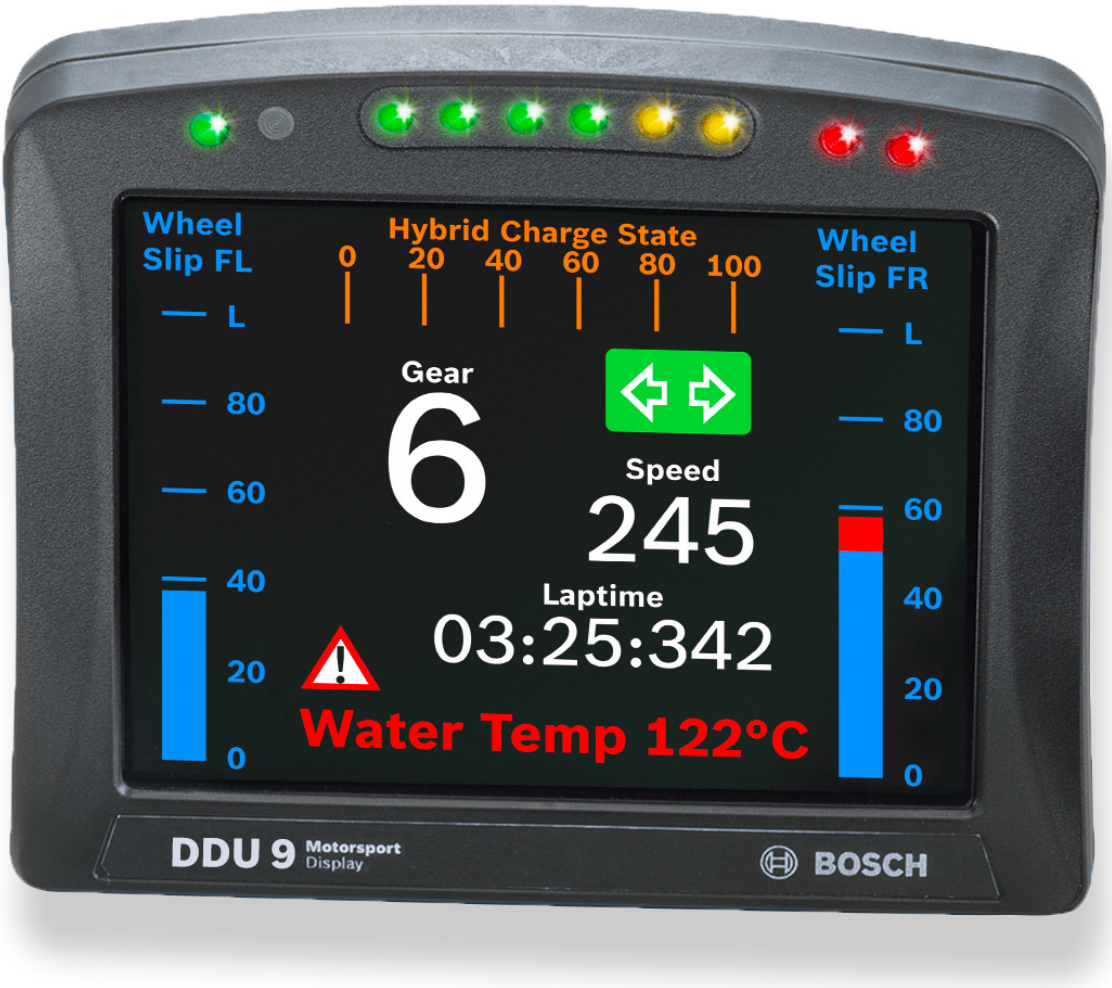
BOSCH



Display DDU 9

Manual

Version 1.1 24/06/2020

Content

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. Do not hesitate to contact us, contact data can be found on the last page of this document.

Important information on Electromagnetic Conformity

To avoid unwanted interference with the environment (people, animals, electronic devices) or unwanted harm to the environment, it is mandatory that the user of the DDU 9 carries out an appropriate analysis to determine the electromagnetic interaction the DDU 9 may have with its individual installation environment.

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.

NOTICE

In this document, many screenshots are created by way of example for a display. Please consider this and replace the product names with the name of your device.

2 Warnings and safety instructions

The classification of the warnings and safety instructions is carried out by the respective signal word (Danger, Warning, Caution) next to the warning symbol.

Danger

⚠ DANGER

Nature and source of danger

Consequences

Warning of death or serious physical injury, which are sure to occur if ignored.

Warning

⚠ WARNING

Nature and source of danger

Consequences

Warning of death or serious injury, which can occur if this is not observed.

Caution

⚠ CAUTION

Nature and source of danger

Consequences

Warning of slight bodily injury in case of Disregard.

Notice

NOTICE

Nature and source of danger

Consequences

Warning of damage to equipment in case of ignoring.

3 Onboard Network Concept

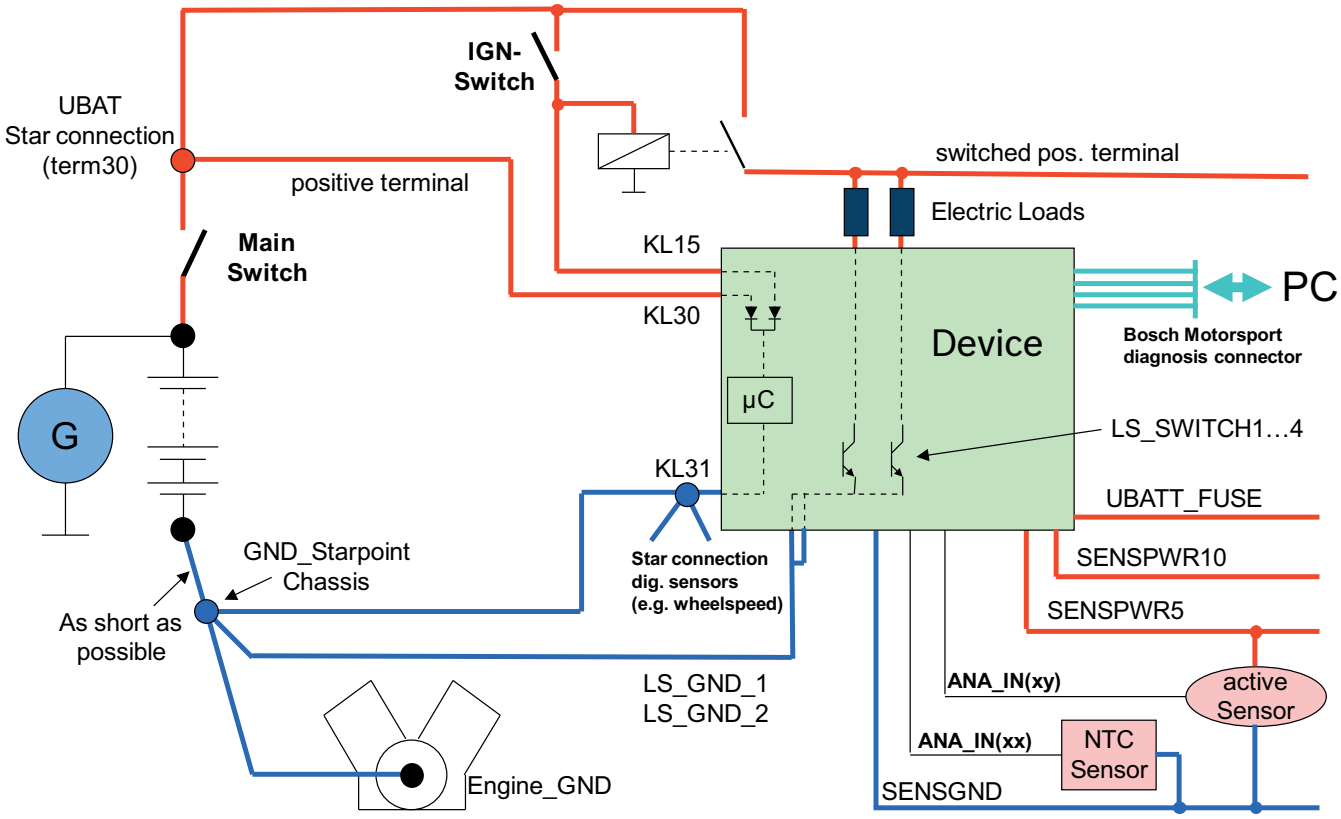
Please ensure that you have a good ground installation. That means:

- 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!



NOTICE

This schematic is not device specific. Please see the section Technical Data for the specifications of your device.

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	– 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)	

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

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 ± 1 % (250 mA)	2
Sensor supply 10 V ± 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 Kit	Rugged USB flash drive Bosch File System (BFS) format, works with Bosch File System (BFS) preformatted USB Flash drive only Adapter cable to USB-Port Adapter for wiring harness SW licence USB-Port unlocked
CCP_MASTER	CCP-Master (ASAP2 file from ECU manufacturer required)
FULL_LOG_1	Enable full logging performance of 3 GB partition 1
FULL_LOG_2	Enable full logging performance of 1 GB partition 2
I_O EXTENS	Enable additional 12 analog input channels

Connectors and Wires

Motorsport connector on Display	AS216-35PN
Mating connector AS616-35SN	F02U.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.
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.

Pin	Name	Comment	Status
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.

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 one 100 MBit full duplex Ethernet communication ports. The port is 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.

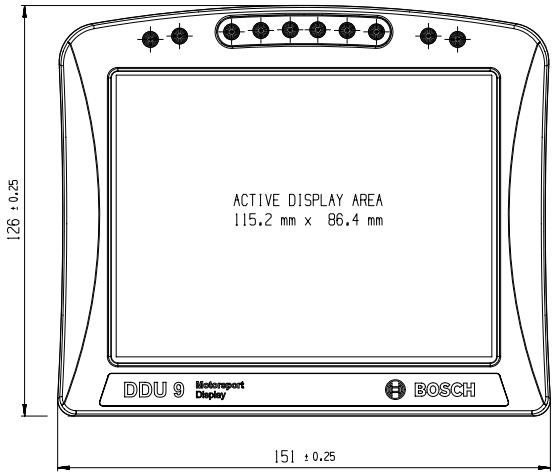
Vehicle diagnosis connector

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: AS012-35SN

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	Name	Description	Used for DDU 9
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



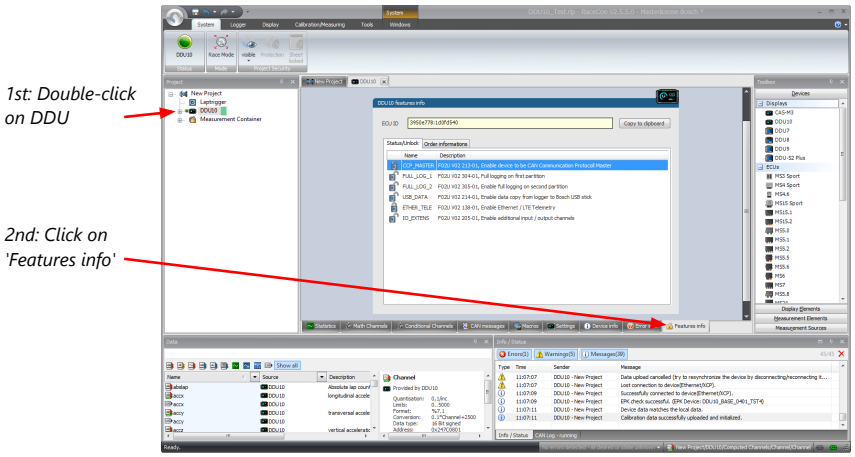
7 Starting up

7.1 Feature activation

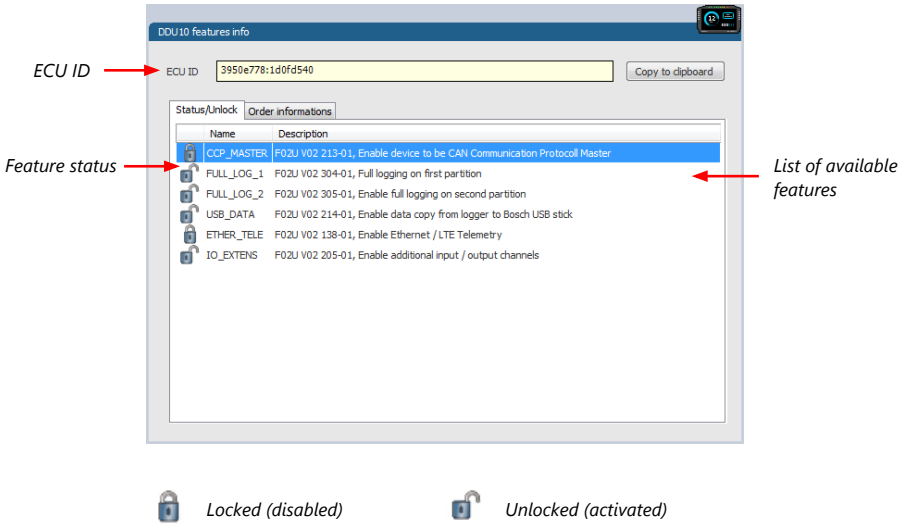
- Optional software feature packages are available for the DDU 9 .
- All software feature packages can be purchased prior to delivery or after you have received your device.
- If you have purchased an optional software feature package, it must be activated before it becomes operational.
- The feature 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 .
- When purchasing a software feature package, you have to tell Bosch the ECU ID code.

