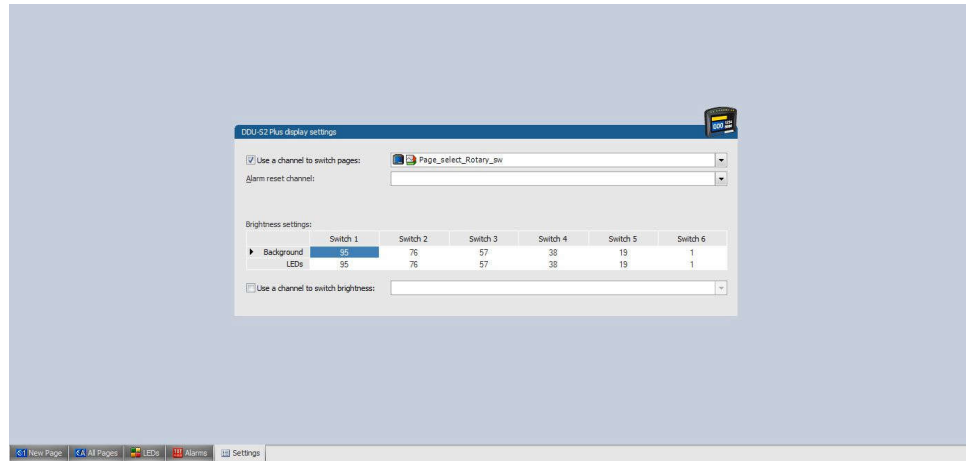
7. Select Display – Open.



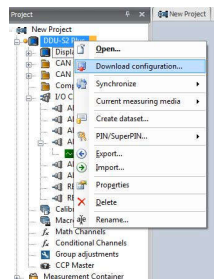
8. Select Setting.



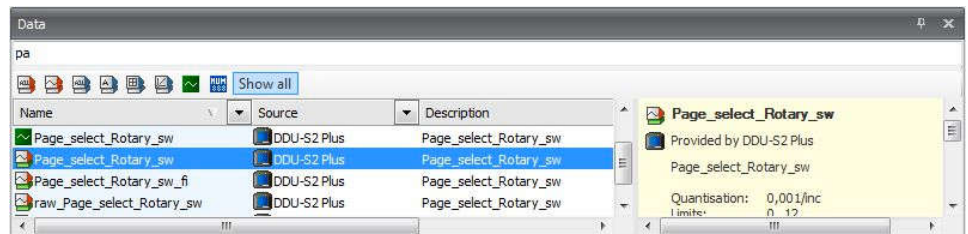
- Check "Use a channel to switch pages:" and select channel configured above.



- Select Download configuration.

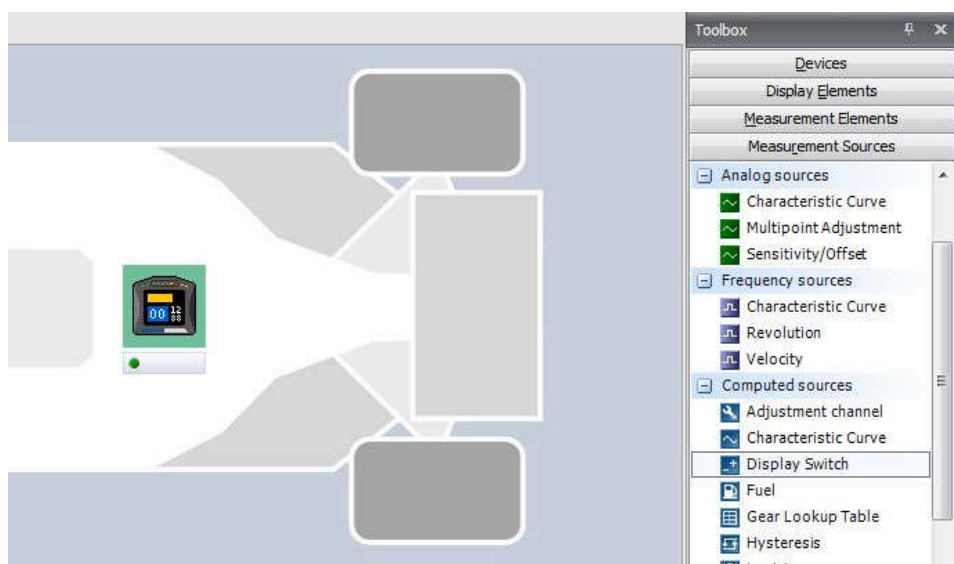


- Search configured channel and double click and then it shows Raw voltage and Page position.

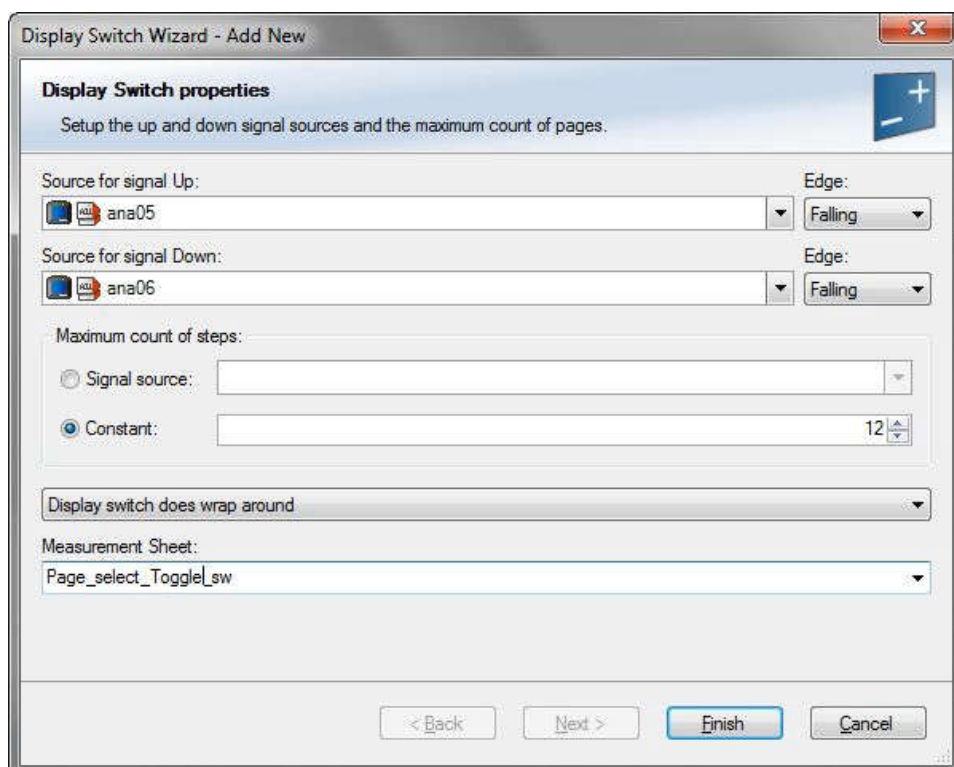


8.4.2 Option 2: Up/Down switches

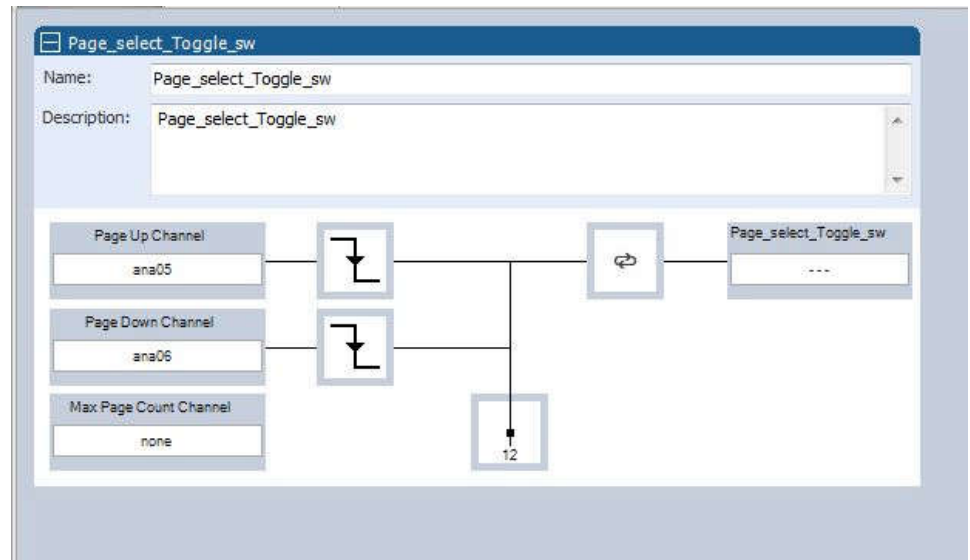
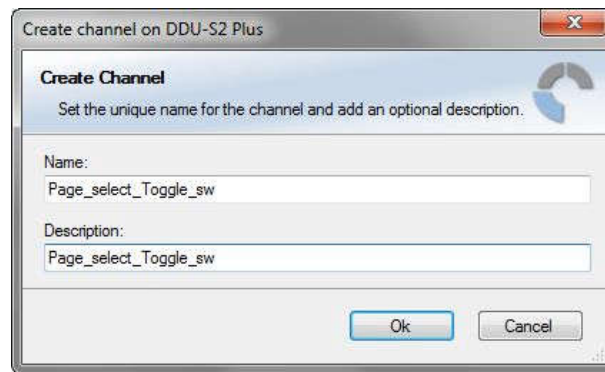
- Connect Up/Down switch to analog input ANAxx and sensor GRD.
- Select Display Switch and drag into DDU 9.



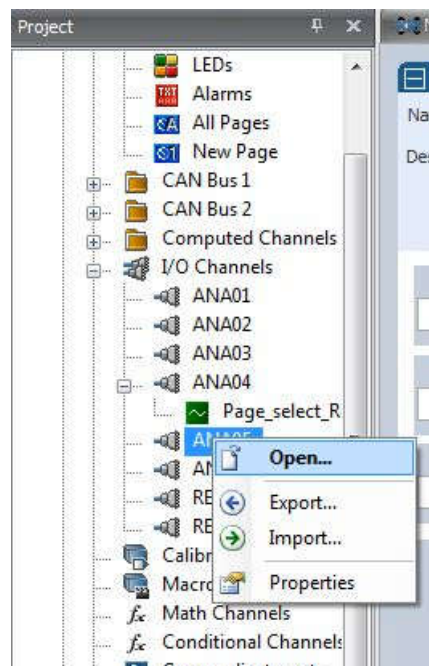
3. Select source for signal Up/Down and Edge Falling or Rising.
 Select Maximum count of steps from signal source or constant.
 Select Display switch does wrap around or Display switch does not wrap around.
 Display switch does wrap around goes Maximum position to Minimum position or the other way round by switching, and Display switch does not wrap around does not.
 Input measurement Sheet and go 'Finish'.

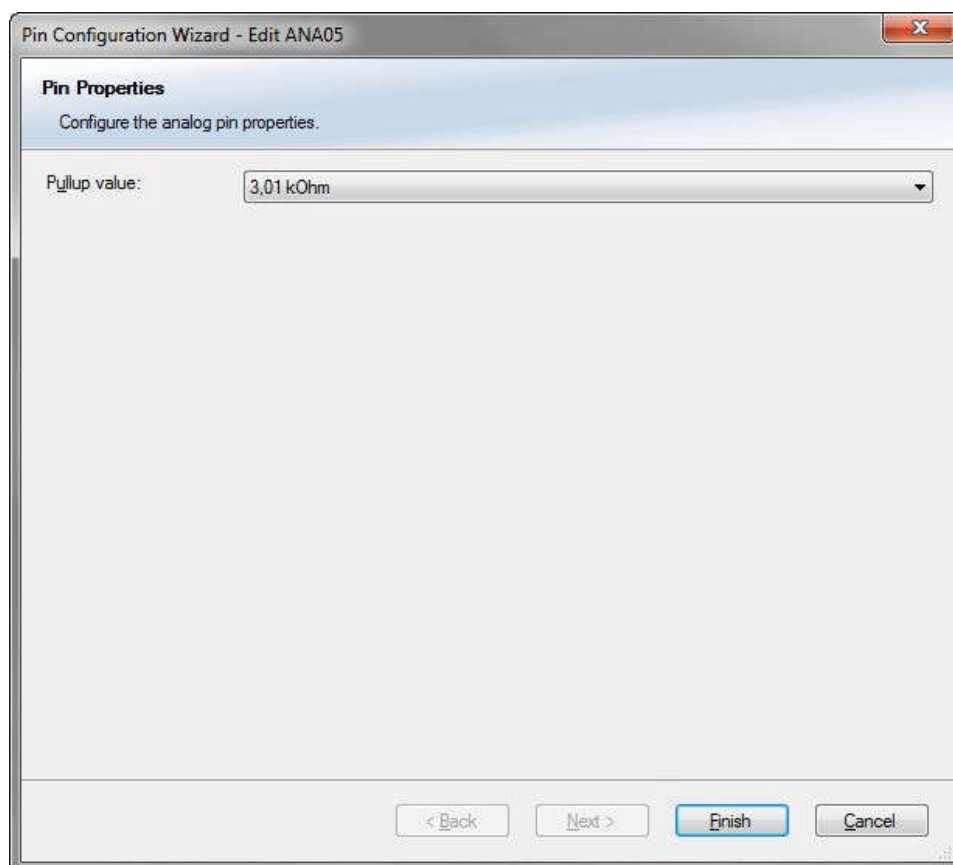


4. Input Name and Description and go 'Ok'.

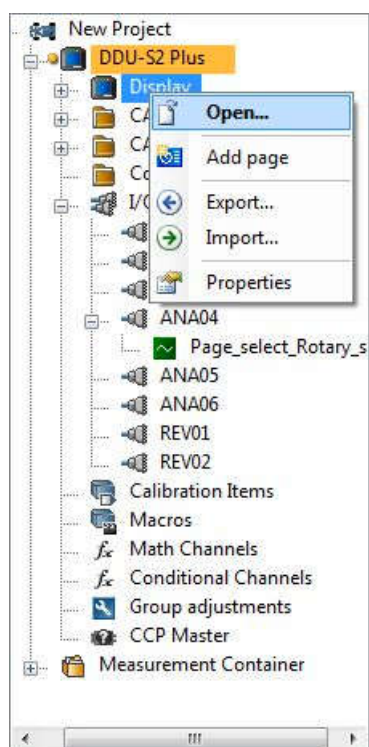


5. Open configured ANA channel and change pull-up value to 3.01 kOhm and go 'Finish'.

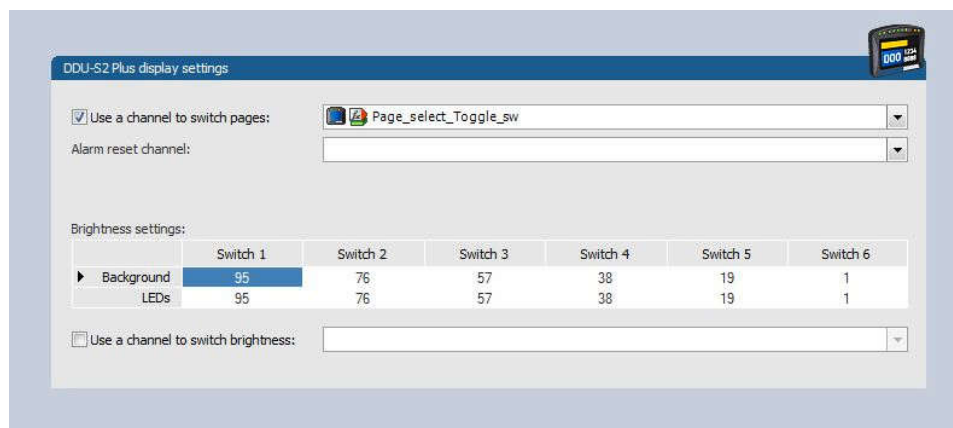




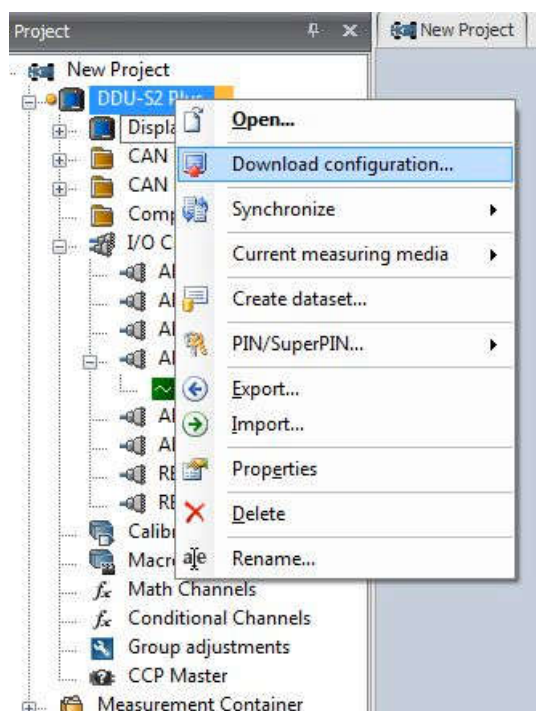
6. Select Display – Open.



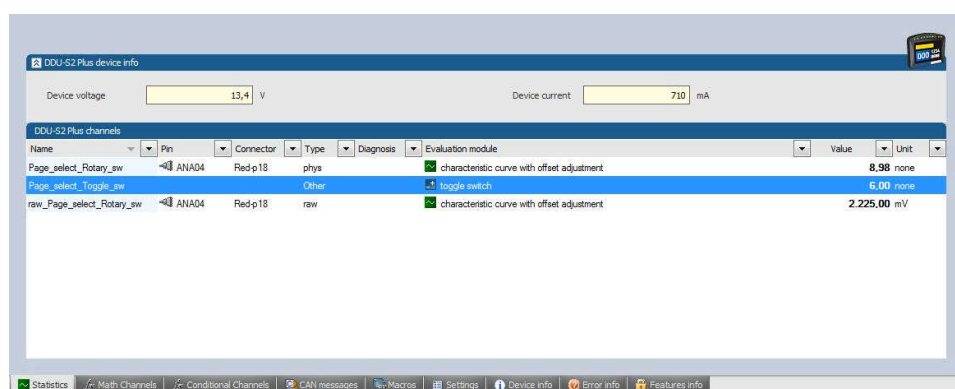
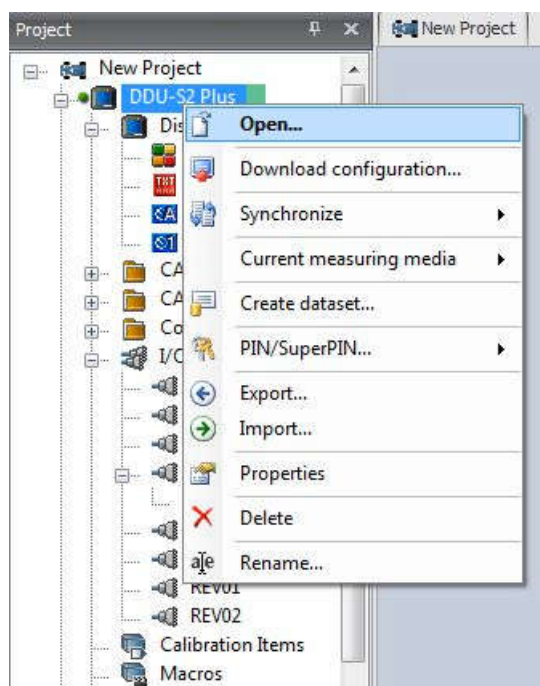
7. Check "Use a channel to switch pages:" and select channel configured above.



8. Select Download configuration.

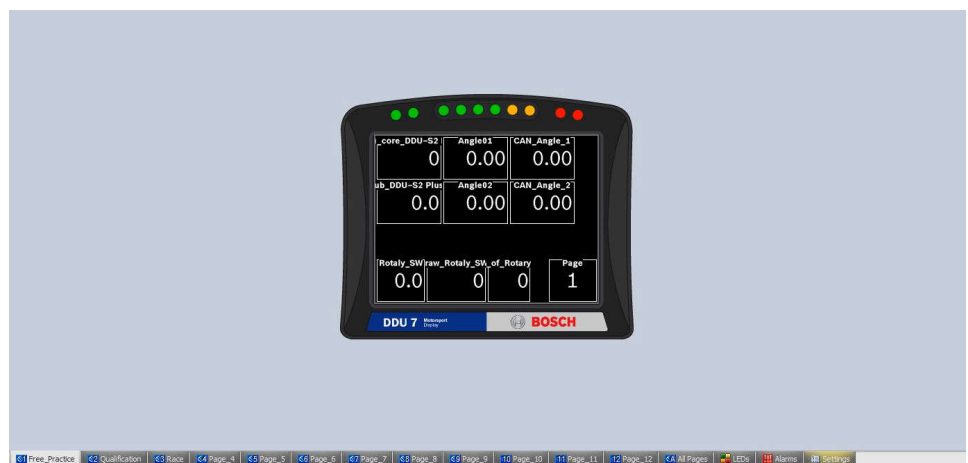
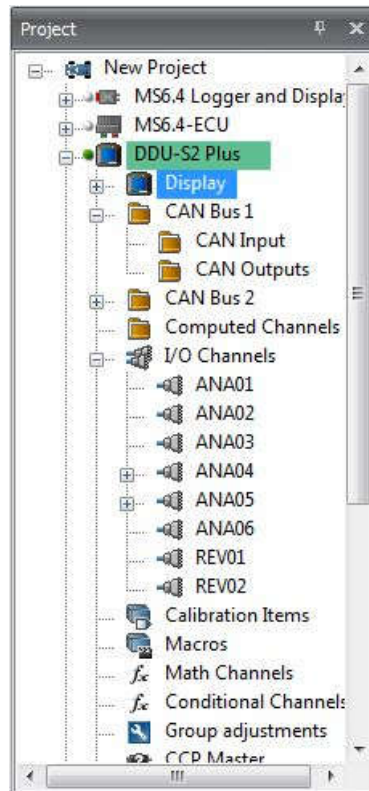


9. Open DDU 9 and go Statistics, configured channel position is shown.

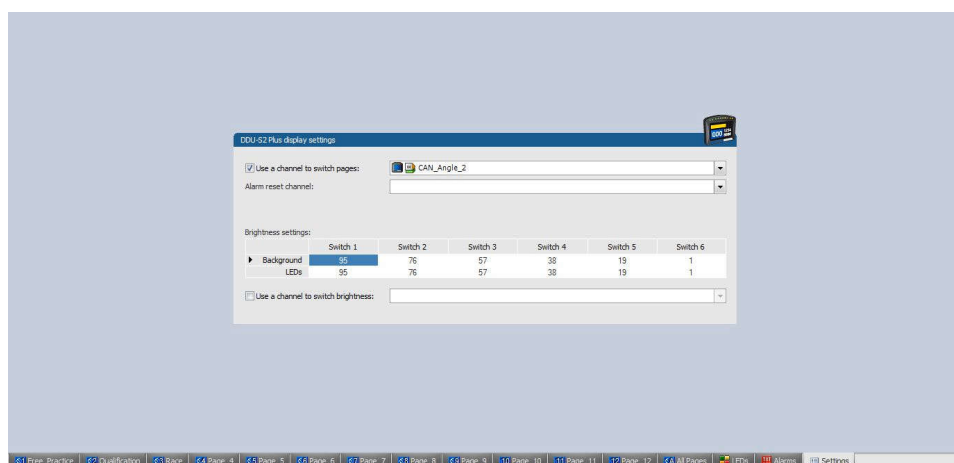


8.4.3 Option 3: CAN input signal, math channel or ANA_IN channel

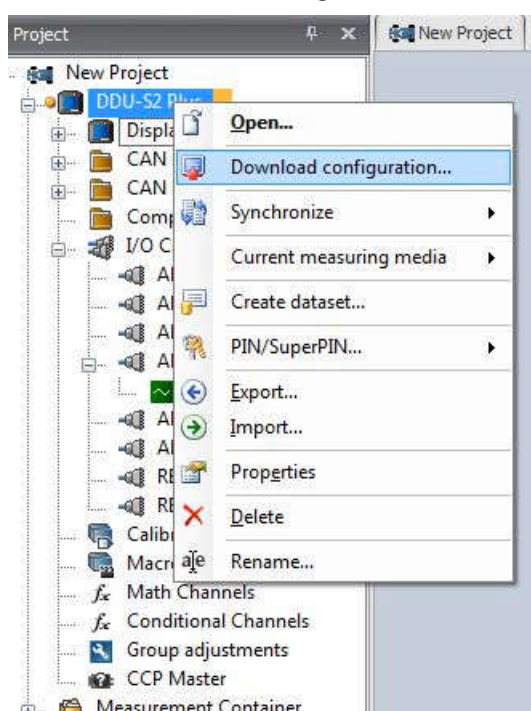
1. Select Display and Setting.



2. Check "Use a channel to switch pages:" and select CAN channel, math channel or ANA_IN channel.
The selected channel has to include value from 0.5 to 11.5.
Page 1 is shown with the value < 1.5
Page 2 is shown with $1.5 \leq \text{the value} < 2.5$
Page 3 is shown with $2.5 \leq \text{the value} < 3.5$
Page 12 is shown with $11.5 \leq \text{the value}$



3. Select Download configuration.

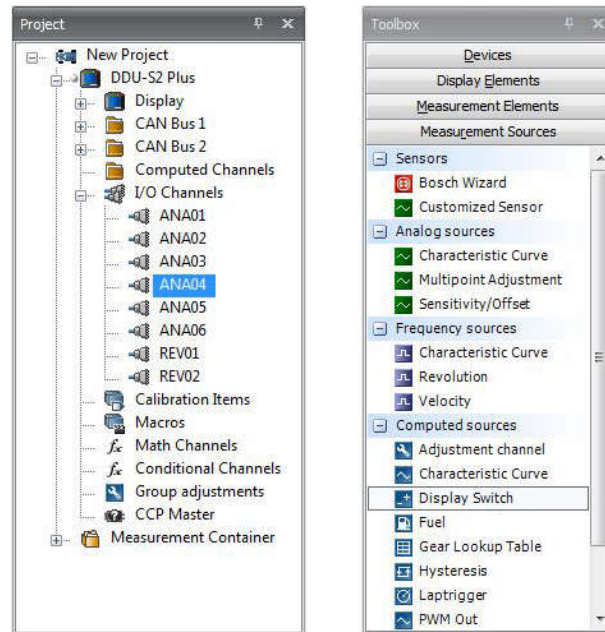


8.5 Display + LED brightness

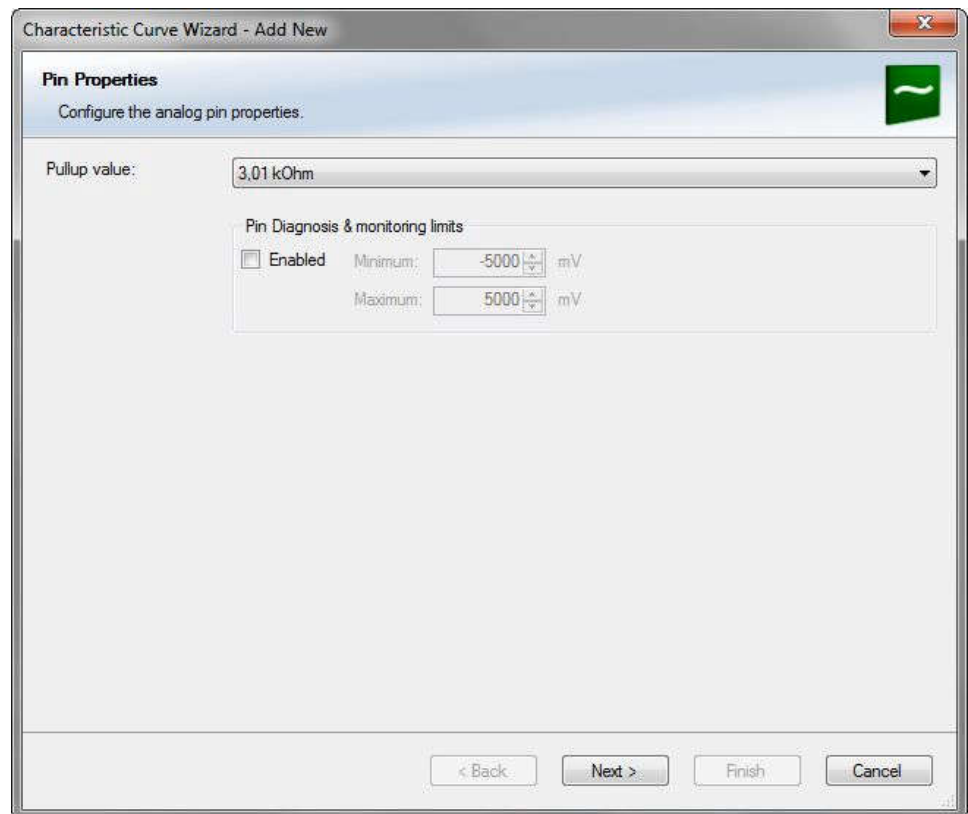
Any "event" can be used to change display brightness and/or page. This can be an input switch, a math channel etc..

8.5.1 Option 1: 6 position switch

1. Connect 6 position switch to one of Analog input ANAxx and Sensor GRD.
2. Select one of Analog input and then select Characteristic Curve.

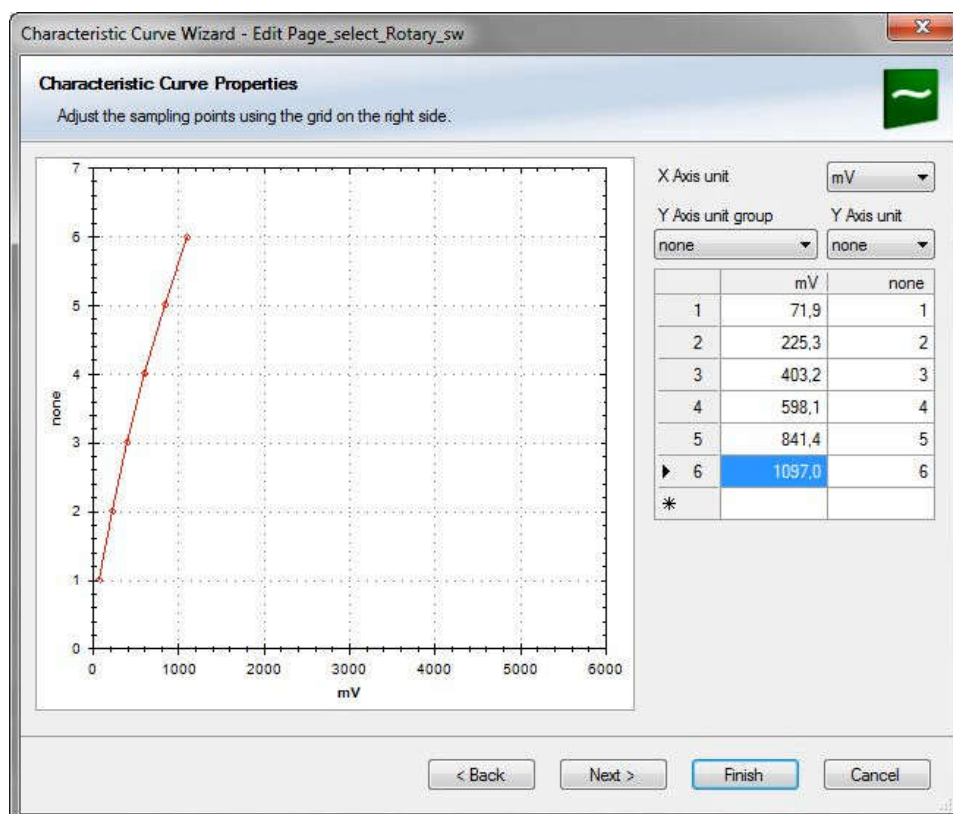


3. Select "Pullup value:" 3.01 kOhm and go Next.

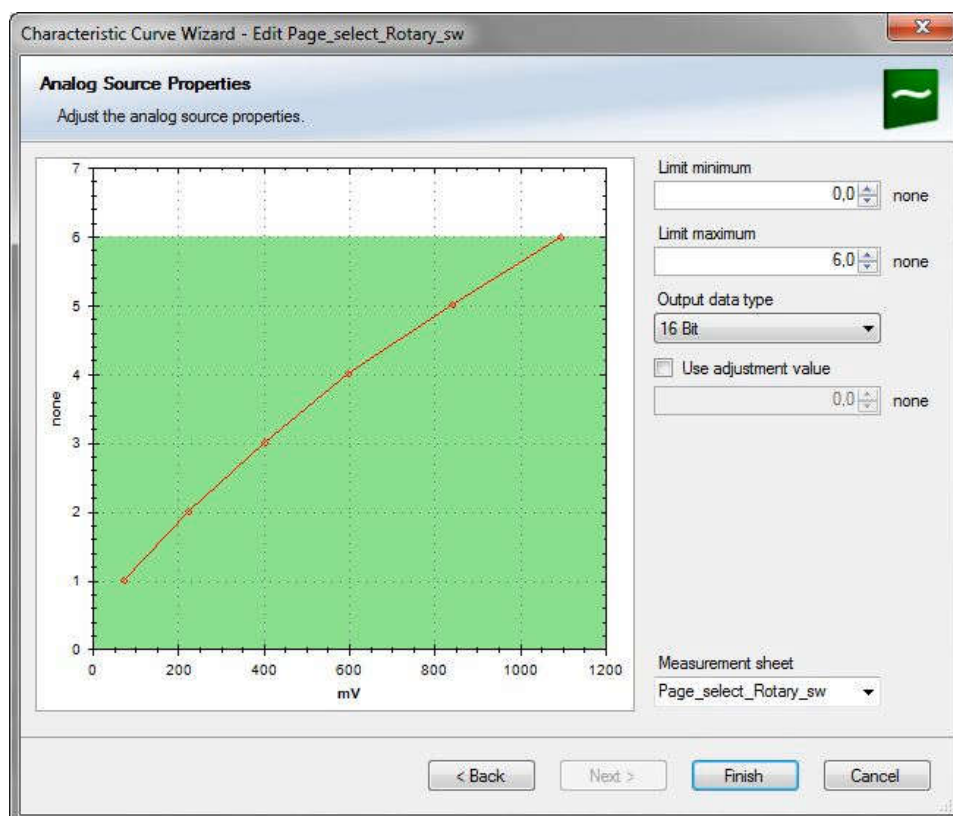


4. Input the relation between voltage and switch position and go Next.

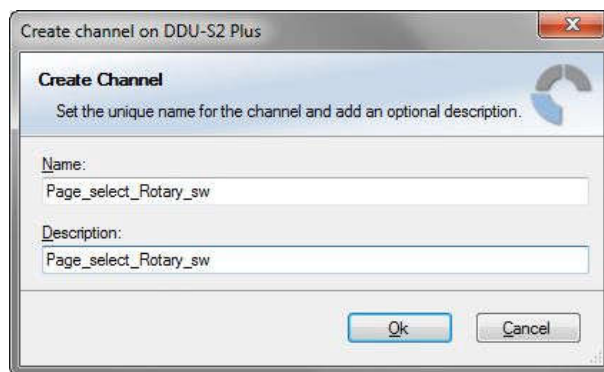
$$\text{Voltage} = 5000 \times R / (R + 3010)$$
 5000: Sensor supply (mV)
 R: Resister for each Rotary sw position (Ohm)
 3010: Pull-up resistor (Ohm)



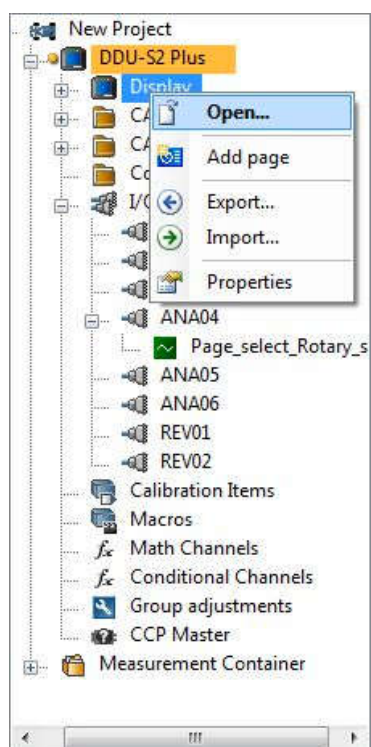
- Input minimum and maximum Limit.
Select Output data type from 8, 16 or 32 Bit.
Do not check Use adjustment value.
Input Measurement sheet and go Finish.



- Input Name and Description and go Ok.



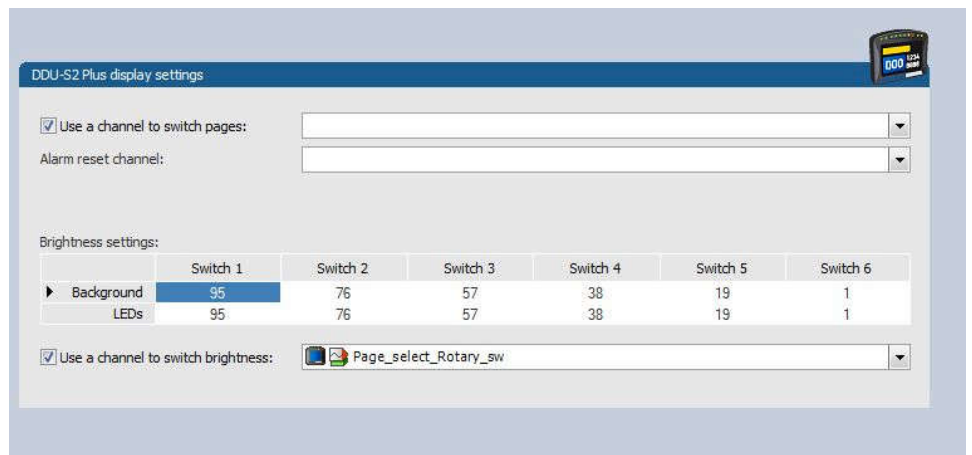
7. Select Display – Open.



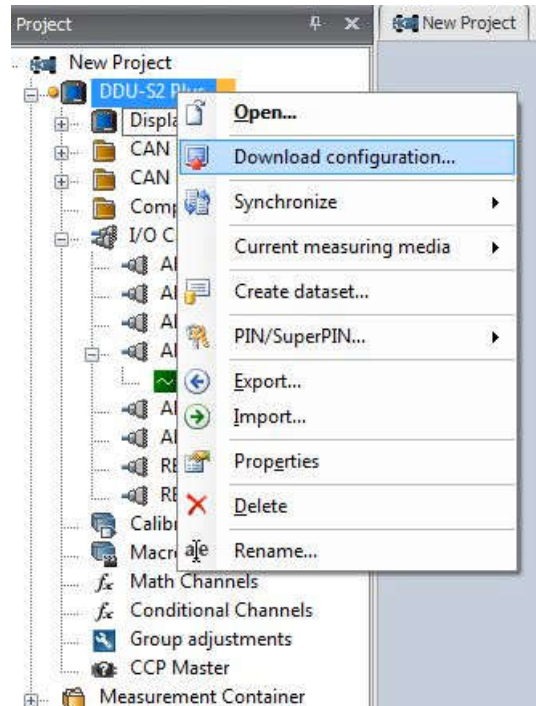
8. Select Setting.



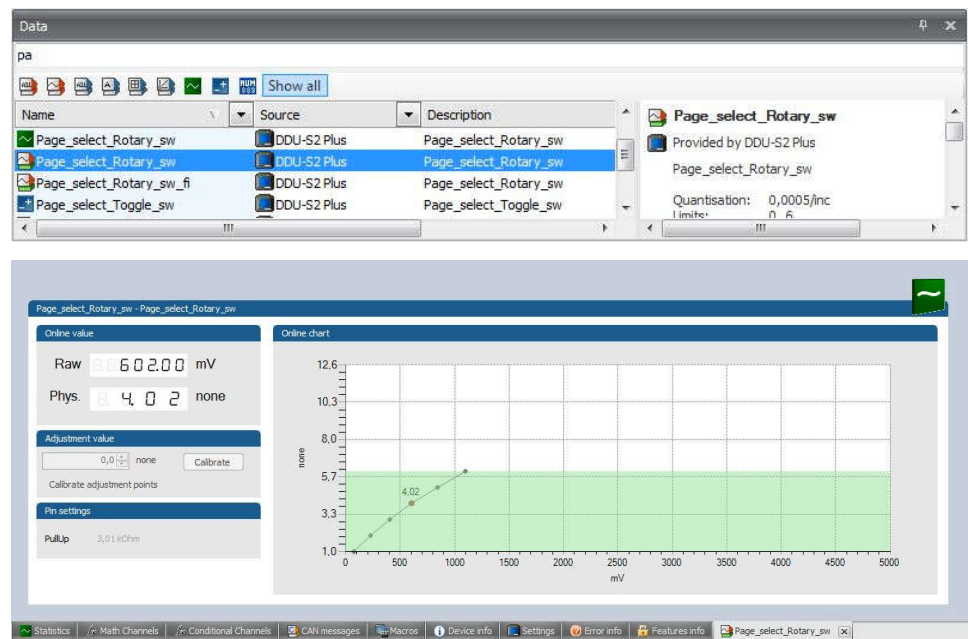
9. Check "Use a channel to switch brightness:" and select channel configured above.
Change value for background and LEDs for each switch position if it is needed.



10. Select Download configuration.

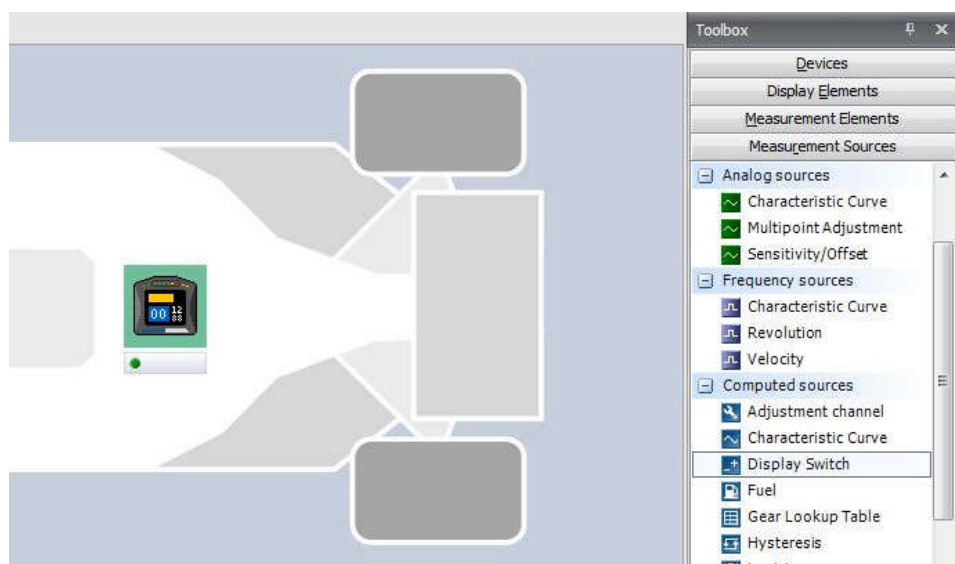


11. Search configured channel and double click and then it shows Raw voltage and switch position.

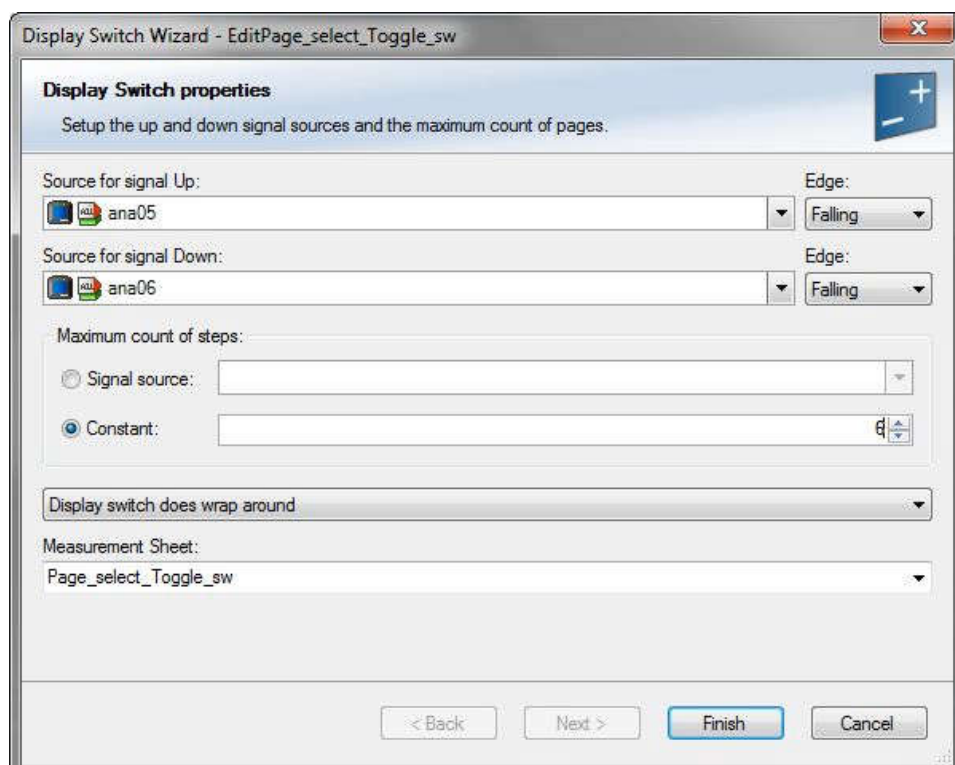


8.5.2 Option 2: Up/Down switches

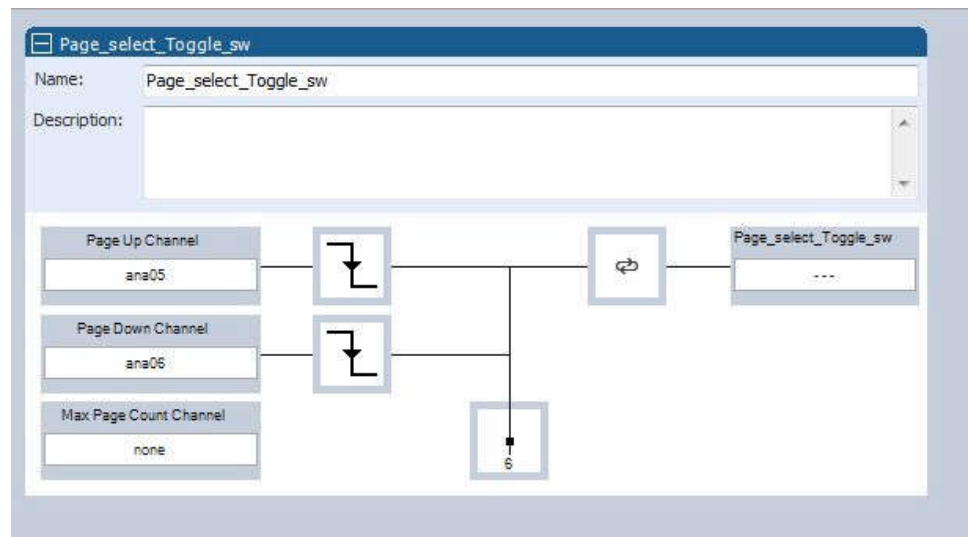
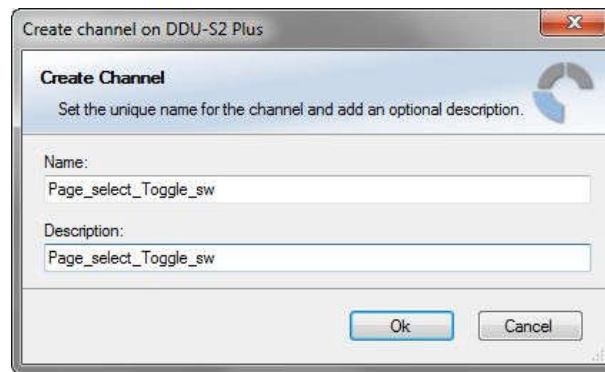
1. Connect Up/Down switch to Analog input ANAxx and Sensor GRD.
2. Select Display Switch and drag into DDU 9.



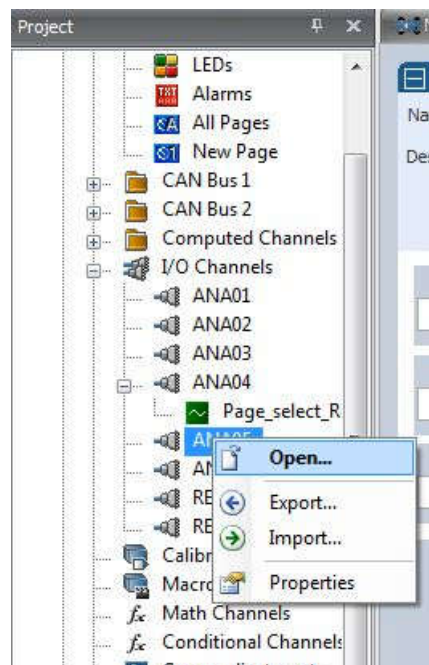
3. Select Source for Signal Up/Down and Edge Falling or Rising.
 Select Maximum count of steps from Signal source or Constant.
 Select Display switch does wrap around or Display switch does not wrap around.
 Display switch does wrap around goes Maximum position to Minimum position or the other way round by switching, and Display switch does not wrap around does not.
 Input measurement Sheet and go Finish.

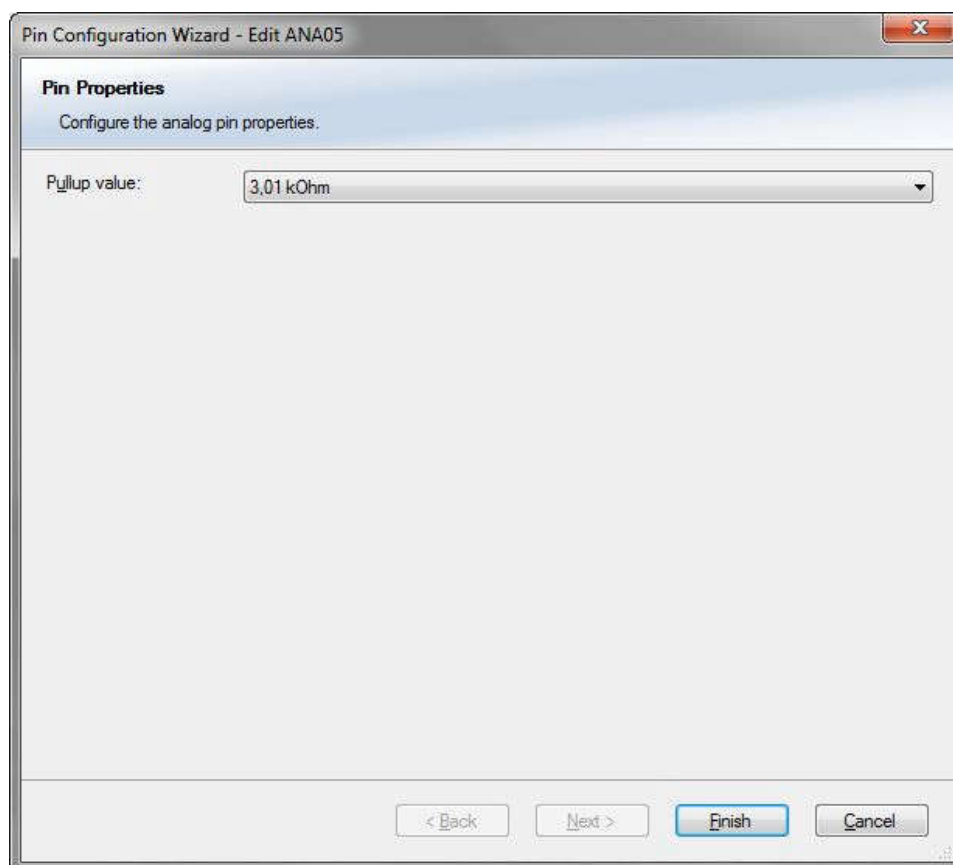


4. Input Name and Description and go Ok.

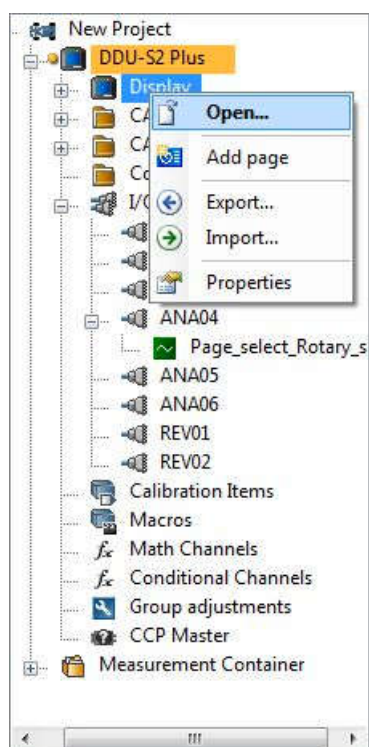


5. Open configured ANA channel and change pull-up value to 3.01 kOhm and go Finish.

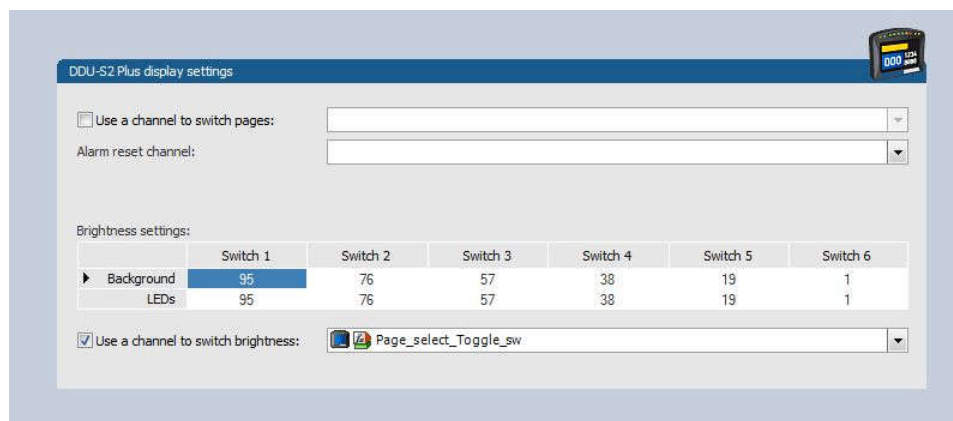




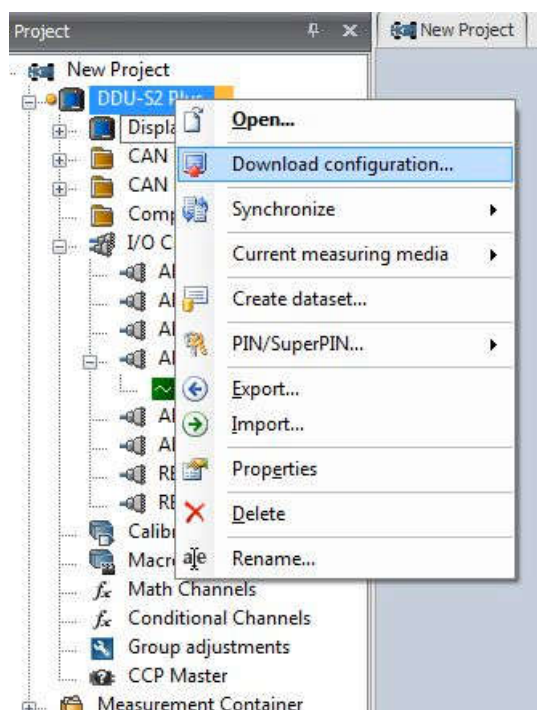
6. Select Display – Open.



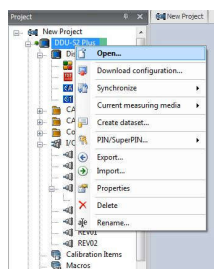
7. Check "Use a channel to switch brightness:" and select channel configured above.
Change value for Background and LEDs for each switch position if it is needed.

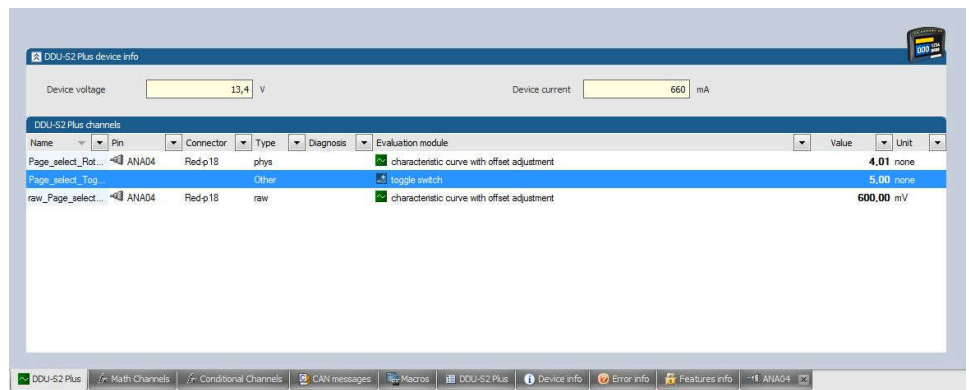


8. Select Download configuration.



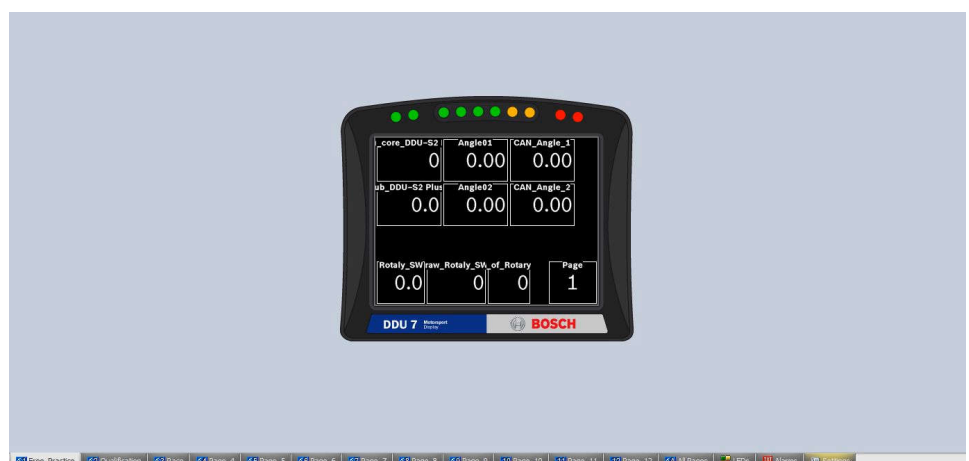
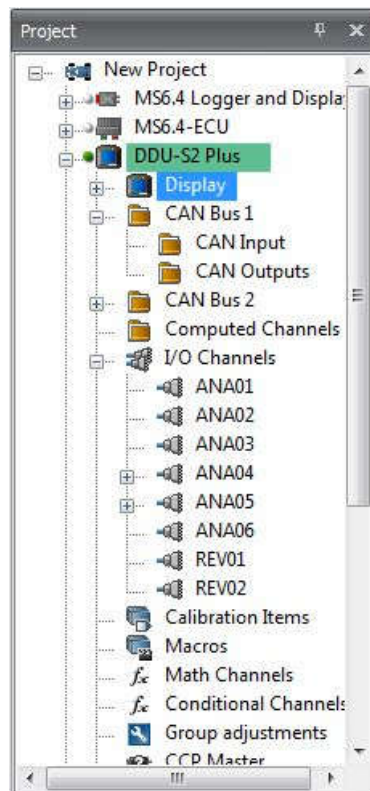
9. Open DDU 9 and go Statistics, Configured channel position is shown.





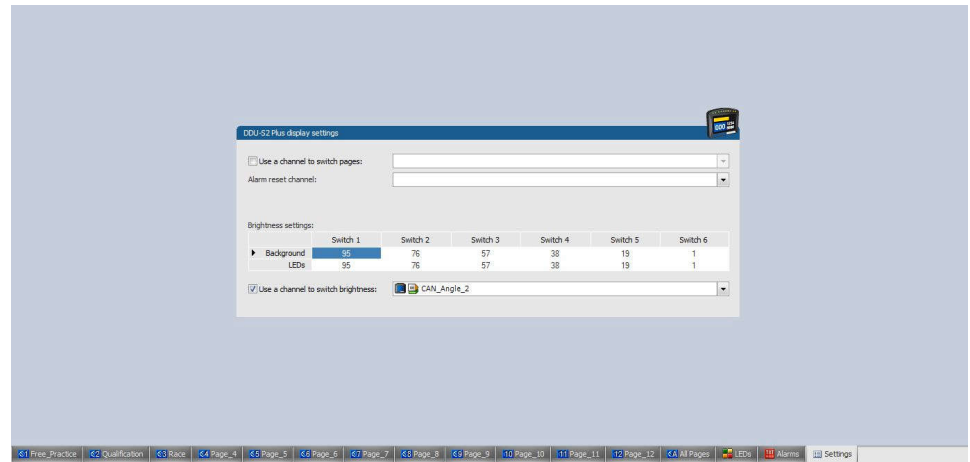
8.5.3 Option 3: CAN input signal, math channel or ANA_IN channel

Select Display and Setting.



Check "Use a channel to switch brightness:" and select CAN channel, Math channel or ANA_IN channel.

Change value for Background and LEDs for each switch position if it is needed.



The channel has to include value from 0.5 to 5.5.

Switch 1 is shown with the value <1.5

Switch 2 is shown with $1.5 < =$ the value <2.5

Switch 3 is shown with $2.5 < =$ the value <3.5

Switch 6 is shown with $5.5 < =$ the value

8.6 Math + condition channels

Math channel

- Arithmetic and logical operations on up to 4 measurement channel(s)
- Numerical result
- Result can be used as input source for various display elements (numeric elements, alarms, Bargraphs) and further calculations in the whole RaceCon project

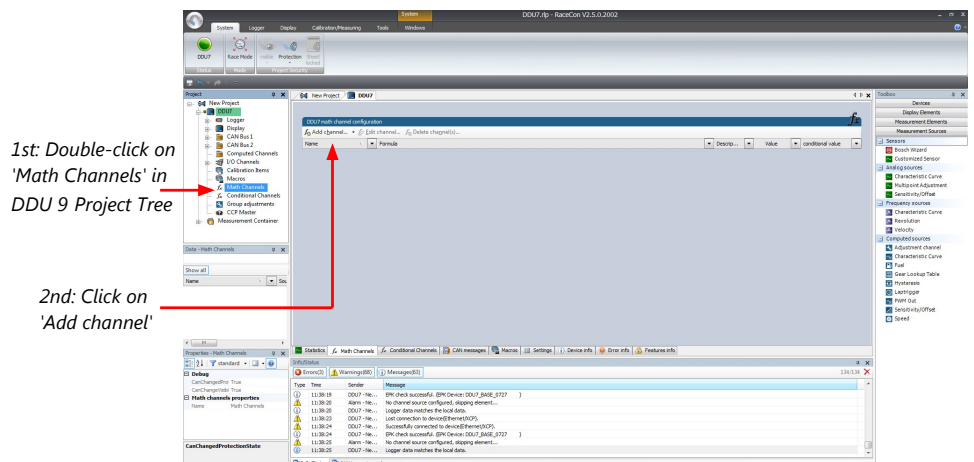
Conditional function

- Arithmetic and logical operations on one or more measurement channel(s)
- If-Else structure with reset
- Numerical result
- Result can be used as input source for various display elements (numeric elements, alarms, Bargraphs) and further calculations in the whole RaceCon project

All math channels can be used globally in the whole DDU 9 project.

8.6.1 Creating a new math channel

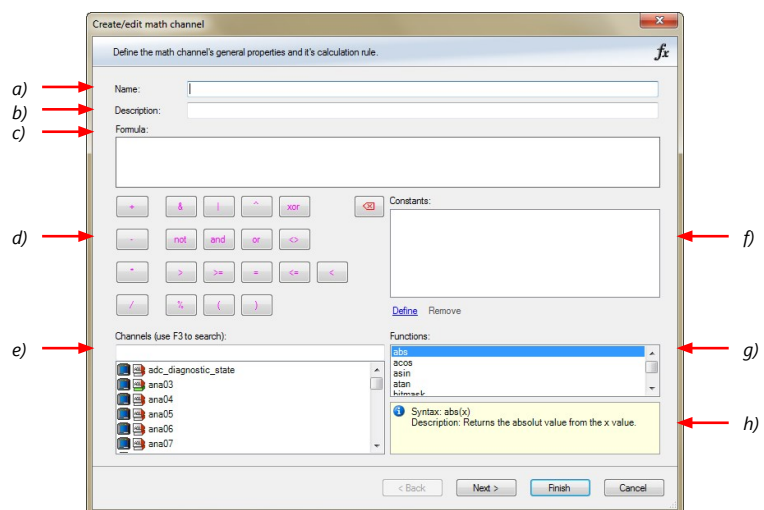
Follow the steps shown in the screenshot.



The 'create/edit math channel' window appears.

Create/Edit Math Channel Window

1. Define the math channel using the following configuration possibilities:



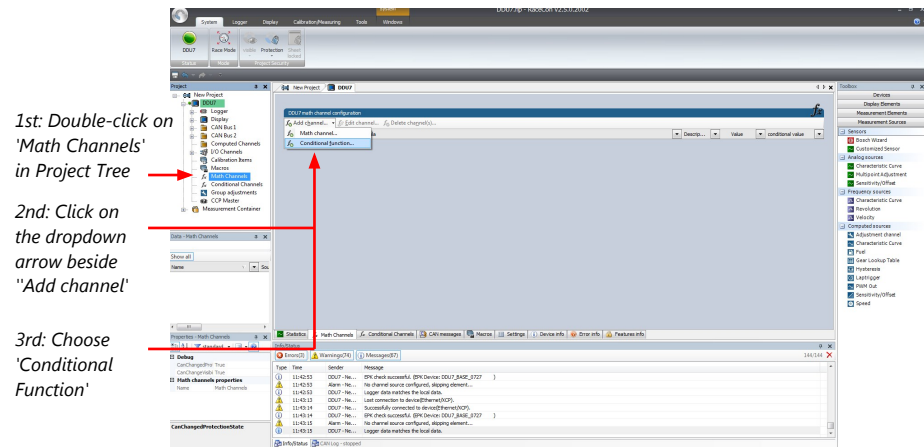
- Enter the name of the math channel.
- Enter a description of the math channel.
- Enter the formula.
- Select the logical operator.
- Choose a measurement channel.
- Define a value that can be used as a constant in the formula.
- Choose a function.
- Describes the function selected above.

2. Click 'Finish' when done.

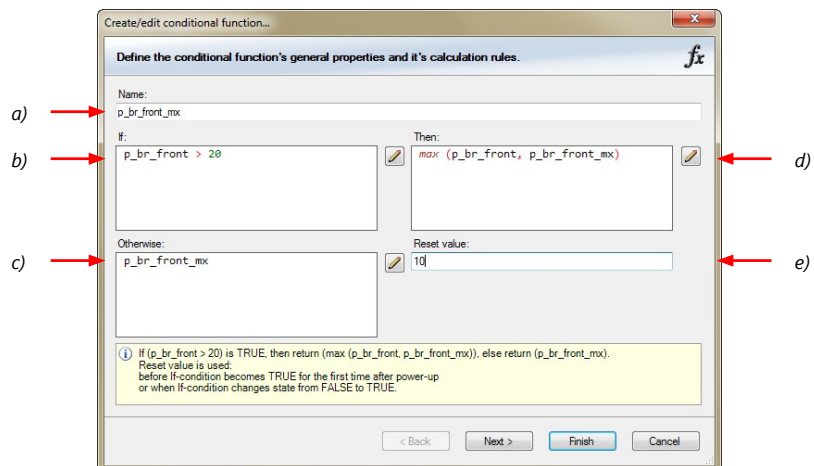
The math channel is displayed in the DDU 9 math channel window.

8.6.2 Creating a new conditional function

Follow the steps shown in the screenshot.



The 'Create/edit conditional function' window appears. Define the conditional function using the following configuration possibilities:



- a) Enter the name of the conditional function.
- b) Enter the If-condition. Click on the pencil symbol to open an editor to enter expressions.
- c) Enter the Then-condition. Click on the pencil symbol to open an editor to enter expressions.
- d) Enter the Otherwise-condition. Click on the pencil symbol to open an editor to enter expressions.
- e) Enter the reset value (must be a number).

Click 'Finish' when done.

The conditional function works the following way:

The program always calculates the condition entered in the IF window and checks if the condition is TRUE or FALSE.

If the condition entered in the IF window is TRUE, the program calculates the condition entered in the THEN window. The returned value is the content of the new variable (entered in 'Name').

If the condition entered in the IF window is FALSE, the program calculates the condition entered in the OTHERWISE window. The returned value is the content of the new variable (entered in 'Name').

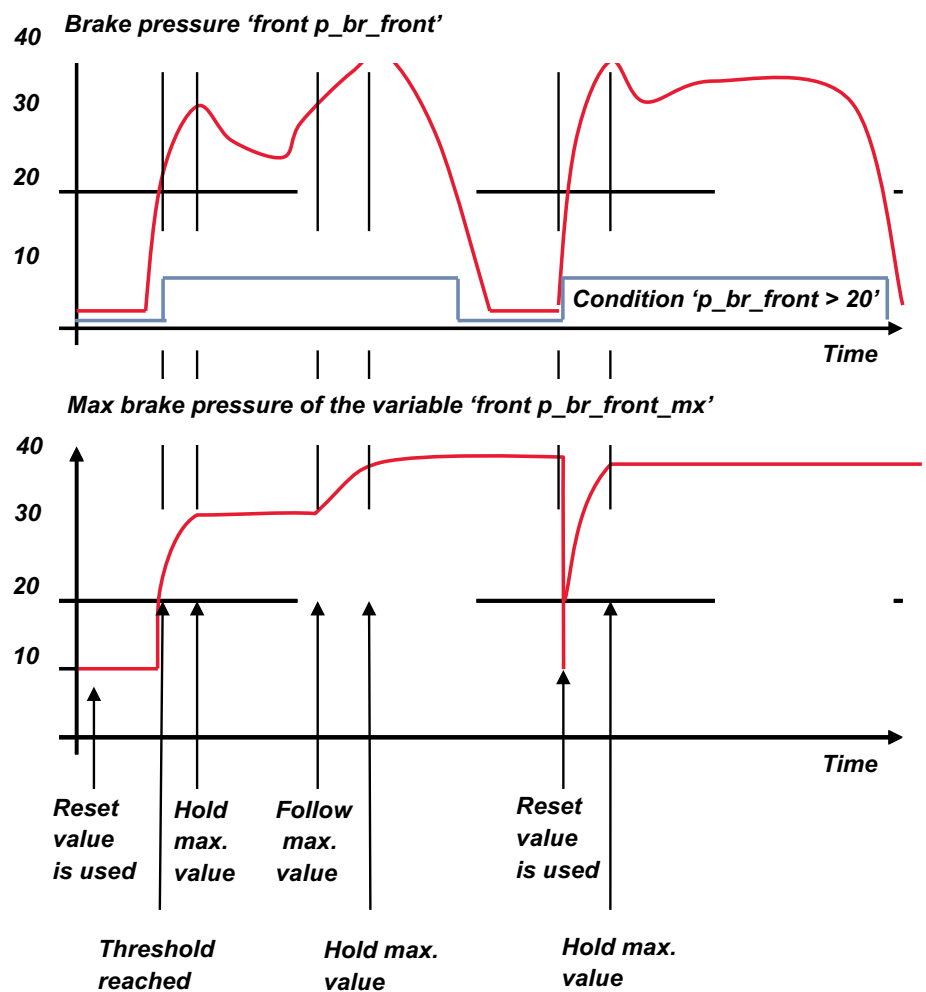
The reset value is always set for the new variable (entered in 'Name'):

- before If-condition becomes TRUE for the first time after power-up
- when If-condition changes state from FALSE to TRUE.

An example of a condition to set up the maximum front brake pressure is given on the next page.

The conditional function is displayed in the math channel window.

Example: Setting up a condition for maximum front brake pressure



- At power-up, the reset value (10) is used for 'p_br_front_mx'.
- 'p_br_front' rises to 30. As 'p_br_front' is > 20 (condition is TRUE), the condition 'max (p_br_front, p_br_front_mx)' in the THEN window is triggered. The condition sets the bigger value as new value for 'p_br_front_mx'. As 'p_br_front' (30) is bigger than 'p_br_front_mx' (10), the new value for 'p_br_front_mx' is set to 30.
- Although 'p_br_front' falls to 25, the value of 'p_br_front_mx' stays 30. This is caused by the THEN-condition, because p_br_front_mx' (30) is still bigger than p_br_front' (25).
- As 'p_br_front' rises to 40. As 'p_br_front' (40) is bigger than 'p_br_front_mx' (30), the new value for 'p_br_front_mx' is set to 40.
- As 'p_br_front' falls below 20, the IF-condition turns to FALSE. Now the OTHERWISE-condition is triggered. Because the condition 'p_br_front_mx' sets the value of 'p_br_front_mx' and the value that is already set to 40 before, nothing changes.
- When 'p_br_front' rises to 40, the IF-condition changes to TRUE again and triggers the THEN-condition. Now the reset value (10) is used for 'p_br_front_mx' in the THEN-condition.
- Because 40 is bigger than 10 the new value of 'p_br_front_mx' is 40.

8.7 Condition channels

Condition channel

- Logical operations on measurement channel(s)
- If-Else structure with reset
- Logical result
- Result can be used as input source for Alarm display elements and further calculations in the whole RaceCon project.

Condition combination

- Combination of several (up to 16) condition channels for more complex calculations
- Logical results

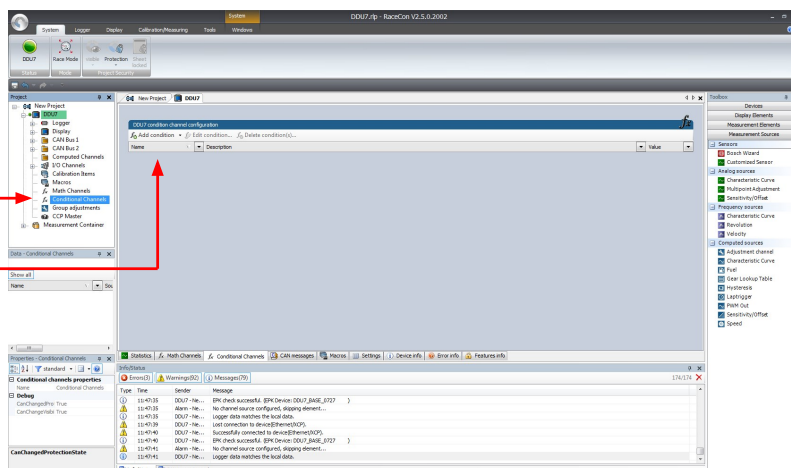
All conditions can be used globally in the whole DDU 9 project.

8.7.1 Creating a new condition channel

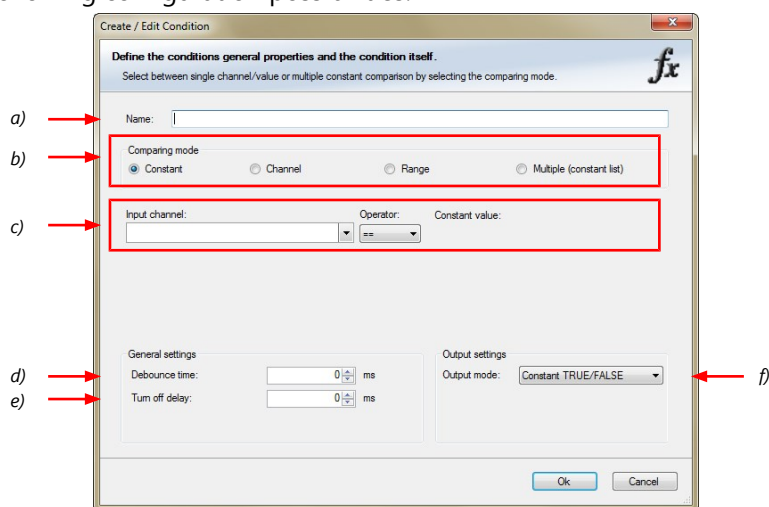
Follow the steps shown in the screenshot.

1st: Double-click on 'Conditional Channels' in Project Tree

2nd: Click on 'Add condition'



The 'Create/edit condition' window appears. Define the condition channel using the following configuration possibilities:



a) Enter the name of the conditional channel.

b) Select the comparing mode:

- Constant: Compare a measurement channel with a constant value.
- Channel: Compare a measurement channel with a measurement channel.
- Range: Compare a measurement channel with a defined value range.
- Multiple: Compare a measurement channel with up to 5 constant values.

c) Depending on the chosen comparing mode, you can enter the following values:

- Constant: Choose the measurement channel or condition, the operator and enter the value of the channel.
- Channel: Choose the measurement channel or condition, the operator and the measurement channel or condition to be compared.
- Range: Choose the measurement channel or condition, the operator and define the minimum and maximum value.
- Multiple: Choose the measurement channel or condition, the operator and enter the value of up to 5 constants.

d) Enter the minimal time to detect the signal of the measurement channel to avoid high-frequent switchovers.

e) Enter the time the signal of the measurement channel is delayed after its ending.

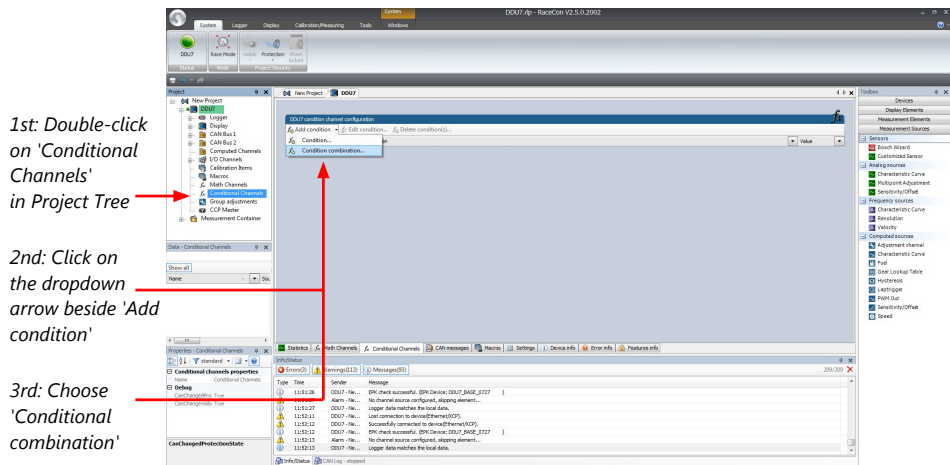
f) Choose the output setting of the result.

- Constant TRUE/FALSE: Result is as a constant with the value TRUE or FALSE.
- Blinking: Result is a blinking if the condition is fulfilled.
- Pulse: Result is a short one-time pulse if the condition is fulfilled.
- Toggling output: Result is a pulse that lasts until the next condition is fulfilled.

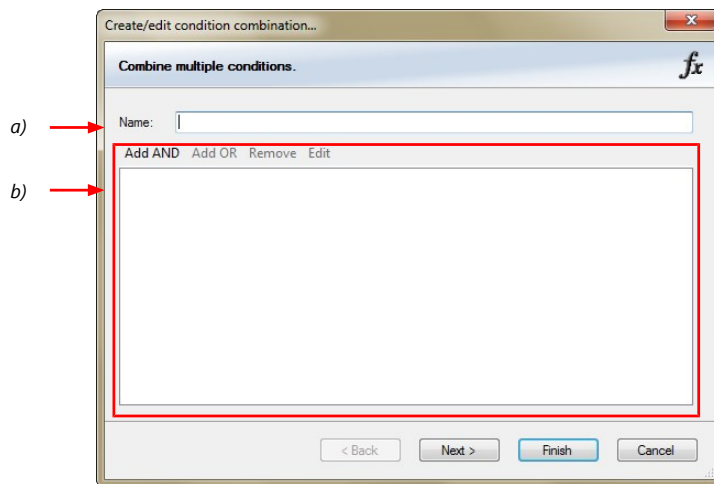
Click 'Ok' when done. The conditional channel is displayed in the condition channel window.

8.7.2 Creating a new condition combination

Follow the steps shown in the screenshot.



The 'Create/edit condition combination' window appears. Define the condition combination using the following configuration possibilities:



- a) Enter the name of the condition combination.
- b) Create the condition combination in the window.
 - Choose a channel (condition, conditional function, math, measurement channel with binary values) to be compared.
 - Combine multiple conditions by adding 'AND' or 'OR' relations.
 - To negate a condition, right-click on the condition and select 'Negation (!)'.
 - Combine several (up to 16) conditions.

Click 'Next' to go to the next page. Choose the output setting of the result:

- Constant TRUE/FALSE: Result is as a constant with the value TRUE or FALSE.
- Blinking: Result is a blinking if the condition is fulfilled.
- Pulse: Result is a short one-time pulse if the condition is fulfilled.
- Toggling output: Result is a pulse that lasts until the next condition is fulfilled.

Click 'Finish' when done. The conditional combination is displayed in the condition channel window.

8.8 CPU Load Limits

As all microprocessors, the DDU 9's processor has limited capacities. The current load of the processor can be monitored using the channel "cpu_load". When configuring your device, please make sure the used CPU load is in a save range below 100 %.

Bosch recommends a maximum CPU load of 85 % (averaged). Exceeding this limit might result in DDU 9 not being able to fulfill its required measuring/logging/display tasks or even in the DDU 9 crashing and rebooting.

Main factors influencing the CPU load are:

- Number and complexity of math channels
- Number and complexity of conditions
- CAN traffic on both CAN lines
- Display configuration, especially displaying pictures
- Logger configuration (total logging rate [kB/s], conditional measurement rates)

To help respecting the limit of 85 % CPU load, the DDU 9 creates an error memory entry. To trigger this error entry, the CPU load must exceed the limit for 5 minutes without interruption.

When being confronted with this error memory entry (see 'Error info' in RaceCon) or when being confronted with DDU 9 resets due to complex configuration set-ups, please consider reducing the demands on the DDU 9 adapting the influencing factors mentioned above.

9 CAN Bus

DDU 9 has two fully configurable CAN buses.

- Baudrate (125 kBaud ... 1 MBaud)
- 11 Bit or 29 Bit identifiers
- Input configuration: Read messages from CAN bus and convert to DDU 9 measurement/display variables. CAN bus supports row counter configuration.
- Output configuration: Write DDU 9 measurement variables to CAN messages, output frequency and row counter are configurable, CAN gateway functionality (transfer from one bus to the other).

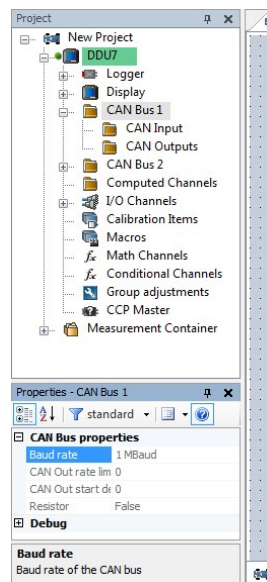
9.1 CAN bus trivia

CAN message

- 11 Bit (standard) or 29 Bit (extended) identifier
- Up to 8 bytes of data payload

CAN bus

- Needs termination resistors (120 Ohm) in wiring harness
- All devices connected to the bus must use identical data rate
- Configuration of bus data rate in 'Properties' menu by double click on the CAN bus in project tree (1 MBaud, 500 kBaud, 250 kBaud, 125 kBaud).



Row counter concept

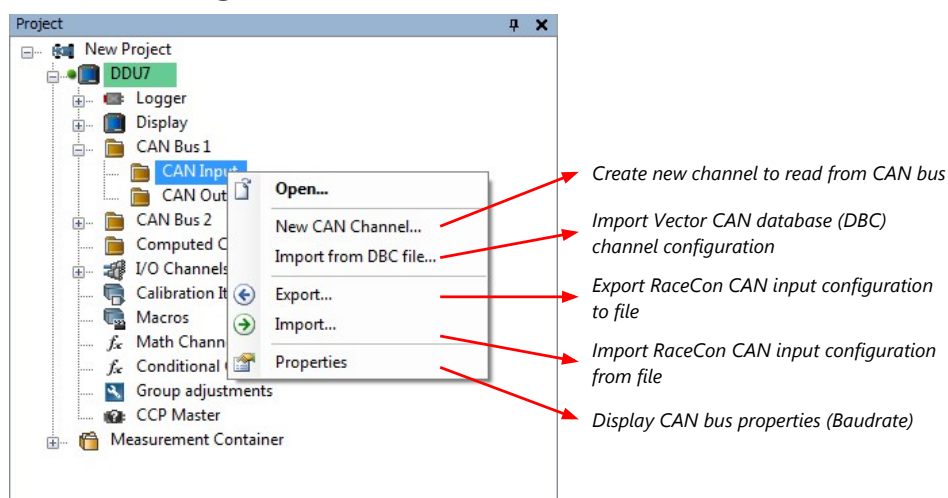
- Re-use (multiplex) of message identifiers
- One byte of message contains row counter
- 7 bytes payload remaining
- Position of row counter is configurable

	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x100	0	p_oil		t_oil				
0x100	1	s_dam_fl		s_dam_fr				
0x100	2	s_dam_rl		s_dam_rr				

Message Id **Row Counter** **Payload Area**

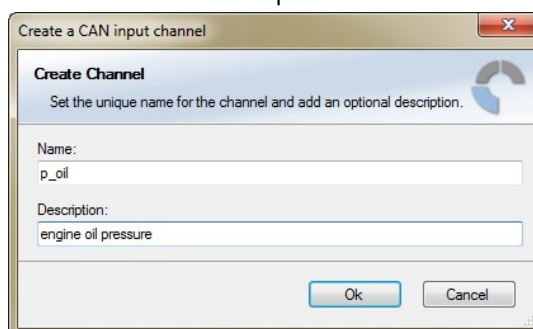
9.2 CAN input

9.2.1 Input configuration



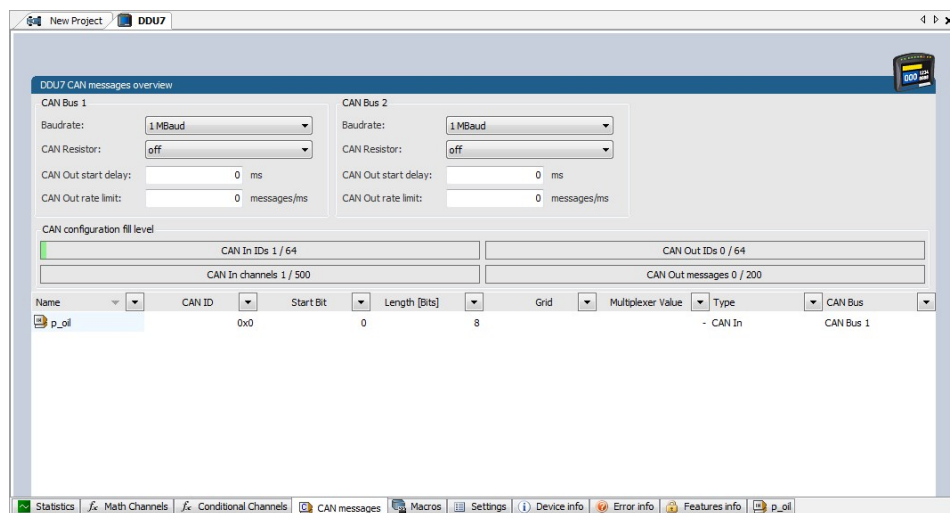
9.2.2 Create new CAN channel

1. Right-click on CAN Input of desired bus (CAN1, CAN2 or CAN3).
2. Select 'New CAN Channel' from menu.
3. Insert name and description of channel.