  The ECU ID code is device specific and can be found in the ‘features info‘ window, shown in the screenshots below.
- If you have not purchased an optional software feature package, the next steps can be skipped.

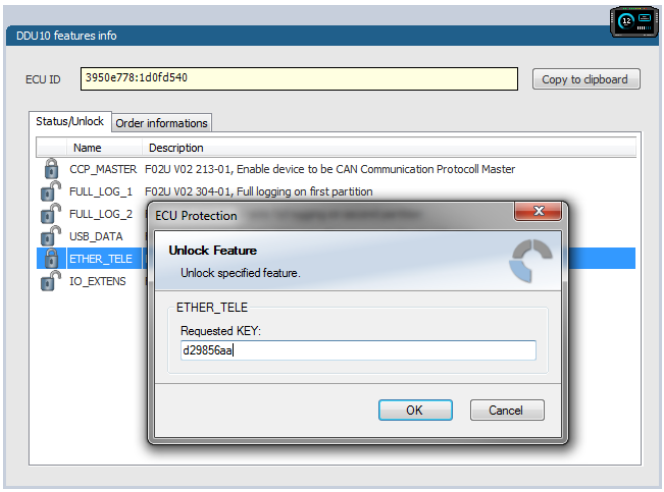
1. Ensure a connection to the device.
2. To activate a feature, double-click on ‘DDU 9‘ in the Project Tree.
3. Click on the ‘Features info‘ tab in the Main Area.



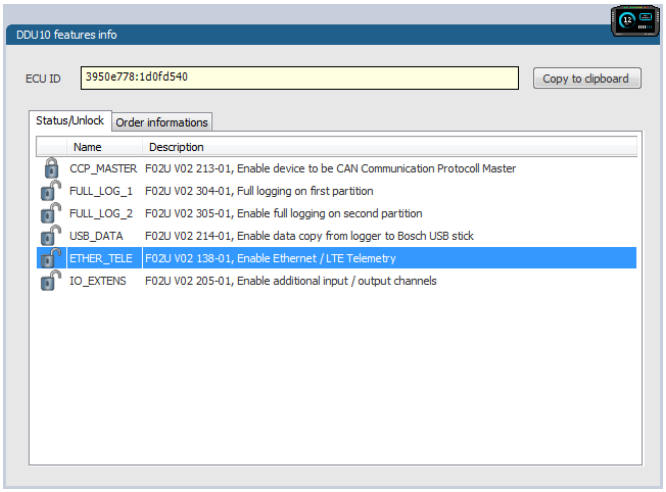
The ‘DDU 9 features info‘ window appears.



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



5. Enter the activation key you received for this feature on this device and click 'OK' when done. The feature's status changes to 'unlocked'.



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

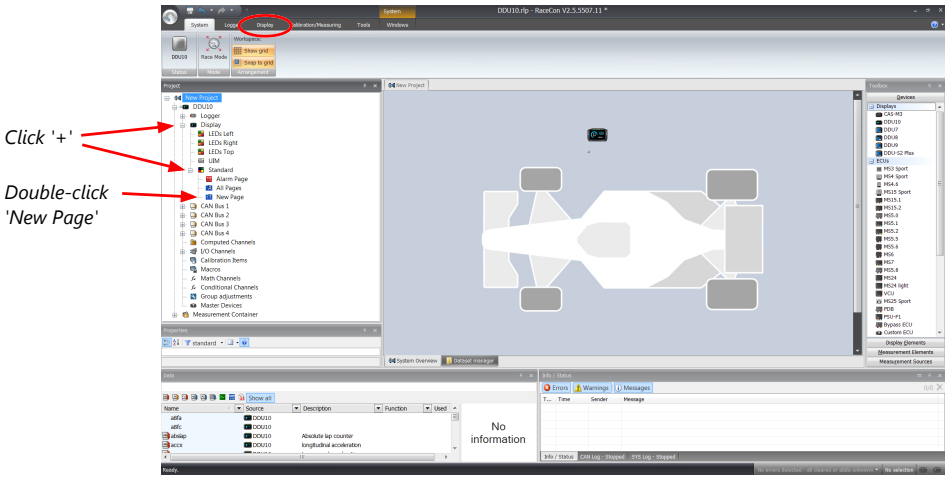
7.2 First display configuration (Quick Start)

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

See chapter Display element configuration for a detailed instruction to configure display elements.

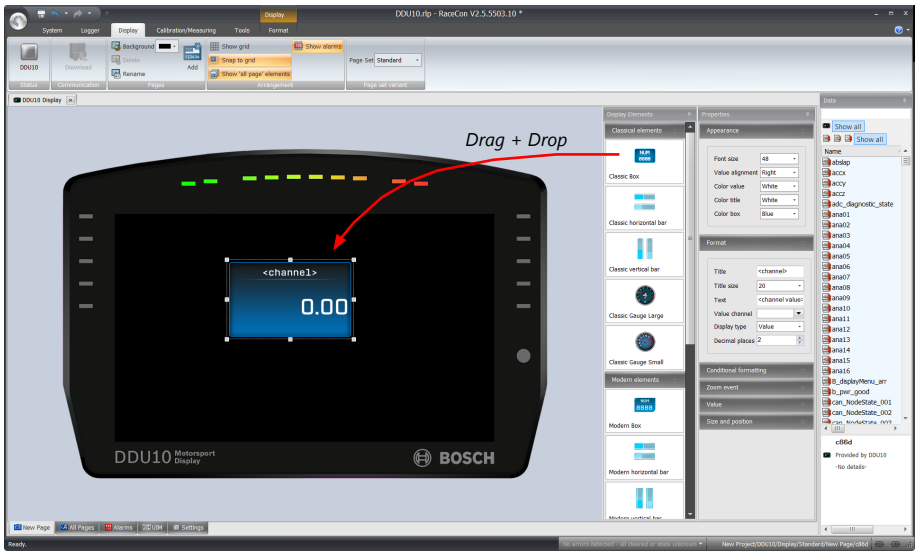
1. Click on '+' to expand the DDU 9 project tree.
2. Click on '+' to expand 'Display'.
3. Double-click on 'New Page', or click on the 'Display' tab.

   RaceCon changes to the page 'Display' to open the DDU 9 display configuration area.

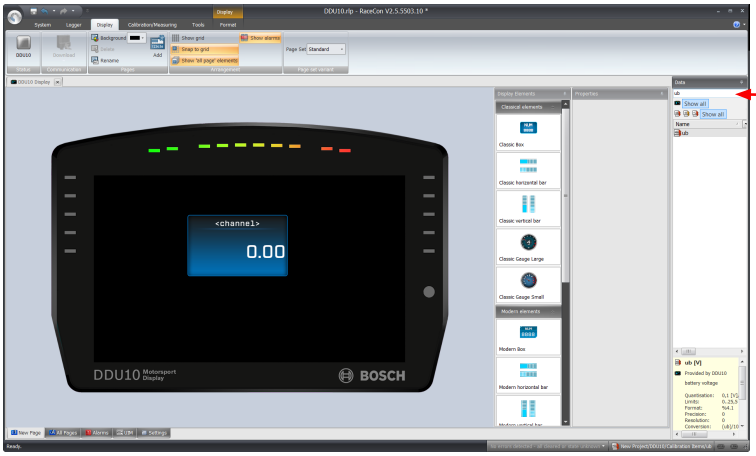


4. Drag any display element from the Toolbox and drop it on the display page.

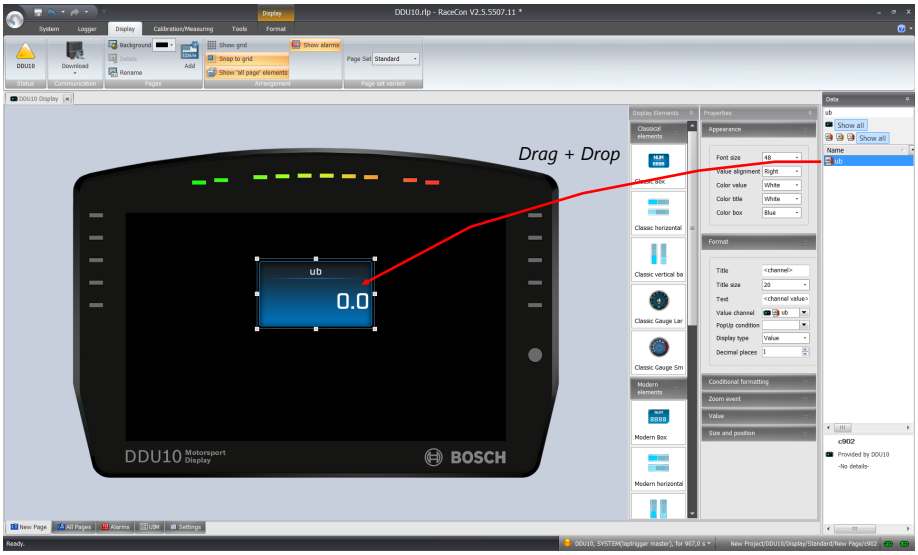
   The status signal in the upper left corner switches from green to orange, because the configuration in the tool differs from the configuration of the device.



5. Use the search bar in the 'Data' window, to search for 'ub' (measurement channel for battery voltage).

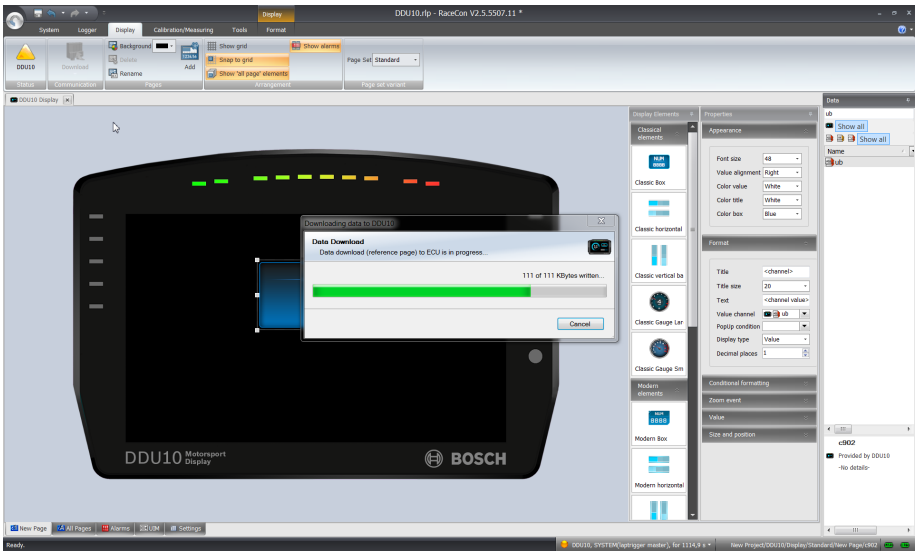


6. Drag the 'ub' measurement channel from the 'Data' window and drop it on the display element.



7. Click on the 'Download' button in the upper left corner.

   The configuration download starts and the DDU 9 carries out a reset. The status signal in the upper left corner switches to green.