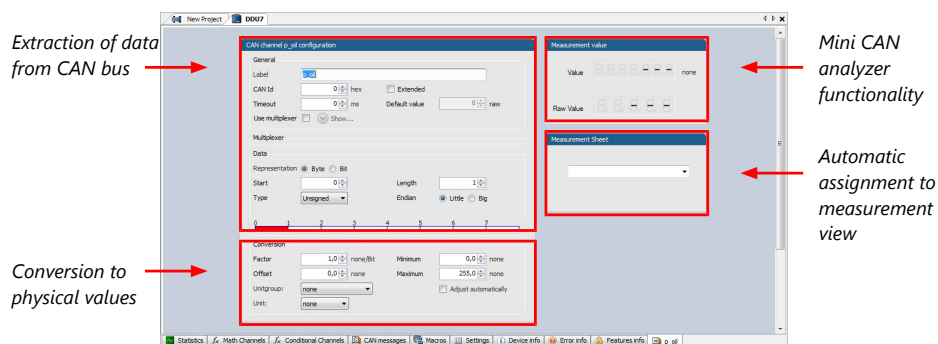


4. Click 'OK' when done.

The channel is listed in the Data window and a CAN channel configuration window opens.



9.2.3 CAN channel configuration



9.2.4 Extracting data from CAN bus

Representation: Byte

Some CAN devices need to be addressed by a byte represented CAN channel. The address can be assigned in this window and is illustrated by a bargraph.

CAN channel p_oil configuration

General

Label: p_oil

CAN Id: 0 hex ☐ Extended

Timeout: 0 ms Default value: 0 raw

Use multiplexer: ☒ Hide... Multiplexer value: 0

Multiplexer

Representation: ☒ Byte ☐ Bit

Start: 0 Length: 1

Type: Unsigned Endian: ☒ Little ☐ Big

Data

Representation: ☒ Byte ☐ Bit

Start: 0 Length: 1

Type: Unsigned Endian: ☒ Little ☐ Big

Conversion

Factor: 1,0 none/Bit Minimum: 0,0 none

Offset: 0,0 none Maximum: 255,0 none

Unitgroup: none ☐ Adjust automatically

Unit: none

Bargraph: 0 1 2 3 4 5 6 7

- a) Enter the name of the CAN-channel.
- b) Enter CAN message ID. Check the box, if extended IDs (29 bit) are used.
- c) If replacement values are used, specify time-out period and raw value.
- d) Check the box, if a multiplexer (row counter) is used.
- e) Enter data position, length and format.
- f) The bargraph shows assignment of the bytes.
- Red colored fields show the assignment of the data bytes.
 - Orange colored fields show the assignment of the multiplexer bytes.

Representation: Bit

Some CAN devices need to be addressed by a bit represented CAN channel. The address can be assigned in this window and is illustrated by a matrix table.

CAN channel p_oil configuration

General

Label: p_oil

CAN Id: 0 hex ☐ Extended

Timeout: 0 ms Default value: 0 raw

Use multiplexer: ☒ Hide... Multiplexer value: 0

Multiplexer

Representation: ☐ Byte ☒ Bit

Start: 0 Length: 7

Type: Unsigned Endian: ☒ Little ☐ Big

Data

Representation: ☐ Byte ☒ Bit

Start: 25 Length: 7

Type: Unsigned Endian: ☒ Little ☐ Big

Hide image...

	7	6	5	4	3	2	1	0
0	msb							lsb
1								
2								
3	msb							lsb
4								
5								
6								
7								

Conversion

Factor: 1,0 none/Bit Minimum: 0,0 none

Offset: 0,0 none Maximum: 255,0 none

Unitgroup: none ☐ Adjust automatically

Unit: none

- a) Enter name of the CAN-channel.
- b) Enter CAN message ID. Check the box, if extended IDs (29 bit) are used.
- c) If replacement values are used, specify time-out period and raw value.
- d) Check the box, if a multiplexer (row counter) is used.
- e) Enter data position, length and format.
- f) The matrix table shows the assignment of the bits.
 - Red colored fields show the assignment of the data bits.
 - Orange colored fields show the assignment of the multiplexer bits.

9.2.5 Conversion to physical values

Conversion

Factor: 1,0 bar/Bit Minimum: 0,0 bar

Offset: 0,0 bar Maximum: 255,0 bar

Unitgroup: pressure ☐ Adjust automatically

Unit: bar

- a) Enter factor (gain) for conversion to physical value.
- b) Enter offset for conversion to physical value.
- c) Select type of physical value.
- d) Select unit of physical value.
- e) Enter minimum physical limit of the channel. (for manual setup)
- f) Enter maximum physical limit of the channel. (for manual setup)
- g) Check the box to automatically adjust the limits of the channel.

9.2.6 Special features

CAN analyzer functionality

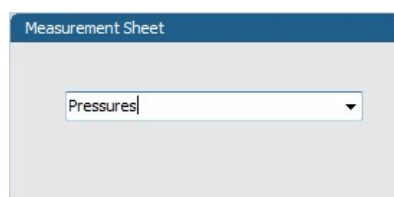
This functionality is only available, if a MSA-Box (I or II) is used to connect the DDU 9 to the PC. Choose the CAN bus that is connected to the MSA-Box to display the raw value and the converted physical value here.



Automatic creation of online measurement sheets

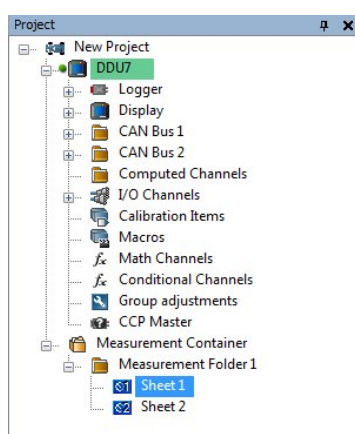
The CAN channel can be automatically inserted to a measurement sheet. Insert a name for a new sheet or select an existing sheet from the list box.

For an online view of the value measured by the DDU 9, insert the channel in an online measurement sheet which is described in the next chapter.



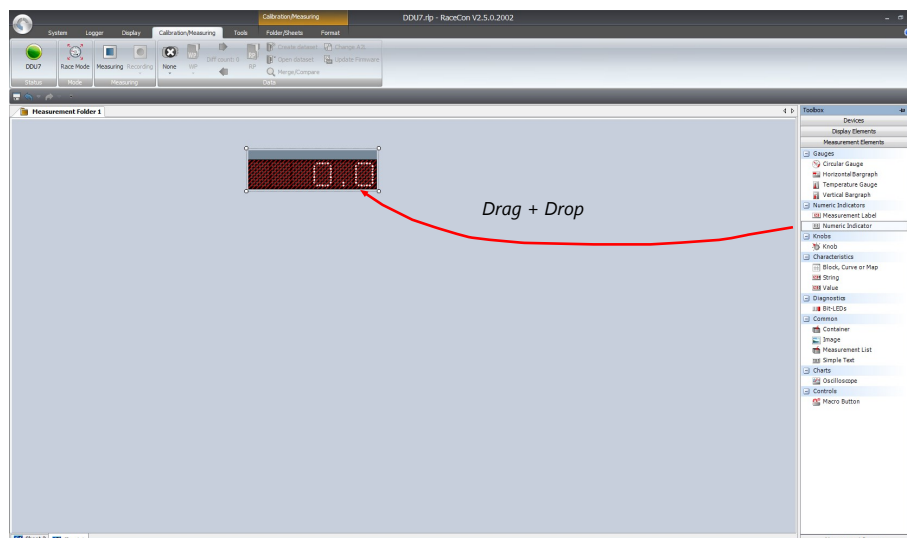
9.2.7 Online view of CAN channels in vehicle

1. Double-click on 'Sheet 1' in Project Tree.

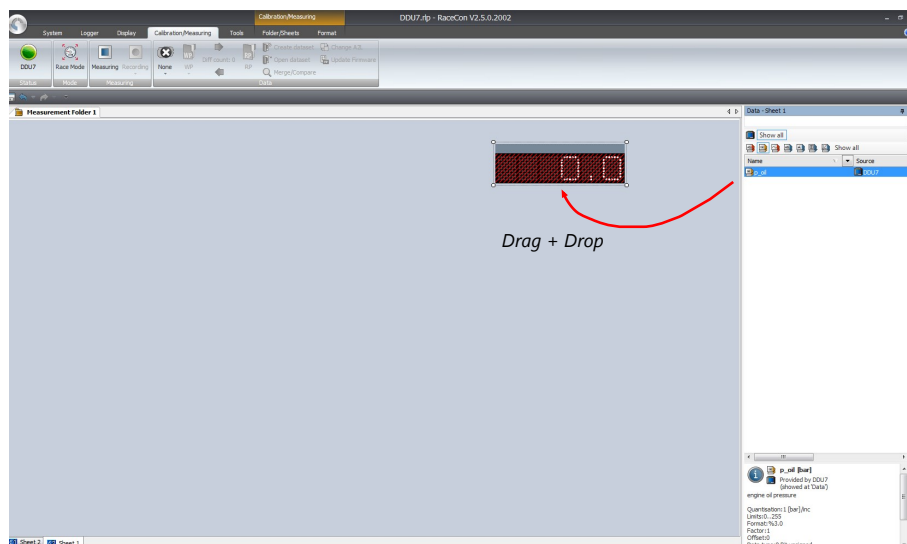


Measurement Sheet 1 is displayed in Main Area.

2. Click on 'Measurement elements' in the Toolbox.
3. Drag the desired Measurement element (e.g. Numeric Indicator) and drop it on the Measurement Sheet.



4. Click on folder 'CAN Input' of desired CAN bus to display available channels.
5. Drag desired Measurement channel and drop it on the Measurement element.



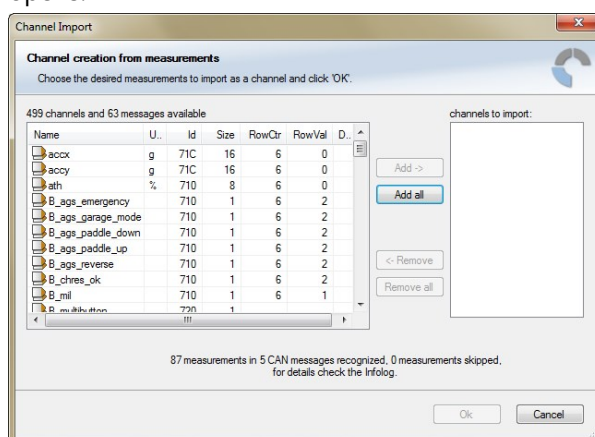
The measurement element displays the values of the assigned channel.

6. Connect PC to the vehicle and switch to 'Race Mode' by clicking 'F11' on the keyboard to display online data.

9.2.8 Import a CAN database (DBC) file

1. Right-click on CAN Input of desired bus (CAN1, CAN2 or CAN3).
2. Select 'Import DBC file' from menu. A file browser opens.

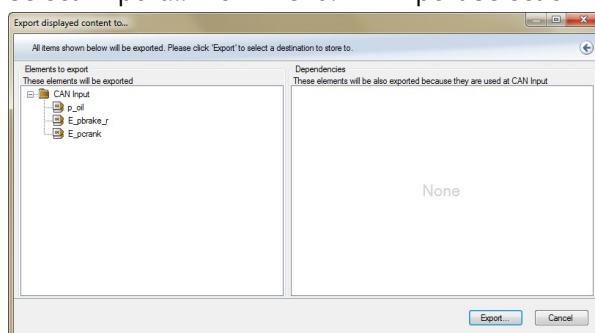
3. Select DBC file to import and click 'OK' when done. A channel import window opens.



4. Select desired channels on the left and use the 'Add' button to add them to import list.
5. Click 'OK' when complete. The channels are inserted in the Data window.

9.2.9 Export RaceCon CAN configuration

1. Right-click on CAN Input of desired bus (CAN1, CAN2 or CAN3).
2. Select 'Export...' from menu. An 'Export Selection' window opens.

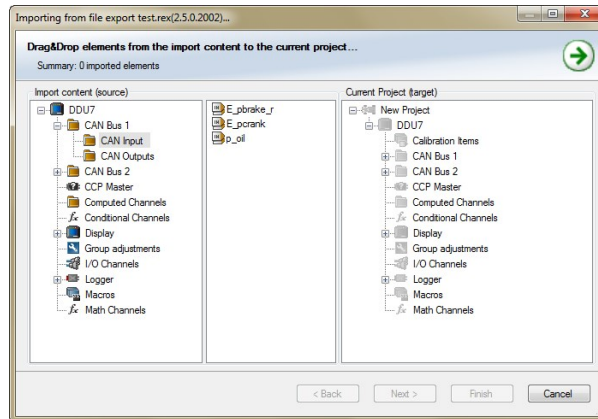


3. Specify the filename.
4. Click 'OK' when done.

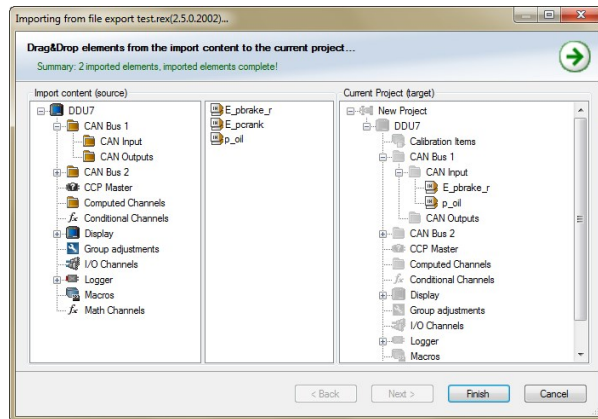
9.2.10 Import RaceCon CAN configuration

1. Right-click on CAN Input of desired bus (CAN1, CAN2 or CAN3).
2. Select 'Import...' from menu. A file browser opens.

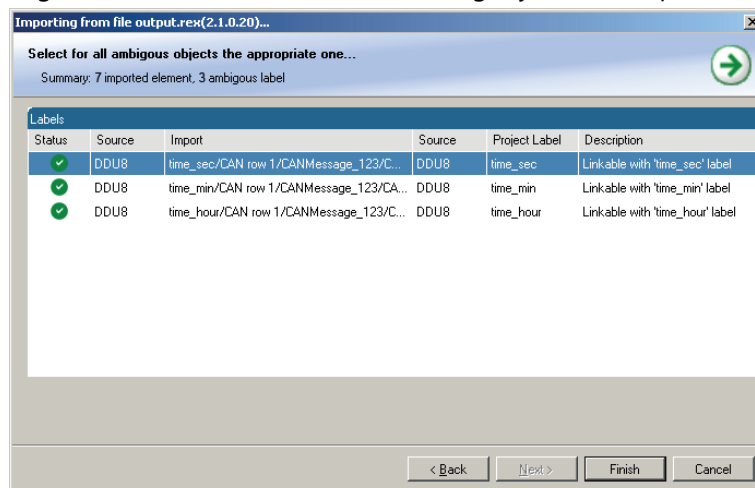
3. Select the input file and click 'OK'. An 'Import Selection' window opens.



4. Select channels to import.
5. Drag and drop the channel to 'CAN Input' of desired CAN bus on right hand side.



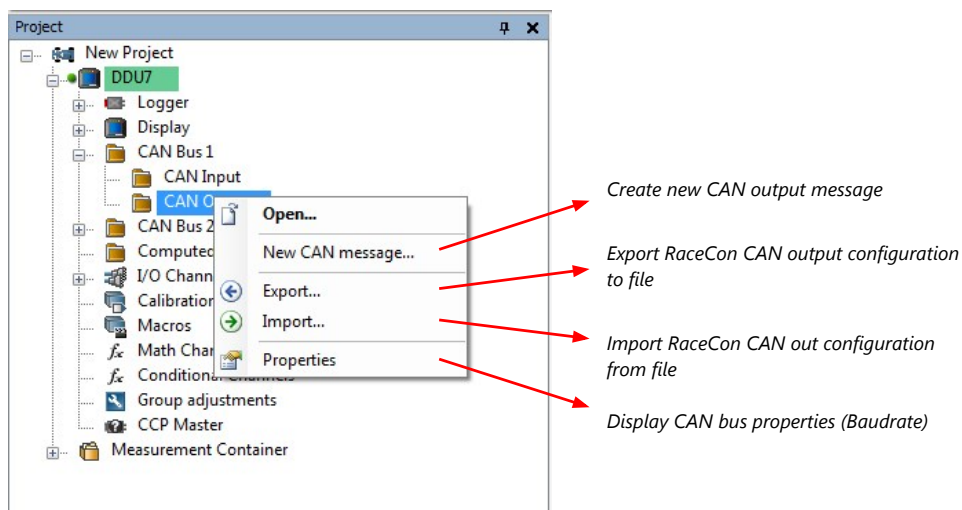
6. Click 'Finish'. If a measurement channel belongs to more than one source (e.g. and MS 5.1), the 'Solve Label Ambiguity' window opens.



7. Assign the ambiguous channels to the desired source.
8. Click 'Finish'.

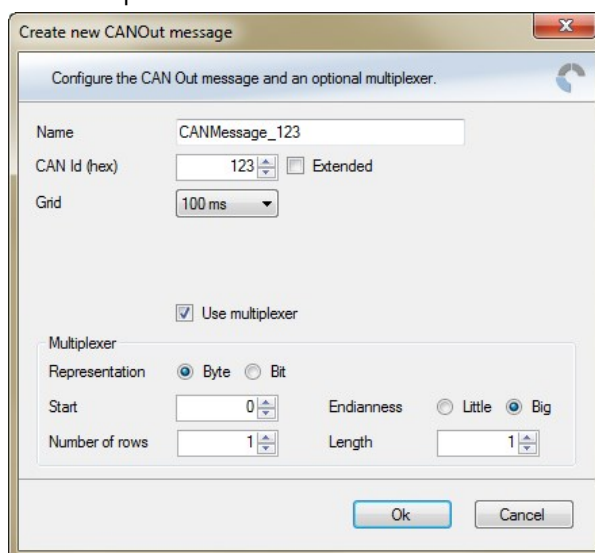
9.3 CAN output

9.3.1 Output configuration



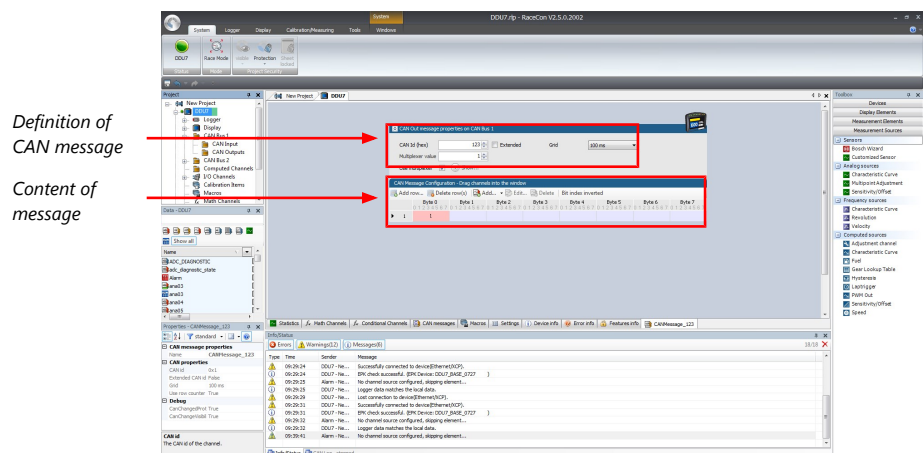
9.3.2 Create new CAN output message channel

1. Right-click on CAN Output of desired bus (CAN1, CAN2 or CAN3).
2. Select 'New CAN Message' from menu. The 'Create new CAN Out message' window opens.

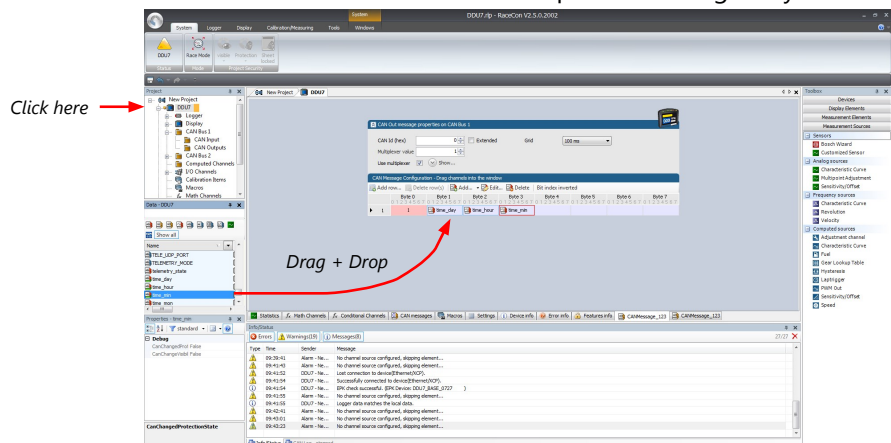


3. Enter name of message, CAN-Id and Grid (output interval).
4. Optionally, specify a multiplexer.

- Click 'OK' when done. A CAN message configuration window opens in the Main Area.

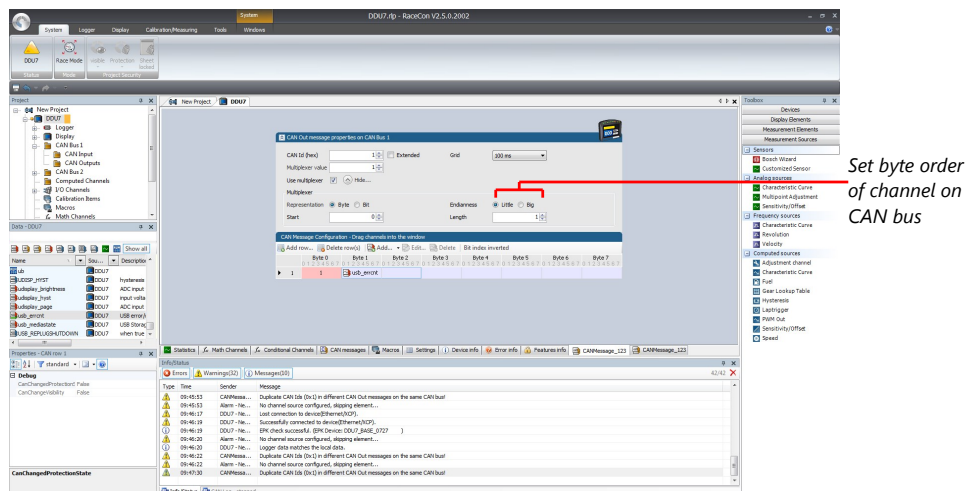


- Click on " in the Project Tree to display all labels.
- Select the desired measurement channel and drop it on message's bytes.



The measurement channel is assigned to the CAN message.

9.3.3 Set up word length, byte order and quantization

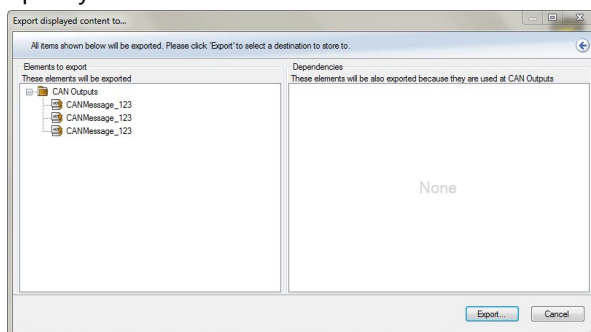


Word length and quantization of channel are fixed.

Byte Order can only be changed if a channel allocates more than one byte.

9.3.4 Export RaceCon CAN configuration

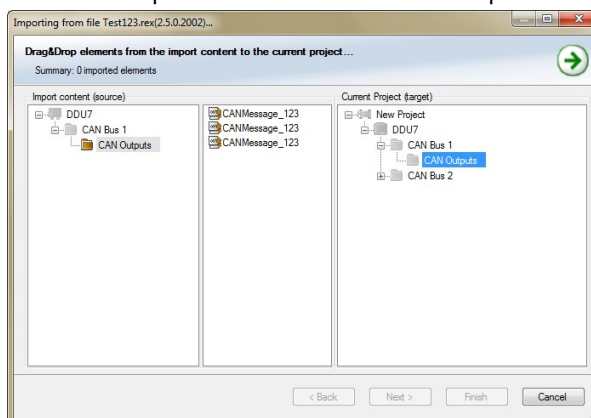
1. Right-click on 'CAN Output' of desired bus (CAN1, CAN2 or CAN3).
2. Select 'Export...' from menu. The 'Export Selection' window opens.
3. Specify the filename.



4. Click 'OK' when done.

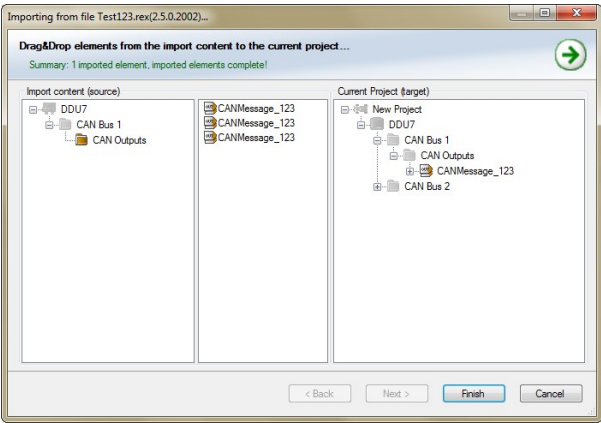
9.3.5 Import RaceCon CAN configuration

1. Right-click on 'CAN Outputs' of desired bus (CAN1, CAN2 or CAN3).
2. Select 'Import...' from menu. A file browser opens.
3. Select the input file and click 'OK'. An 'Import Selection' window opens.

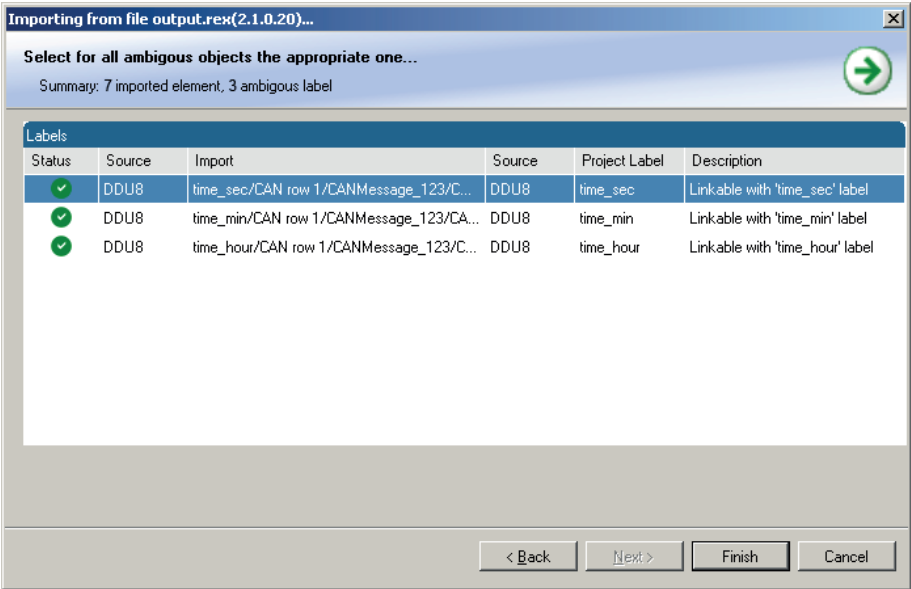


4. Select channels to import.

- 5. Drag and drop the channel to 'CAN Outputs' of desired CAN bus on right hand side.



- 6. Click 'Finish'. If a measurement channel belongs to more than one source (e.g. and MS 5.1), the 'Solve Label Ambiguity' window opens.



- 7. Assign the ambiguous channels to the desired source.
- 8. Click 'Finish'.

10 Analog and Frequency Inputs

10.1 Features

Analog inputs

- 0 to 5 V
- 12 bit A/D converter
- Switchable 3.01 kOhm pull-up resistor
- 8 kHz acquisition rate, up to 1 kHz recording rate
- Linear phase digital filter

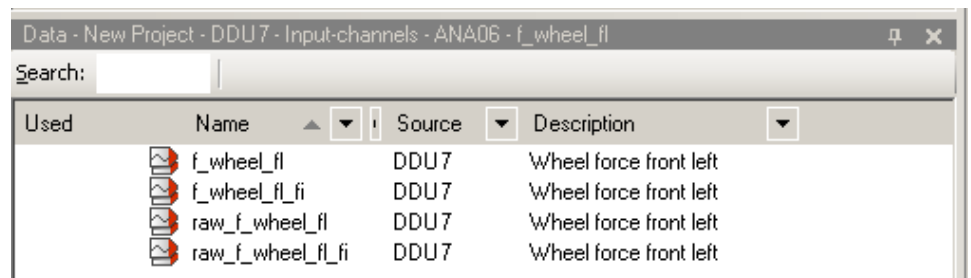
Frequency inputs

- 5 V Hall-effect type, 2.5 V trigger level
- 20 kHz max. frequency
- 10 ms measurement window

10.2 Analog inputs

10.2.1 Measurements channels

For each analog channel, several 'subchannels' are available.



Used	Name	Source	Description
	f_wheel_fl	DDU 7	Wheel force front left
	f_wheel_fl_fi	DDU 7	Wheel force front left
	raw_f_wheel_fl	DDU 7	Wheel force front left
	raw_f_wheel_fl_fi	DDU 7	Wheel force front left

Measurement labels with the characters 'raw' show the exact values in mV.

Measurement labels with the characters '_fi' show filtered values.

The word 'name' in the table is a placeholder for the channel's name.

Measurement label	Function
raw_name	mV value of sensor
raw_name_fi	Filtered mV value of sensor
name	Physical value of sensor
name_fi	Filtered physical value

Filtered channels are routed through digital low pass filters:

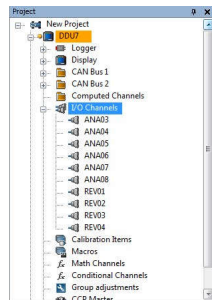
- DDU 9 uses A/D converter oversampling and digital filtering to recording rate
- Digital filters eliminate 'out-of-band' noise
- Cut-off frequency automatically adjusted to recording rate

- Linear phase – no signal distortion
- Latency compensation – no filter delay in recorded data

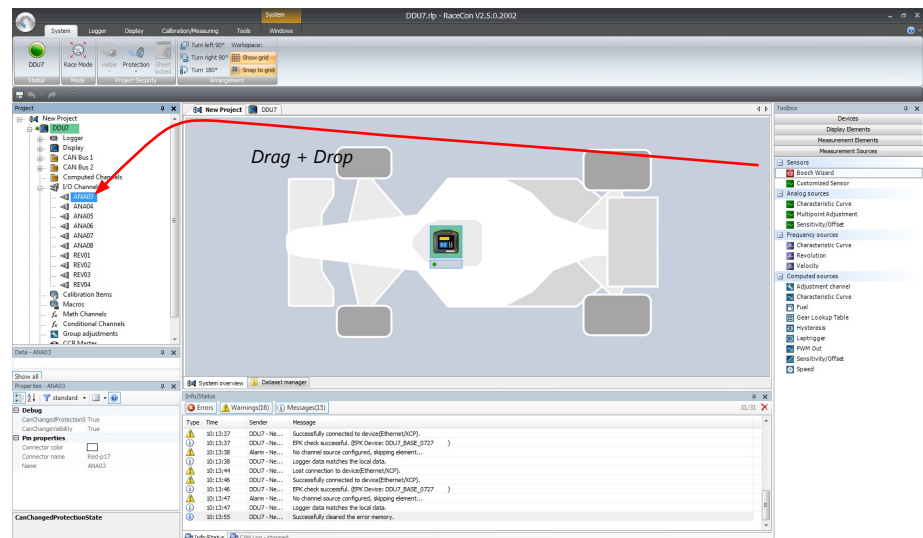
10.3 Configuring inputs

10.3.1 Configuring a predefined Bosch sensor with the 'Bosch Sensor Wizard'

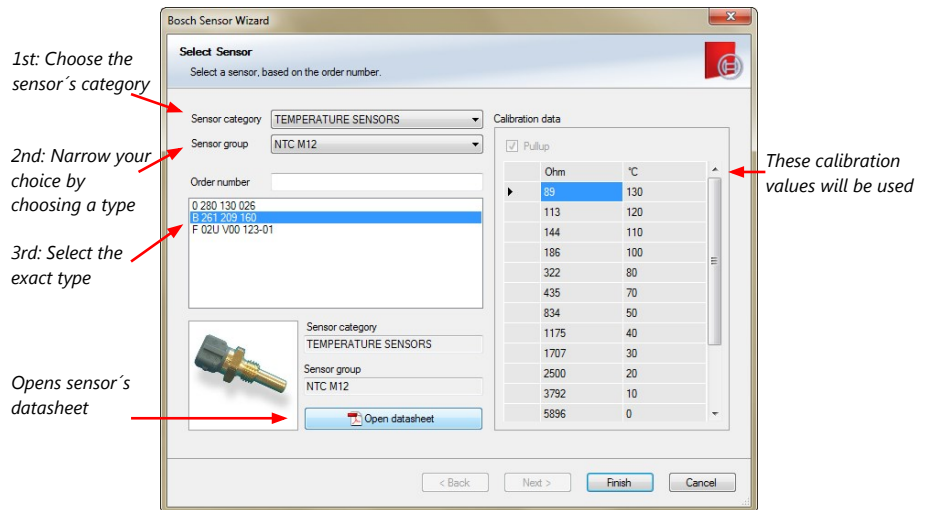
1. Click on 'Measurement Sources' in the Toolbox.
2. Expand the list of 'I/O Channels' by clicking on '+' in the DDU 9 Project Tree.



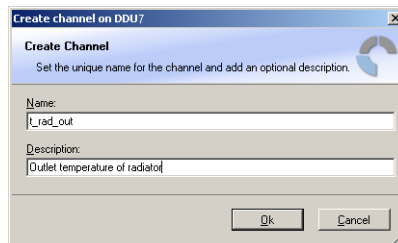
3. Drag the 'Bosch Sensor Wizard' from the Toolbox and drop it on the desired analog input channel in the DDU 9 Project Tree.



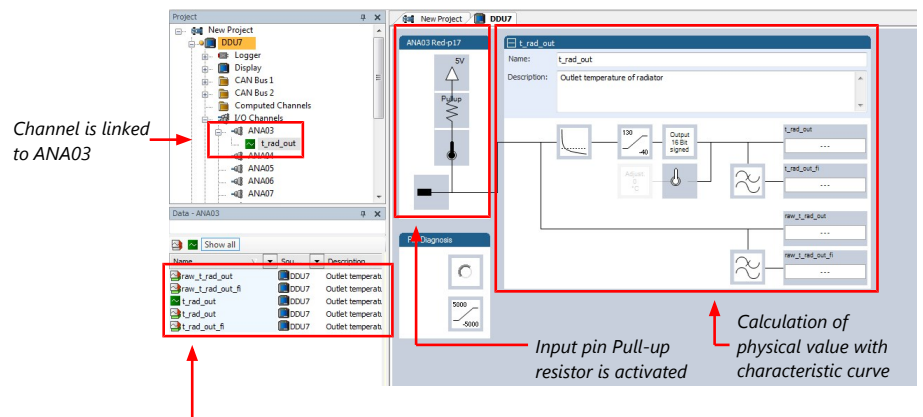
The 'Bosch Sensor Wizard' opens.



4. Click 'Finish' when done.
The 'Create channel' window opens.
5. Enter channel name and description.



6. Click 'Ok' when done.
The channel is inserted into the DDU 9 Project Tree.



Available measurements for channel:

Measurement label	Function
raw_name	mV value of sensor
raw_name_fi	Filtered mV value of sensor
name	Physical value of sensor
name_fi	Filtered physical value

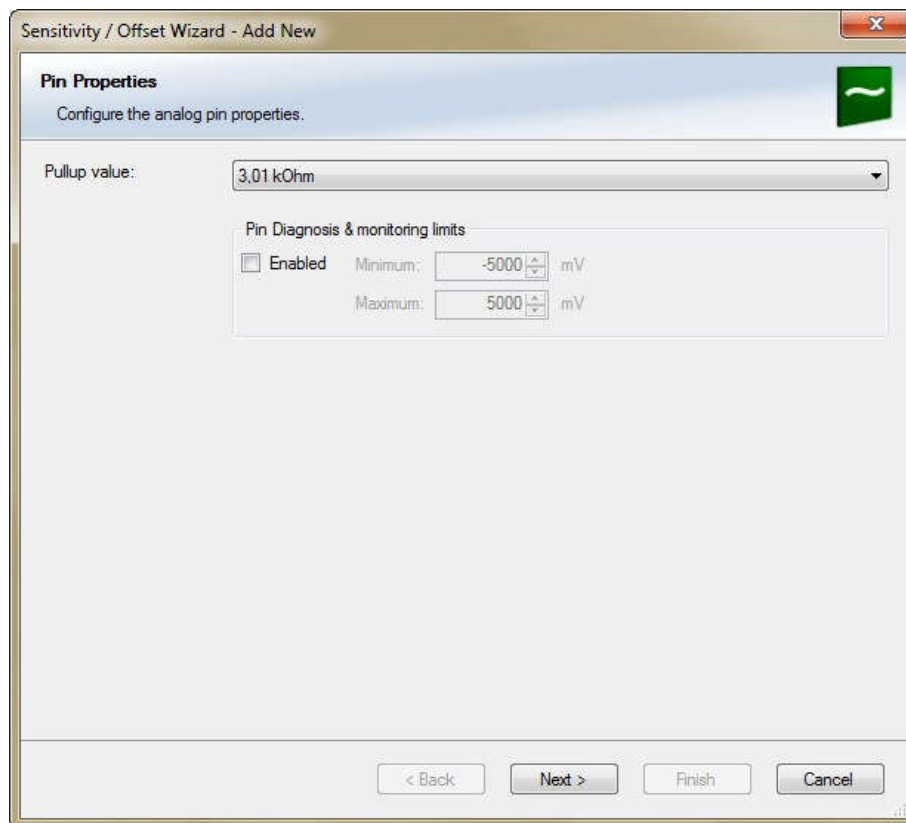
10.3.2 Configuring a generic linear sensor

Example: Acceleration sensor 5 g

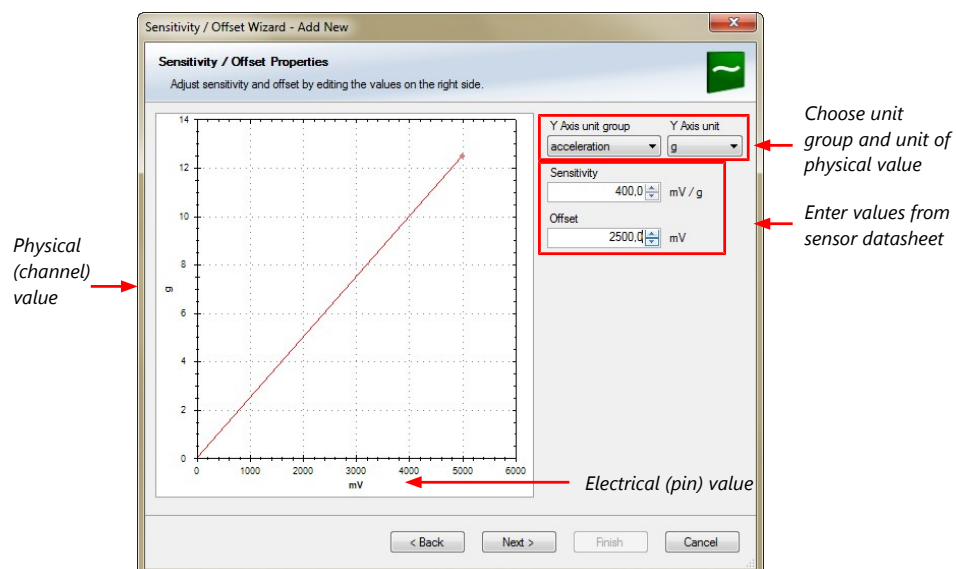
- From sensor data sheet – operating characteristics:

Output Signal					
Zero g ($T_A = 25^\circ\text{C}$, $V_{DD} = 5.0\text{ V}$) ⁽⁴⁾	V_{OFF}	2.25	2.5	2.75	V
Zero g ($V_{DD} = 5.0\text{ V}$)	V_{OFF}	2.0	2.5	3.0	V
Sensitivity ($T_A = 25^\circ\text{C}$, $V_{DD} = 5.0\text{ V}$) ⁽⁵⁾	S	380	400	420	mV/g
Sensitivity ($V_{DD} = 5.0\text{ V}$)	S	370	400	430.1	mV/g
Bandwidth Response	f_{3dB}	42.5	50	57.5	Hz
Nonlinearity	NL-OUT	-1.0	—	+1.0	% FSO

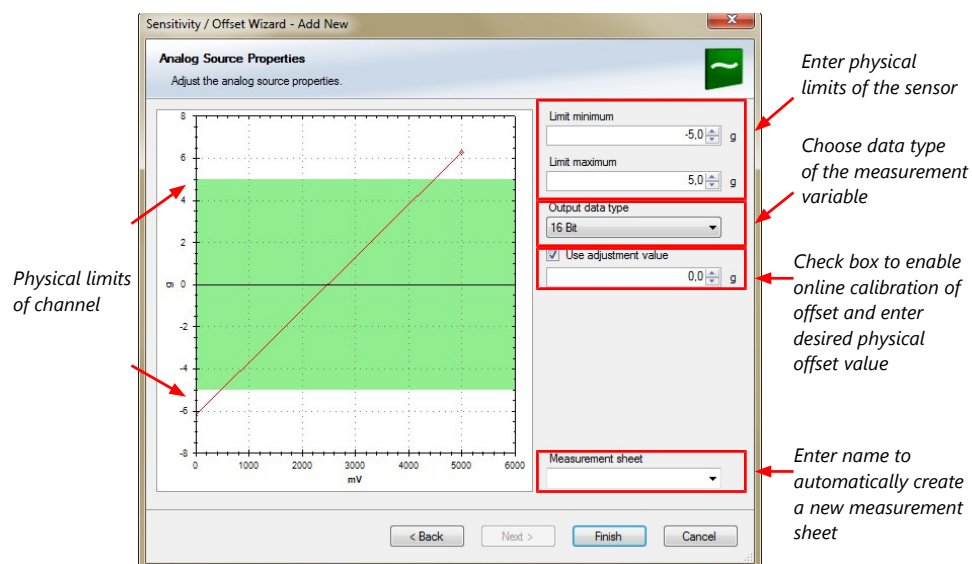
- Sensitivity 400 mV/g, Offset 2,500 mV
 - The sensor has a linear output signal with sensitivity and offset
- Click on 'Measurement Sources' in the Toolbox.
 - Expand the list of 'I/O Channels' by clicking on '+' in the DDU 9 Project Tree.
 - Drag the 'Sensitivity/Offset' analog signal source from the Toolbox and drop it on the desired analog input channel in the DDU 9 Project Tree. A 'Sensitivity/Offset Wizard' opens.
 - To activate the internal pullup-resistor, check the box. The internal pullup-resistor is used to get a 5 V signal at the analog channel of the DDU 9. It allows you to use a push-button. The fixed value of the internal pullup-resistor is 3,010 Ohm. If using an additional external pullup-resistor, set up the overall resistance.