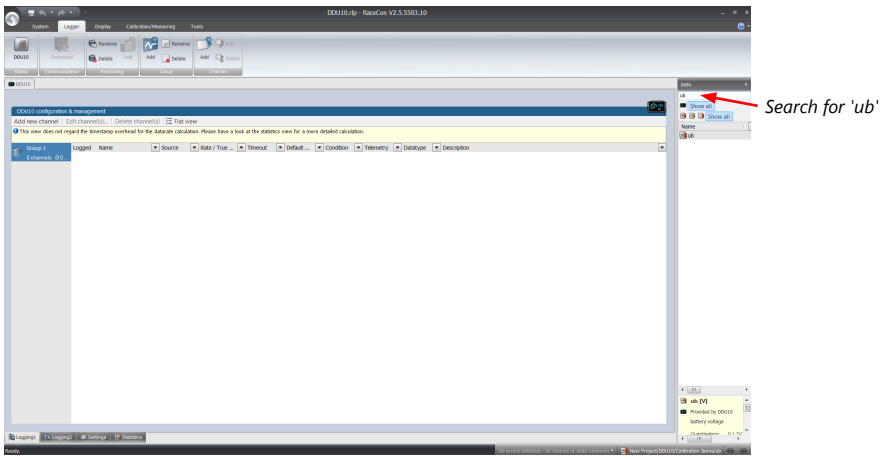


The value of the battery voltage is displayed on the DDU 9.

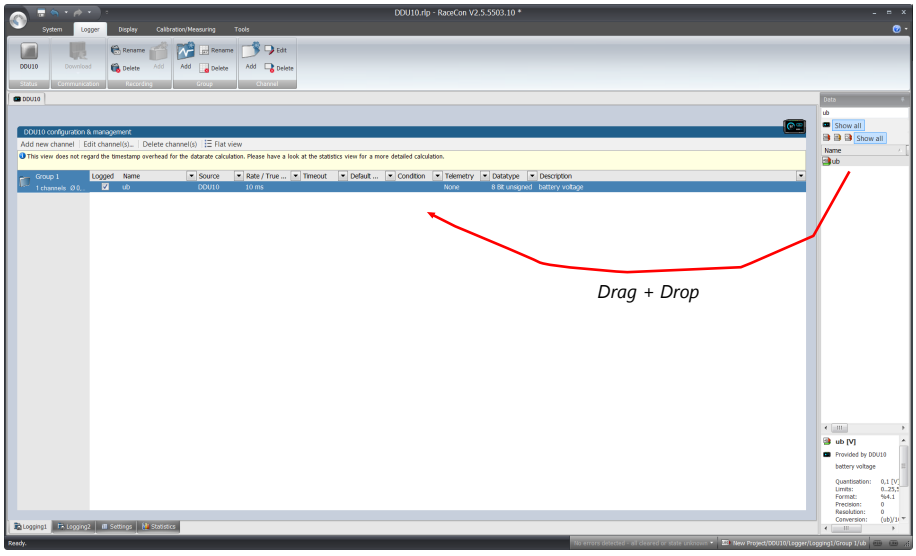
7.3 First recording (Quick Start)

This chapter explains the configuration of the recording of the battery voltage channel. See chapter 'Recording [▶ 103]' for a detailed instruction to configure recordings.

1. Click on the 'Logger' tab to go to the page 'Logger'.
2. Use the search bar in the 'Data' window, to search for 'ub' (measurement channel for battery voltage).



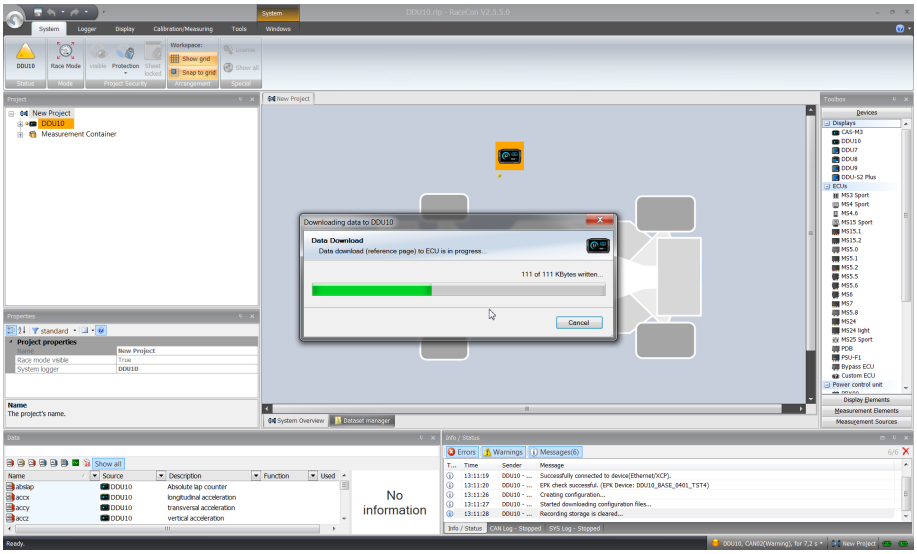
3. Drag and drop the 'ub' measurement channel into the recording area.



4. Click on the 'Download' button in the upper left corner.

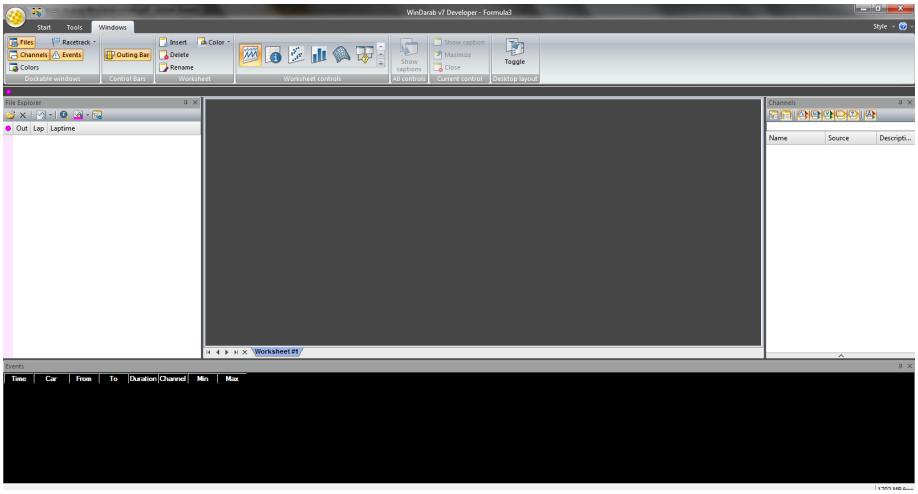
   The configuration download starts and the DDU 9 carries out a reset.

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



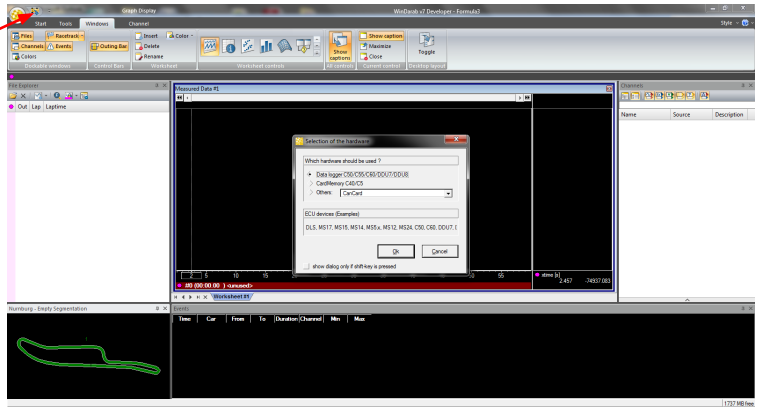
As we did not define global start conditions, recording starts immediately.

5. Start the WinDarab software.



6. Disconnect the DDU 9 network cable.
7. Click on the 'Read Data from Logging Device' icon.
8. Choose your logger and click 'OK' when done.

Click 'read data from logging device'

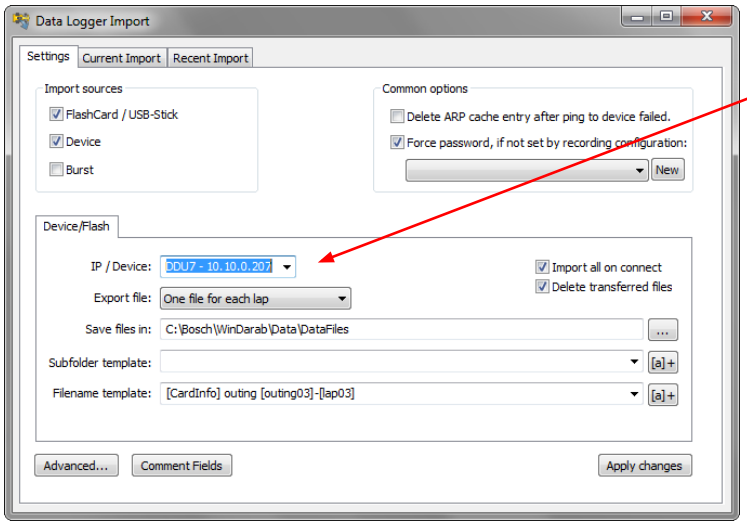


The 'Data Logger Import' dialog opens.

NOTICE

Refer to the WinDarab V7 manual for instructions on how to use the 'Data Logger Import' dialog and for more detailed descriptions and instructions.

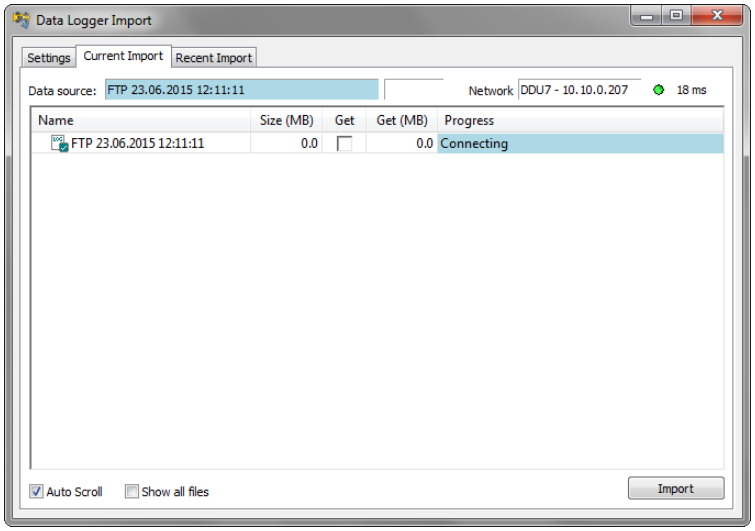
9. Choose the device and the IP address for the device.
10. Click 'Apply changes' when done.



Choose your DDU from dropdown list

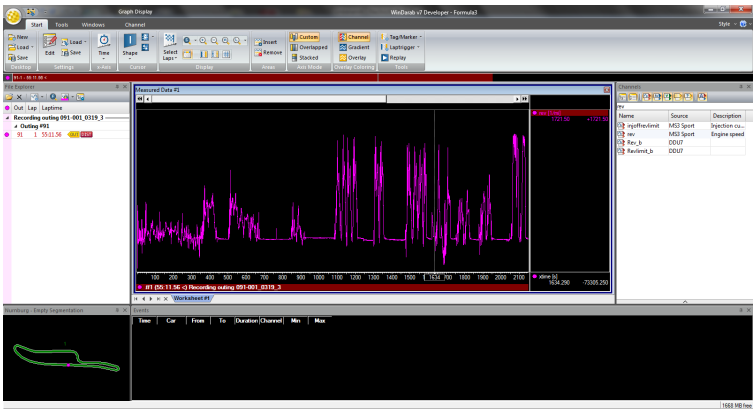
11. Connect the DDU 9 network cable.
12. Click on the 'Current Import' tab.
13. Click on 'Import' in the lower right corner.