- Click 'Next' when done.
The second part of the 'Sensitivity/Offset Wizard' opens.



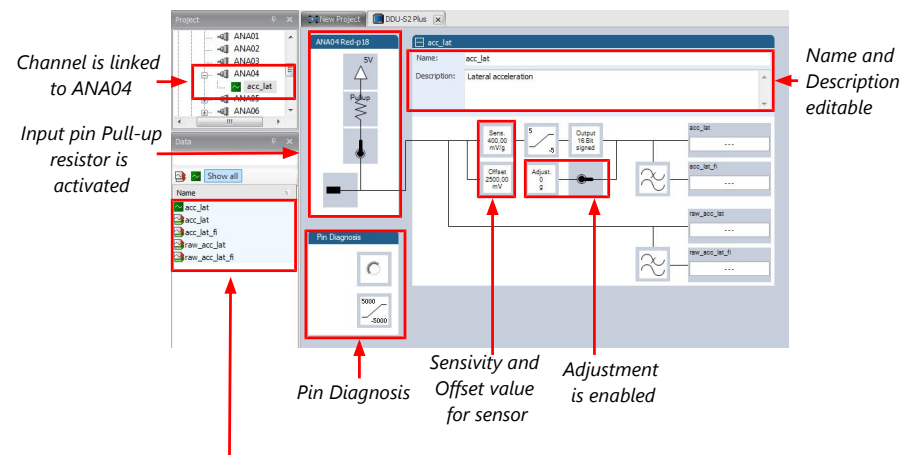
- Click 'Next' when done.
The third part of the 'Sensitivity/Offset Wizard' opens.



Notice

Working with automatically created measurement sheets is explained in chapter 'Setting up an online measurement [▶ 108]'.

- Click 'Finish' when done.
- Enter channel name and description.
- Click 'OK' when done.
The channel is inserted into the DDU 9 Project Tree.



Available measurements for channel:

Measurement label	Function
raw_name	mV value of sensor
raw_name_fi	filtered mV value of sensor
name	physical value of sensor
name_fi	filtered physical value

10.3.3 Configuring a generic nonlinear sensor

Example: Thermistor 5 kOhm

PART NR.: 2381 640 502
HTCLE100E3502

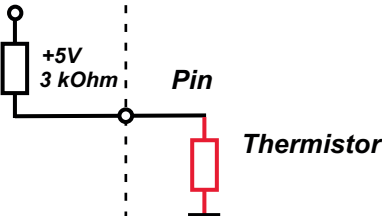
T _{oper} [°C]	R _T [Ω]
-40	166 047
-35	119 950
-30	87 600
-25	64 643
-20	48 179
-15	36 250
-10	27 523
-5	21 078

T _{oper} [°C]	R _T [Ω]
0	16 277
5	12 669
10	9 936
15	7 849
20	6 244
25	5 000
30	4 030
35	3 267

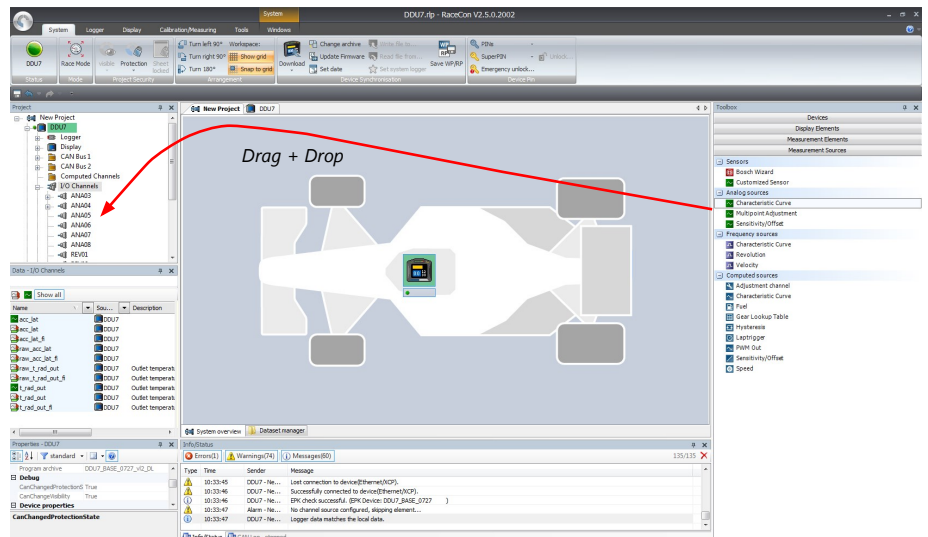
T _{oper} [°C]	R _T [Ω]
40	2 685
45	2 166
50	1 903
55	1 494
60	1 245
65	1 024
70	876
75	740

T _{oper} [°C]	R _T [Ω]
80	628
85	535
90	457
95	399
100	338
105	292
110	251
115	221

- From sensor data sheet: resistance values over temperature
- The sensor has a nonlinear behaviour
- Use characteristic curve for linearization
- Input voltage is the ratio between pull-up resistor and thermistor

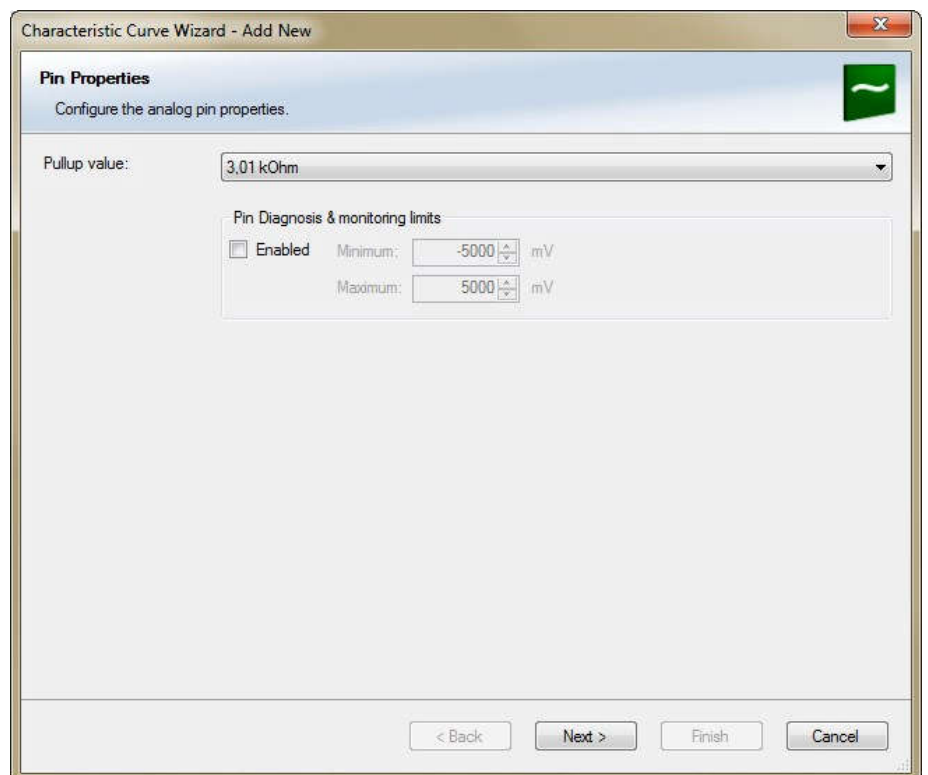


1. Click 'Measurement Sources' in the Toolbox.
2. Expand the list of 'I/O Channels' by clicking on '+' in the DDU 9 Project Tree.
3. Drag the 'Characteristic Curve' analogue signal source from the Toolbox and drop it on the desired analogue input channel in the DDU 9 Project Tree.

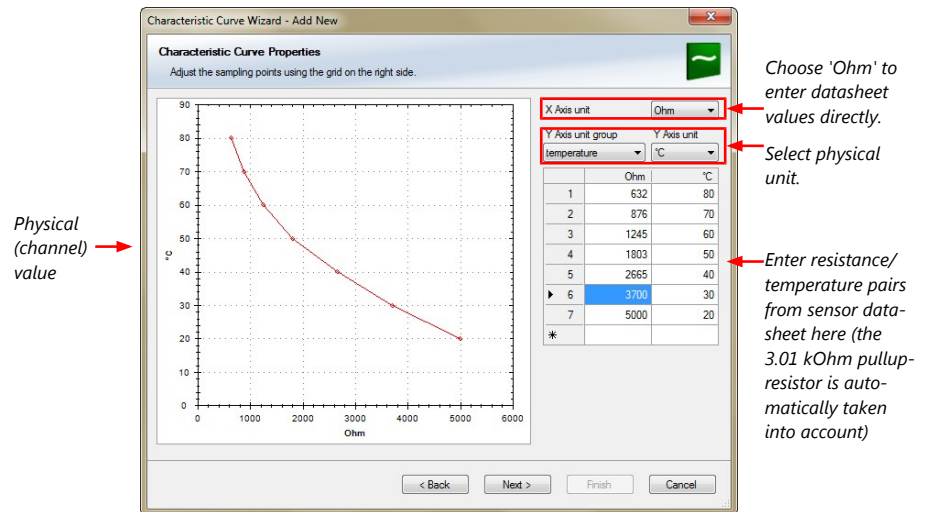


A 'Characteristic Curve Wizard' opens.

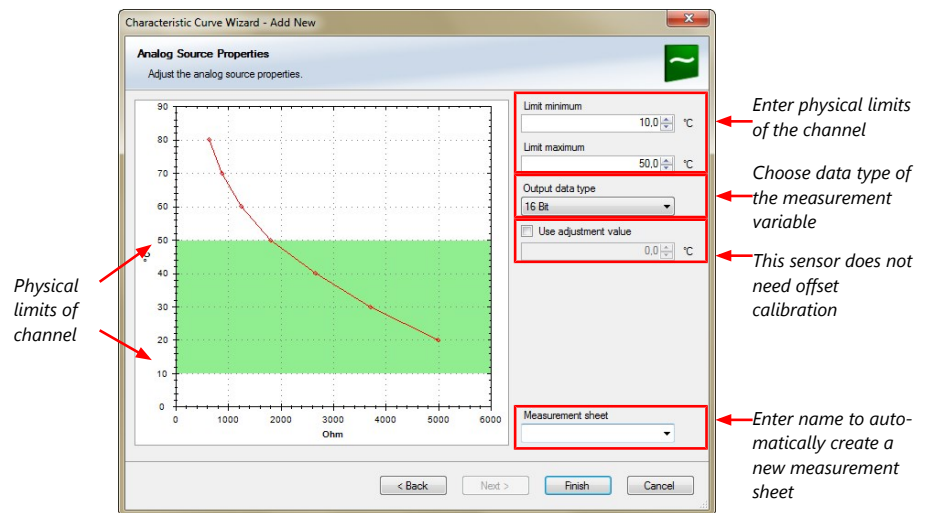
4. To activate the internal pull up-resistor, check the box. The DDU 9 pull up-resistor is used to get a 5 V signal at the analogue channel of the DDU 9. It allows you, to use a push-button. The fixed value of the internal pull up-resistor is 3,010 Ohm. If using an additional external pull up-resistor, set up the overall resistance.



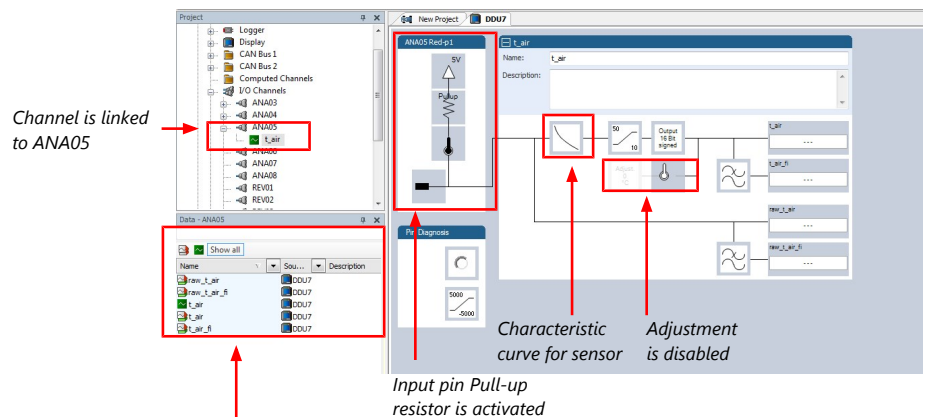
5. Click 'Next' when done.
The second part of the 'Sensitivity/Offset Wizard' opens.



- Click 'Next' when done.
The third part of the 'Characteristic Curve Wizard' opens.



- Click 'Finish' when done.
- Enter channel name and description.
- Click 'OK' when done.
The channel is inserted into the DDU 9 Project Tree.



Available measurements for channel:

Measurement label	Function
raw_name	mV value of sensor
raw_name_fi	filtered mV value of sensor
name	physical value of sensor
name_fi	filtered physical value

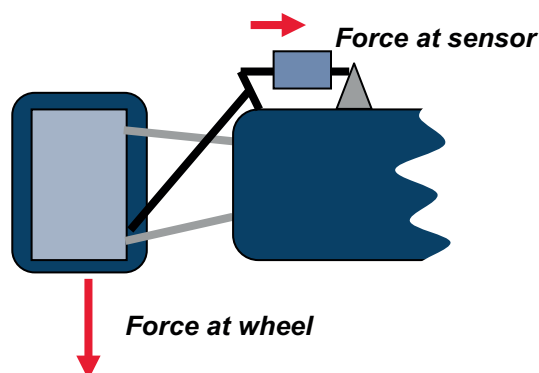
Notice

Working with automatically created measurement sheets is explained in chapter 'Setting up an online measurement [▶ 108]'.

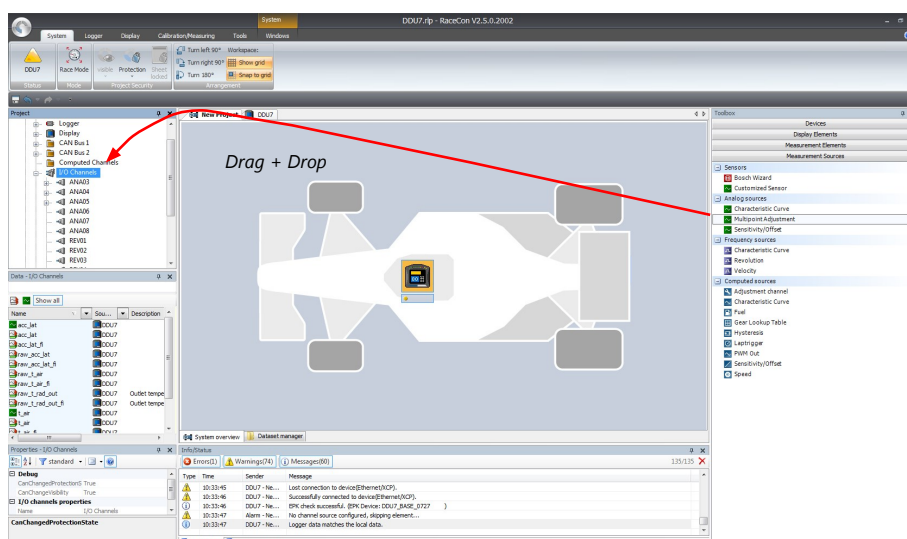
10.3.4 Configuring a multipoint adjustment

Example: Measurement of wheel force

- Physical property 'wheel force' not directly measurable
- Load transfer through suspension kinematics
- Physical value at sensor position defined by vehicle
- Curve definition by online adjustment at vehicle

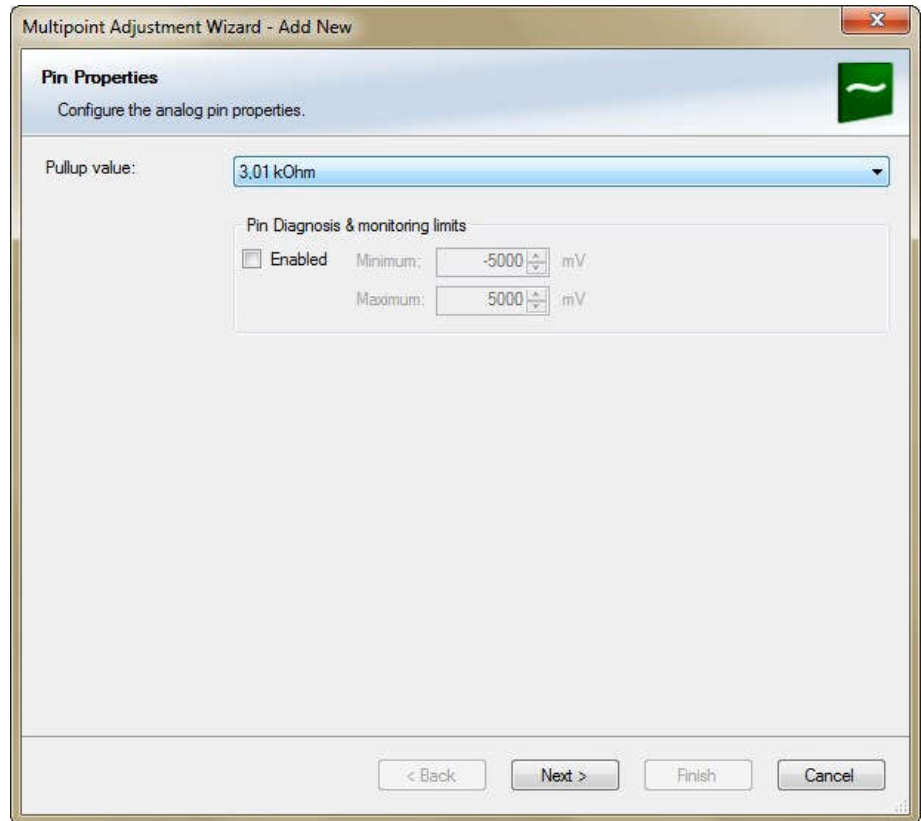


- Click on 'Measurement Sources' in the Toolbox.
- Expand the list of 'I/O Channels' by clicking on '+' in the DDU 9 Project Tree.
- Drag the 'Multipoint Adjustment' analog signal source from the Toolbox and drop it on the desired analog input channel in DDU 9 Project Tree.

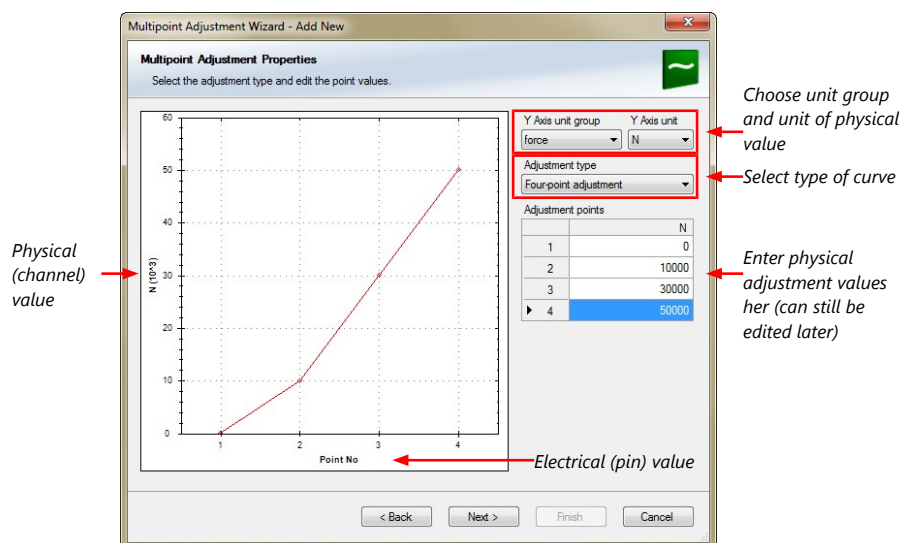


A 'Multipoint Adjustment Wizard' opens.

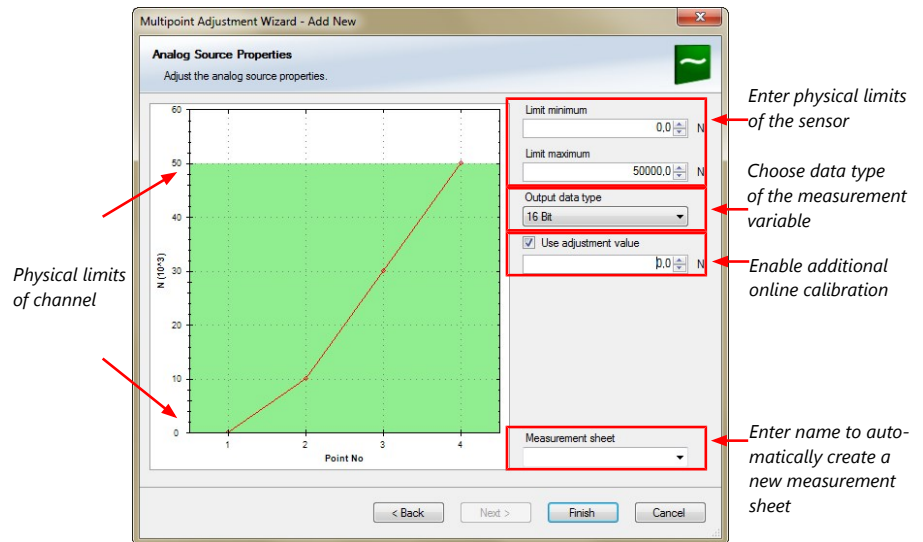
4. To activate the internal pullup-resistor, check the box. The internal pullup-resistor is used to get a 5 V signal at the analog channel of the DDU 9. It allows you to use a push-button. The fixed value of the internal pullup-resistor is 3.01 kOhm. If using an additional external pullup-resistor, set up the overall resistance.



5. Click 'Next' when done.
The second part of the 'Multipoint Adjustment Wizard' opens.



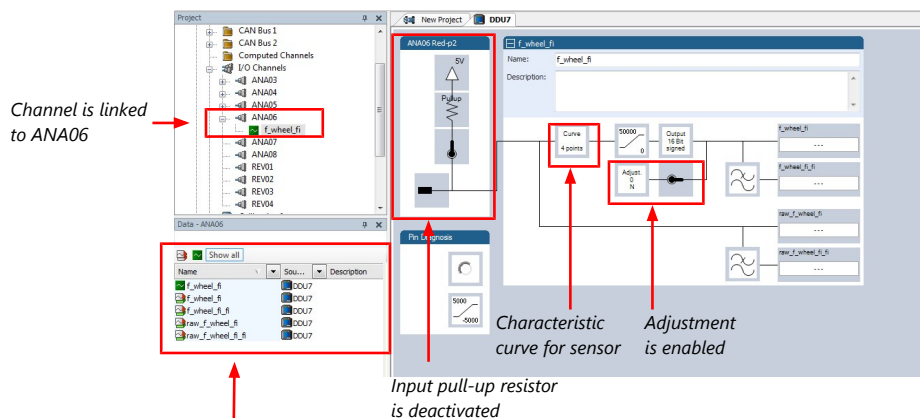
6. Click 'Next' when done.
The third part of the 'Multipoint Adjustment Wizard' opens.



Notice

Working with automatically created measurement sheet is explained in chapter 'Setting up an online measurement [► 108]'.

7. Click 'Finish' when done.
 8. Enter channel name and description.
 9. Click 'OK' when done.
- The channel is inserted into the DDU 9 Project Tree.



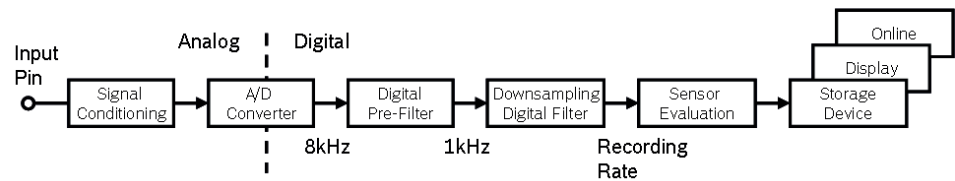
Available measurements for channel:

Measurement label	Function
raw_name	mV value of sensor
raw_name_fi	filtered mV value of sensor
name	physical value of sensor
name_fi	filtered physical value

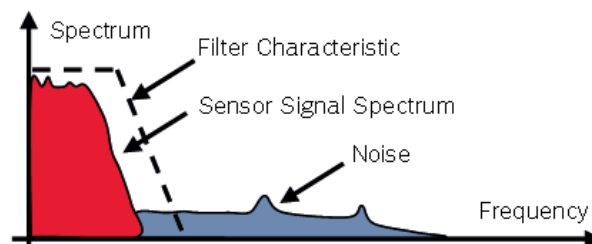
Online definition of the curve is covered in the chapter 'Online calibration of measurement channels [► 114]' of this manual.

10.3.5 Digital filter details

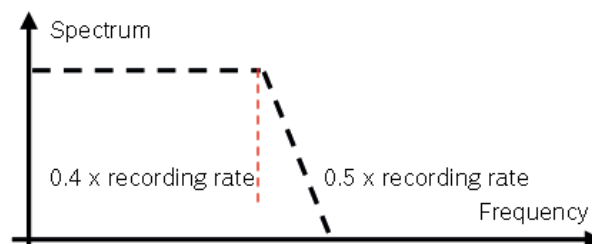
DDU 9 uses A/D converter oversampling and digital filtering to recording rate.



Digital filters eliminate 'out-of-band' noise



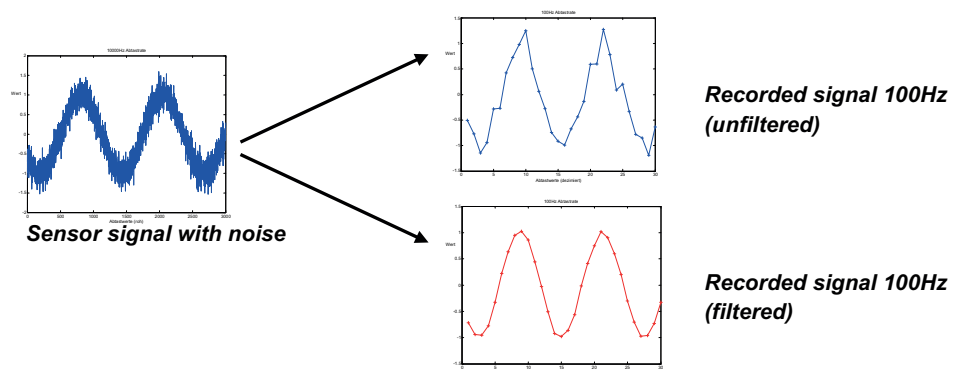
Cut-off frequency automatically adjusted to recording rate



Example:

- 100 Hz recording rate (10 ms)
- <40 Hz pass band (>99 %)
- >50 Hz stop band (<1 %)

Linear phase – no signal distortion



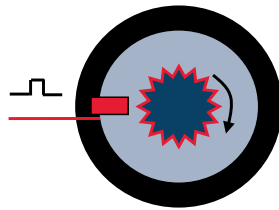
Latency compensation – no filter delay in recorded data

- Filtering is (smart) averaging over several samples
- Filtered signal is delayed with respect to real time signal
- DDU 9 filters have constant, frequency independent delay
- Delay (e.g. 22 samples at 10 ms) is corrected during recording
- No delay filtered vs. unfiltered in recorded data
- Correction is (of course) not possible for real time data (display, online, PWM out)
- Use filtered data for recording, use unfiltered data for real-time

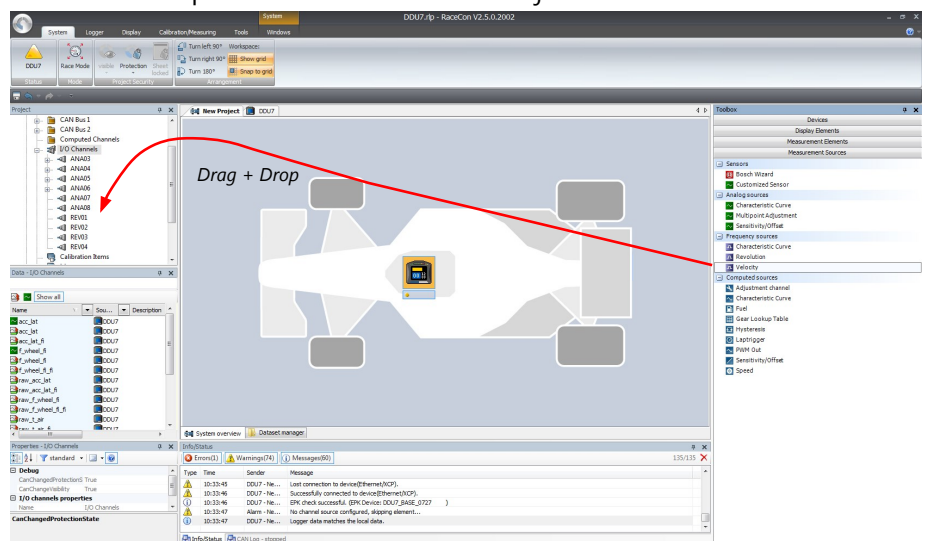
10.3.6 Configuring a frequency input

Example: measurement of wheel speed

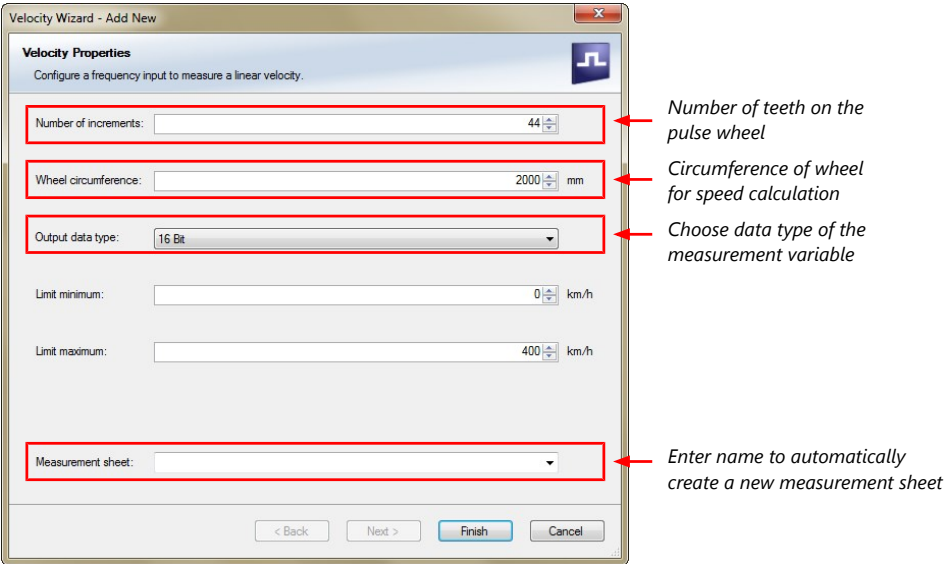
- Pulse wheel attached to wheel
- Each passing tooth of pulse wheel triggers hall sensor
- Calculation of wheel speed with wheel circumference



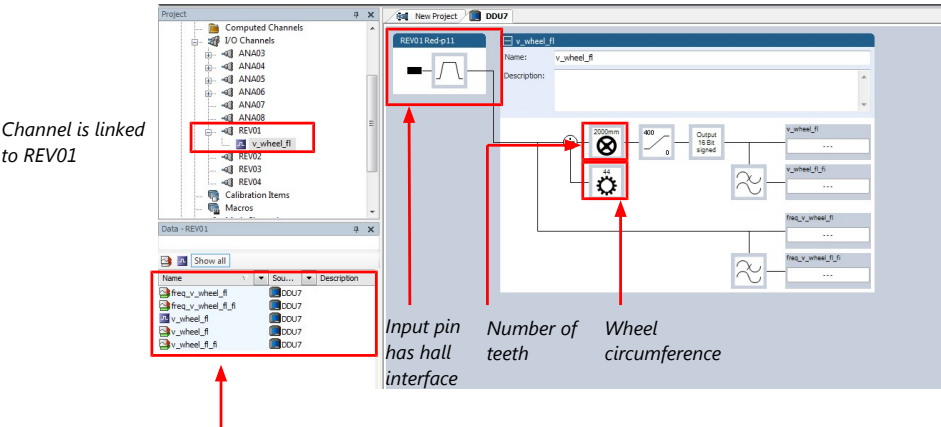
1. Click 'Measurement Sources' in the Toolbox.
2. Expand the list of 'I/O Channels' by clicking on '+' in the DDU 9 Project Tree.
3. Drag the 'Velocity' digital signal source from the Toolbox and drop it on the desired 'REV' input channel in the DDU 9 Project Tree.



The 'Velocity Wizard' opens.



- 4. Click 'Finish' when done.
 - 5. Enter channel name and description.
 - 6. Click 'OK' when done.
- The channel is inserted into the DDU 9 Project Tree.



Available measurements for channel:

Measurement label	Function
raw_name	mV value of sensor
raw_name_fi	filtered mV value of sensor
name	physical value of sensor
name_fi	filtered physical value

Notice

Measurement of 'Revolution' is similar.

10.4 Configuring computed sources

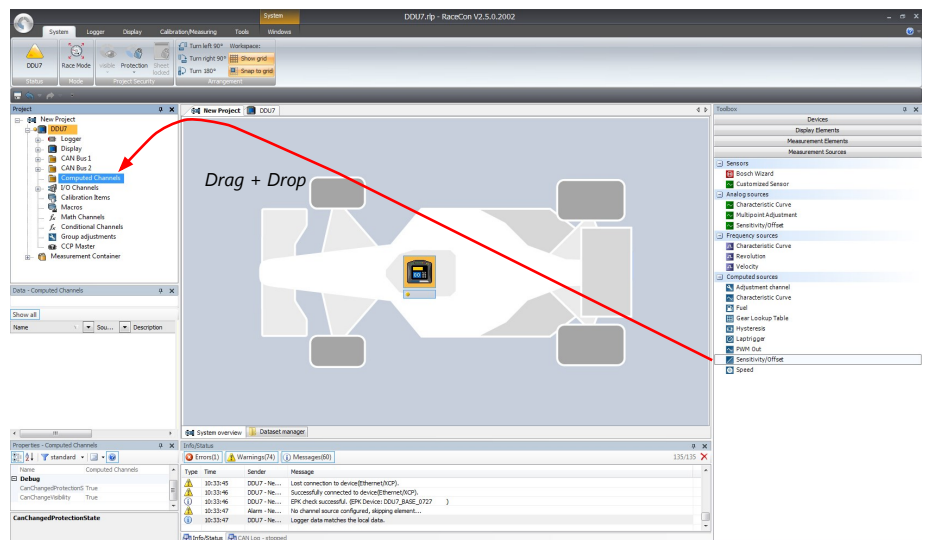
Computed sources receive data from a measurement channel rather than an input pin.

- Sensitivity/Offset calculation on input channel

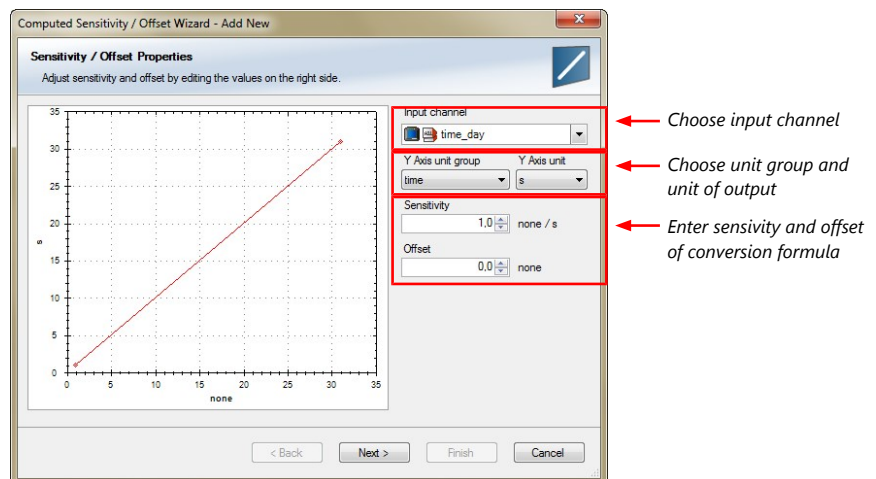
- Characteristic curve calculation on input channel
- Computed vehicle speed
- Lap trigger (covered in a special section)

Example: Sensitivity/offset calculation on input channel

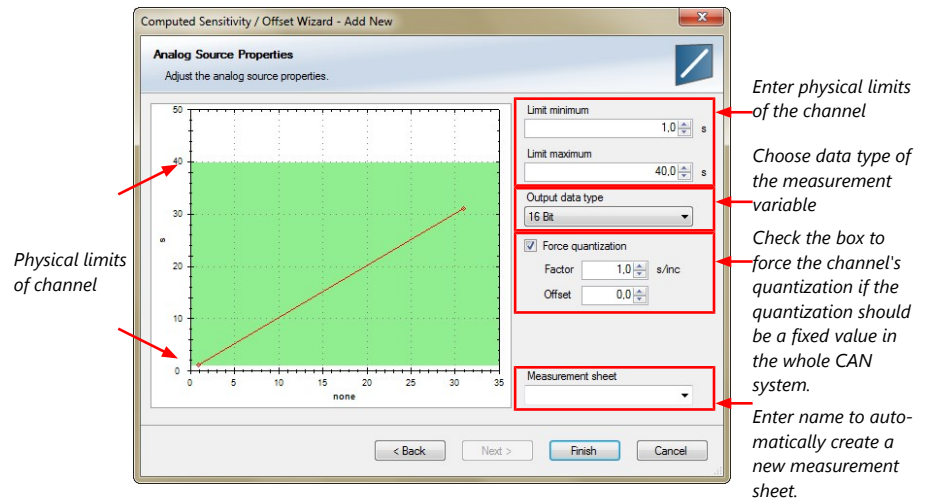
1. Click 'Measurement Sources' in the Toolbox.
2. Drag the 'Sensitivity/Offset' computed source from the Toolbox and drop it on 'Computed Channels' in the DDU 9 Project Tree.



A 'Computed Sensitivity/Offset Wizard' opens.



3. Click 'Next' when done.
The second part of the 'Computed Sensitivity/Offset Wizard' opens.



4. Click 'Finish' when done.
5. Enter channel name and description.
6. Click 'OK' when done.

The channel is inserted into the DDU 9 Project Tree.

Notice

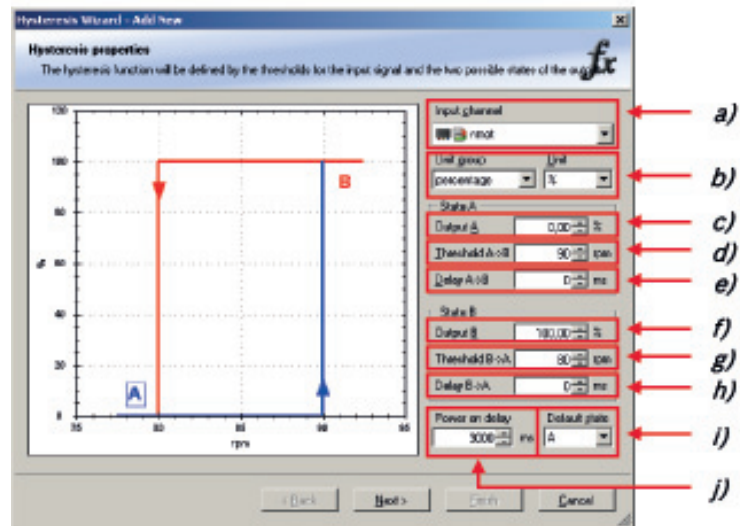
Working with automatically created measurement sheets is explained in chapter 'Setting up an online measurement'.

10.5 Hysteresis

The hysteresis function avoids the high-frequency switchover of the measurement channel value. The hysteresis can be adjusted for each input measurement channel individually and can be used for further processing.

1. Click 'Measurement Sources' in the Toolbox.
2. Drag the 'Hysteresis' computed source from the Toolbox and drop it on 'Computed Channels' in the DDU 9 Project Tree.

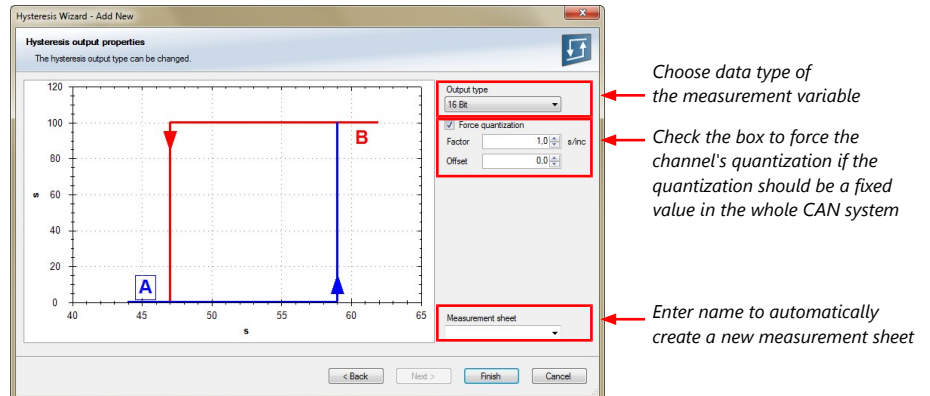
A 'Hysteresis Wizard' opens.