    If the 'Import all on connect' box is checked, the data transmission from the DDU 9 starts automatically. Measurement files are stored automatically in the folder defined under 'Settings'.



14. Click on 'Close' when the transmission has finished.
15. Click on the Start button and choose 'Open measurement file'.
16. Select the measurement files from the storage folder.
17. Click on 'Open'.
18. Click on 'New Desktop' to open a new measurement data window.

19. Drag the ‘ub’ measurement channel from the channel list and drop it into the measurement data window. The ‘ub’ measurement channel‘s graph is displayed.

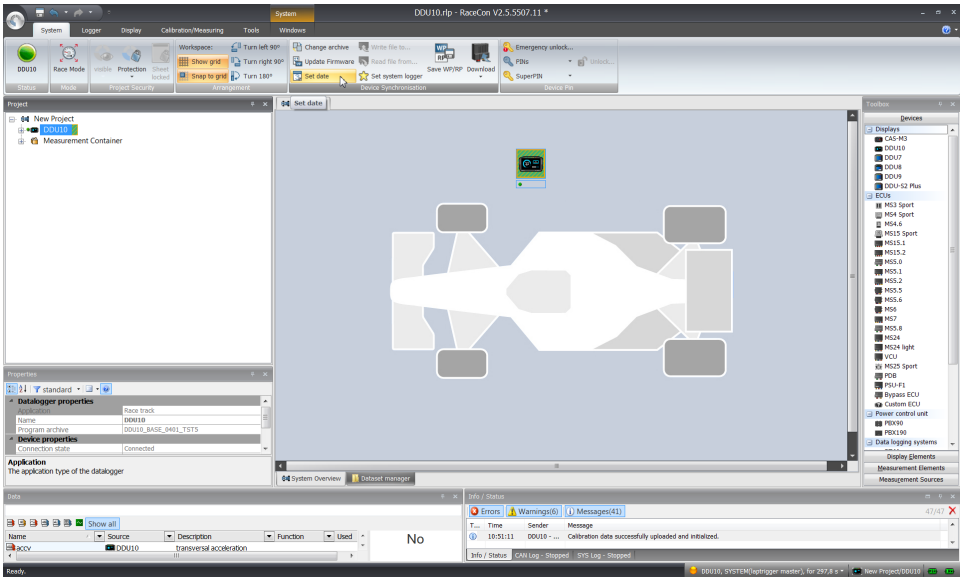


7.4 Set time and date

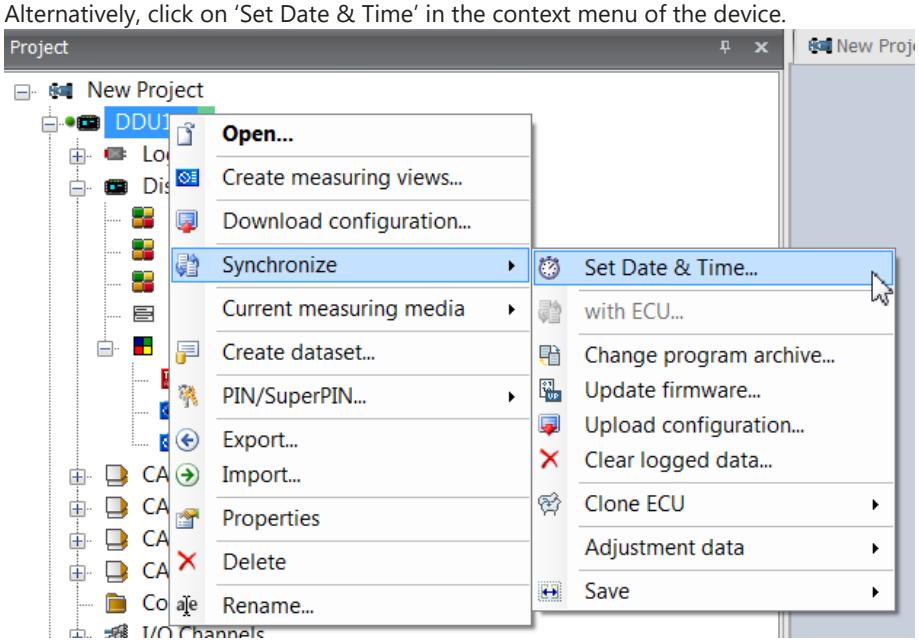
The DDU 9 is equipped with a real time clock which is supplied by an internal accumulator. Once this accumulator is charged correctly by 12 V supply of the display, ‘Date & Time’ can be programmed by RaceCon.

Reassure that the time is set correctly, if the device has not been used for more than two weeks.

1. Connect the DDU 9 to the PC.
2. Click on the ‘Set date’ button in the ‘System’ tab menu.



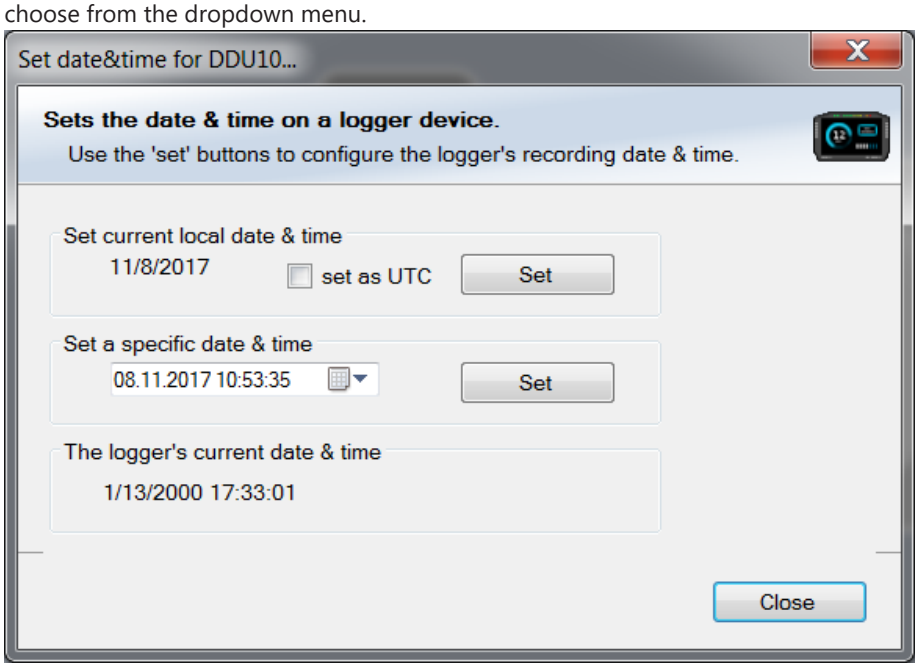
3. Alternatively, click on ‘Set Date & Time’ in the context menu of the device.



A ‘Set Date & Time’ menu opens

4. Set the current local date and time as coordinated universal time.

5. At ‘Set a specific date & time’ click and type on the value you want to change, or choose from the dropdown menu.

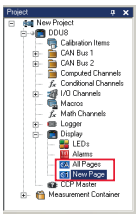


8 Display Configuration

- DDU 9 features: 800 x 480 full color TFT display + 10 color LEDs
- Display and LEDs are fully configurable
- ECU channels, analog channels, and CAN channels can be displayed
- Display elements: large numeric, medium numeric, bar graph style, alarm messages, static elements, image element
- DDU 9 supports up to 12 display pages, 6 brightness settings for display and LEDs

8.1 Display page setup

8.1.1 Organizing display pages



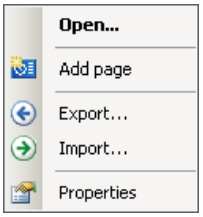
- All Pages: Display elements placed on this page are displayed on all pages. Recommended for 'Alarm' display elements.
- Single Page: Display elements placed on this page are displayed only on this page.

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.

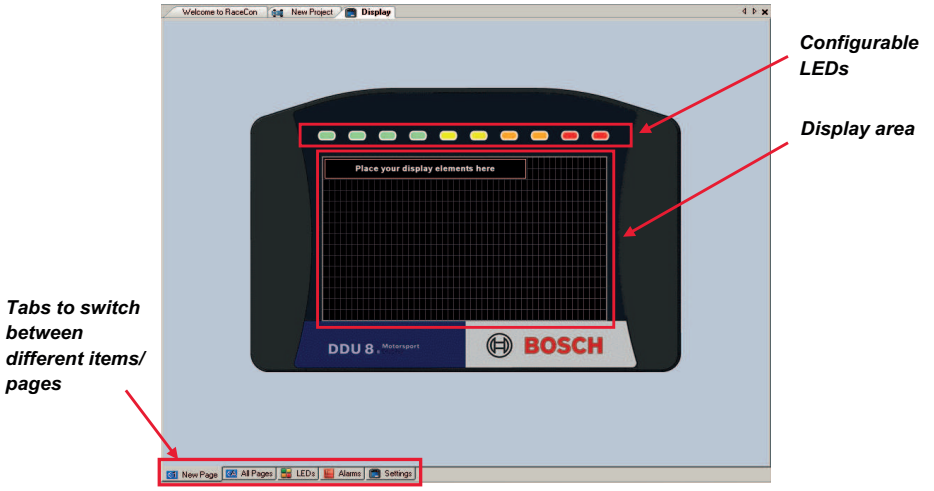


A new empty page opens.

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

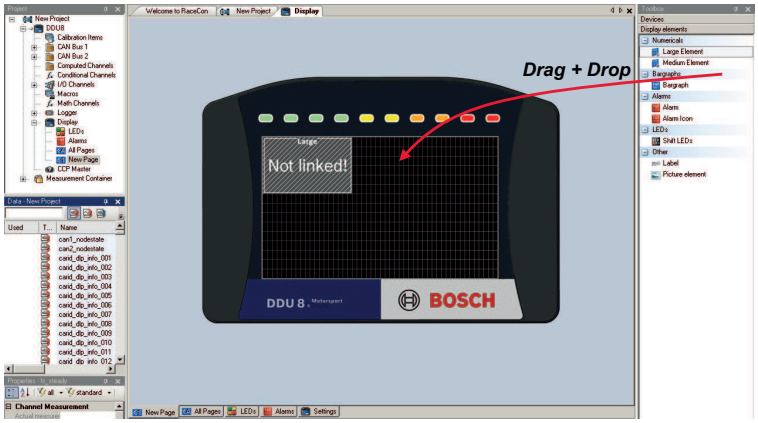
Adding a numeric display element to display page

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

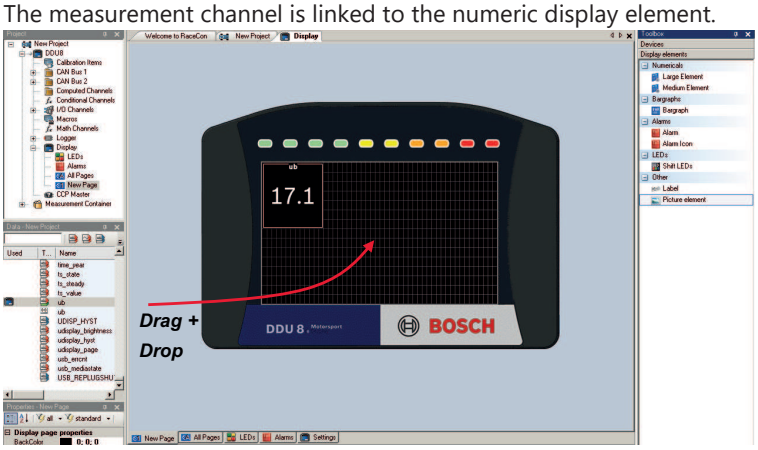
In this view the displayed values are random values and do not show the real values of the measurement channels.