- a) Choose input measurement channel.
- b) Choose unit group and unit of output.
- c) Enter output value of state A in the unit selected in b).
- d) Enter threshold value when state changes from A to B.
- e) Enter delay time when state changes from A to B.
- f) Enter output value of state B in the unit selected in b).
- g) Enter threshold value when state changes from B to A.
- h) Enter delay time when state changes from B to A.
- i) Enter time when the hysteresis function is activated after vehicle's startup.
- j) Enter the channel's state (A or B) at startup.

3. Click 'Next' when done.

The second part of the 'Hysteresis Wizard' opens.

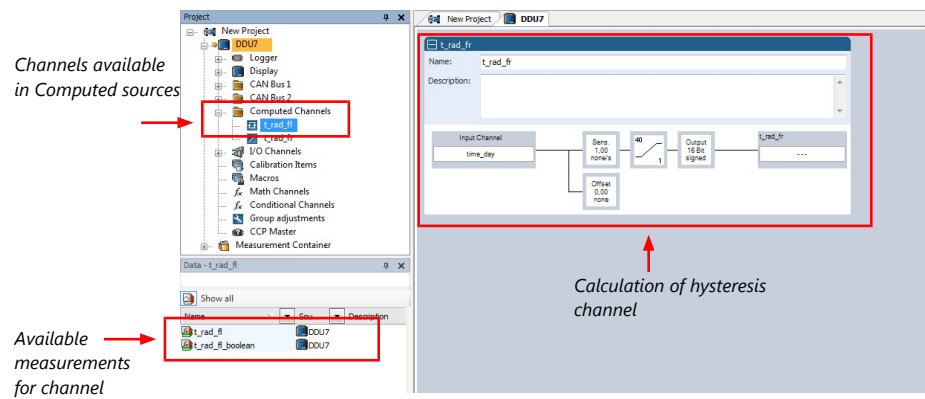


4. Click 'Finish' when done.

5. Enter channel name and description.

6. Click 'OK' when done.

The channel is inserted into the DDU 9 Project Tree.



10.5.1 Special functionality: Vehicle speed

This functionality allows:

- high performance vehicle owners to measure wheel spin under acceleration and wheel slip/lock under braking.
- calculating vehicle 'speed over ground'.

Vehicle speed calculation function

- Calculating vehicle speed of 2 wheel drive: (Wheel speeds of non-driven axle as input)

Calculated speed is average of both speeds if speed difference between wheels < limit.

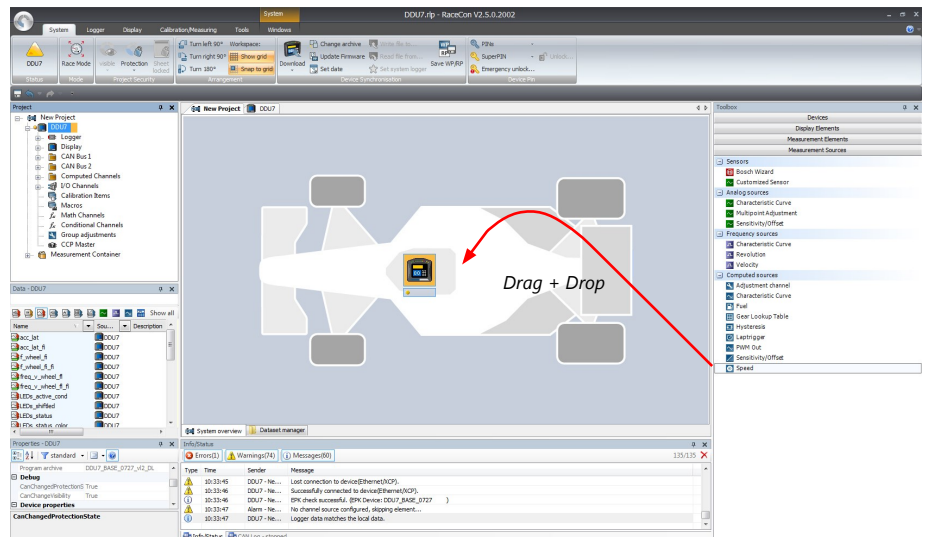
Calculated speed is maximum of both speeds if speed difference between wheels > limit.

- Calculating vehicle speed of 4 wheel drive: (Wheel speeds of all wheels as input)

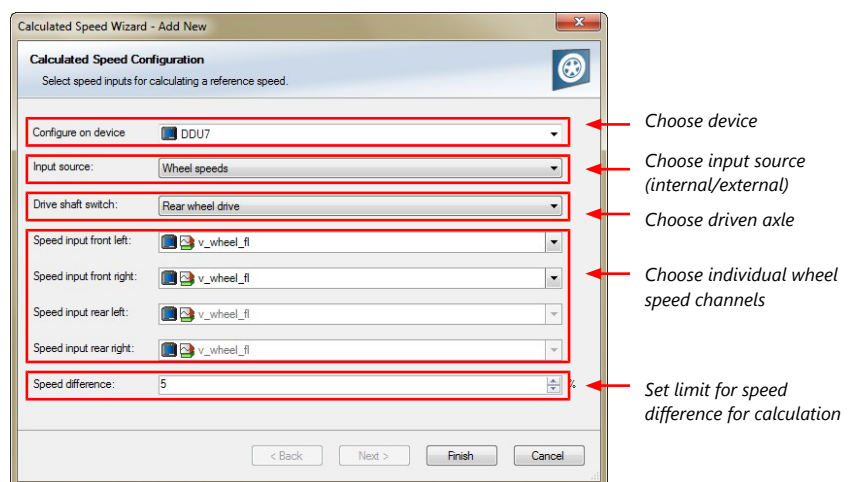
Calculated speed is speed of 2nd fastest wheel.

10.5.2 Setting up calculated speed

1. Click on tab 'System Overview'.
2. Click on 'Measurement Sources' in the Toolbox.
3. Drag the 'Speed' computed source from the Toolbox and drop it on 'Computed Channels' in the DDU 9 Project Tree. Do not drop it on 'DDU 9'!

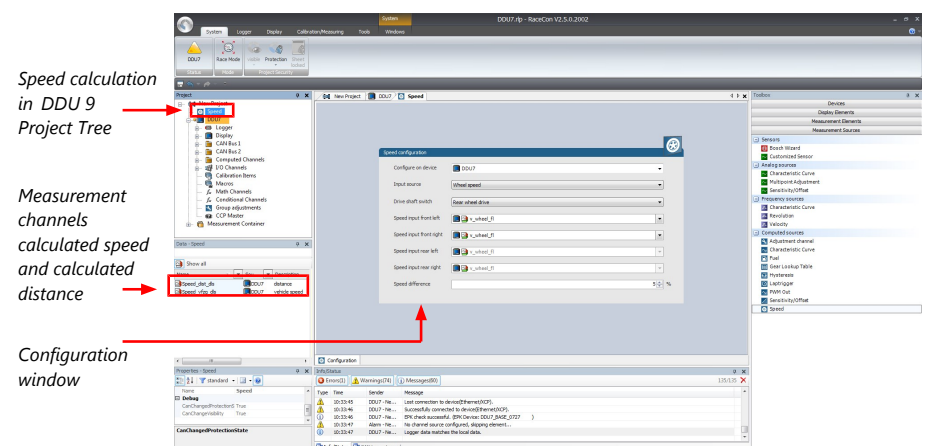


A 'Calculated Speed Wizard' opens.



4. Click 'Finish' when done.

The speed calculation is inserted into the DDU 9 Project Tree.



11 Online Measurement

DDU 9 configuration

- System configuration (channel + display configuration, CAN I/O, etc.) is stored in the DDU 9
- Use RaceCon to create and download configuration from the PC to DDU 9
- Communication interface: Ethernet
- Communication protocol: XCP

Online measurement + calibration

- System status and diagnosis
- Check and calibrate sensors in the vehicle
- Live display of sensor values on the PC
- Use RaceCon for diagnosis, online measurement and calibration
- Communication interface: Ethernet
- Communication protocol: XCP

11.1 Achieving an online connection

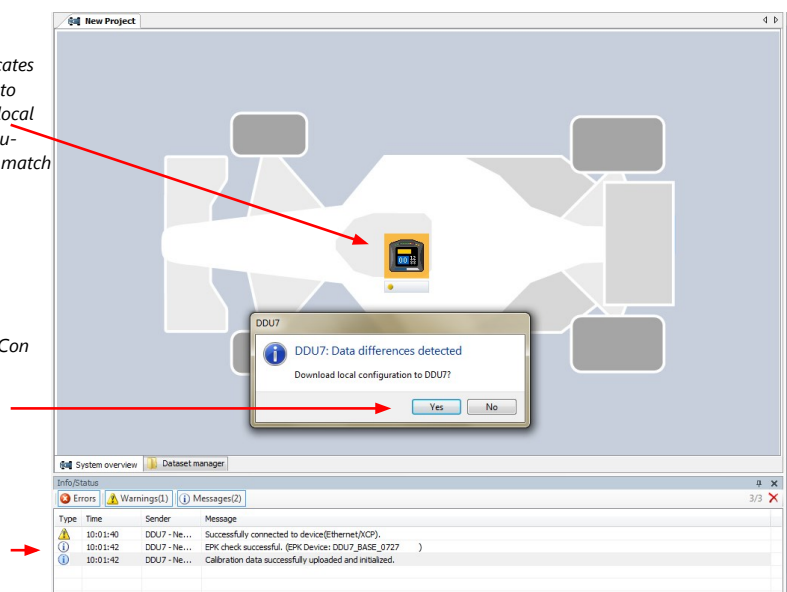
11.1.1 Set up the PC for access to the Unit

1. Switch off local firewall on the PC.
2. Set IP Configuration for the Ethernet interface to 'automatic configuration' (DHCP). See chapter 'Setting up the network interface [► 15]' for details.
3. Start RaceCon.
4. Establish the Ethernet connection to the vehicle.
5. Power on the vehicle.

Yellow dot indicates live connection to the device, but local RaceCon configuration does not match the DDU 9's configuration

Click 'OK' to download RaceCon configuration to device

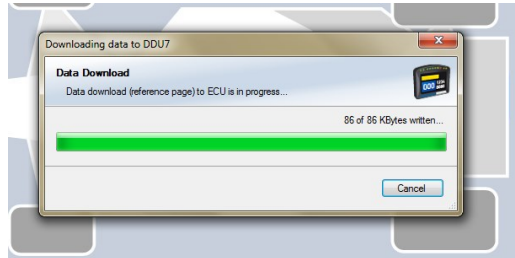
Status message below



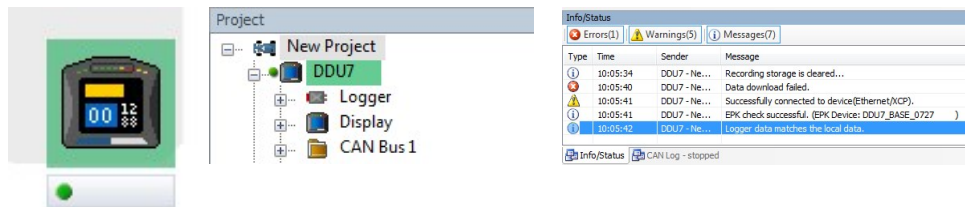
11.1.2 Going online

Click 'OK' to download RaceCon configuration to DDU 9.

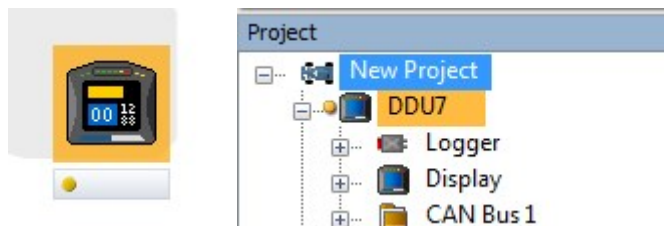
The download starts.



A green dot and background at the device in the project view and the DDU 9 Project Tree indicate a successful download and system consistency.

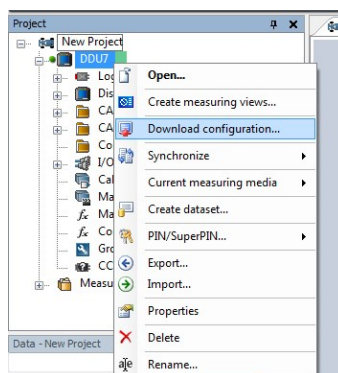


If the system's configuration in RaceCon has been changed, the dot and background becomes yellow and a configuration download is necessary.



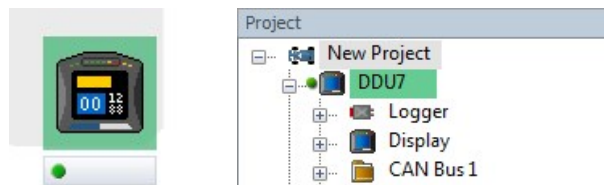
11.1.3 Configuration download

1. Right-click on DDU 9 in the DDU 9 Project Tree.
2. Select 'Download configuration'.



The configuration download starts.

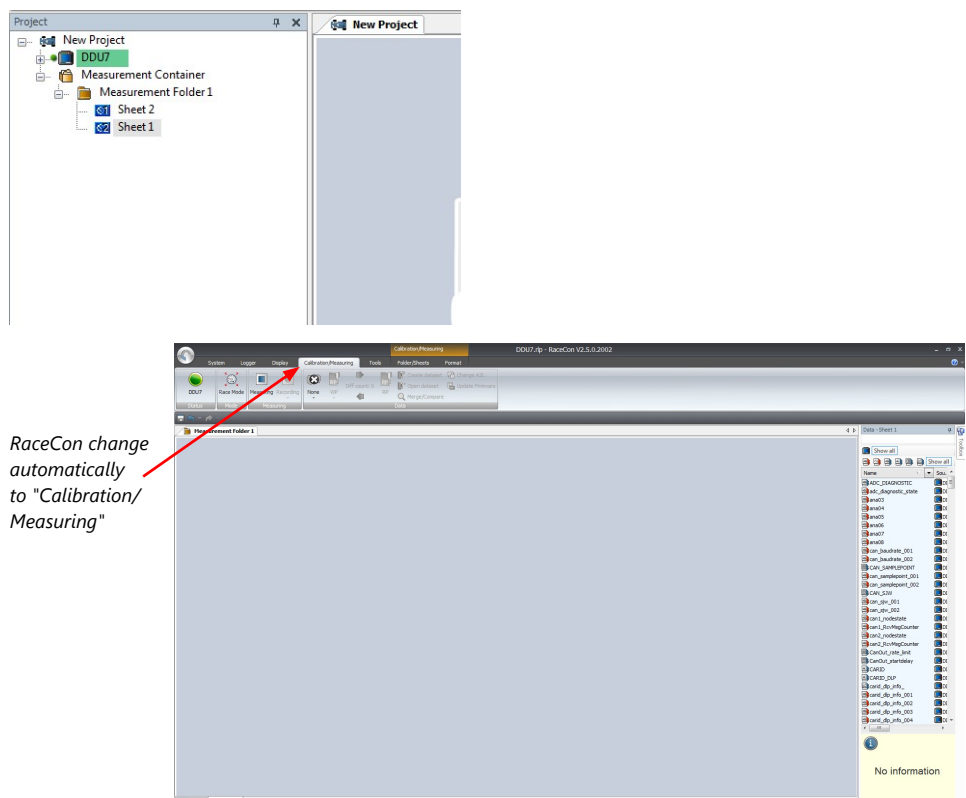
A Green dot and background indicate a successful download.



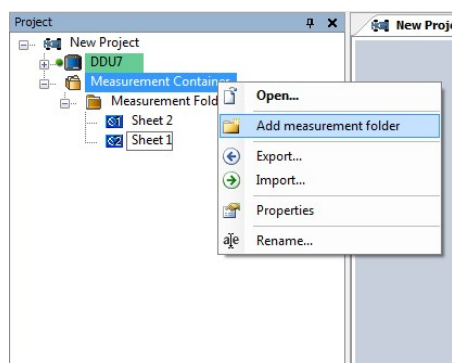
11.2 Setting up an online measurement

DDU 9 supports online measurement of sensor values and diagnostic variables.

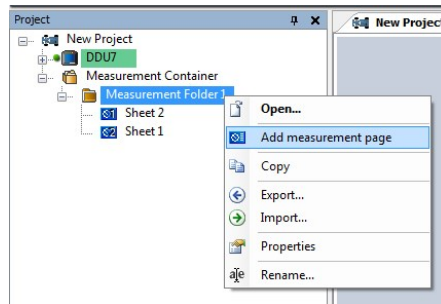
Expand 'Measurement Container' and 'Measurement Folder 1' in the Project Tree and double-click on 'Sheet1'. 'Sheet 1' is opened in a new page ('Calibration/Measuring').



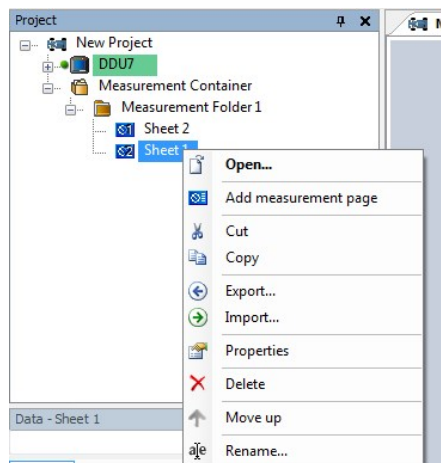
Back to page 'System', from the context menu of the project, new measurement pages can be created.



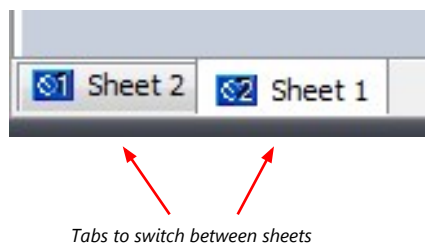
From the context menu of a measurement page, the folder can be renamed and deleted. It also allows the creation of measurement pages.



From the context menu of a measurement page, the page can be renamed and deleted.

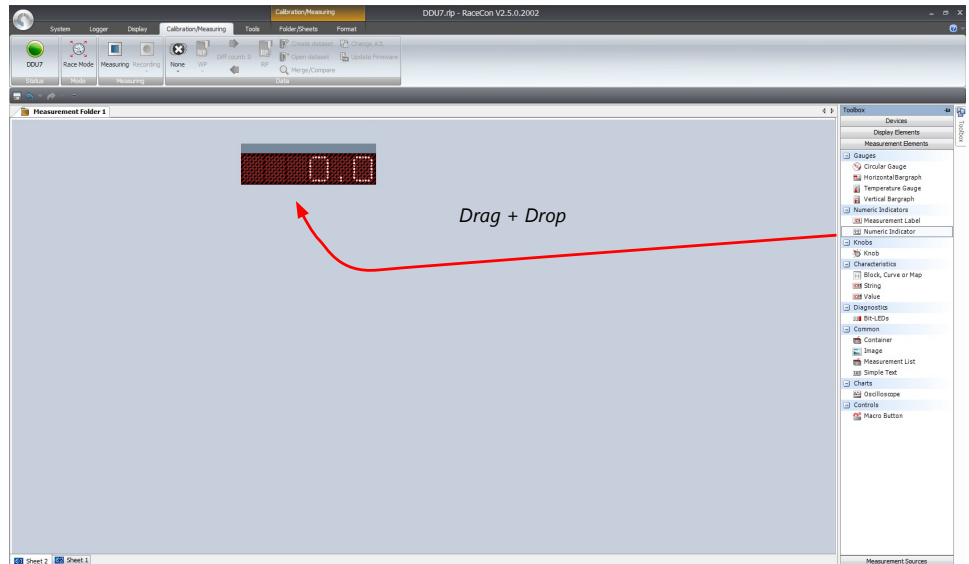


To change between different pages, click on the tabs on the bottom of the page ('Calibration/Measuring).



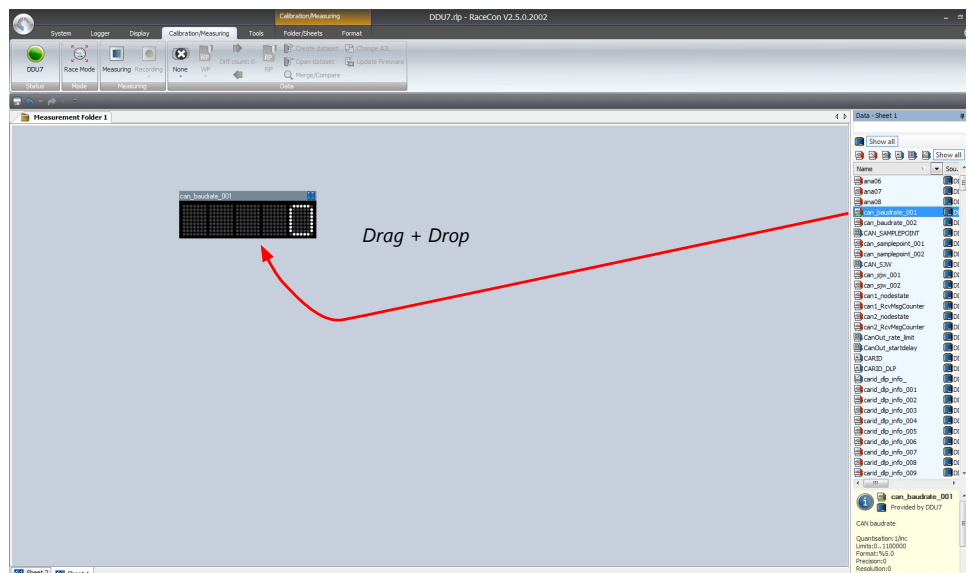
To add an element to a measurement sheet, do following steps:

1. Drag a measurement element from the Toolbox and drop it on the measurement sheet.

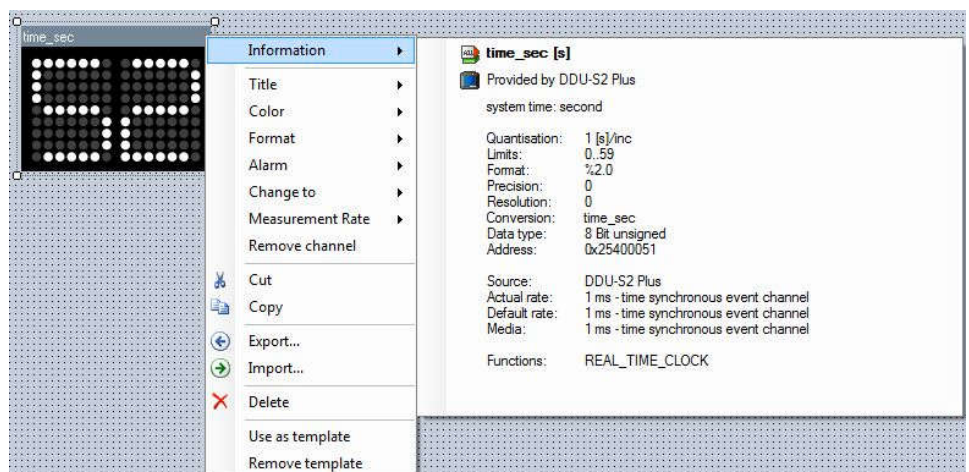


2. Select the desired measurement channel and drop it on the measurement element.

If the DDU 9 is online, the value is displayed.



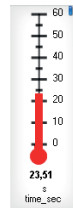
The measurement element's appearance can be changed from the context menu of the element.



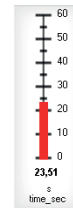
RaceCon offers different types of measurement elements:



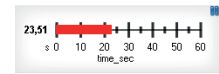
Circular gauge



Temperature gauge



Vertical Bar graph style



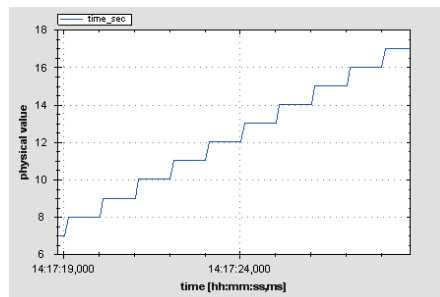
Horizontal Bar graph style



Measurement label



Numeric indicator

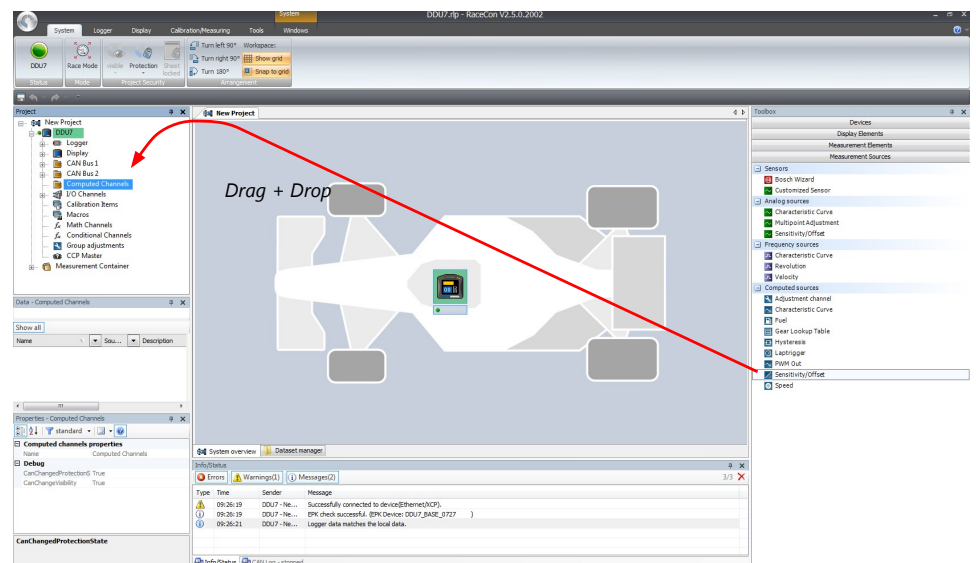


Oscilloscope (Chart)

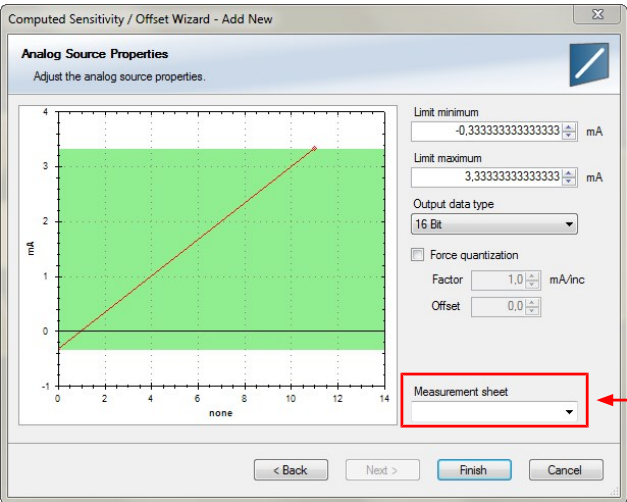
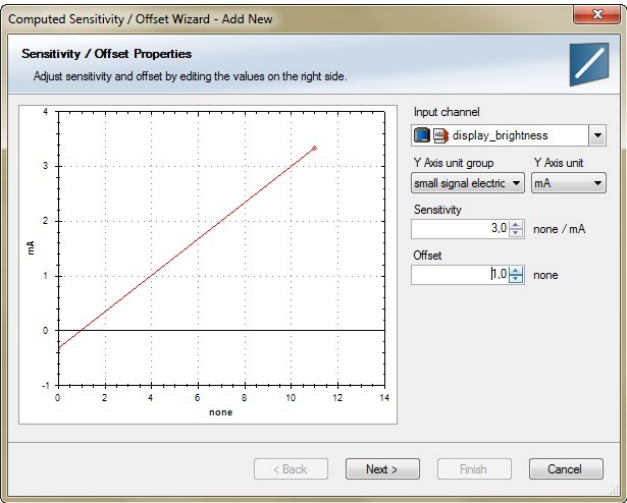
11.2.1 Automatic creation of measurement sheets

RaceCon can create measurement sheets automatically.

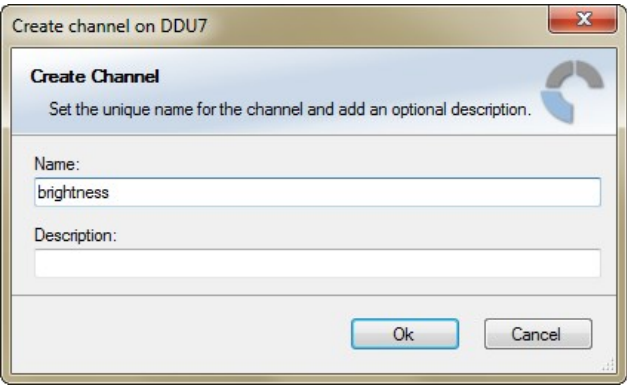
You can create and use measurement sheets with the DDU 9 as well as with all other devices connected to RaceCon.

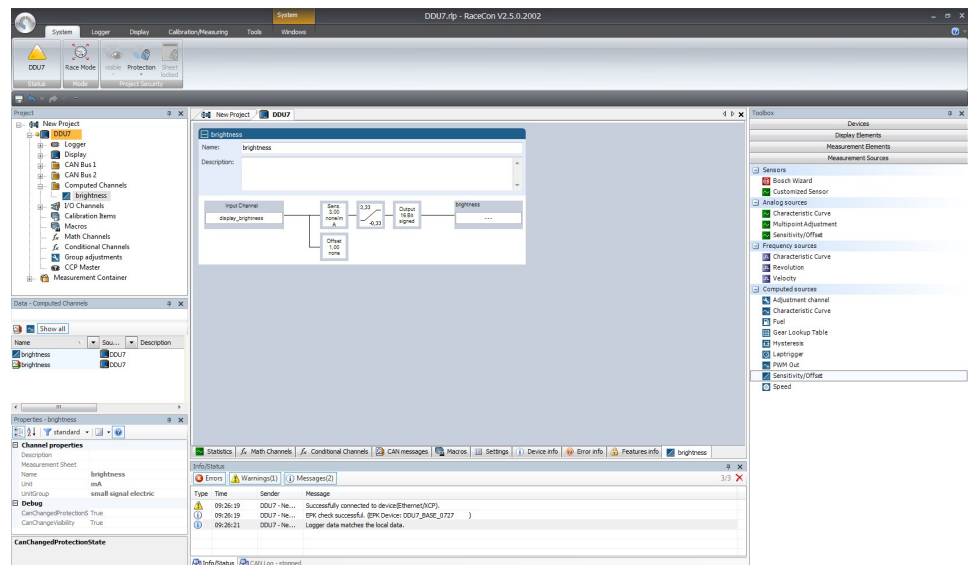


- 1. During the configuration of a measurement channel, select a measurement sheet from the list box or enter a name for a new measurement sheet.

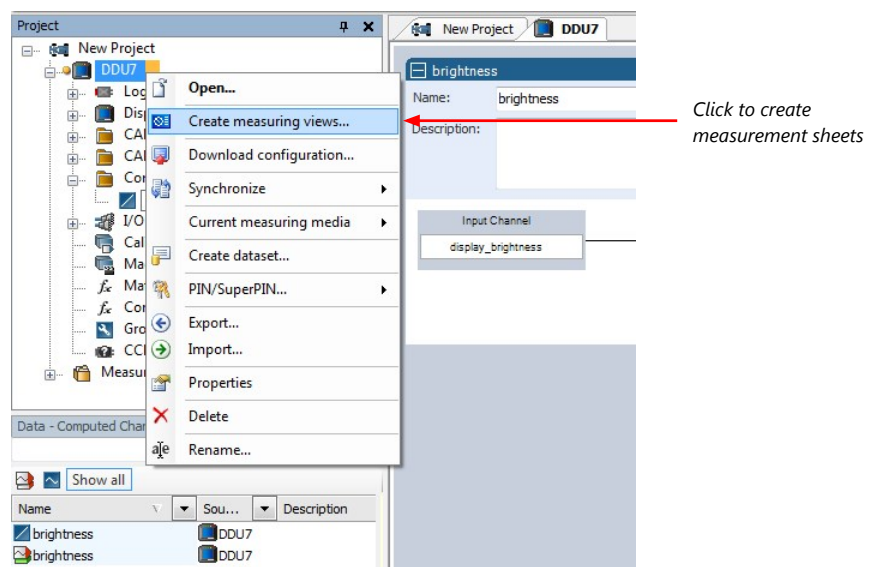


Select existing sheet
from list or enter name
of new sheet





2. To create the sheets, right-click on DDU 9 and select 'Create measurement views...' from the DDU 9 context menu.

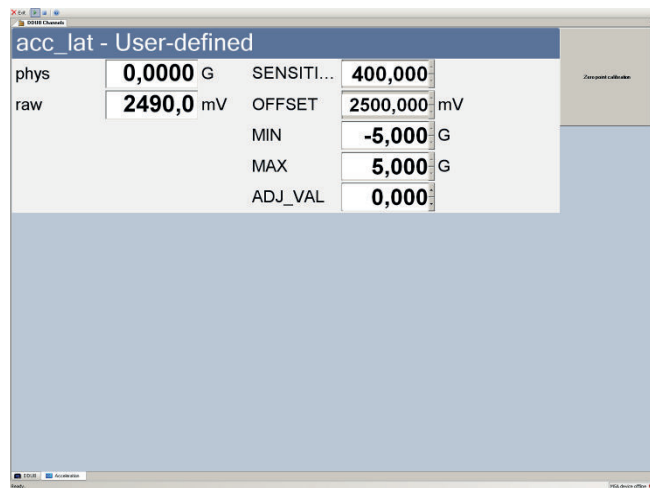


The automatically created sheet is inserted in the Project Tree under 'Measurement Container' and 'Device Channels'. If the DDU 9 is connected to RaceCon, live values of the channels are shown.

The Button "Zero Point Adjustment" is active when the DDU 9 is online. This function zeros only when this functionality is activated in the settings of this channel. (see chapter 'Enable online offset calibration for measurement channel [► 114]')

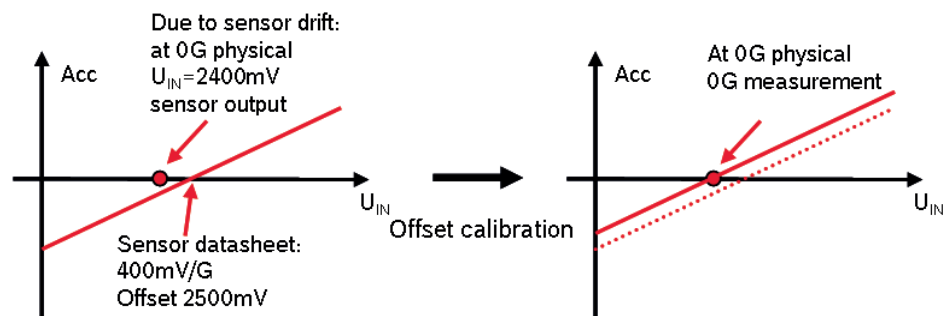
11.2.2 Using the measurement sheets

1. When RaceCon is online, press the 'F11' key to switch from 'Design Mode' into 'Race Mode'. The measurement sheet is extended to full screen. The button for offset calibration is active.
2. Switch between different sheets using the tabs at the bottom of the page or the keyboard shortcuts associated with the sheets.
3. Press the 'Esc' key to return to 'Design Mode'.



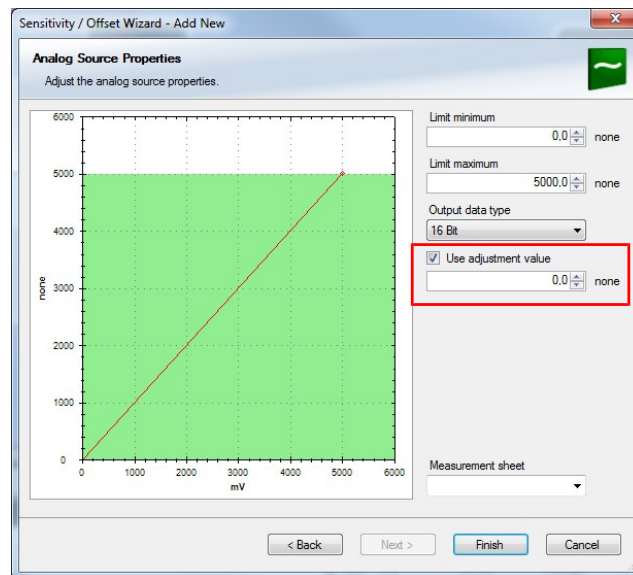
11.3 Online calibration of measurement channels

- Analog sensors drift with age, temperature, etc.
- Manual calibration is necessary
- Solution: online offset calibration
- Example: acceleration sensor



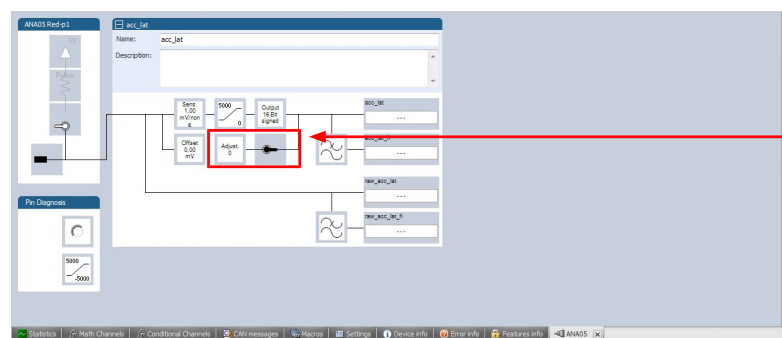
11.3.1 Enable online offset calibration for measurement channel

During creation of the measurement channel



Check box to enable online offset calibration and enter desired physical target value

In the channel view

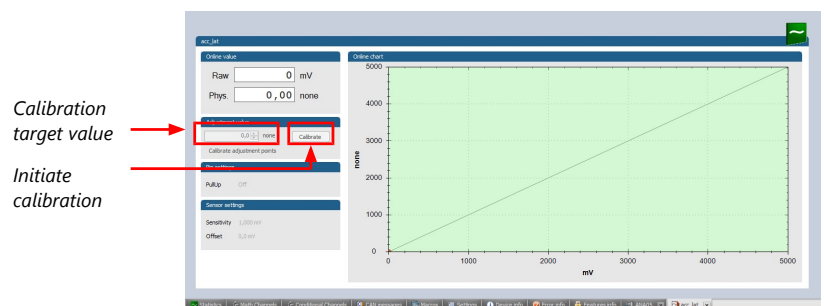


Activate switch to enable online calibration

11.3.2 Performing the online offset calibration

DDU 9 has to be connected to RaceCon to calibrate the sensor's offset.

1. Apply the desired physical condition to the sensor (e.g. 1 G to an acceleration sensor).
2. Open the measurement channel's online page by double-clicking on the measurement channel name in the Data Area.
3. Enter the physical target value (e.g. 1 G) and press the 'Calibrate' button.



The sensor's offset is now calibrated.

11.4 Group adjustment

Group adjustment is the simultaneous online calibration of several channels. This is useful e.g. to set all wheel forces and damper positions to '0' when the vehicle is positioned on a flat patch.

11.4.1 Configuration of group adjustment

Group adjustment consists of two components:

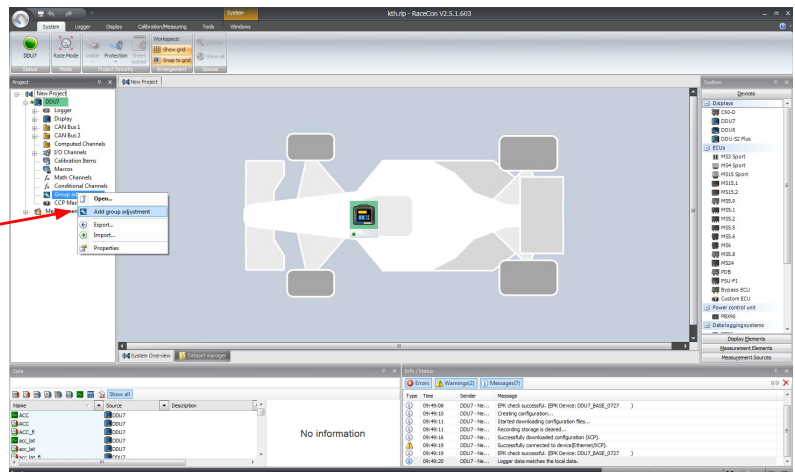
- An input channel which triggers the adjustment event
- A group of input channels linked to the group adjustment event

11.4.2 Setting up the group adjustment trigger channel

1. Click 'Measurement Sources' in the Toolbox.
2. Drag the 'Group Adjustment Channel' element from the Toolbox and drop it on the DDU 9.

A 'Group Adjustment Channel Wizard' opens.

Double-click
"add group
adjustment"



Notice

If a low-active signal is selected as an input channel, do not forget to enable the pull-up resistor for the pin. Otherwise the group adjustment will be triggered periodically.

See chapter 'Configuring a generic linear sensor [▶ 90]' for further information concerning the pull-up-resistor.

3. Click 'Next' when done.

The second part of the 'Computed Sensitivity/Offset Wizard' opens.

Notice

Working with automatically created measurement sheets is explained in chapter 'Setting up an online measurement [▶ 108]'.

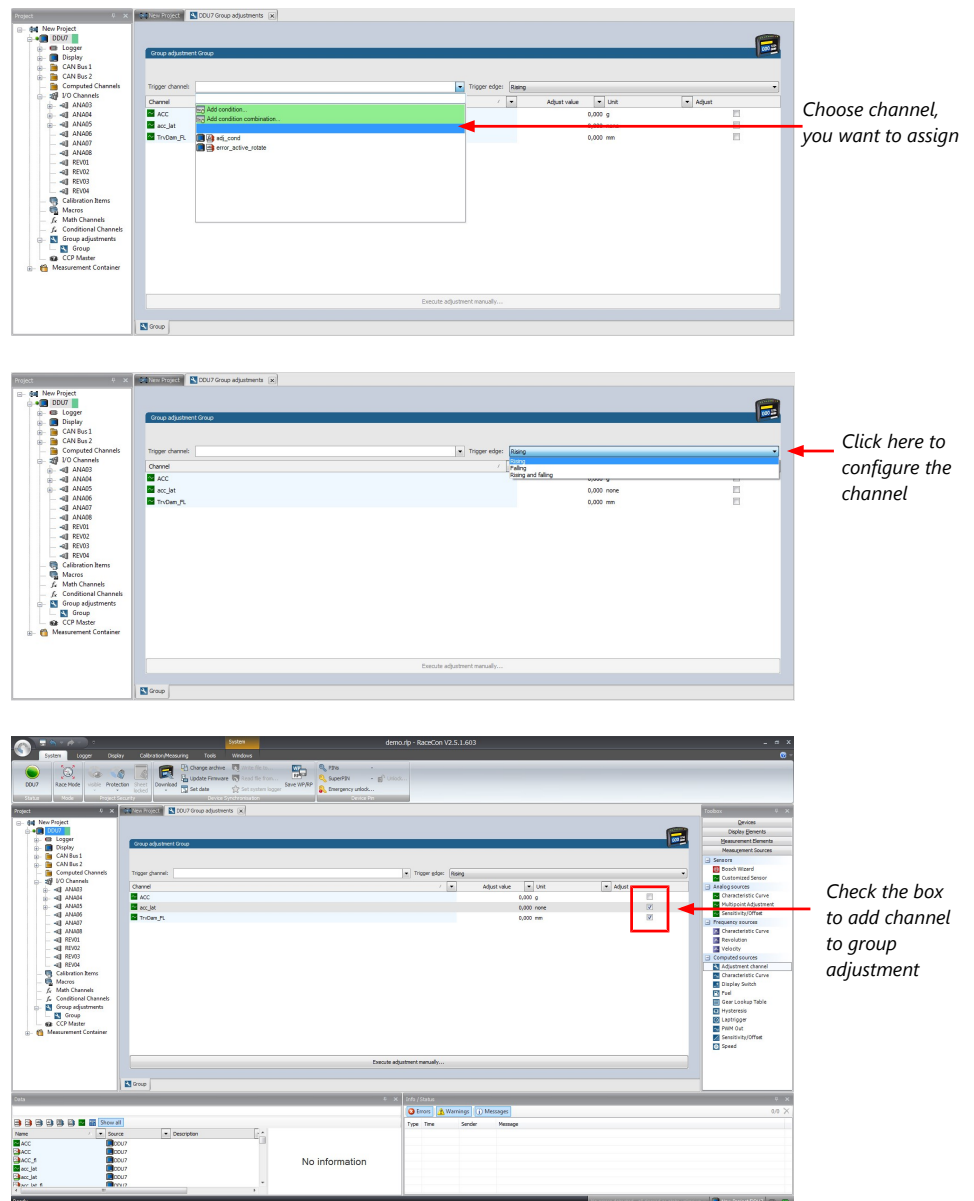
4. Click 'Finish' when done.
5. Enter channel name and description.
6. Click 'OK' when done.

11.4.3 Assigning channels to the group adjustment

1. Double-click on the created channel (e.g. 'grp_adj_channel') in the Project Tree.

In the Main Area, an overview of the available adjustment channels opens.

2. To add measurement channel(s) to the group adjustment event, check the 'Calibrate' box of the desired channel(s).



The selected measurement channels are added to the group adjustment event.

11.4.4 Triggering the group adjustment

1. Connect the input pin to GND using a push-button.
2. Make sure the pullup-resistor is enabled, if you selected 'active low' trigger polarity.
3. Double-click on the input channel 'grp_adj_channel' of the group adjustment.

4. Download the configuration on the DDU 9. To connect the DDU 9 to Race-Con, see chapter 'Connecting the unit to RaceCon [► 16]'.
5. Open a measurement sheet by clicking on the desired measurement sheet in the Project Tree.
6. Drag the 'grp_adj_channel' and the 'input_grp_adj_channel' to the online measurement sheet.
7. Press and release the push-button.
8. The measurement labels indicate the state of the input pin and the state of the adjustment.

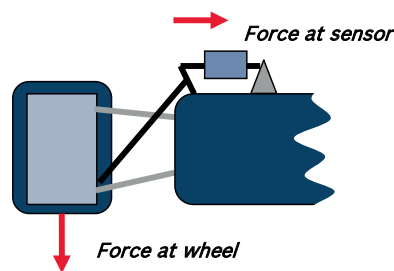
Notice

A display alarm can be linked to the trigger channel to indicate that the trigger has been detected.

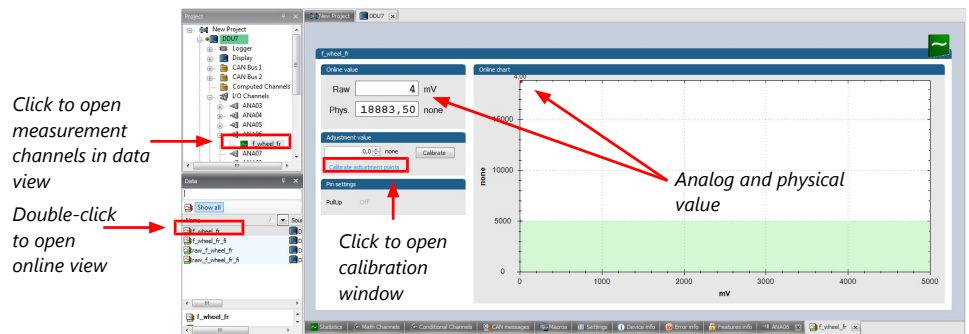
11.5 Online calibration of multipoint adjustment channels

Example: measurement of wheel force

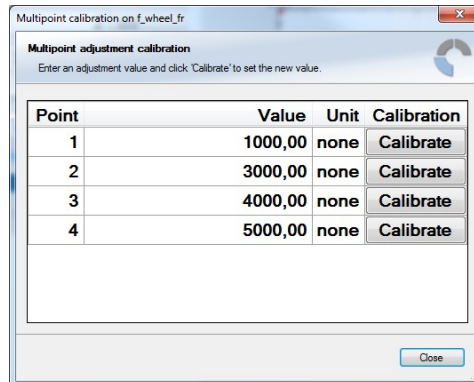
- Physical property 'wheel force' not directly measurable
- Load transfer through suspension kinematics
- Physical value at sensor position defined by vehicle
- Curve definition by online adjustment at vehicle



1. Create a multipoint adjustment measurement channel. To create a multipoint channel, see chapter 'Configuring a multipoint adjustment [► 95]'.
2. Download the configuration on the DDU 9. To connect the DDU 9 to Race-Con, see chapter 'Connecting the unit to RaceCon [► 16]'.
3. Click on the desired channel in the DDU 9 Project Tree.
4. Double-click on a measurement channel in the Data Area to open the online view.

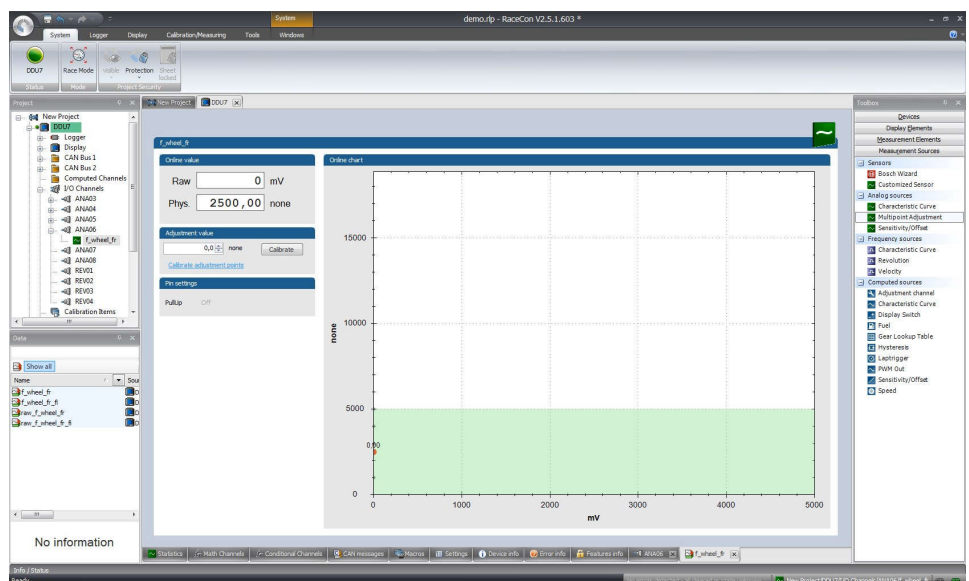


5. Click on 'Calibrate adjustment points' to open calibration window.

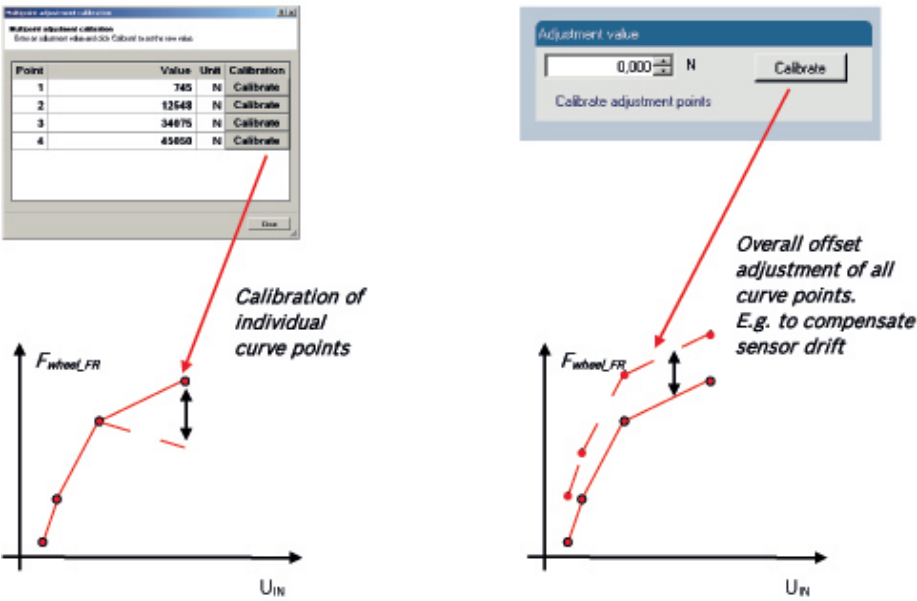


6. Apply the desired physical condition to the sensor (e.g. by applying a force on the wheel).
7. Enter the physical value in the value column of the desired calibration point (e.g. 745 N).
8. Press the 'Calibrate' button of the desired calibration point.
9. Repeat for all curve points.
10. Click 'Close' when done.

The calibration curve is displayed in the online view.



Adjustment points vs. offset adjustment



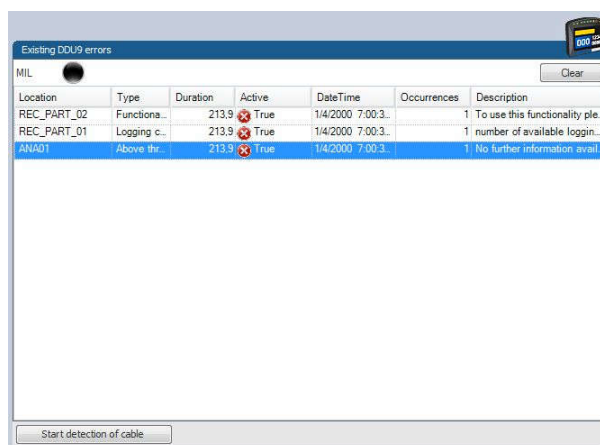
12 Error Memory

12.1 General note

In this chapter "Error Memory", a lot of screenshots are created by way of example for DDU 8. Please consider this and replace the product name 'DDU 8' in this case with the name of your product.

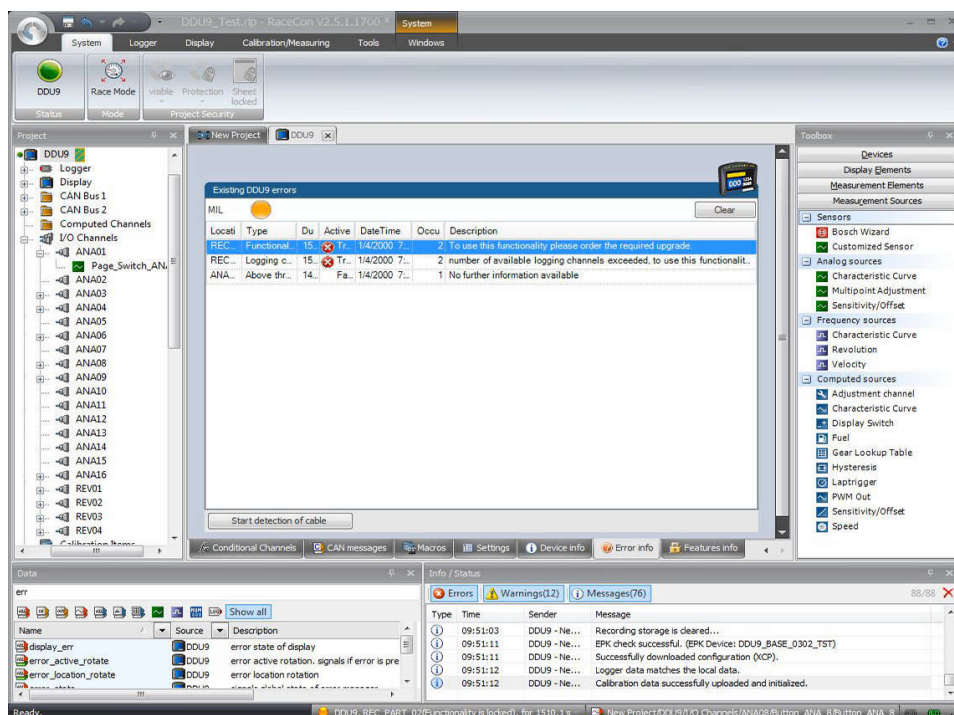
12.2 Error memory representation in RaceCon

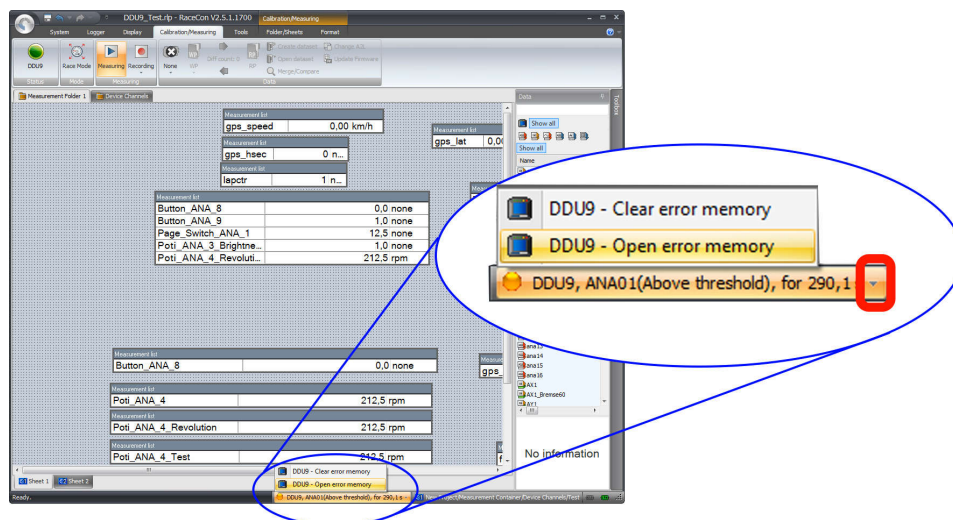
Bosch Motorsport devices feature an error memory. Information on errors can be visualized via RaceCon (online measurement) or can be transmitted via telemetry.



12.2.1 Accessing the memory

The error memory can be accessed as shown in the illustration:





The memory is situated inside the device and is non-volatile. As a consequence, an error which has occurred and has not been cleared by the user will remain in the error memory even after a power cycle. The error state will then reflect if the error is still active or not.

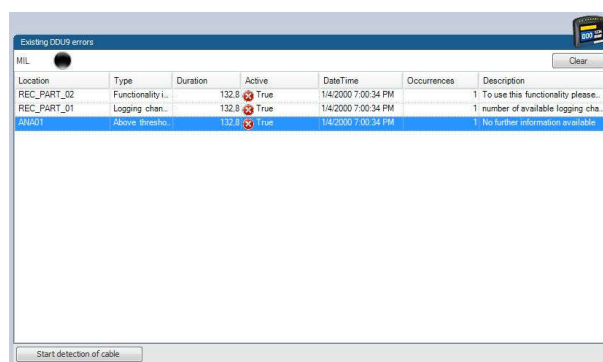
An error is deleted from the list when

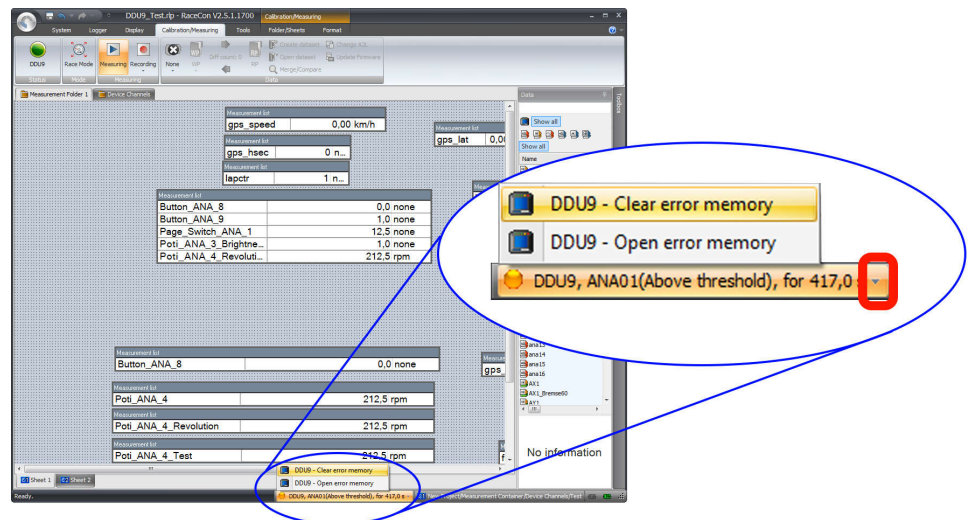
- the user actively clears the error memory
- the user updates the firmware

The error memory is not cleared by a configuration download and is not cleared by a power cycle.

12.2.2 Clearing the error memory

There are two ways of clearing the error memory, both are shown in the following illustration:





12.3 Information on errors available from the error memory

In general, properties of the error memory and properties of an individual error need to be distinguished.

12.3.1 Error Memory Properties

The following property is available for the error memory itself:

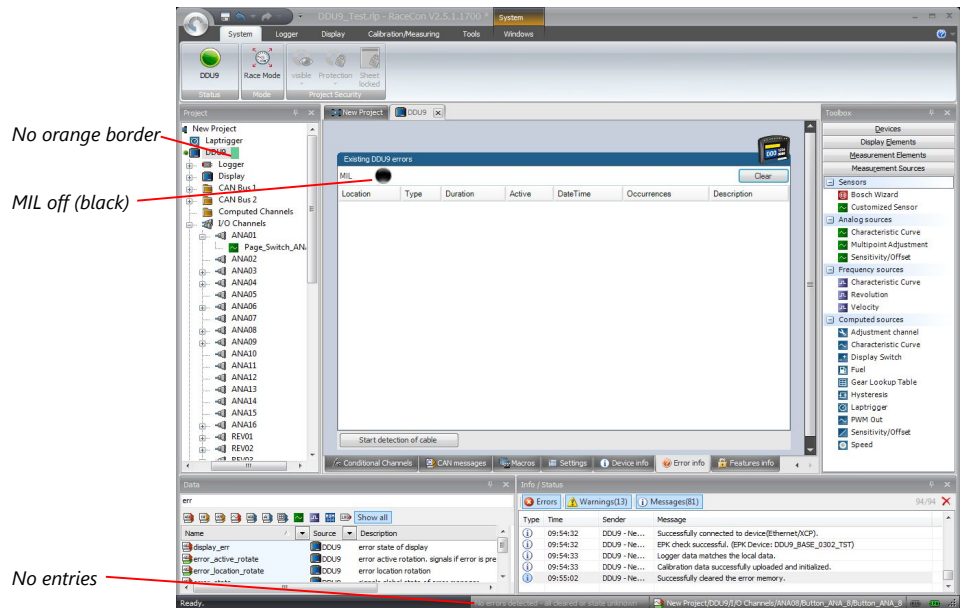
- Error Status (device measurement label "error_state")
 - 0: no error present in memory
 - 1: at least one inactive error present in memory, no active errors
 - 2: at least one active error present in memory

If displayed in a measurement sheet, this property's value (0, 1 or 2) is translated into a verbal description:

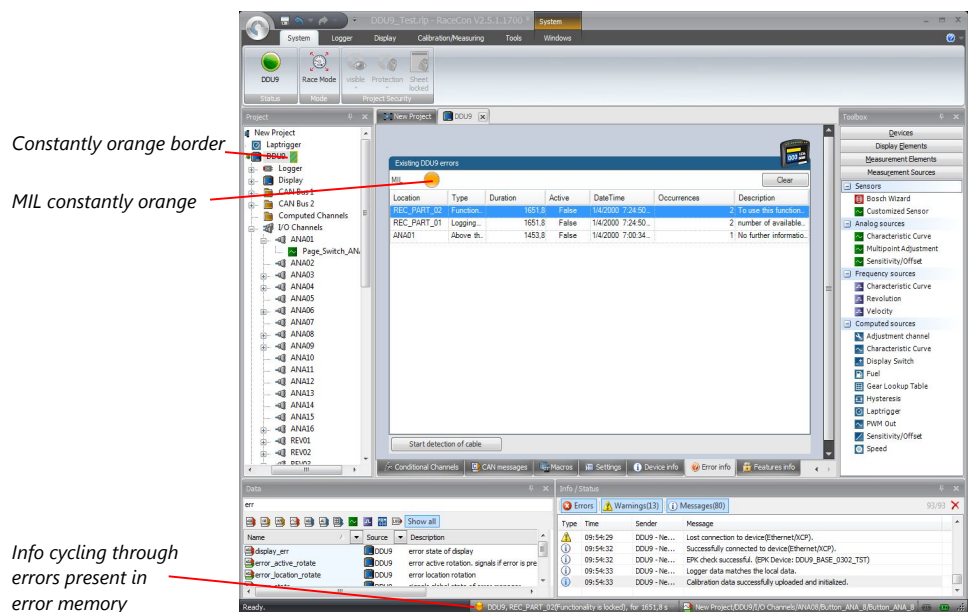
Measurement list	
error_state	Active error(s) present

It is also represented by a color scheme within RaceCon (provided RaceCon is online with the system):

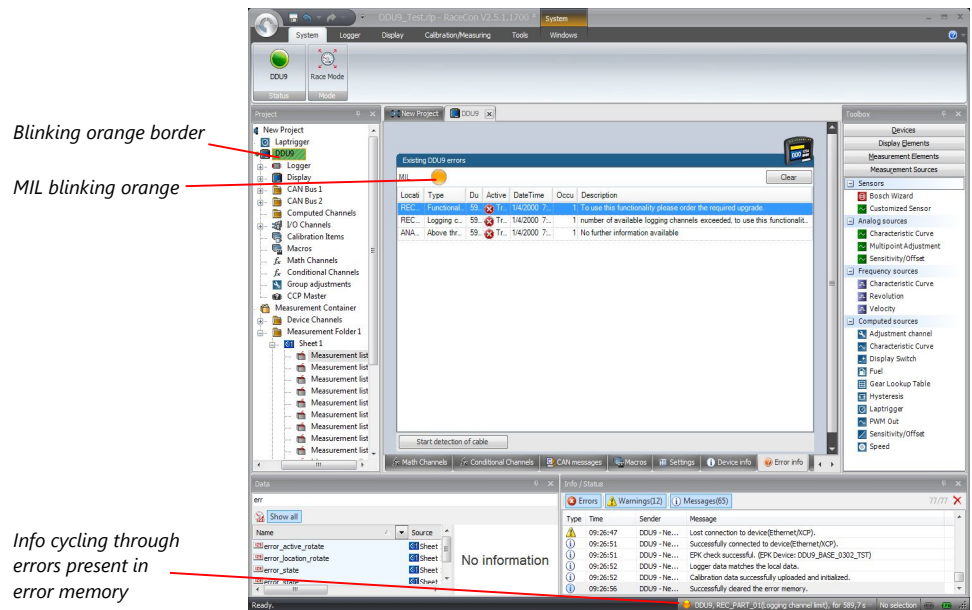
0 (no error present in memory):



1 (at least one inactive error present in memory, no active errors)



2 (at least one active error present in memory)



12.3.2 Error Properties

The following error properties are recognized and memorized inside the devices:

- Error type (device label "error_type_rotate"):

e.g. "below_threshold" for a violation of the minimum voltage range defined in the configuration, "shortcut_Batt" for a shortcut to battery voltage etc.
- Error locations (device label "error_location_rotate"):

e.g. "ANA01" for an error concerning the first ANA channel
- Error durations

For how long a period has the error been active? If an error encounters a non-active period before being cleared from the memory and is then detected again, the error duration keeps on accumulating. The number of active periods can be seen from the "number of occurrences".
- Number of occurrences

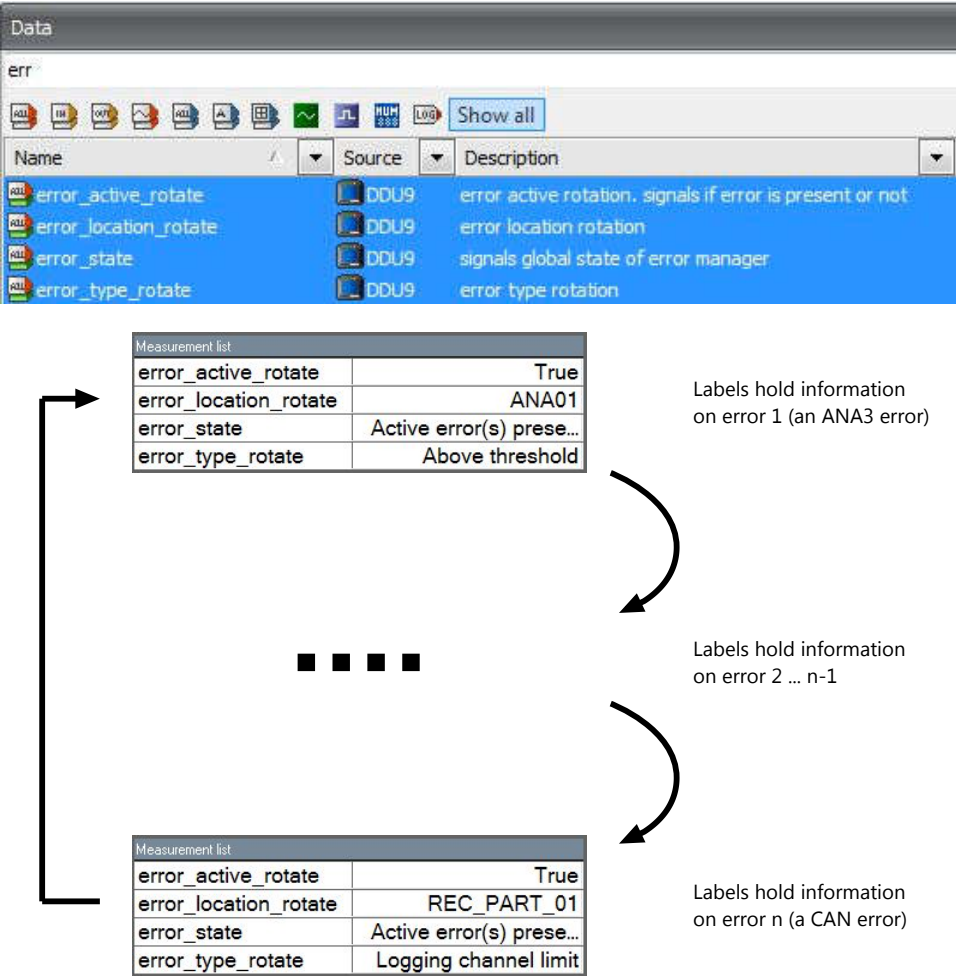
How many times has the error been detected since the last time the error memory was cleared.
- Error active state (device label "error_active_rotate")

All failure modes are continuously diagnosed; any error detected will be written to the error memory. Once an error is detected, it is qualified as "active".

 - 1 (TRUE) Error was detected in most recent diagnose run (active)
 - 0 (FALSE) Error is inactive: error was not detected in most recent diagnostic run, however the error has not been cleared from the memory by the user and remains in the non-volatile memory

The aforementioned labels (error_active_rotate, error_location_rotate, error_type_rotate) are device properties (e.g. C 60) and are not error properties (e.g. "error no. 3 from the error memory"). As a consequence, only one property label is available in each device. The errors from the error memory (possibly more

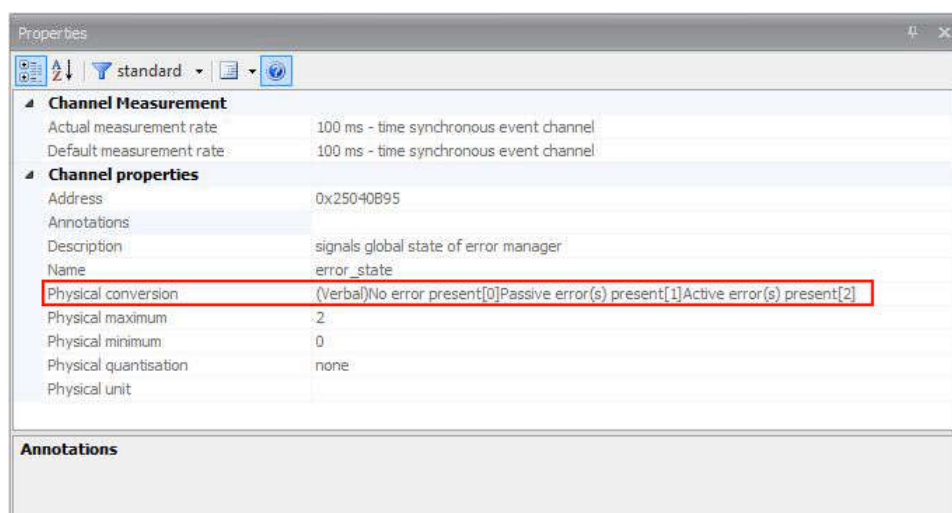
than one error possible per device) share these three labels. The labels cycle through the errors currently present in the memory and represent the respective property of each error periodically.



After the last error and its error properties have been displayed, the labels will start again with the first error in the error memory stack and its error properties will be displayed again. So, monitoring these labels over a sufficiently long period of time provides the information on all individual errors in the error memory. To understand this behavior, it is recommended to observe the three labels in a measurement sheet (while more than one error is active) and watch the values change periodically:

Measurement list	
error_active_rotate	True
error_location_rotate	REC_PART_01
error_state	Active error(s) prese...
error_type_rotate	Logging channel limit

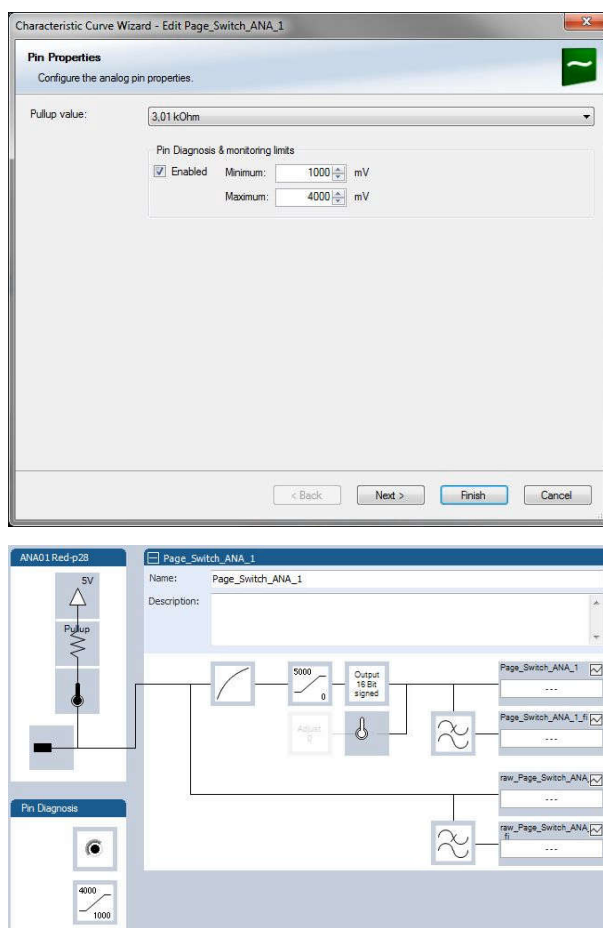
The verbal representation of the numerical codes of these labels can be visualized in the properties window of the respective label:



12.4 Configuration

12.4.1 Monitoring limits / Shortcut Detection / Cable Breakage

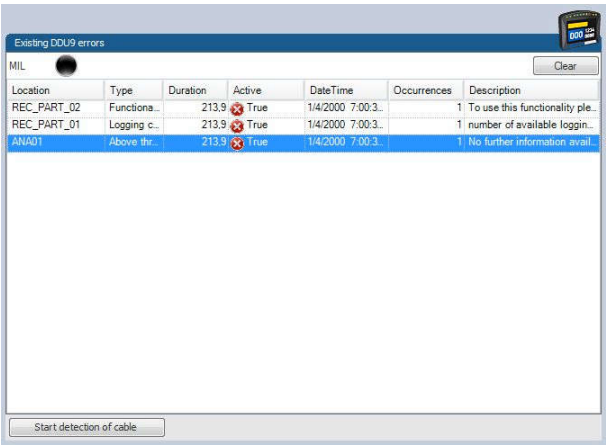
The pin diagnosis functionality (check whether measurement is within the desired range) can be activated in the ANA pin setup wizard; to allow for a diagnosis regarding shortcut to ground, shortcut to battery voltage, cable breakage, a minimum / maximum has to be defined.



12.4.2 Open Line Detection

The implementation of open line detection consists of pull up resistors being activated and deactivated; evaluating the behaviour of the measured value detects cable breakage, regardless of the pull up resistor being activated by the user.

Open line detection is triggered as shown in the illustration:



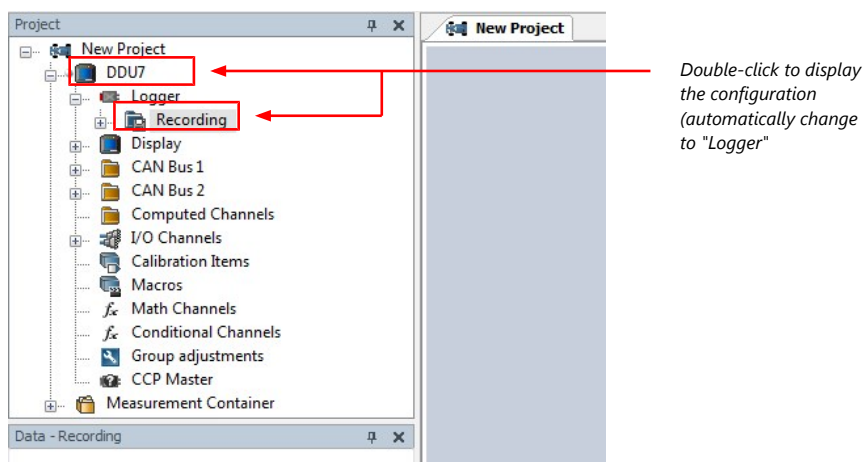
13 Recording

13.1 Features

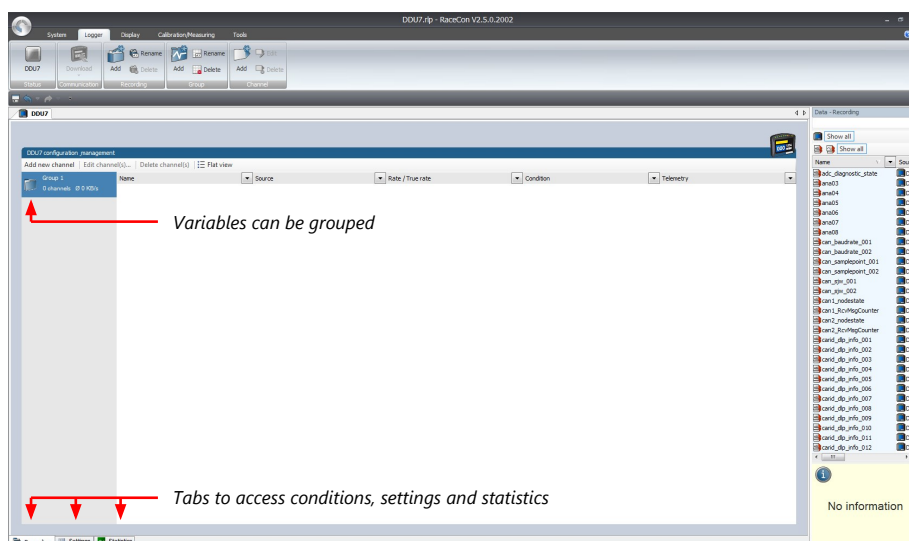
- Synchronized recording of DDU 9 analog and digital input channels, DDU 9 internal measurement channels, ECU data, Data from external sensor interfaces
- Up to two independent recordings
- Measurement rate 1 ms...1 s
- Two global start conditions (thresholds)
- Up to 16 measurement conditions (fast-slow-switches)

13.2 Configuration of recordings

1. Expand the list of 'Loggers' by clicking on '+' in the DDU 9 Project Tree.

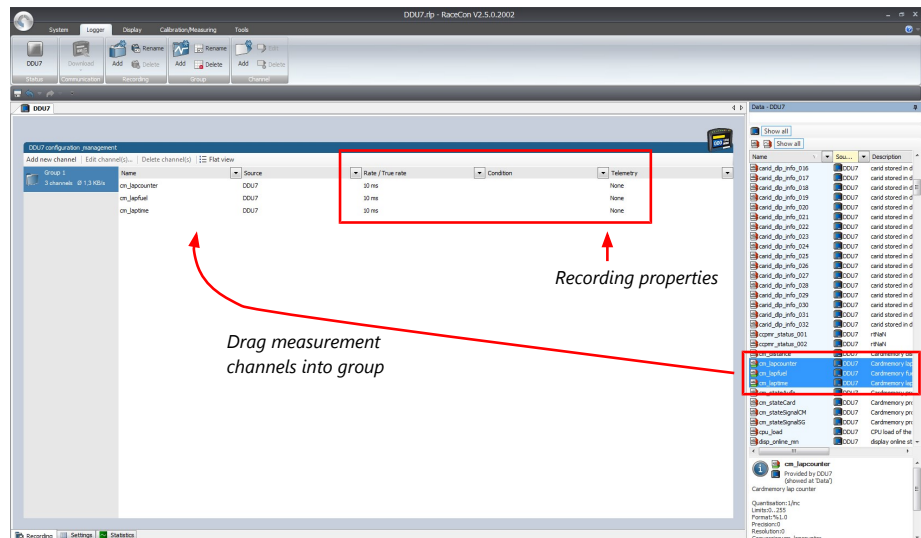


2. Double-click on 'Recording' in DDU 9 Project Tree. The recording configuration is displayed in the Main Area.

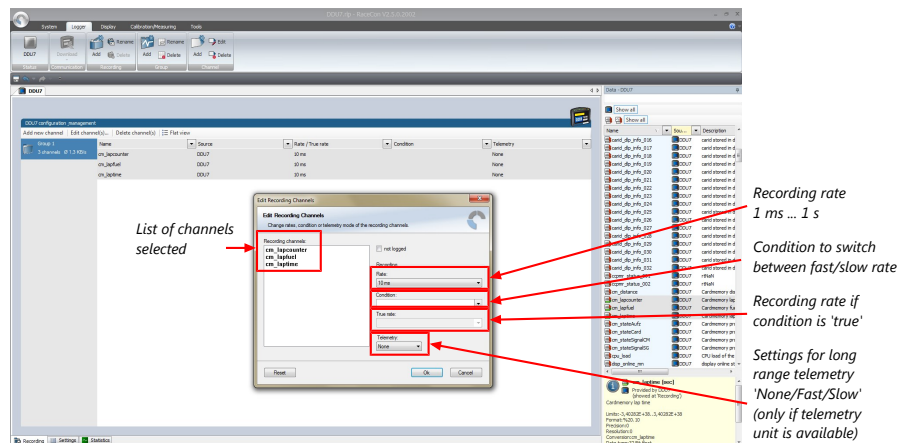


3. To add measurement channels to a recording, click 'DDU 9' in the DDU 9 Project Tree. In the Data Area, the measurement channels are displayed.

4. Drag and drop desired measurement channels into recording group.



5. To edit channel's settings, mark the channel(s) and click 'Edit Channel'. An 'Edit Recording Channels' window opens.



6. Click 'OK' when done.

Notice

If no condition is defined or condition is 'false', measurement channels are recorded at the value chosen in 'Rate'.

If the condition is 'true', measurement channels are recorded at the value chosen in 'True rate'.

Using fast block/slow block transmission

DDU 9 telemetry uses available bandwidth of Telemetry Unit FM 40 (19,200 baud -> approx. 1,700 bytes/s). The bandwidth has to be divided into channel information to be transmitted high-frequently and low-frequently using the 'fast/ slow block' setting.

Channels are grouped into 8 blocks which are transferred each cycle:

- Fast block (Block 1) is transferred every cycle and used for a high-frequent transmission of channel information (e.g. speed, rpm).
- Slow blocks (Block 2...n) are transferred every n-th cycle and used for a low-frequent transmission of channel information (e.g. tire pressure, oil temperature).

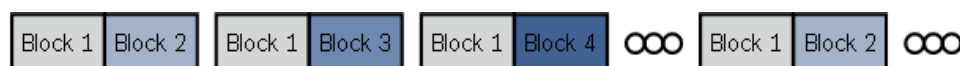


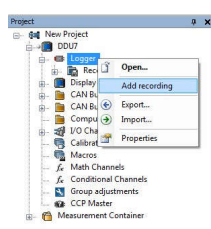
Fig. 1: Transmission Scheme

If the maximum bandwidth of a block is reached, a warning will be displayed. To fix this problem you can view the allocation of the channels and data rate in the 'Statistics' tab of the Main Area. See chapter 'Recording statistics [▶ 132]' for more information.

13.2.1 Adding a recording

DDU 9 supports up to two independent recordings.

To add a recording, select 'Add Recording' from the context menu of the Logger in the DDU 9 Project Tree.

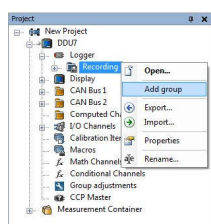


Maximum two recordings are possible. In the device software the 2nd recording is reserved for scruteneering data. This recording is invisible (protected).