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.



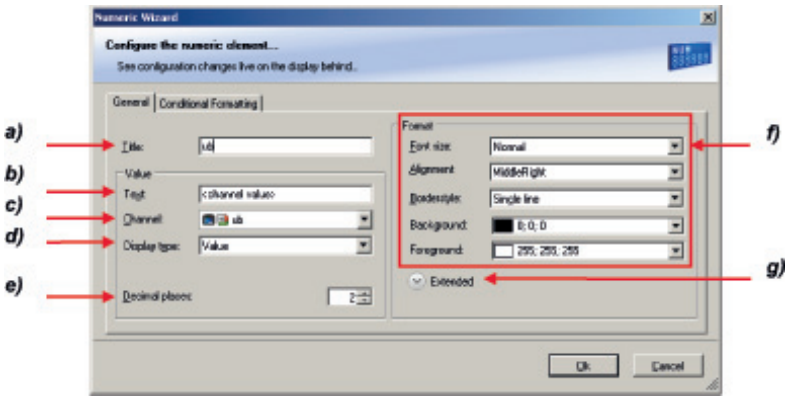
2. Drag a measurement channel from the Data Area and drop it on the numeric display element.

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 he 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.

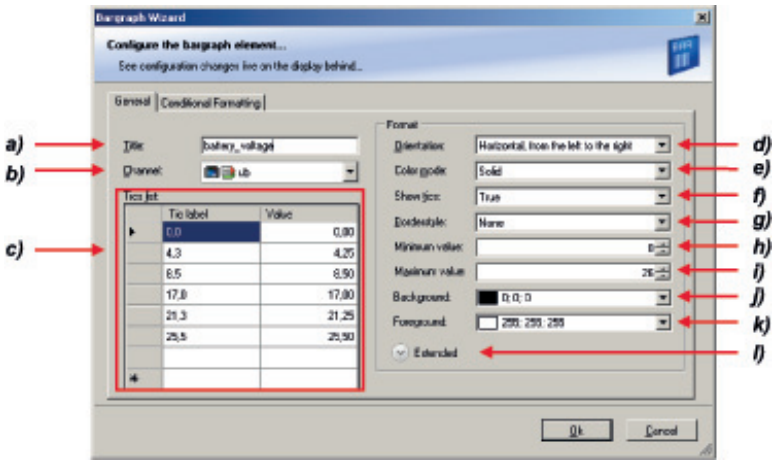
8.2.2 Bargraph display element

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 tic labels by entering values in the row labeled with *.*
d) Choose the orientation of the Bargraph (horizontal or vertical).
e) Chose 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'.
a) Define if ticks and numbers are shown.
b) Choose the style of the border lines.
c) Enter the physical value where the Bargraph begins.
d) Enter the physical value where the Bargraph ends.
e) Choose the background color of the Bargraph.
f) Choose the foreground color of the Bargraph.
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.

NOTICE

The tab 'Conditional Formatting' is explained in chapter 'Conditional formatting [▶ 30]'.

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:

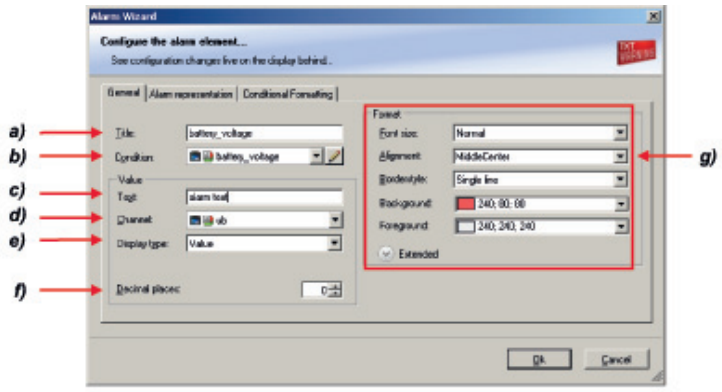
- Alarm: An alarm displaying a defined text
- Alarm Icon: An alarm displaying a defined image (e.g. a warning triangle)

Adding an 'Alarm' display element to display page

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

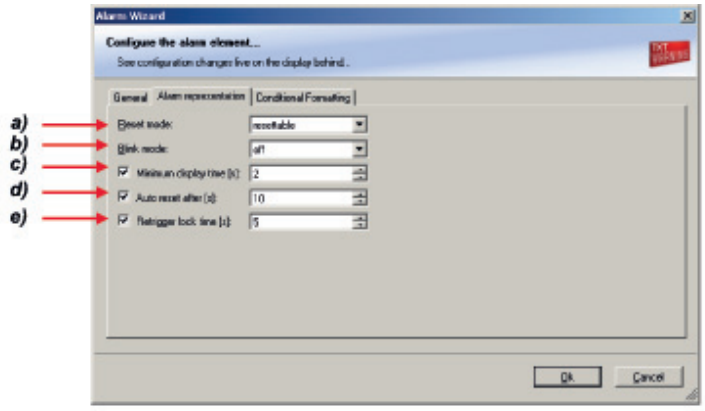
Configuring an ‘Alarm’ (text) display element

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



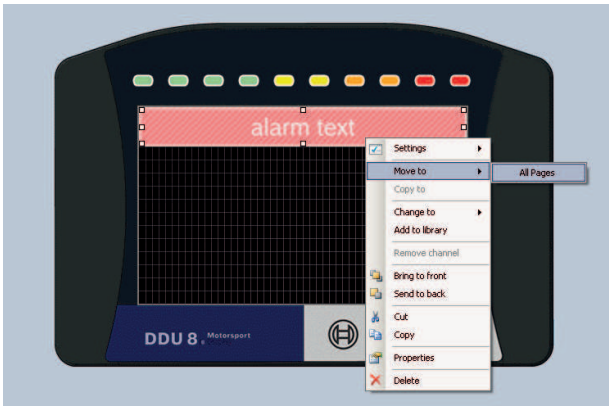
a) Enter the title displayed on top of the ‘Alarm’ display element.
b) Choose the condition when the alarm will be activated:
• Create a condition using the Condition Creator. For more information see chapter ‘Creating a new condition channel’.
• Choose an existing condition
The Alarm is displayed if 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.

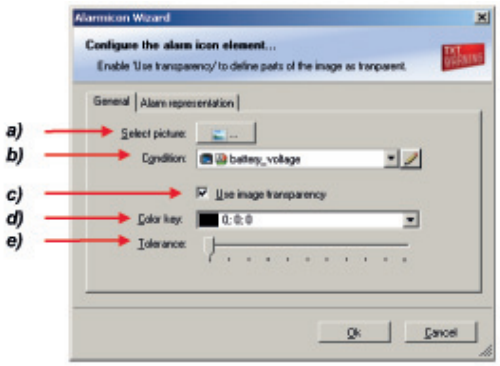
3. Click ‘OK’ when done.
4. Copy alarm to all display pages by clicking ‘Move to’ -> ‘All Pages’.



Configuring an 'Alarm Icon' (image) display element

1. Double-click on the 'Alarm Icon' display element.

   The Alarm Icon Wizard window opens.



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.

2. Switch to the tab 'Alarm representation'. It is configured in the same way as the 'Alarm' text display element.
3. Click 'OK' when done.

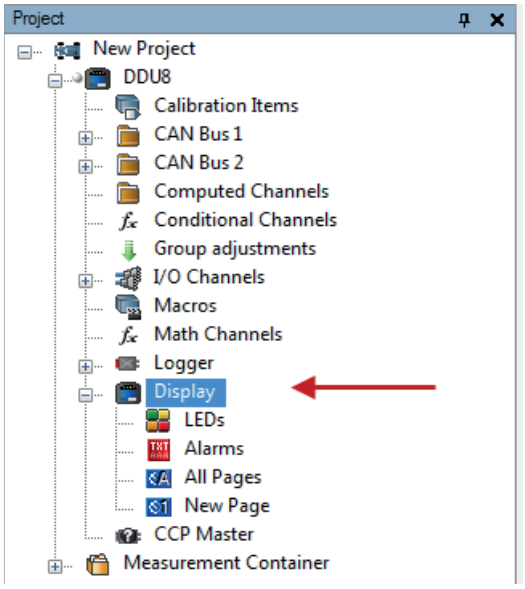
NOTICE

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

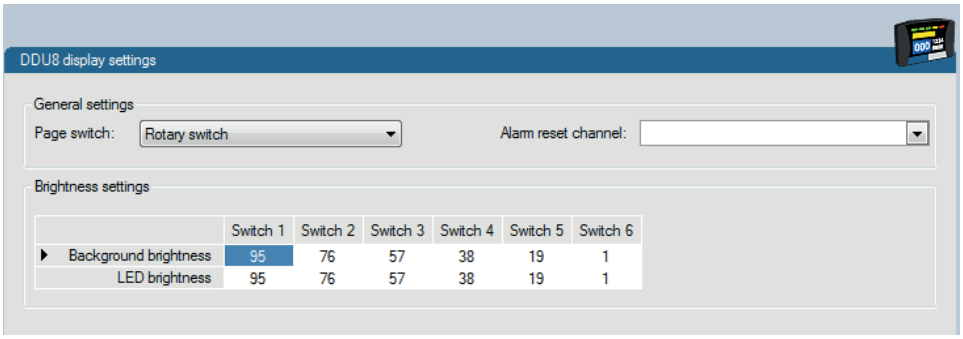
Configuring an 'Alarm Reset Channel'

The Alarm Reset Channel can be defined in the display setting menu.

1. Double click on the display icon in the project tree.



On the settings Tab the Alarm Reset Channel can be defined.



8.2.4 Other display elements

Two types of other display elements are available:

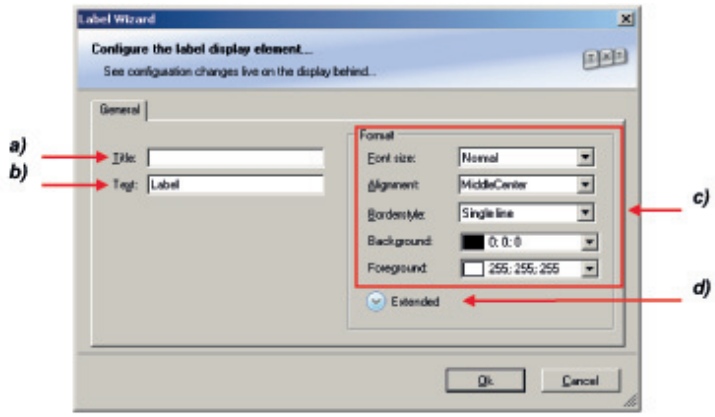
- Label: A label displaying a specified text
- Picture element: An element displaying a static picture (e.g. temperature warning)

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.



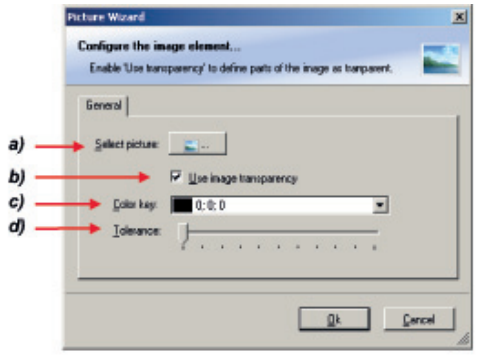
a) Enter the title displayed on top of the Label display element.
b) Enter the text displayed in the middle of the Label display element.
c) Choose the font size, alignment, borderstyle, background and foreground color of the Label display element.
d) Click the Extended button to show further options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



The lower and the upper limits are configured in the same way.
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, border and text individually. If a 'Bargraph' display element is used, its colors can also be changed.

2. Click 'OK' when done.

8.2.5 Conditional formatting

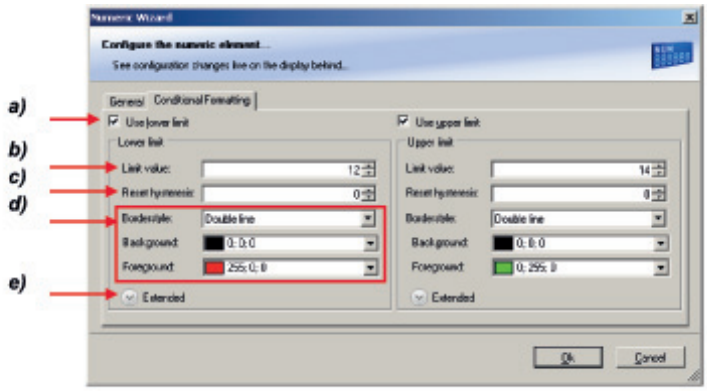
This function pigments the displayed values in dependence of a specified measurement channel value.

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'.

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

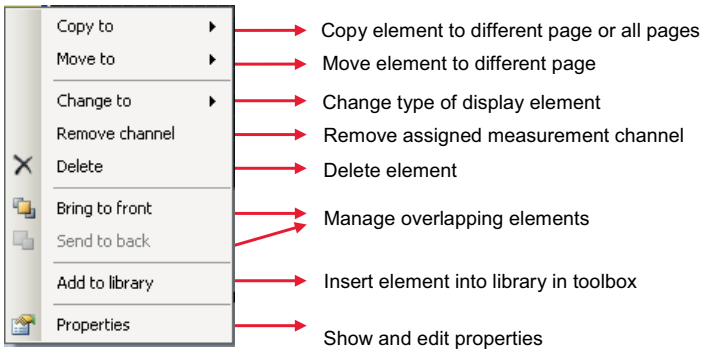


a) Check the box to activate the formatting at a lower limit.
b) Enter the limit value when the formatting is active.
c) Enter the limit value when the reset hysteresis function is active. The reset hysteresis function avoids the high-frequent switchover of the measurement channel value.
d) Choose the 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, border and text individually. If a 'Bargraph' display element is used, its colors can also be changed.

3. Click 'OK' when done.

8.2.6 Context menu

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



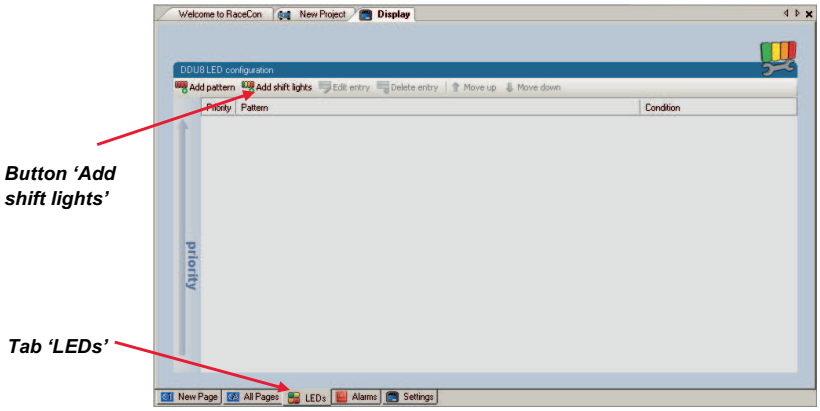
8.3 LEDs

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.

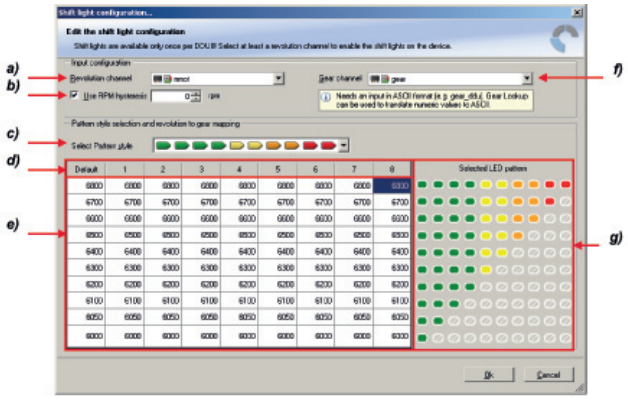
1. Click on the tab 'LEDs' in the display view.
2. Click on the button 'Add shift lights'.



The shift light configuration window appears.

Shift Light Configuration

1. 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-frequent 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) Define the RPM-limits individually for each LED and each gear.
f) 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'.)
g) Choose the number and color of the LEDs corresponding to the RPM-limits shown in the table. You can choose the number and color of each LED individually by right-clicking.

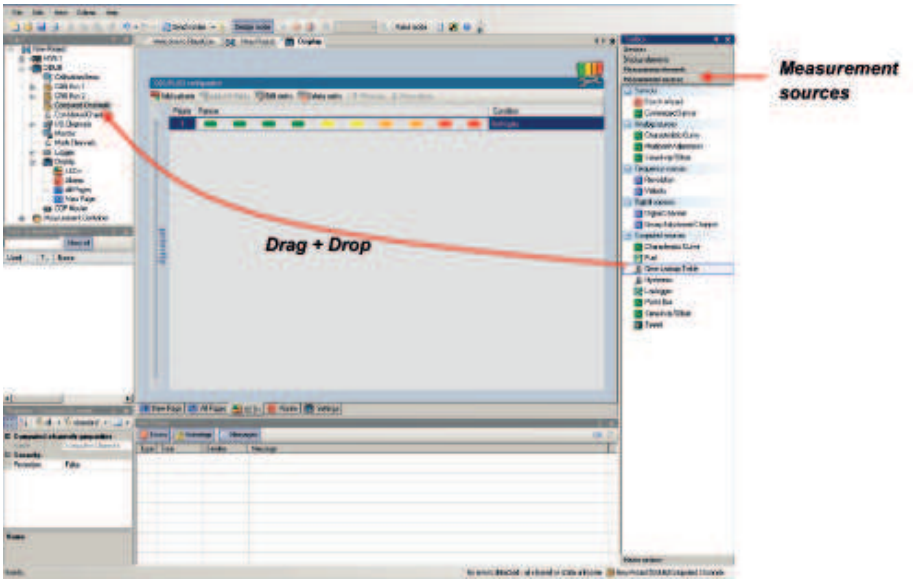
2. Click 'OK' when done.

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.

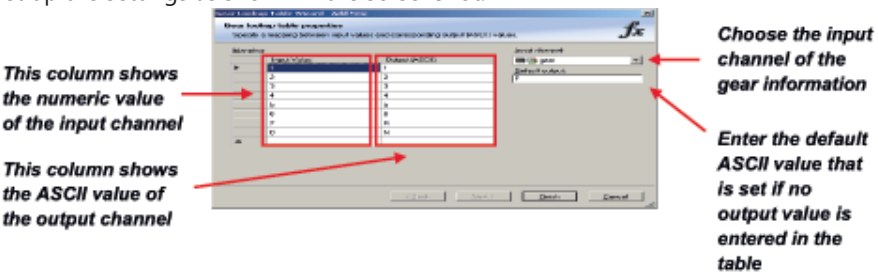
1. Click on the Measurement Sources button in the Toolbox.
2. Drag the 'Gear Lookup Table' symbol and drop it in the 'Computed Channels' folder.



The Gear Lookup Table Wizard appears.

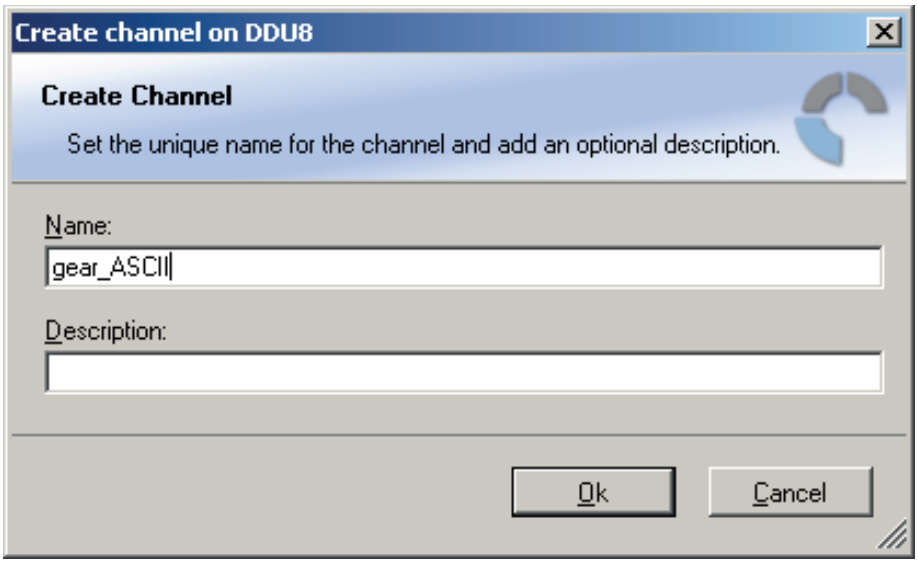
Gear Lookup Table Wizard

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



2. Click 'OK' when done. The 'Create channel on DDU 8' window appears.

   Enter the name and an optional description of the translated ASCII measurement channel.



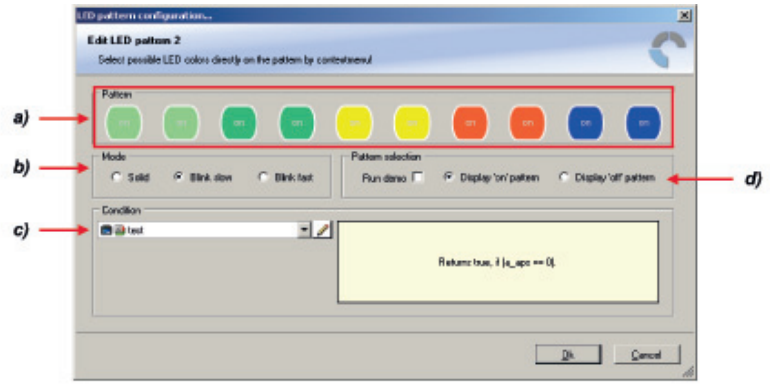
3. Click 'Ok' when done.

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.

1. 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.
3. The configuration is displayed in the DDU 9 LED Configuration window.

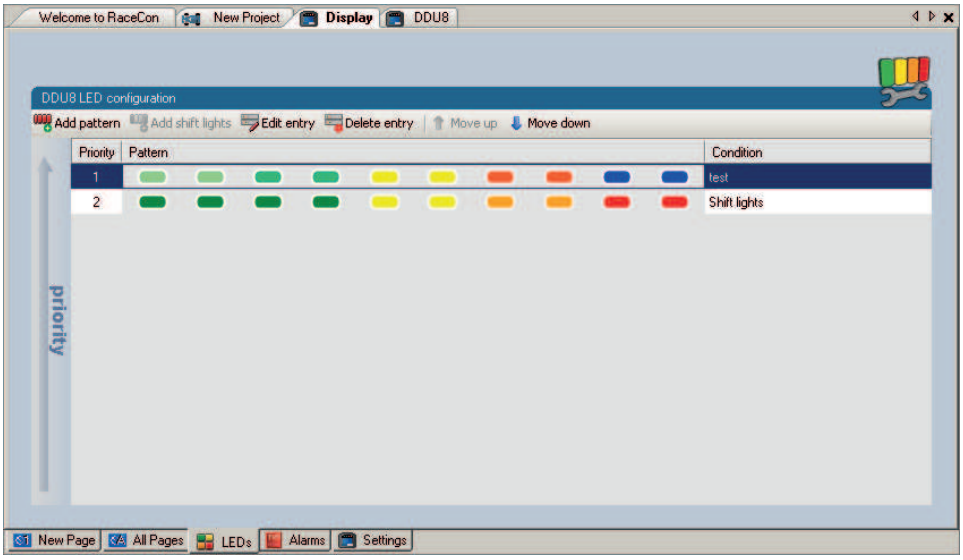
8.3.4 Assigning display pattern priority

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.