13.2.2 Adding a recording group

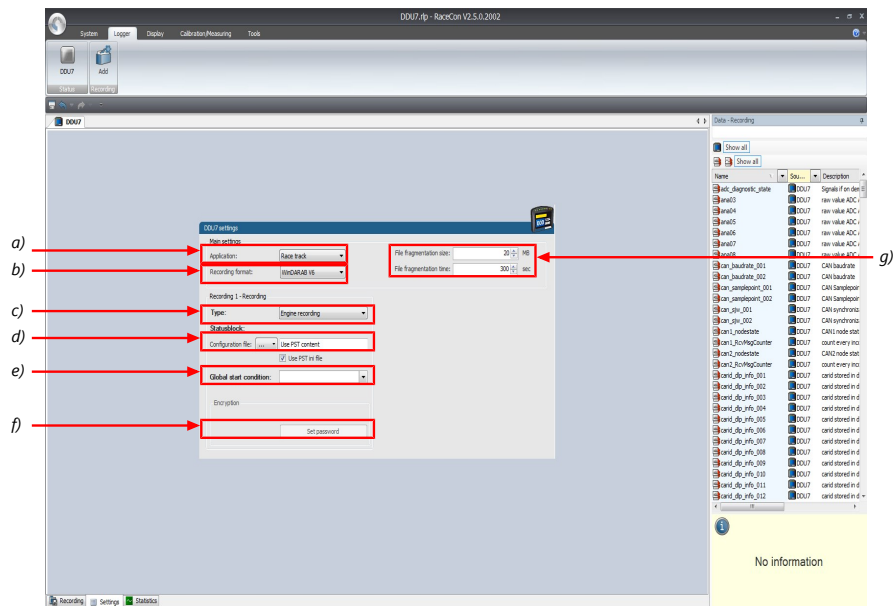
Recording channels can be grouped.

To add a new group, select 'Add group' in the context menu of the recording. The groups can be renamed to 'Gearbox', 'Aero', 'Engine', etc.



13.2.3 Global settings

To display the global DDU 9 settings, select the 'Settings' Tab.



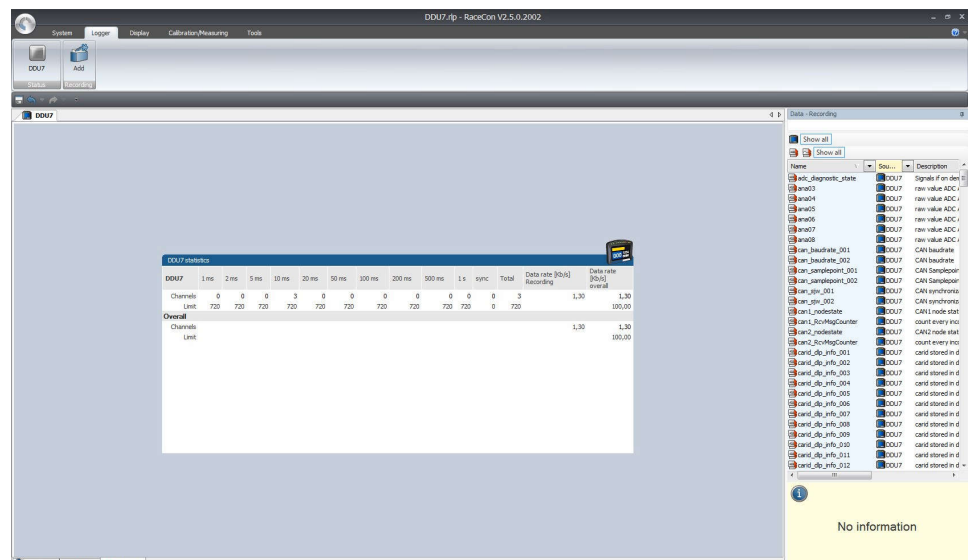
- Choose setting for outing counter mode:
 - For testbench (without lap trigger) select 'Testbench'.
 - For racetrack (with lap trigger) select 'Racetrack'.
- Choose your WinDarab version. In V6 the file is encrypted by WinDarab. In V7 you can enter an optional self created password in the 'Encryption' field shown in f).
- Choose Baud rate of CAN bus 1 and 2.
- Select 'Type' [Funktion neu, Bedeutung klären]
- Choose or create the condition to start recording.
- If selecting WinDarab V7 in b), enter a password hint and a password (optional).
- Setting for automatic fragmentation. Do not change!

13.2.4 Recording statistics

The tab 'Statistics' shows the channels' allocation and their current data rate related to the transmission frequency of the DDU 9 and the whole transmission system.

The overview helps to detect bandwidth bottlenecks of channels. Bandwidth bottlenecks can be solved by changing the 'fast/slow block' setting for each channel.

The data rate of the whole system is often less than the data rate of the DDU 9 and limits the overall transmission speed.



13.2.5 Recording diagnosis

The channel 'statectrl_ok' of the DDU 9 can be used for online monitoring of recording status.

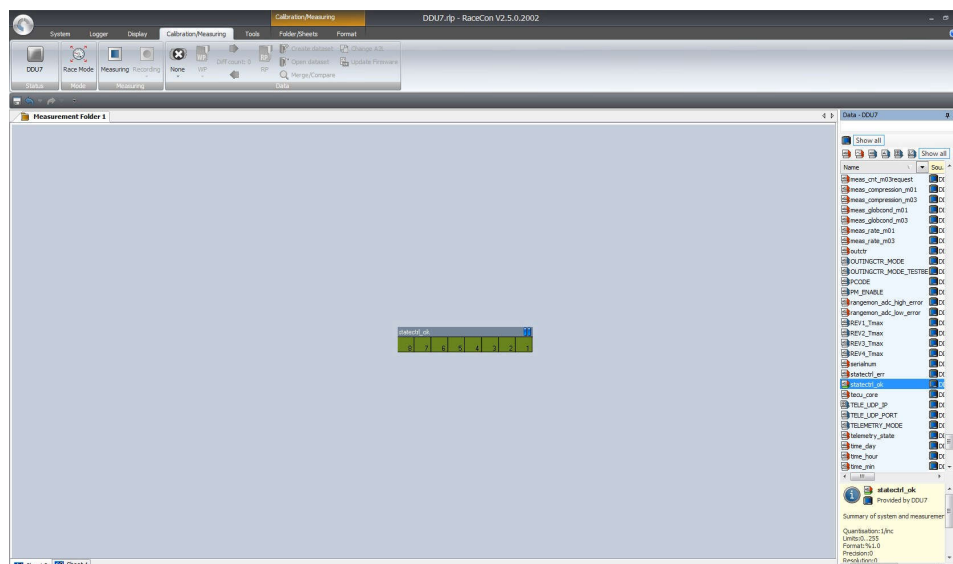
Bit	Value	Name
0	1	RECORD
1	2	DATAOK
2	4	BLKOK
3	8	-
4	16	-
5	32	-
6	64	STARTED
7	128	-

Content of status bits

Name	Bitset	Bit cleared
RECORD	Measurement data is recorded.	No measurement data will be stored because measurement thresholds are not reached.
DATAOK	Received data without error.	Discarding received data because of wrong timestamps. Check wiring of SYNC signal.
BLKOK	All measurement blocks have been set up correctly.	Some measurement blocks have not been set up correctly.
STARTED	A measurement has been set up.	A measurement is not set up. Either no recording configuration has been found or logger software upgrade is not activated.

13.2.6 Displaying online recording diagnosis ('statectrl_ok')

1. To add a Recording Diagnosis element to a measurement sheet, change to page "Calibration/Measuring" and drag a 'Bit-LED' element from the Toolbox and drop it on measurement sheet.
2. Drag channel 'statectrl_ok' from the Data Area and drop it on the 'Bit-LED' element.

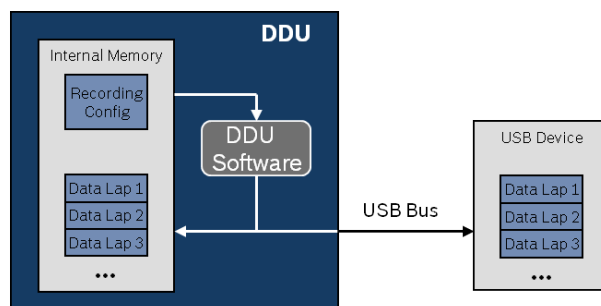


The 'Bit-LED' element shows the state of received channel data in bit-representation. A green highlighted channel means 0, a red highlighted channel means 1.

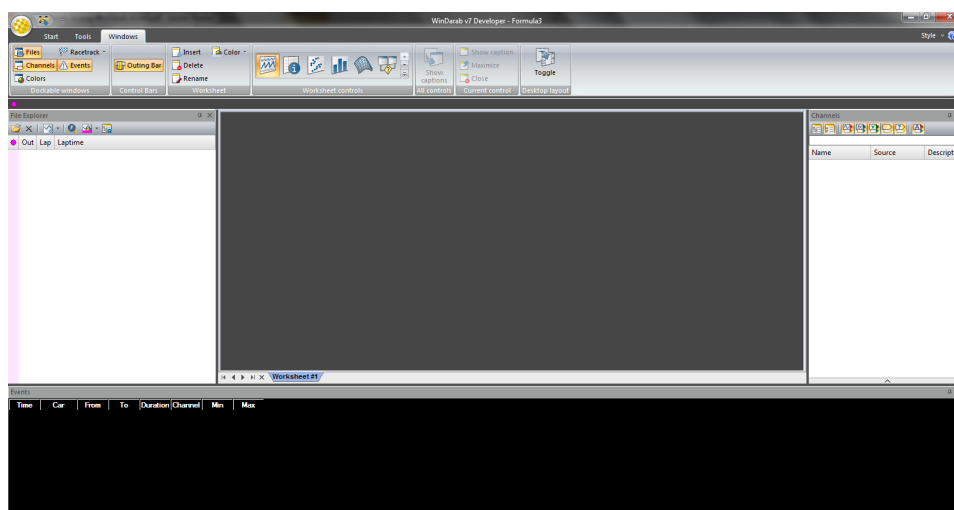
- Measurement correctly initialized, but recording threshold(s) not reached: 254
- Measurement correctly initialized, DDU 9 is recording data: 255
- Values less than 254 indicate an error state
- 'statectrl_ok' can be linked to an alarm on the display. See chapter "Alarm display element ▶ 331" for details.

13.3 Recording data on USB device

1. Plug an USB device to DDU 9.
2. Prepare a recording configuration in RaceCon.
3. Power on the system and connect with RaceCon to the vehicle.
4. Download the configuration to the DDU 9.
5. Record measurement data. If an USB device is present, the DDU 9 stores the data in parallel on the internal memory and the USB device.

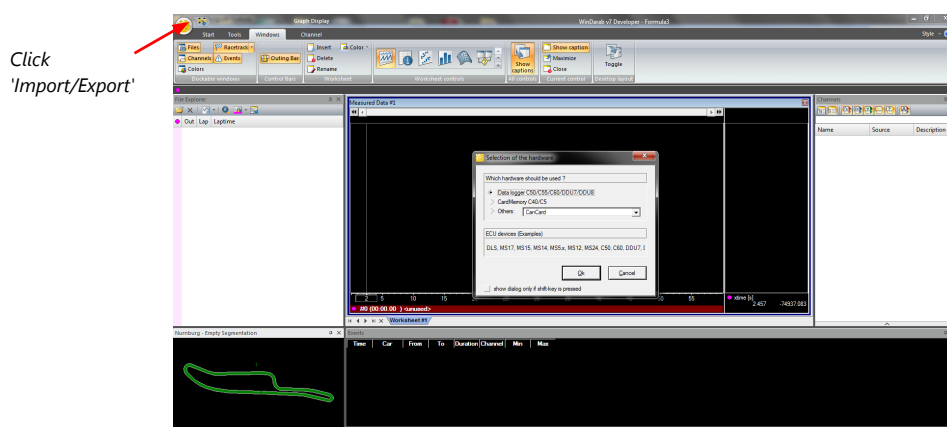


6. Power off the system.
7. Remove USB device from the vehicle.
8. Start the WinDarab software.

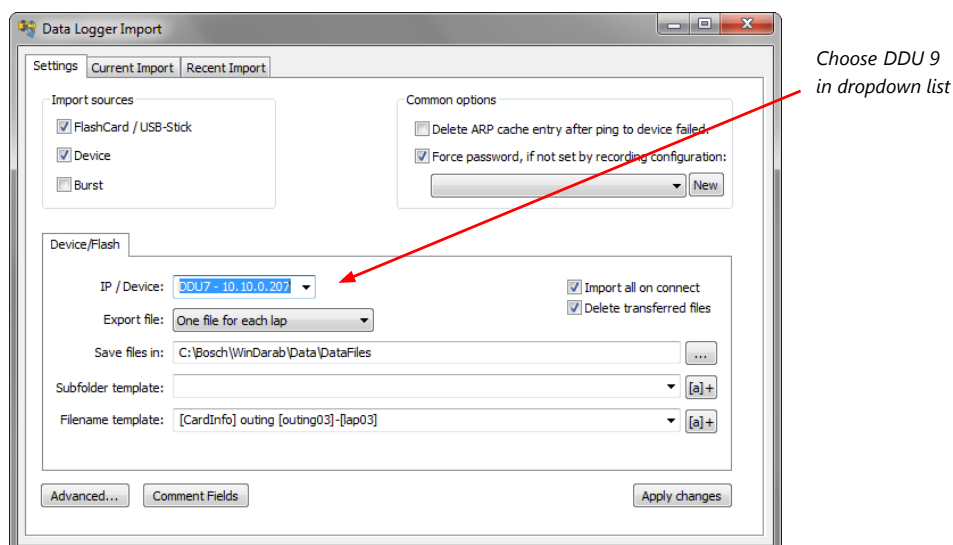


9. Click on the 'Import/Export' icon.

10. Select 'Data logger CXX/DDUX/MSX and click 'OK' when done. The 'Read measurement data' dialog opens.

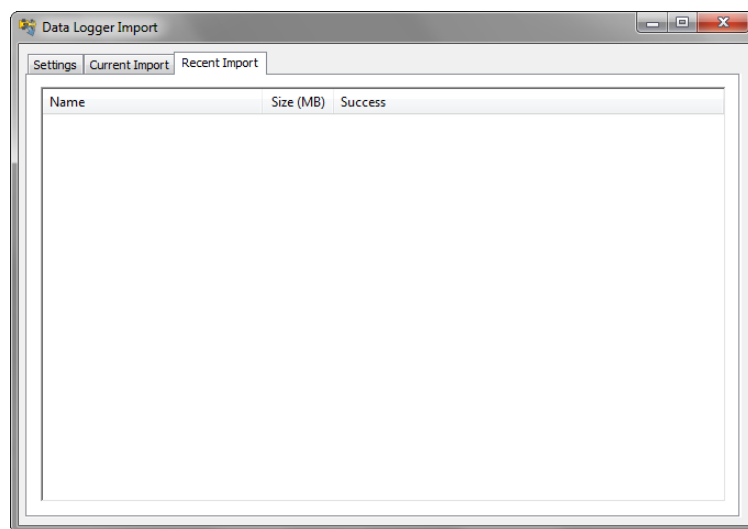
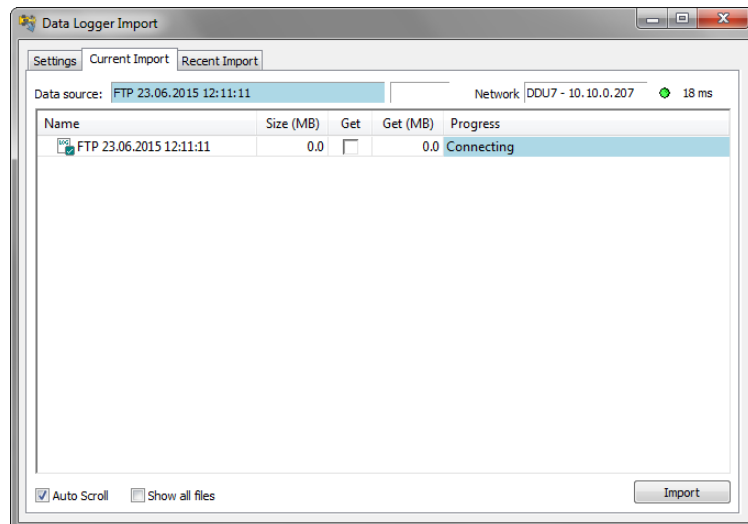


11. Click on 'Settings' tab and select the option 'Flash Card/USB Stick'.

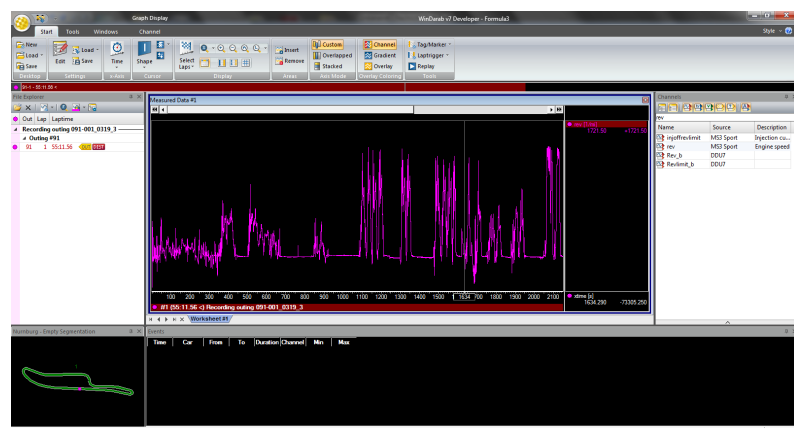


12. Activate 'Apply changes'.

Insert the USB device into the PC. Data transmission from device starts automatically. Measurement files are stored automatically in the base folder.



13. Click 'Close' when transmission has finished.
14. Click on the Start button and choose 'Open measurement file'.
15. Select the measurement files from the storage folder.
16. Click on 'Open'.
17. Click in 'New Desktop' to open a new measurement data window.
18. Drag the desired measurement channel from the Channel list and drop it into the measurement data window. The measurement channel's graph is displayed



Notice

For more detailed descriptions and instructions refer to the WinDarab V7 manual.

13.3.1 USB device handling hints

Using the USB device

Always plug the USB device into vehicle before power up to ensure that all measurement data is stored on the USB device.

If the USB device is plugged in after recording has started, the existing recording is saved.

Data recorded on the DDU 9 before the USB device is plugged in will not be saved.

Removing the USB device

Always power off the system before unplugging the USB device!

If the USB device is unplugged while recording is active, parts of the measurement data may be missing.

If the USB device is unplugged and re-inserted for < 4 s while the DDU 9 is powered up, the DDU 9 still records data.

If the USB device is unplugged and re-inserted for > 4 s while the DDU 9 is powered up or a different USB device is plugged in, the DDU 9 restarts. In this case, the DDU 9 is not operational for 1.5 s.

13.3.2 Troubleshooting

When no data on the USB device is recorded:

Configure the measurement label **usb_mediastate** on a RaceCon measurement view or on a DDU 9 display page.

The value of **usb_mediastate** reflects the operating condition of the USB bus:

State	Description
0: Wait: Device not found	The USB device is not found (also: waiting for re-plug stick). No USB device inserted. USB device is defect. No electrical connection or wiring harness problem. USB software upgrade not activated (Purchase of unlock code needed).
1: Wait: Device detected	An USB device is found, but not yet installed.
2: Ok: Media installed	The USB device is found and is operational (idle). This does not imply that recording data is written!
3: Stop: Device unplugged	The USB device has been removed. The DDU 9 performs a restart when an USB device is re-plugged in.

State	Description
4: Ok: Media access	Data is currently read from/written to the USB device.
5: Error: Media error	The communication to the USB device broke down. The USB device is defect. The USB device is not supported by DDU 9.
6: Error: Media corrupt	The USB device is not in valid BFS format. (Hint: Re-format the USB device in RaceCon.)

14 Lap Trigger

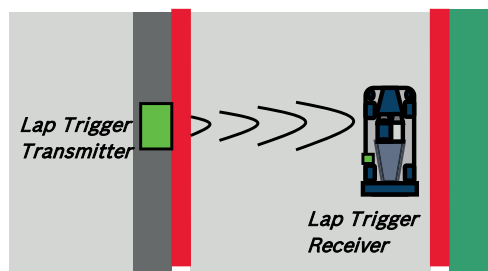
14.1 Lap trigger (timing beacon)

Why do we need a lap trigger (timing beacon)?

- Vehicle lap time measurement
- Calculation of lap-dependent functions (lap fuel consumption, min/max values)
- Calculation of lap distance dependent functions
- Control of data logging system

System consists of

- Transmitter (trackside unit)
- Receiver (in-vehicle unit)



Types of systems

- GPS based (low cost, low precision)
- IR based (low cost, high precision, limited reliability)
- RF (microwave) based (high precision, high reliability)

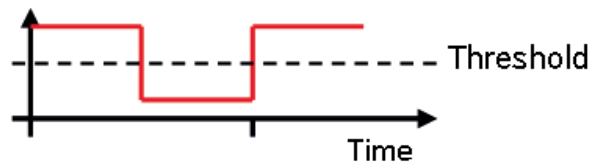
14.1.1 Electrical trigger signal

In DDU 9 all sources of measurement channels can be used as trigger signal.

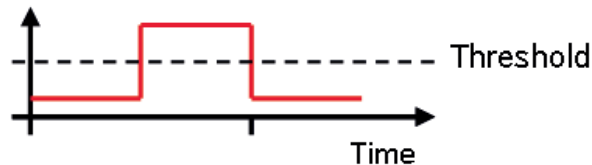
- Analog input
- Digital input
- CAN input

Signal (measurement channel) properties

Low active signal (Bosch triggers): Trigger releases if signal is below the threshold.



High active signal (other manufacturer's triggers): Trigger releases if signal is above the threshold.



Two types of trigger signal:

- Main trigger (end-of-lap at start/finish line)
- Sub-trigger (segment time, optional, not applicable with GPS lap trigger)

Bosch standard:

- Main trigger 20 ms, low active (Recommendation for RaceCon "Detecion Time" setting: 15 ms, Setting must be a slightly shorter period than the signal length of the trigger to avoid a missed trigger due to the update rate)
- Sub trigger 40 ms, low active (Recommendation for RaceCon "Detecion Time" setting: 30 ms)

14.1.2 Software functionality

- Race track topology and transmitter location frequently cause false triggers.
- Software functionality prevents acceptance of false triggers.
- Under race conditions, trigger signals are sometimes missed. Software functionality introduces 'forced trigger'.

14.1.3 Prevention of false triggers

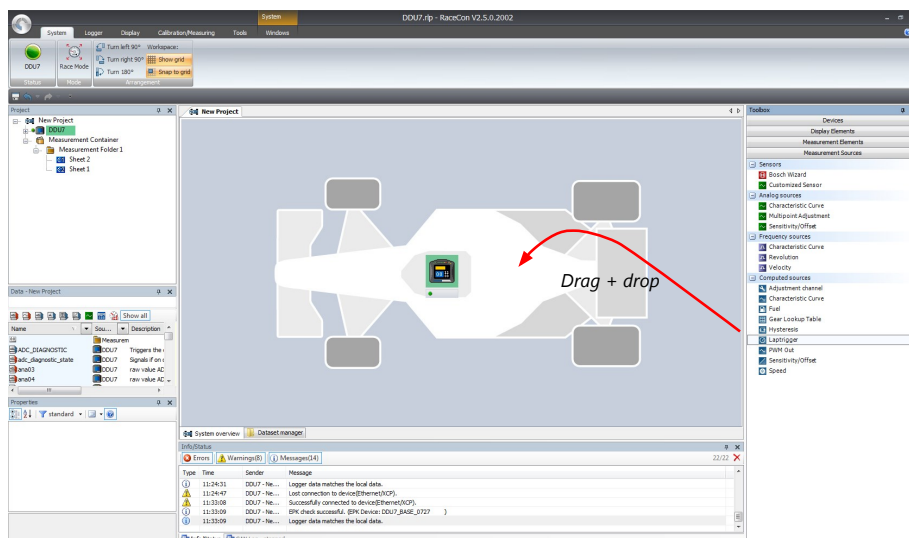
- Minimum vehicle speed for acceptance of trigger prevents false triggers while vehicle is stationary in the pits.
- Time based re-trigger protection prevents false triggers due to signal reflections on main straight.
- Lap distance based retrigger protection prevents false triggers due to track topology.

14.1.4 Forced triggers

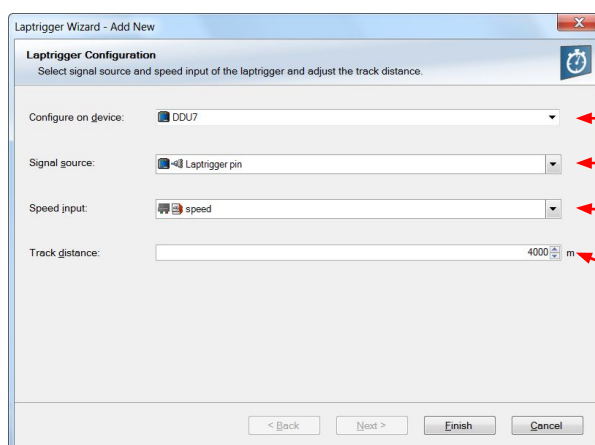
Lap distance based insertion of 'forced trigger'.

14.1.5 Setting up a lap trigger

1. Click 'Measurement Sources' in Toolbox.
2. Drag 'Laptrigger' into 'System Overview' and drop it on vehicle. Do not drop it on 'DDU 9'!



A 'Laptrigger Wizard' window opens.



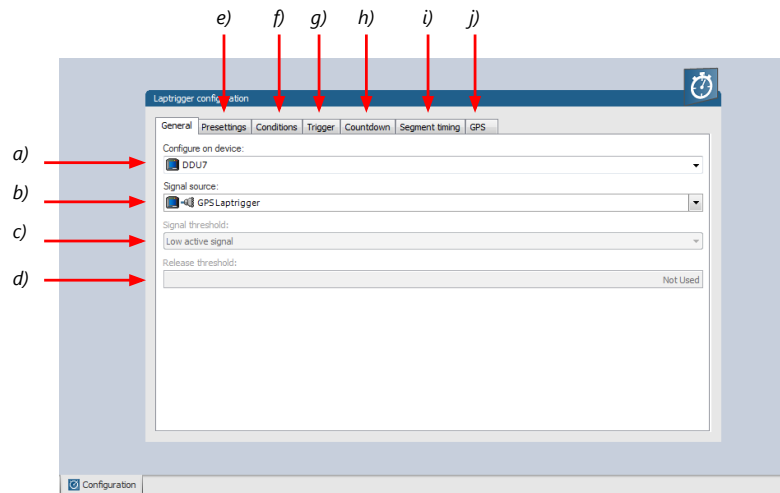
- Choose the signal device for the trigger signal
- Choose the signal channel for the trigger signal
- Choose the source for the vehicle speed
- Enter the distance of the racetrack

3. Click 'Finish' to complete the operation.

Notice

In this example, the Rx is connected to the dedicated lap trigger pin of DDU 9. The channel 'speed' is calculated from 4 wheel speeds.

A pre-configured lap trigger window opens.

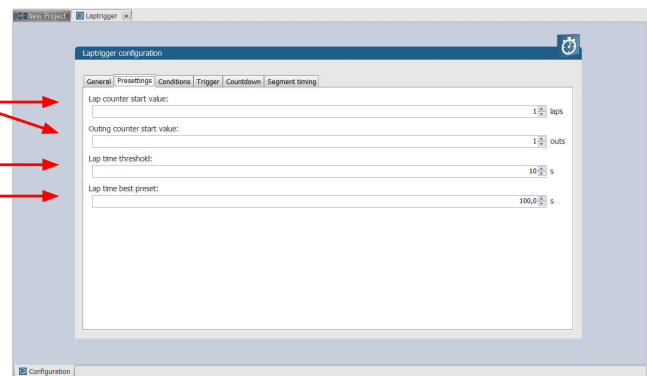


- a) Change signal device, if desired.
- b) Change signal channel, if desired.
- c) Choose signal threshold. See chapter 'Electrical trigger signal' for details.
- d) Define threshold of input channel signal when trigger is released. Only possible, if no digital source is selected as signal source.
- e) Define presets for trigger. See chapter 'Lap trigger presets' for details.
- f) Define condition settings; change signal for vehicle speed, define speed settings. See chapter 'Distance based retrigger protection' and 'Distance based forced trigger' for details.
- g) Define settings for main trigger. See chapter 'Lap timing' for details.
- h) Define settings for countdown timer. See chapter 'Countdown timer' for details.
- i) Define settings for sub trigger. See chapter 'Segment timing' for details.
- j) Define settings for a GPS lap trigger. See chapter 'GPS lap trigger' for details. Only applicable if the signal source is set to 'GPS lap trigger'.

Preset values for lap counter and outing counter

Minimum laptime that a new 'best laptime' is accepted

Preset value for 'best laptime'

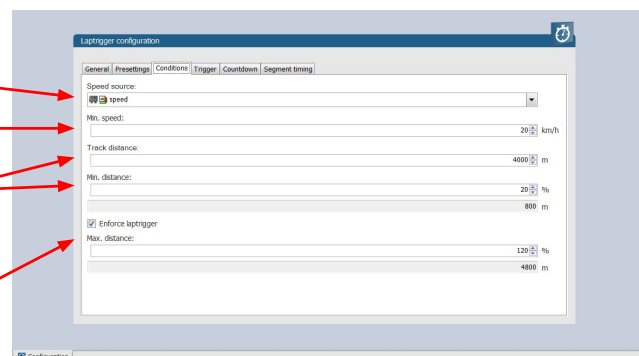


Change signal for vehicle speed, if desired.

Enter minimum speed for trigger release.

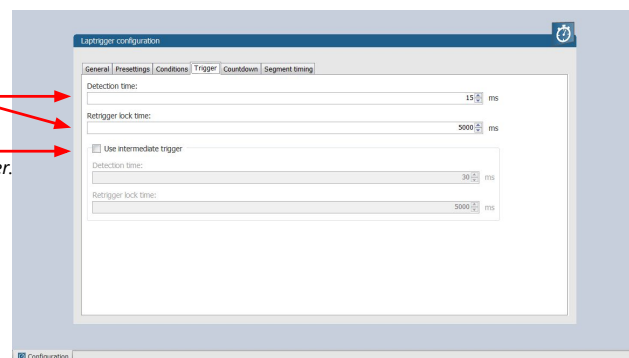
Define settings for distance based retrigger protection.

Define settings for distance based forced trigger.

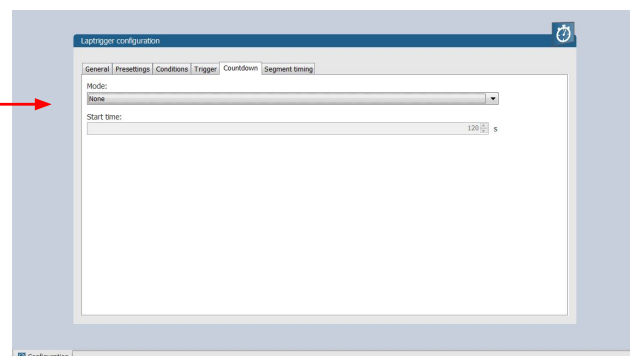


Define settings for lap timing
(main trigger).

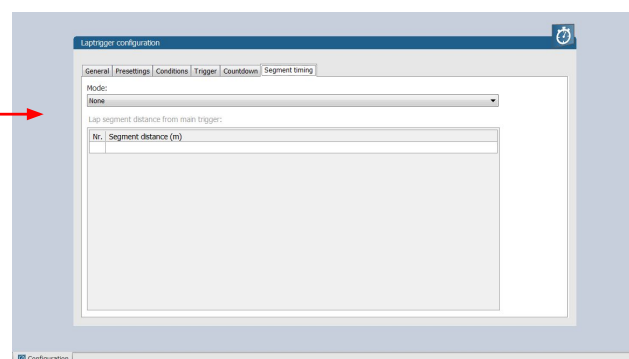
Define settings for sub trigger.
Not applicable with a GPS lap trigger.



Define settings for countdown
timer.



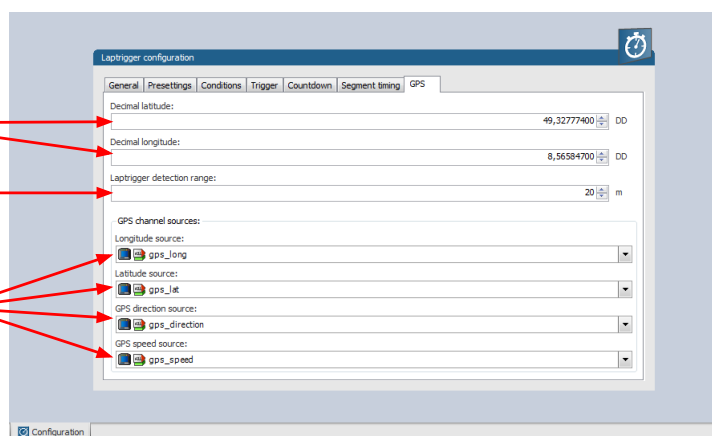
Define settings for segment
timing.



Define the latitude and
longitude of the GPS
detection point.

Define the detection
range around the
detection point.

Define the channel
sources for Longitude,
Latitude, Direction and
Speed.

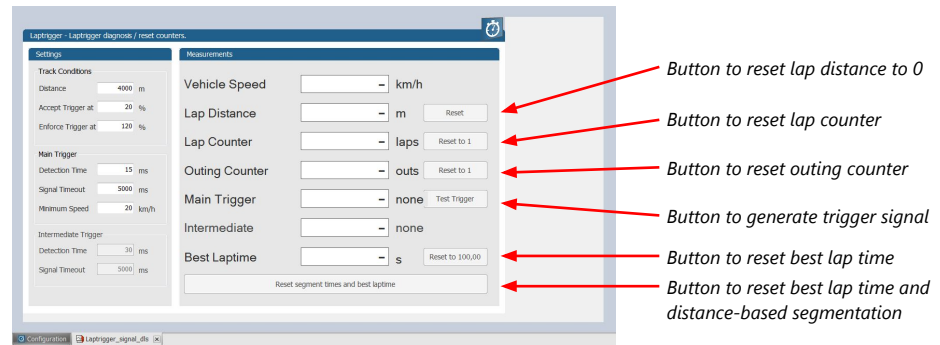


14.1.6 Lap trigger channel diagnosis/counter reset

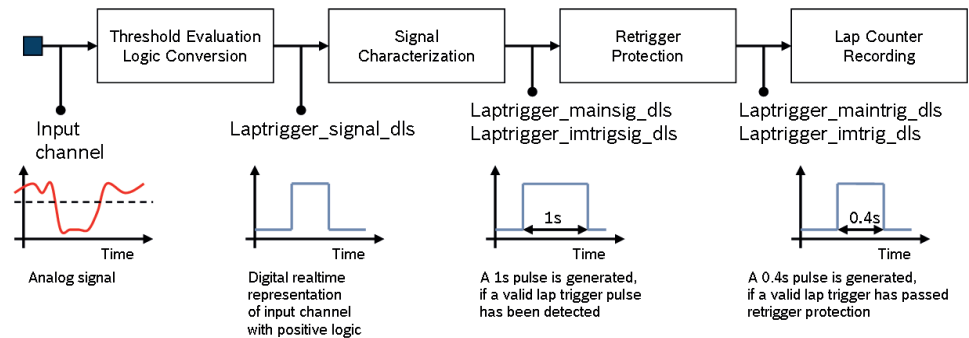
To display a quick lap trigger channel diagnosis and to reset counters use the diagnosis page in RaceCon. Any 'Laptrigger_xxx' channel can be displayed.

Double-click on any 'Laptrigger_xxx' channel in the Data Area. Example: 'laptrigger_lapdist_dls'

A diagnosis window opens in Main Area.



Lap trigger diagnosis scheme



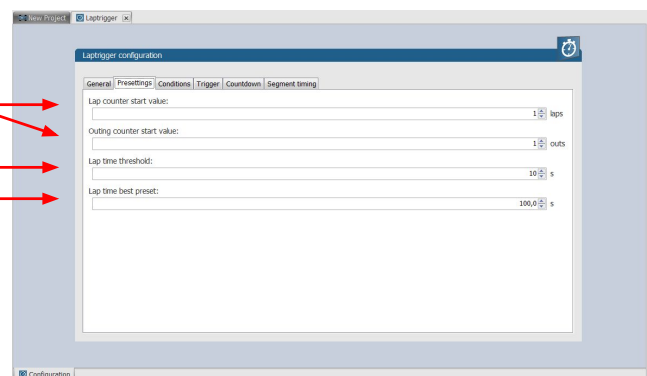
14.1.7 Lap trigger presettings

When the reset buttons on the diagnosis page are activated, these values are used.

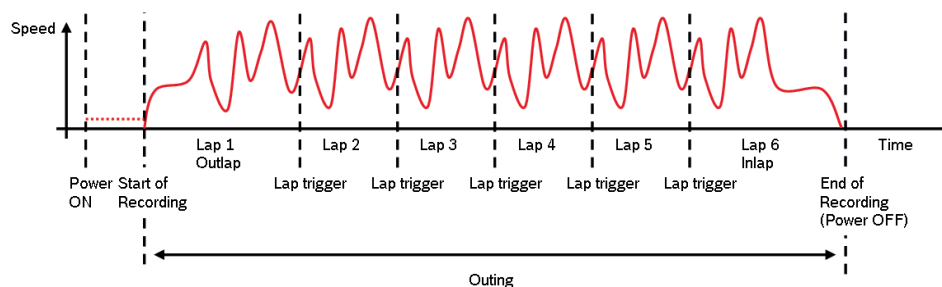
Preset values for lap counter and outing counter

Minimum laptime that a new 'best laptime' is accepted

Preset value for 'best laptime'



14.2 Counting outing/laps/fragments



Functionality

- Power ON: system + measurement is initialized but not yet started
- Global start condition fulfilled: recording starts
- Reception of valid lap trigger: recording of lap completed, new lap starts
- Power OFF or Global start condition not fulfilled: recording of lap completed, system shutdown

The system is counting:

Outing:

- The outing counter is incremented with each power cycle when at least one valid lap (not by forced lap trigger) was recorded

Lap:

- Leaving the pits to lap trigger
- Lap trigger to lap trigger
- Enforced lap trigger (see Distance based forced trigger [► 147])

Fragment:

- Test bench operation
- Power cycle on track or box (e.g. engine stalled)
- File fragmentation size [MB], time [sec]

Channels for display

To display counters use the following channels:

Channel	Function
Laptrigger_outcnt_dls	Outing counter
Laptrigger_lapctr_dls	Lap counter
Fractr	Fragment counter

Counting in WinDarab

To automatically name recorded files use filename templates in WinDarab dialog:

Filename template	Function
[outing]	Value of outing counter

Filename template	Function
[lap]	Value of lap counter
[fragment]	Value of fragment counter

[###03] indicates: 'always use 3 digits with leading zeros'.

14.3 Lap timing

There are different possibilities to adjust the lap trigger to the timing situation. The detection time defines the minimum time the input signal changes its state. E.g. a low active signal needs to be below the threshold for min. 15 ms to release the trigger.

Channels for display

To display lap times use the following channels:

Channel	Function
Laptrigger_lapctr_dls	Number of completed laps
Laptrigger_laptime_dls	Running laptime
Laptrigger_laptime_best_dls	Laptime of best lap
Laptrigger_laptimeold_dls	Laptime of last lap completed
Laptrigger_laptimeseg_dls	Segment time of last segment
Laptrigger_lapctr_dls	Number of completed laps

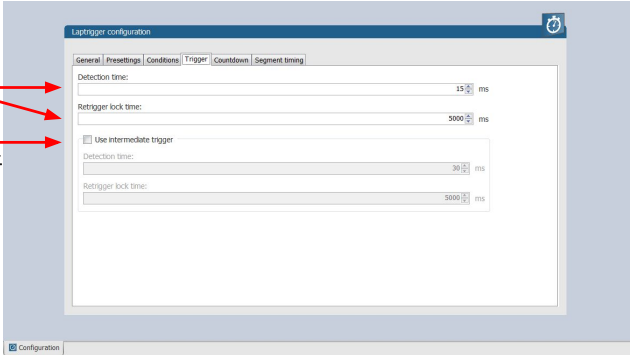
14.3.1 Time based retrigger protection

Trigger is locked for 5 s after main trigger was received. To deactivate time based retrigger protection, set 'Retrigger lock time' to 0 ms.

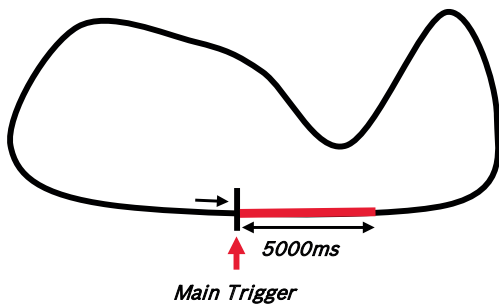
Define settings for lap timing (main trigger).

Define settings for sub trigger.

Not applicable with a GPS lap trigger.



The screenshot shows the 'Laptrigger configuration' window with tabs for General, Presettings, Conditions, Trigger, Countdown, and Segment timing. The 'Trigger' tab is active, showing 'Detection time' set to 15 ms and 'Retrigger lock time' set to 5000 ms. There is a checkbox for 'Use intermediate trigger' which is currently unchecked. Below it, 'Detection time' is set to 30 ms and 'Retrigger lock time' is set to 5000 ms.



The diagram shows a race track with a 'Main Trigger' point marked by a vertical line and a red arrow. A red horizontal bar with a double-headed arrow indicates a 5000ms retrigger lock time starting from the main trigger point.

14.3.2 Distance based retrigger protection

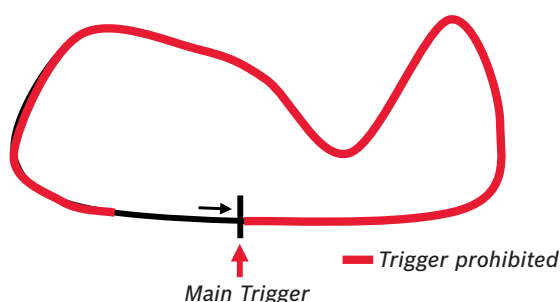
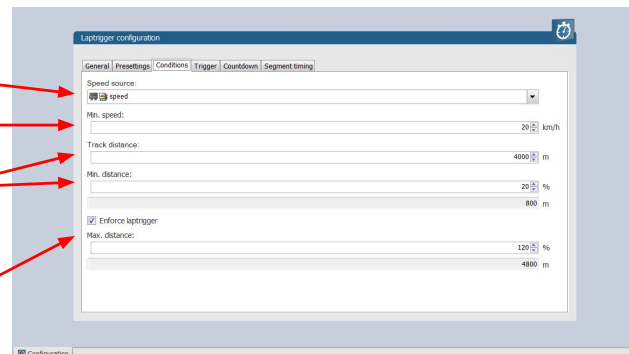
Trigger is locked until configured min distance (i.e. 80 % → 3200 m) of track distance (i.e. 4000 m) has been covered. To deactivate distance based retrigger protection, set min distance to 0 %.

Change signal for vehicle speed, if desired.

Enter minimum speed for trigger release.

Define settings for distance based retrigger protection.

Define settings for distance based forced trigger.



14.3.3 Distance based forced trigger

After a missed main trigger, a forced trigger is inserted, if the configured max. distance (i.e. 120 % → 4800 m) of the track distance (i.e. 4000 m) has been reached. In this case, the channel 'Laptrigger_distlap_dls' starts at the delta between the max. distance and the track distance (i.e. 800 m).