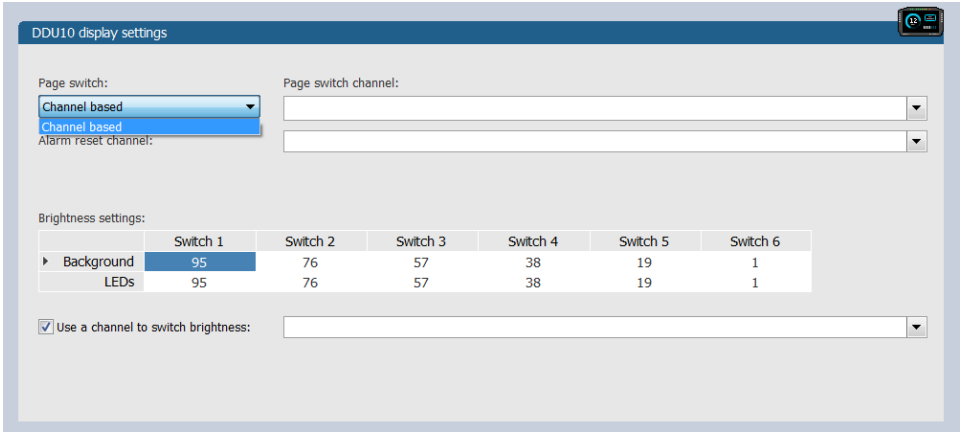
8.4 Page select / Display brightness / LED brightness

Any “event” can be used to change the display and LED brightness or the display page. Those events can be any input channel or an internal calculated channel. In the following chapters, you will find some examples on how to set up such a configuration.

8.4.1 General information

To use a channel as a page switch, select “Channel based” as page switch and select the channel you configure for a switch in the ‘display settings’ dialog (as described in the following chapters).

To use a channel as a brightness switch, check the box “Use a channel to switch brightness” and select the channel you configure for a switch.



Page switch

The pages can be switched from page one too twelve. If not all twelve pages are defined, the device switches up to the highest defined page number, and ignores higher numbers, which are not defined.

If the channel value does not only consist of integers, the pages will be switched as follows:

Page 1 is shown with the value < 1.5

Page 2 is shown with 1.5 <= the value < 2.5

Page 3 is shown with 2.5 <= the value < 3.5

...

Page 12 is shown with 11.5 <= the value

Brightness switch

The brightness can be switched with 6 positions. In the display settings dialog you will find a chart for the 6 switch positions over the display brightness and the LED brightness (the values are in percent).

If the channel value does not only consist of integers, the pages will be switched as follows:

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

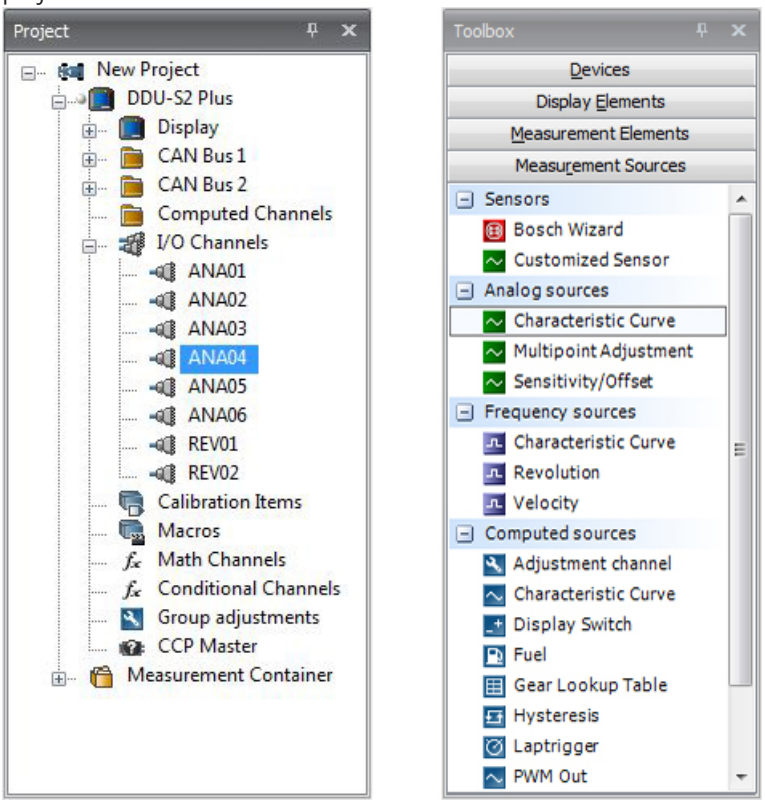
...

Switch 6 is shown with 5.5 <= the value

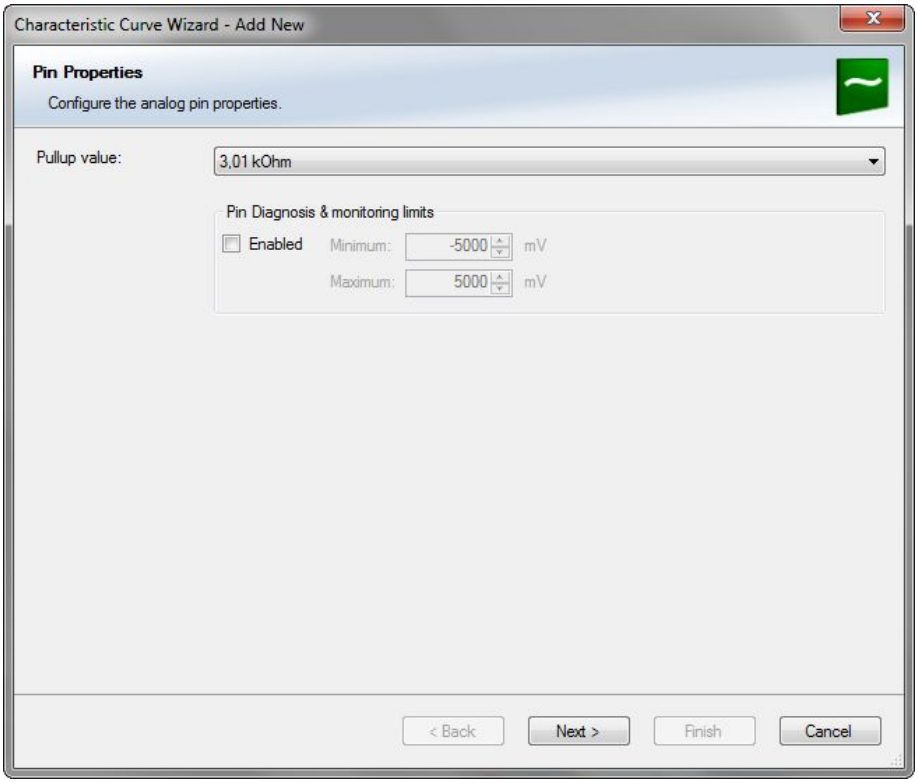
8.4.2 Option 1: 12 Hardwired position switch

1. Connect a 6 or 12 position switch to one of the analog input pins ANAxx and to the sensor ground.
   For recommended position switches, please see the environment section in the chapter “Technical Data.”
2. Select one of the analog inputs in the project tree.

3. Go to ‘Measurement Sources’ in the toolbox and select the ‘Characteristic Curve’ under ‘Analog sources’. Drag and drop it on the selected analog input channel in the project tree.

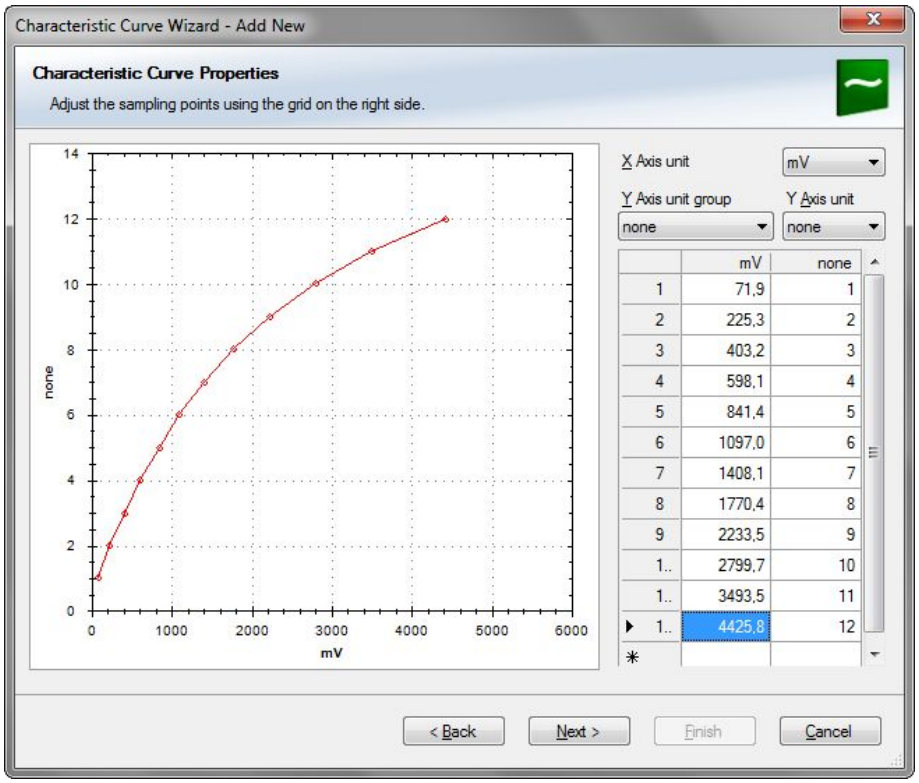


4. Select “Pull-up value:” 3.01 kOhm and click on ‘Next’.

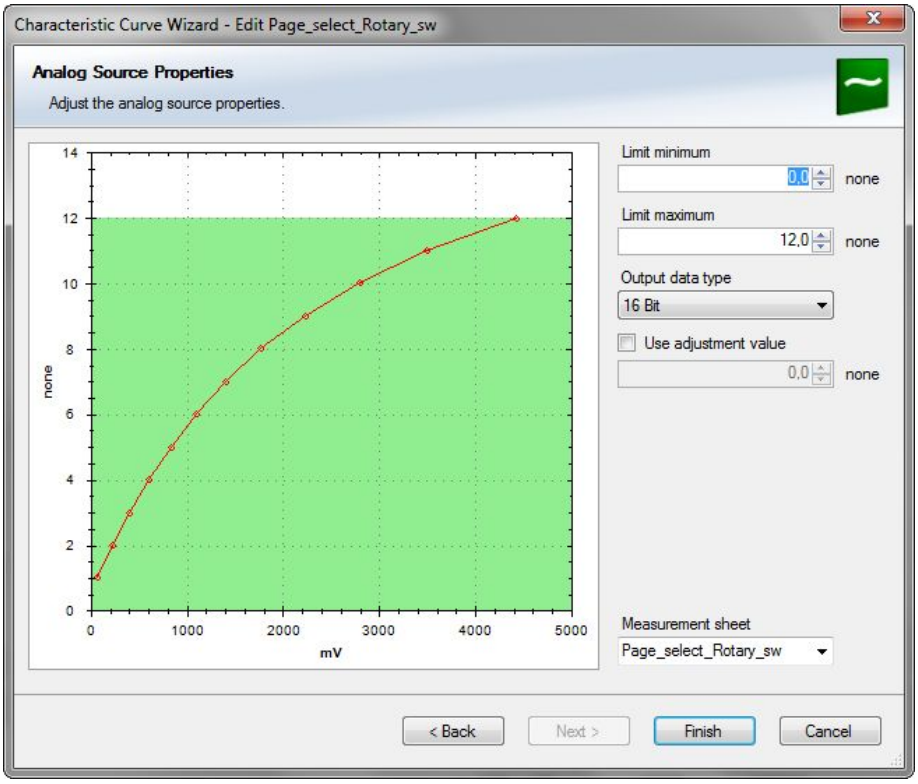


5. Define the relation between voltage and switch position and click on ‘Next’.
   Voltage = 5000 x R/(R + 3010)
   5000: Sensor supply (mV)
   R: Resistor for each Rotary switch position (Ohm)
   3010: Pull-up resistor (Ohm)

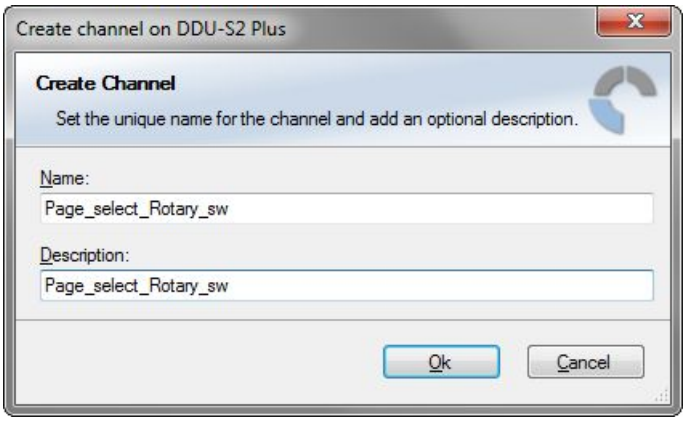
   The following screenshot and the data are an example for a Bosch switch.