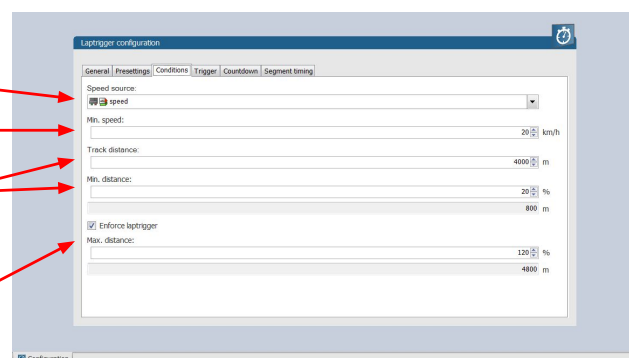
To deactivate distance based forced triggers, uncheck box.

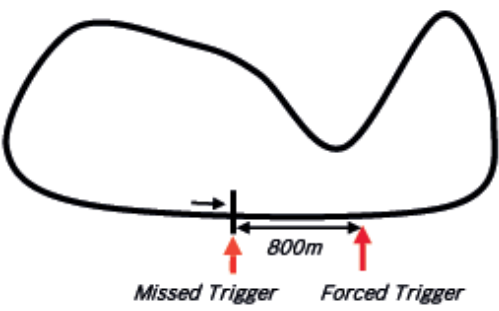
Change signal for vehicle speed, if desired.

Enter minimum speed for trigger release.

Define settings for distance based retrigger protection.

Define settings for distance based forced trigger.





14.4 Segment timing

Segment timing is the calculation of elapsed time for parts of laps (segments).

Segments are defined:

- based on sub-trigger signals (additional transmitters)
- based on distance travelled

Times for segments are compared to:

- Last lap completed
- Fastest lap

Channels for display

To display segment times use the following channels:

Channel	Function
Laptrigger_lapdiff	Time difference between finished lap and last lap
Laptrigger_lapdiffb	Time difference between finished lap and best lap
Laptrigger_lapseg_dlast	Difference of lap segment time compared to last lap
Laptrigger_lapseg_dbest	Difference of lap segment time compared to best lap

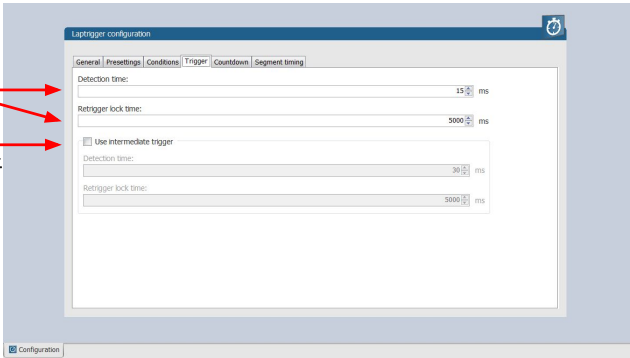
14.4.1 Sub trigger mode

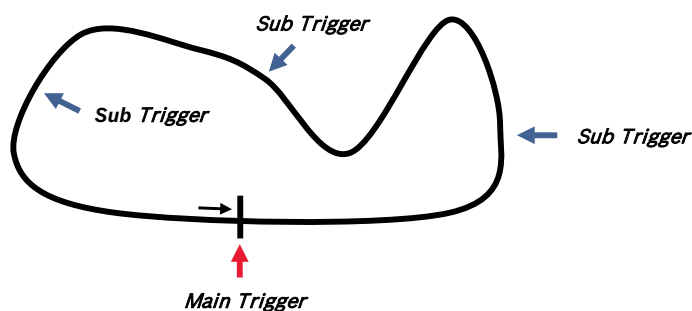
Using main trigger (20 ms pulse) at Start-Finish-Line. 3 sub triggers (40 ms pulse) positioned at 1,000 m, 2,000 m and 3,000 m.

To deactivate sub trigger mode uncheck box.

Define settings for lap timing
(main trigger).

Define settings for sub trigger.
Not applicable with a GPS lap trigger.





The sub trigger mode cannot be used with the GPS lap trigger.

14.4.2 Distance mode

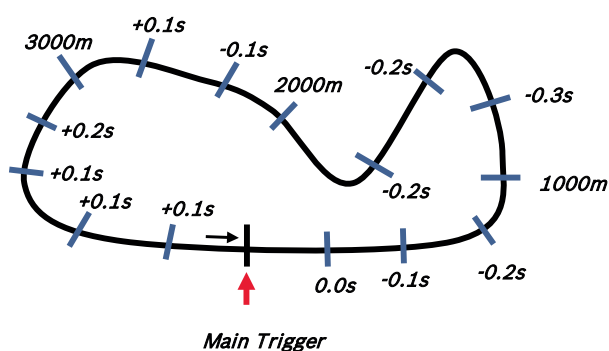
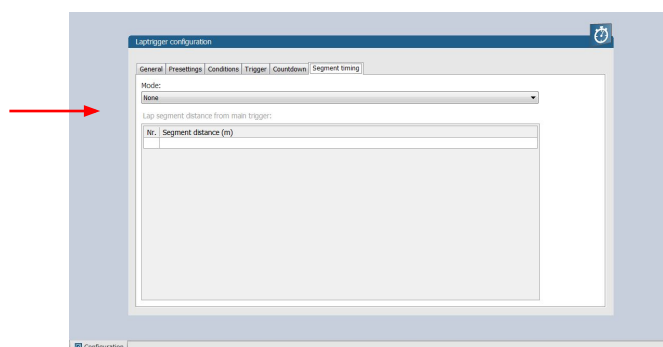
Using main trigger (20 ms pulse) at Start-Finish-Line.

Set 'Mode' to 'Distance' and enter desired segment distances.

Segment time is automatically calculated at each segment. Time difference to last lap and fastest lap is automatically calculated at each segment.

To deactivate distance mode set 'Mode' to 'None'.

Define settings for segment timing.

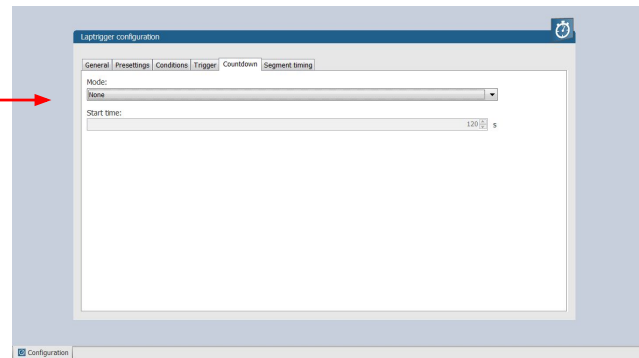


14.5 Countdown timer

Some race classes require a minimum time spent in the pits. An additional lap trigger Tx is configured as a segment trigger positioned at pit entry. The trigger signal starts a timer countdown.

The current value of the timer is stored in the variable **Laptrigger_cntdown_dls** which can be displayed.

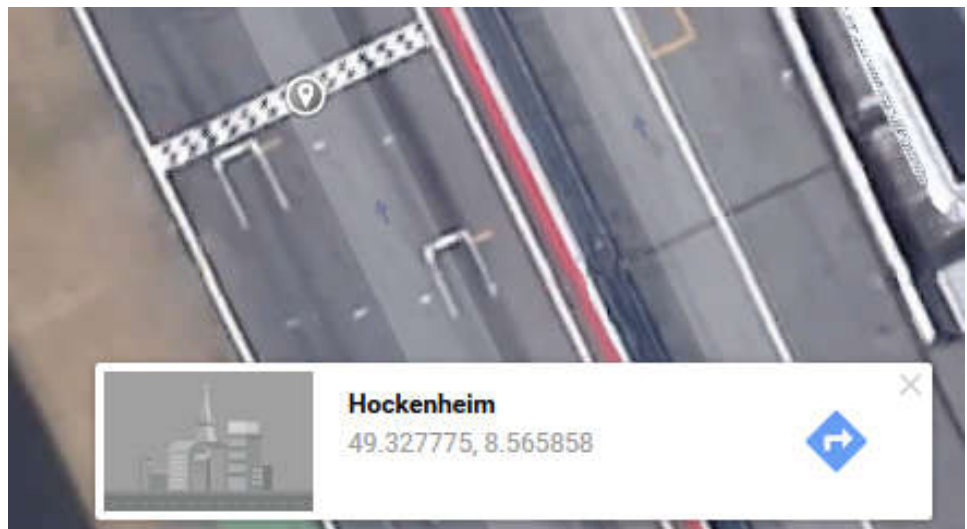
Define settings for countdown timer.



14.6 GPS Lap trigger

The GPS lap trigger uses a GPS signal to trigger the lap timer. To function this timer an external GPS sensor (see GPS Sensor [► 158]) has to be connected to the device and a detection point with a detection range has to be defined in RaceCon.

The GPS detection point is defined by the latitude and longitude. The easiest way to get the latitude and longitude of a finishing line is due to a web mapping program such as google maps. With google maps, simply left-click on the spot where you want to set the detection point. The information about the latitude and longitude will show up, in general the latitude is given at first. You should insert at least five decimal places for sufficient precision.



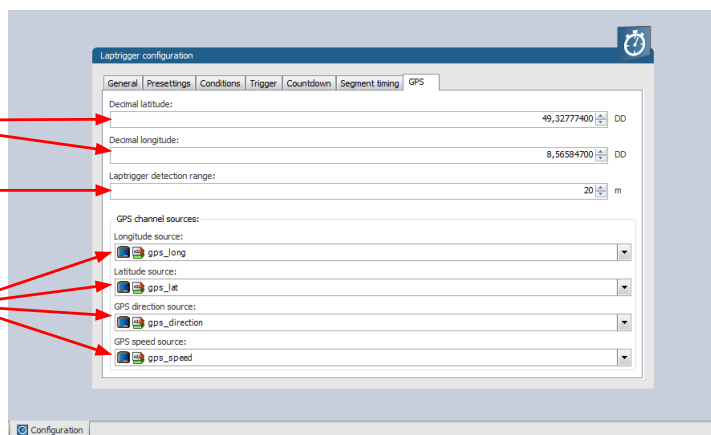
The detection range defines the radius of a circle around the detection point in which the lap trigger can be set. The lap trigger will be set as soon as the distance between the car and the detection point has reached its smallest peak. By this function an imaginary finishing line is calculated inside of the detection circle.

The imaginary finishing line can only be calculated if all channel sources are defined correctly. The latitude and longitude channel sources are mandatory for the functionality. Missing direction or speed source lowers the precision of the system.

Define the latitude and longitude of the GPS detection point.

Define the detection range around the detection point.

Define the channel sources for Longitude, Latitude, Direction and Speed.



Notice

The configuration of the sensor update rate and the detection range must insure to receive a valid GPS point in the detection range, despite the occurring vehicle speed near the detection point.

15 Predated Laptime

The predated laptime function allows to compare the current lap- and segment time with the predated time of an expected lap. Additional the function can estimate the laptime of the current lap. This functionality is integrated in the laptrigger module in RaceCon.

15.1 Setting up the predated laptime

To use the predated laptime function you need to set up a laptrigger as described in chapter 14 Lap Trigger [▶ 139]. Under the ribbon "Segment timing" you need to choose your segmentation mode which can either be distance or intermediate trigger based.

Distance or Intermediate Trigger

Enter your segment time and distance

Enter your expected laptime

Laptrigger configuration

General

Presettings

Conditions

Trigger

Countdown

Segment timing

GPS

Mode:
Distance

☒ Use predated laptime

Lap segment lengths and times

Nr.	Segment length (m)	Segment time (s)
1	500	44,800
2	1.000	93,200
3	1.500	135,600

Entire lap time:

164,500 s

For the distance mode you need to check on an old lap or estimate how long it takes to travel the segment distance. Please enter those values into input field. The values can also be copied and pasted to the input field from a excel sheet as a normal text. In the intermediate trigger you just need to set the expected time the driver takes to reach the segment trigger.

Notice

Please note that the segment time and length is always measured from the start line or where the main lap trigger is set.

15.2 Functionality and channel outputs

Following output channels are generated by the predated laptime function.

Laptrigger_lapdiff_pred_dls	Laptime difference between the predated and the last laptime
Laptrigger_lapsegdiffpred_dls	lagseg difference between the last segment and the predated segment.
Laptrigger_Lapcurrpred_dls	Estimated laptime of the current lap, based on the predated laptime and the predated segment deviations

The channel Laptrigger_lapdiff_pred_dls is updated as soon as the main lap trigger is received. Both other channels are updated as soon as the next segment distance is travelled or the next intermediate trigger is received.

16 Firmware

16.1 Firmware and configuration

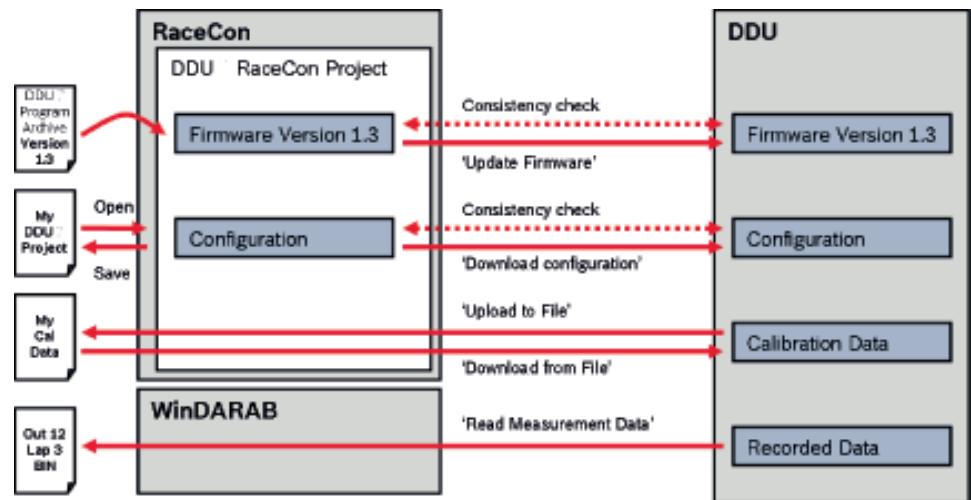
DDU 9 holds 4 types of data:

Firmware: the software (PST program file) of the DDU 9.

Configuration: the configuration of Input channels, CAN I/O, PWM, display configuration, recording + telemetry configuration.

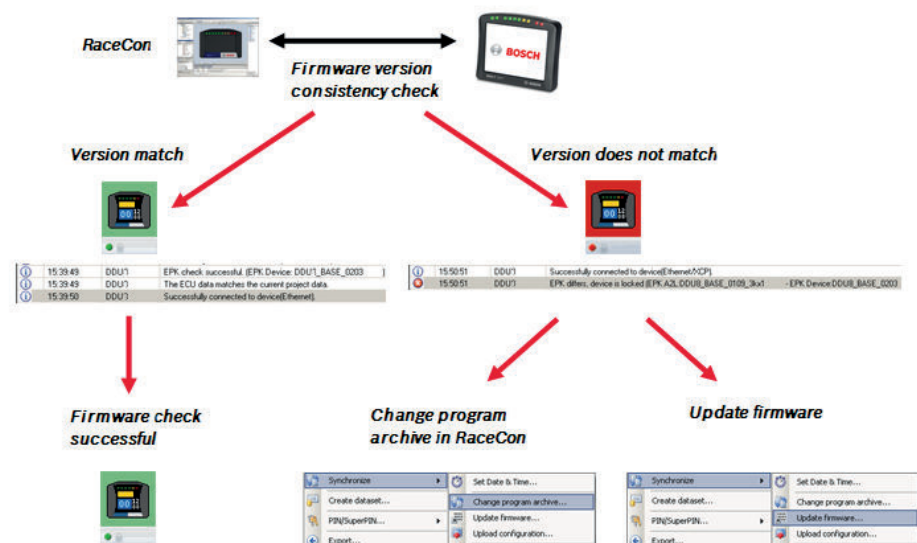
Calibration data: Characteristic curves and offsets created by online calibration at the vehicle.

Recorded data: Measurement data recorded during vehicle operation.



16.2 Firmware update

The scheme shows the process during each connection between RaceCon and DDU 9.

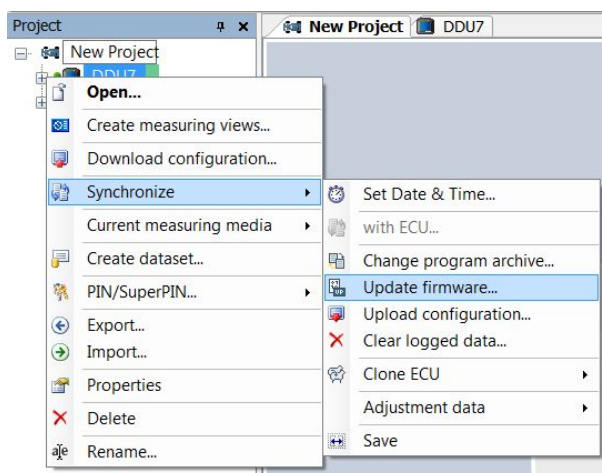


16.2.1 Performing the firmware update

Firmware update is only possible if the DDU 9 is connected to RaceCon.

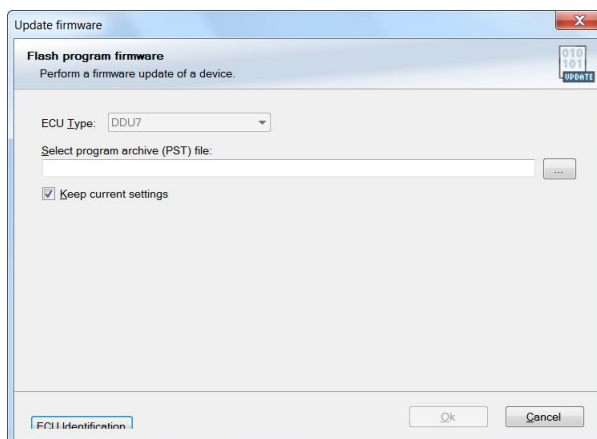
The configuration of Input channels, CAN I/O, display, recording + telemetry will not be changed.

1. In the DDU 9 Project Tree, right-click on 'DDU 9' and choose 'Synchronize' then 'Update firmware'.

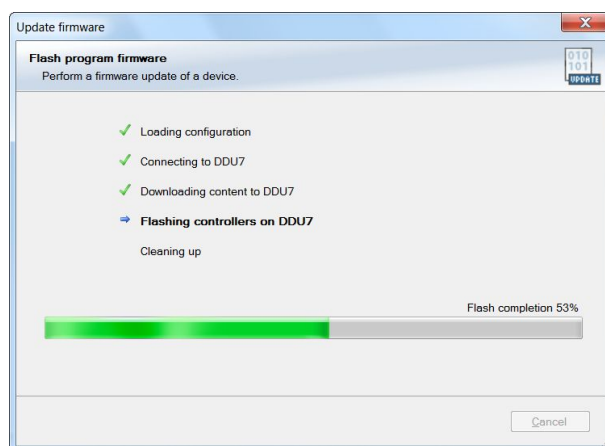


A pop-up menu opens.

2. Select the destination of the firmware archive (PST).

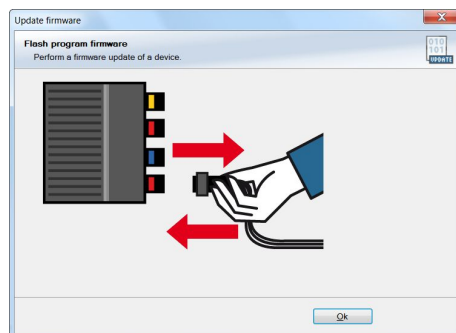


3. Click 'OK' when done.
The firmware update starts. The DDU 9 displays the message 'Updating firmware'. Do not switch off the car's ignition or interrupt the power supply of the DDU 9!



When the firmware update is complete, the DDU 9 displays the message 'Updating firmware finished. Do a powercycle.'

Switch the car's ignition off and on again to cycle the power of the DDU 9.

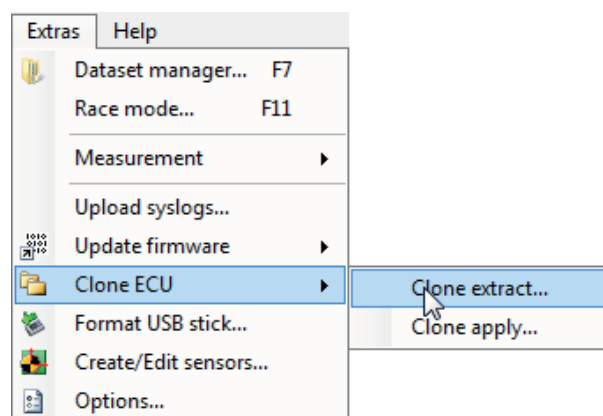


17 Clone the Unit

To replace a DDU 9 by another device, it is possible to clone it. A clone is a 1:1 copy of a device.

Create a clone file

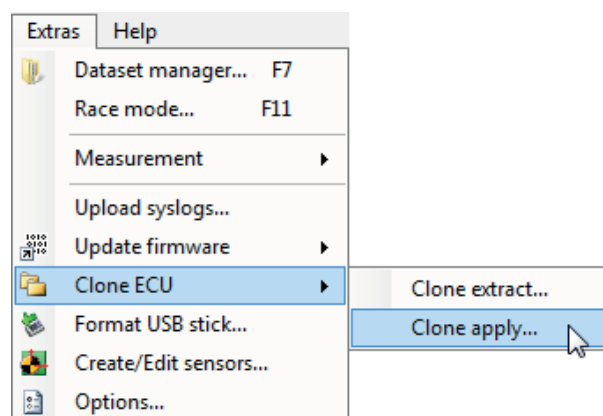
1. Click 'Clone extract' in Extras menu.



2. Choose the hardware device which should be cloned.
3. Define destination and filename.
4. Click 'OK' to start procedure.

Change the device

1. Click 'Clone apply' in Extras menu.



2. Choose clone file.
3. Click 'Ok'.

Please remember that following properties are not stored into the clone:

- Lifetime of device
- Serial number
- Upgrade features

18 GPS Sensor

18.1 GPS (Global Positioning System)

Space-based global navigation satellite system.

GPS provides positioning, navigation, and timing services to worldwide users.

GPS receiver (sensor) gives digital information about position (longitude, latitude, height), ground speed, course, and status.

Two types of GPS receivers:

CAN output -> Read in messages via CAN Input of DDU 9 (not covered here)

Serial output -> Read in messages via RS232 Interface of DDU 9 (serial interface 2)

18.1.1 Serial interface characterization

Serial Interface is characterized by:

Voltage levels: RS232 is standard (+/-12 V), UART (0 V/ 5 V) needs level shifter

Baud rate: 9,600 is standard for GPS, DDU 9 supports 1,200 to 115,200 baud. GPS Rx interface baud rate must match DDU 9 interface baud rate. DDU 9 Baud rate can be set with the 'GPS_BAUDRATE' characteristic Data format: DDU 9 expects 8 data bits, no parity bit, 1 stop bit (8N1)

18.2 Protocol

DDU 9 expects NMEA Protocol (ASCII).

The following messages are decoded:

Message	Function
GGA	GPS fix information
GSA	Overall satellite data
GSV	Detailed satellite data
RMC	Recommended minimum data for GPS
VTG	Vector track and speed over the ground

On most GPS sensors, these messages are activated in the default configuration.

18.3 Sensor recommendation

The system has been tested with the Navilock NL-8004P MD6 Serial PPS Multi GNSS Receiver. This sensor is based on a U-Blox 8 chipset and is fully configurable with the Navilock "U-Center" software. To use this sensor with Bosch Motorsport components the transfer rate, the satellite system and the update rate need to be reconfigured. More information about the configuration can be found in the Appendix.

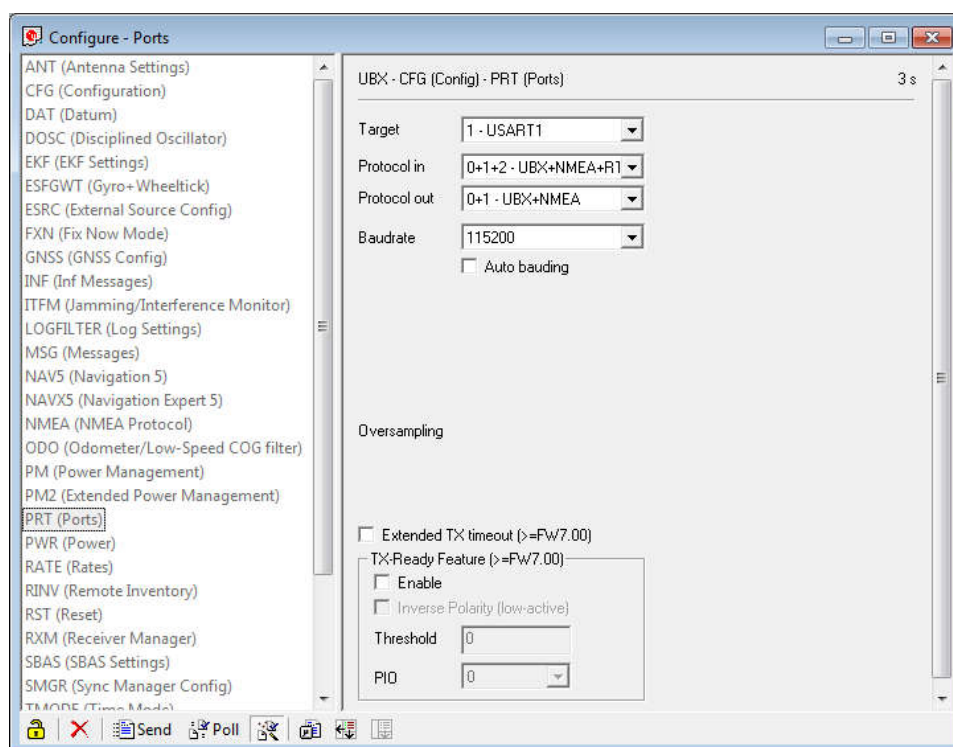
18.3.1 Configuration of the recommended Navilock NL-8004P MD6 Serial PPS Multi GNSS Receiver

For the sensor configuration, the sensor needs to be connected to the Navilock software "U-Center" which is available from Navilock free of charge. Navilock offers a USB connection cable for the sensor.

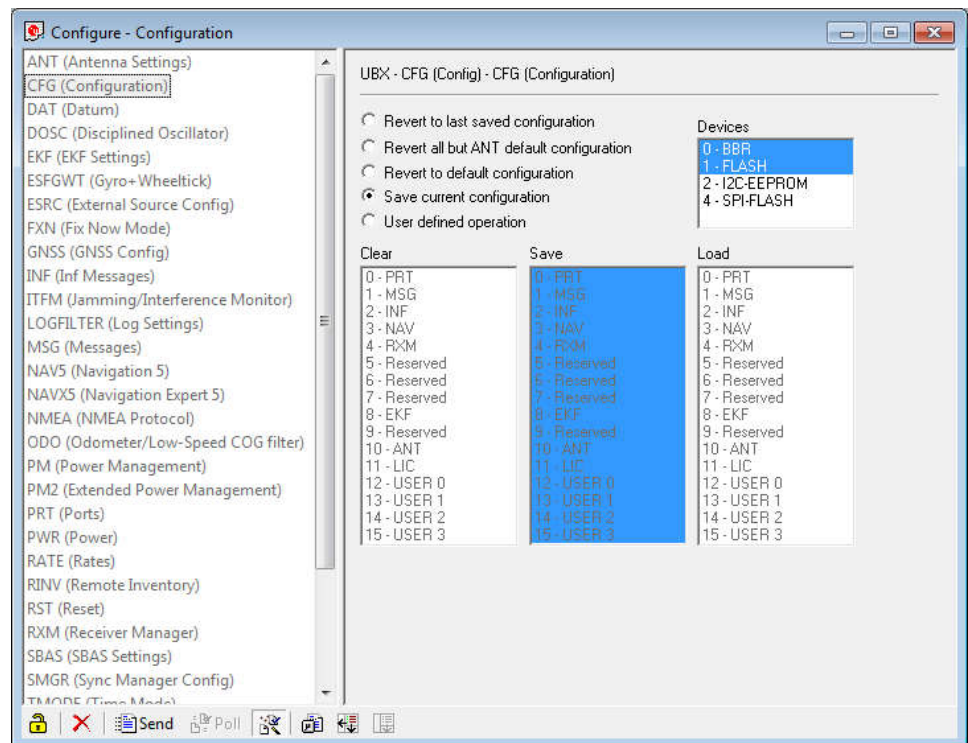
In "U-Center" click "**View**" – "**Configuration View**" to start the configuration. The following 3 points have to be changed:

Transfer Rate

- Click on "**PRT (Ports)**".
- Change the baud rate to a fix value, this value needs to meet the setting of RaceCon. For a good signal quality we recommend 115,200 baud.
- Click on "**Send**" to store the new setting in "U-Center".

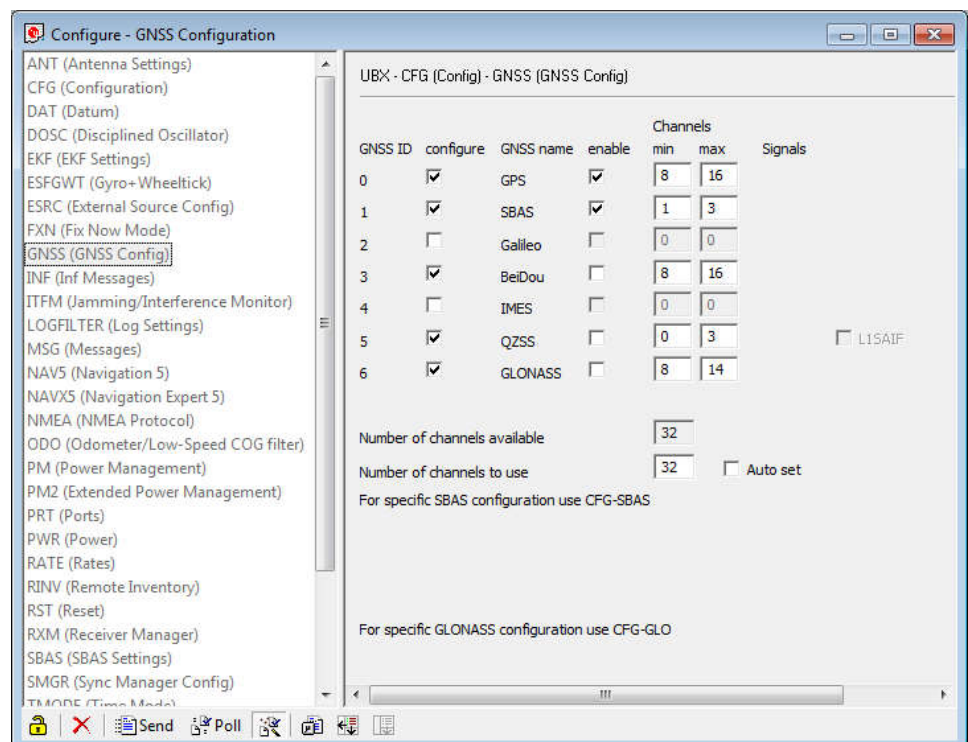


- Click on "**CFG (Configuration)**".
- Click on "**Send**" to save the new setting on the sensor.



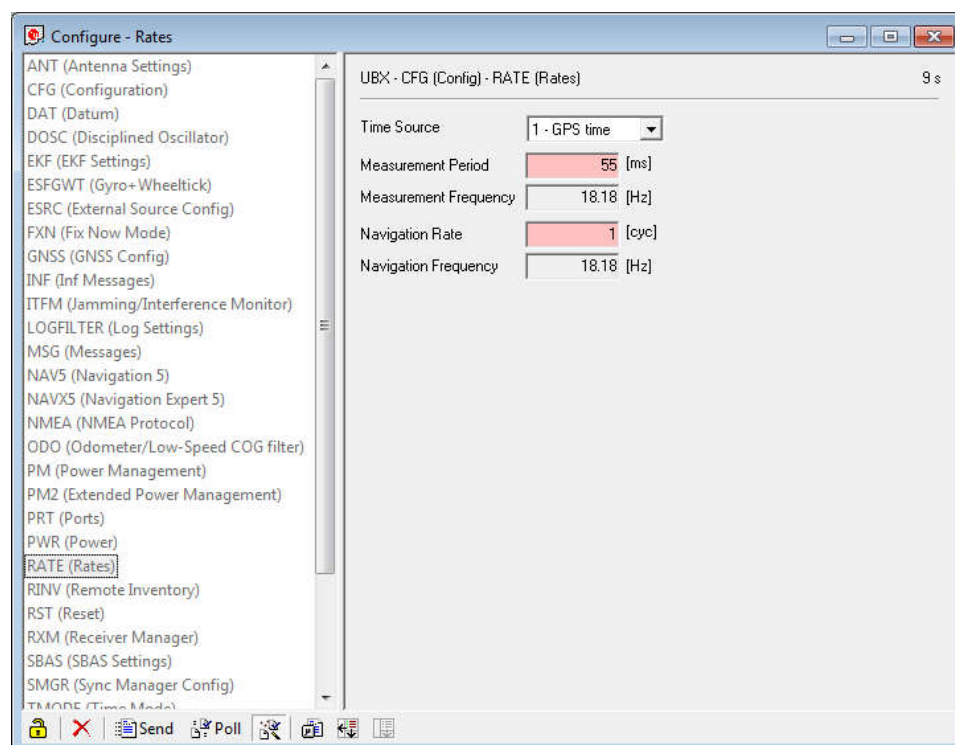
Satellite System

- Click on **"GNSS (GNSS Config)"**.
- Set the ticks as shown in the following picture.
- Click on **"Send"** to store the new setting in "U-Center".
- As during configuration step 1, click on **"CFG (Configuration)"**.
- Click on **"Send"** to save the new setting on the sensor.



Update Rate

- Click on **"RATE (Rates)"**.
- Change the "Measurement Period" to 55 ms.
- Change the "Navigation Rate" to 1 cyc.
- Values which lead to a lower frequency will lower the precision of the sensor, we recommend the mentioned values.
- Click on **"Send"** to store the new setting in "U-Center".
- As during configuration step 1, click on **"CFG (Configuration)"**.
- Click on **"Send"** to save the new setting on the sensor.



Notice

**Sensor needs reception for visible signal.
It takes time to start the sensor.**

18.4 Measurement labels

The decoded NMEA messages are copied to these DDU 9 measurement labels.

Measurement label	Function
gps_PDOP	Position Dilution Of Precision
gps_HDOP	Horizontal Dilution Of Precision
gps_VDOP	Vertical Dilution Of Precision
gps_lat	Latitude +/- [degree]
gps_long	Longitude +/- [degree]
gps_elv	Antenna altitude above/below mean sea level (geoid) in meters

Measurement label	Function
gps_speed	Speed over the ground in kilometers/hour
gps_direction	Track angle in degrees
gps_declination	Magnetic variation degrees (Easterly var. subtracts from true course)
gps_year	Years since 1900
gps_mon	Months since January - [0,11]
gps_day	Day of the month - [1,31]
gps_hour	Hours since midnight - [0,23]
gps_min	Minutes after the hour - [0,59]
gps_sec	Seconds after the minute - [0,59]
gps_hsec	Hundredth part of second - [0,99]
gps_smask	Bit mask over received NMEA sentences (Bit 0 = GGA, Bit 1 = GSA, Bit 2 = GSV, Bit 3 = RMC, Bit 4 = VTG) within last second.
gps_sig	GPS quality indicator (0 = Invalid; 1 = Fix; 2 = Differential, 3 = Sensitive)
gps_fix	Operating mode, used for navigation (1 = Fix not available; 2 = 2D; 3 = 3D)

These measurement labels are arrays, where the indexed element points to the same satellite.

(E.g. gps_info_satsigstrength[3] tells the receiving signal strength of satellite 3. Satellite 3 has the SAT-ID given in gps_info_satid[3])

Measurement label	Function
gps_info_satid[]	Satellite PRN number
gps_info_satinuse[]	Used in position fix
gps_info_satelevation[]	Elevation in degrees, 90 maximum
gps_info_satazimuth[]	Azimuth, degrees from true north, 000 to 359
gps_info_satsig-strength[]	Signal, 00-99 dB

18.5 GPS troubleshooting

Electrical

Is the transmitter signal of the GPS sensor connected to the receiver pin of serial interface 2 of the DDU 9?

Is the GPS sensor powered up?

Does the GPS sensor deliver RS232 signal levels?

Is the sensor connected to the „sensor ground“ of the device?

Interface

Do the baud rates of the GPS sensor and the DDU 9 match?

Is the GPS sensor set up for 8N1 transmission parameters?

Is the GPS sensor set up for NMEA messages?

Are the GGA, VTG, RMC messages activated?

GPS sensor start-up

Does the GPS sensor 'view' the sky?

Did the GPS sensor complete its initial start-up procedure? This may take up to 20 min.

A correct reception is indicated when 'gps_fix' is showing '3D Fix'.

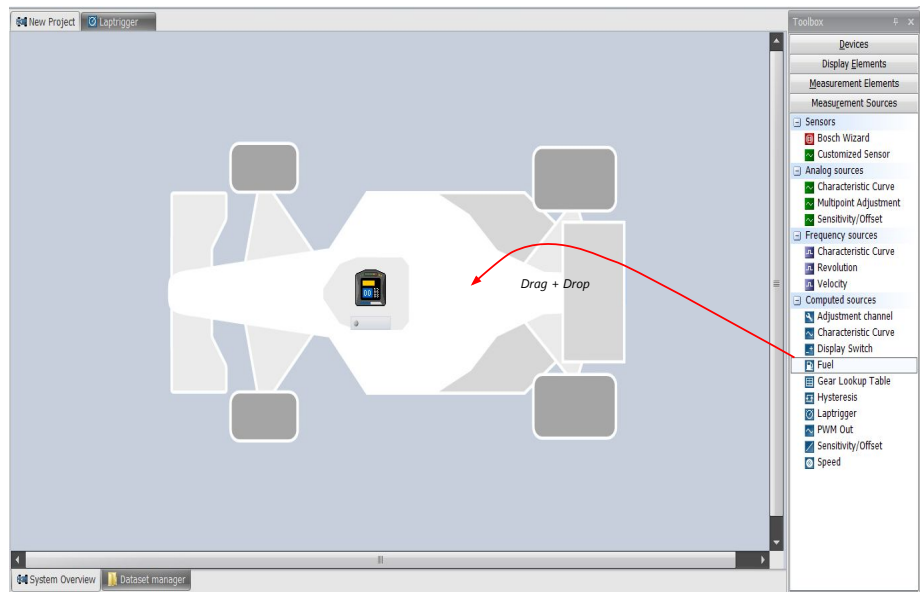
GPS sensor values are frozen

Does the sensor has lost its reception? The old values will be kept if the reception is lost. The gps_mask channel shows which NMEA sentence is received.

19 Fuel Consumption Calculation

19.1 Setting up fuel consumption calculation and tank management

1. Select 'Measurement Sources' in Toolbox.
2. Drag 'Fuel' element and drop it on the vehicle in System Overview. Do not drop it on the DDU 9!



A 'fuel consumption wizard' opens.

- a) Change device for fuel calculation, if desired.
- b) Enter tank capacity of vehicle.
- c) Choose calculation mode:
- using fuel consumed (summed-up fuel consumption)
 - using fuel flow rate (momentary fuel consumption)
- d) Choose input channel and enter adaption factor. Use adaption factor to adapt value of input channel to:
- 1ml per inc for summed-up fuel consumption
 - 1ml/s per inc for momentary consumption
- e) Enter factor to correct calculated consumption in device vs. 'real' consumption of vehicle, if required.
- f) Choose method to calculate remaining laps with fuel in tank, if desired:
- using fuel consumption of last lap completed
 - using target lap consumption (entered in the field 'Target lap consumption')
- g) Choose values to initiate a reset of fuel consumption, if desired:
- Manually using RaceCon
 - On 'power down' (assuming that the tank is filled each time the ignition is turned off)
 - By signal source as input channel (e.g. a switch connected to input pin)

3. Press 'Finish' when done.

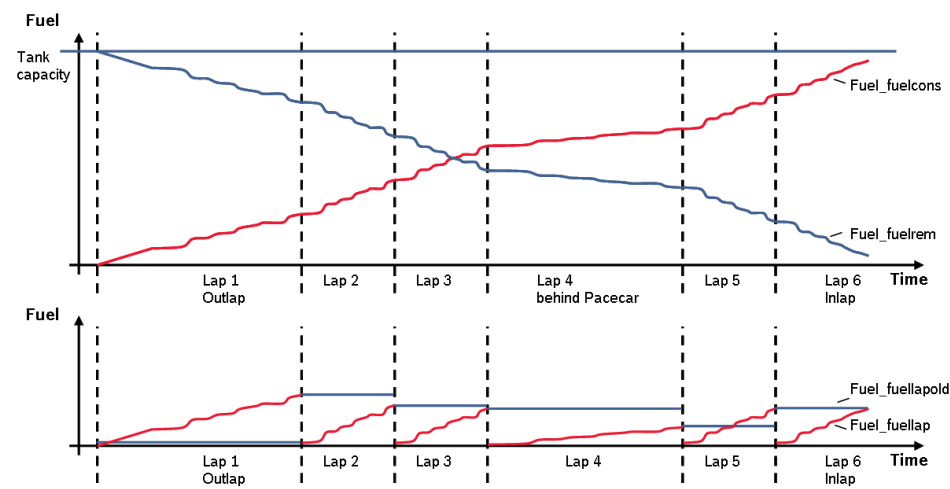
19.2 Fuel consumption diagnosis/counter reset

To display a fuel consumption diagnosis and to reset counters, use the diagnosis page in RaceCon.

Double-click on any 'fuel_xxx' channel in channel list.

A diagnosis window opens in Main Area.

19.3 Example



Measurement label	Function
Fuel_fuelcons_dls	Running fuel consumption, starting at '0'
Fuel_fuelrem_dls	Remaining fuel in tank, starting at tank capacity
Fuel_fuellap_dls	Fuel consumption for current lap, starting at '0'
Fuel_fuellapold_dls	Fuel consumption of last lap completed
Fuel_laprem_dls	Remaining laps with fuel in tank

20 RaceCon Shortcuts

The table shows important shortcuts simplify controlling the DDU 9 in RaceCon.

Shortcut	Function
General navigation	
F1	Open RaceCon help
F2	Rename selected object
F3	Select Data Area
F4	Select Project Tree
F5	–
F6	Start the data comparison
F7	Start dataset manager
F8	Toggle WP/RP
F9	Start measurement
CTRL + F9	Start recording
F10 or Alt	Go to menu bar
F11	Toggle display to fullscreen 'Race Mode'
F12	Enlarge main screen
CTRL + Tab	Switch between opened windows
Project Tree	
Plus (+) at numeric pad or right cursor	Expand selected node
Minus (-) at numeric pad or left cursor	Close selected node
Star (*) at numeric pad	Open all nodes
DEL	Delete selected object
Display page, measurement page	
Cursor	Move selected display element one grid unit in chosen direction
SHIFT + cursor	Enlarge/reduce selected display element one grid unit
Tab	Switch between display elements

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