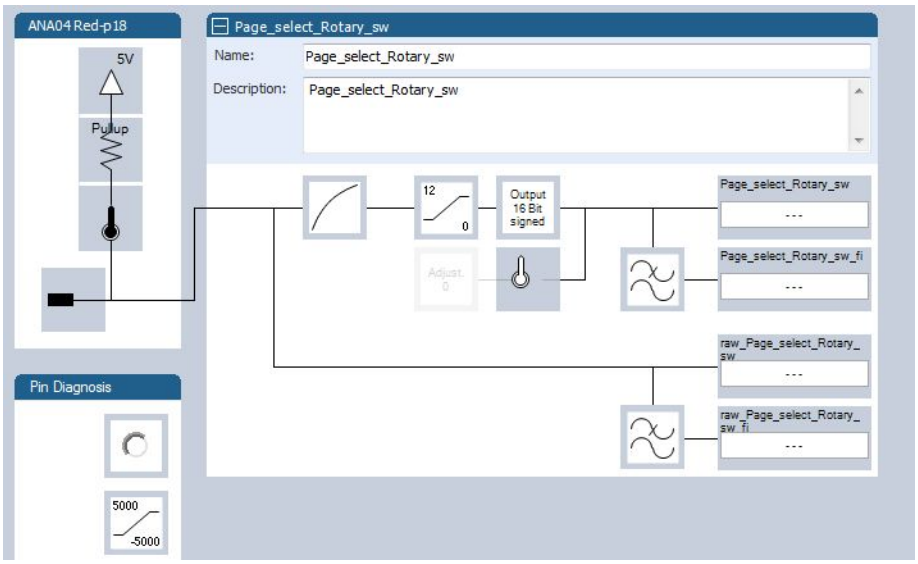


6. Define minimum and maximum Limit.
   Select “Output data type” from 8, 16 or 32 Bit.
   Do not check “Use adjustment value”.
   Choose the Measurement sheet and click on ‘Finish’.



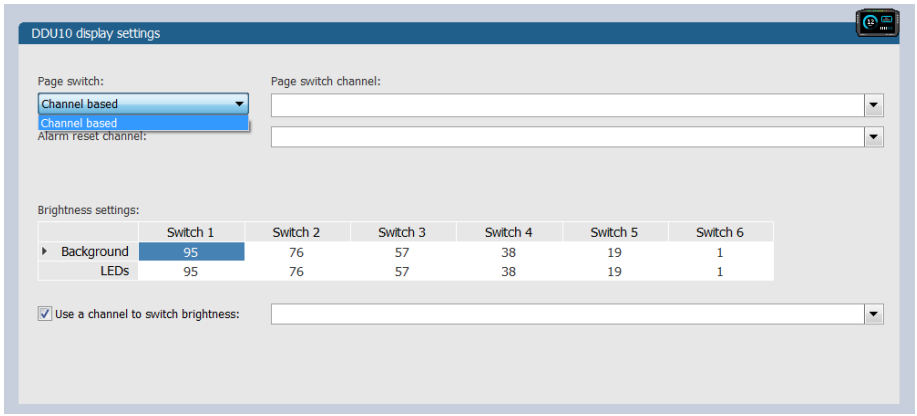
7. Define Name and Description and click on ‘Ok’.



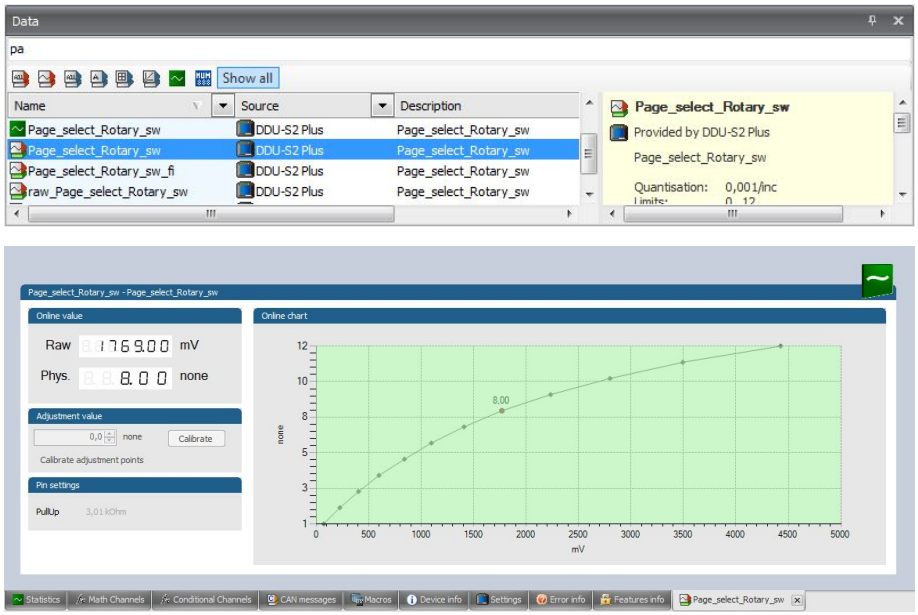


8. Click on the ‘Display’ tab and select the ‘Settings’ tab at the bottom.

9. To use the channel as a Page Switch, Select "Channel based" as page switch and select the channel configured above.
10. To use the channel as a brightness switch, check the box "Use a channel to switch brightness" and select the channel configured above.

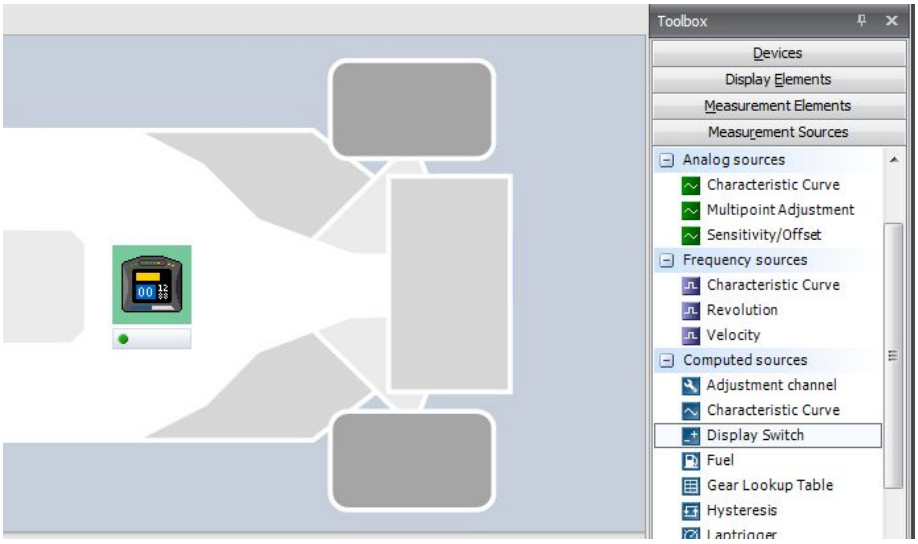


11. Click the ‘Download’ button at the top, to download the configuration.
12. If you want to check your configured channel, ensure that the device status is green, search for the configured channel in the Data window and double-click on it.
You will see a graphical display with the raw and the physical value of the channel.

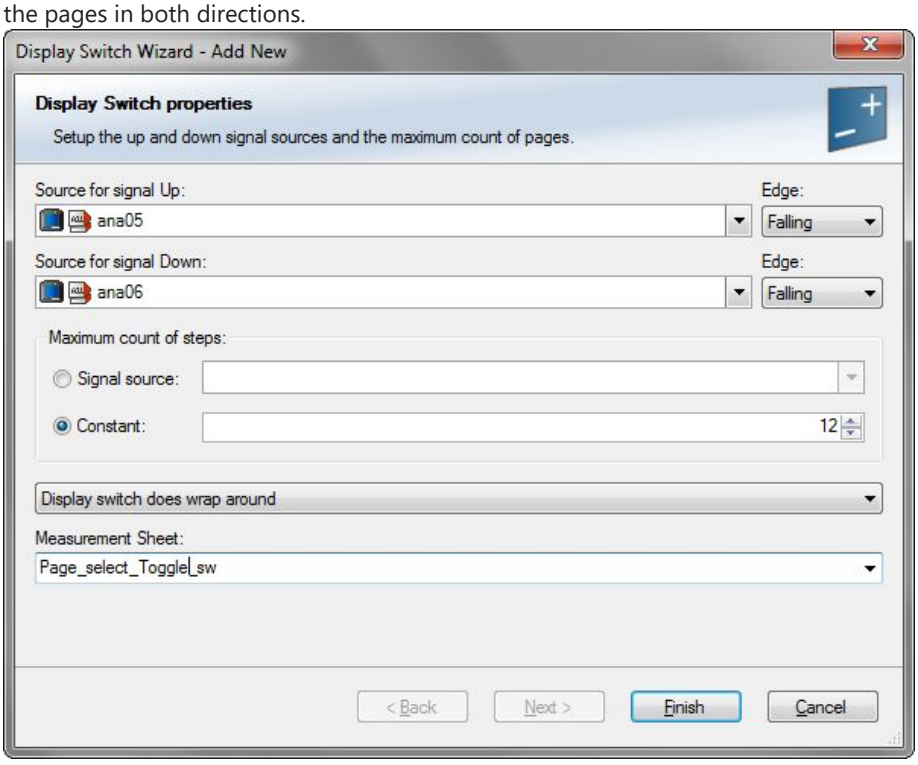


8.4.3 Option 2: Up/Down switches

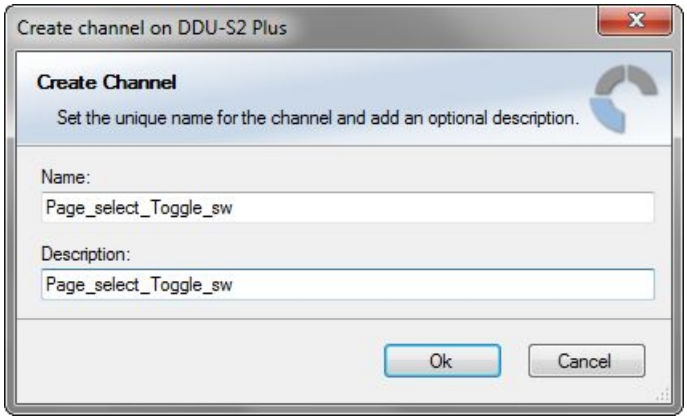
1. Define either one signal for a wrap around switch or two signals for an up/down switch.
2. Select the ‘Display Switch’ and drag it into the DDU 9.

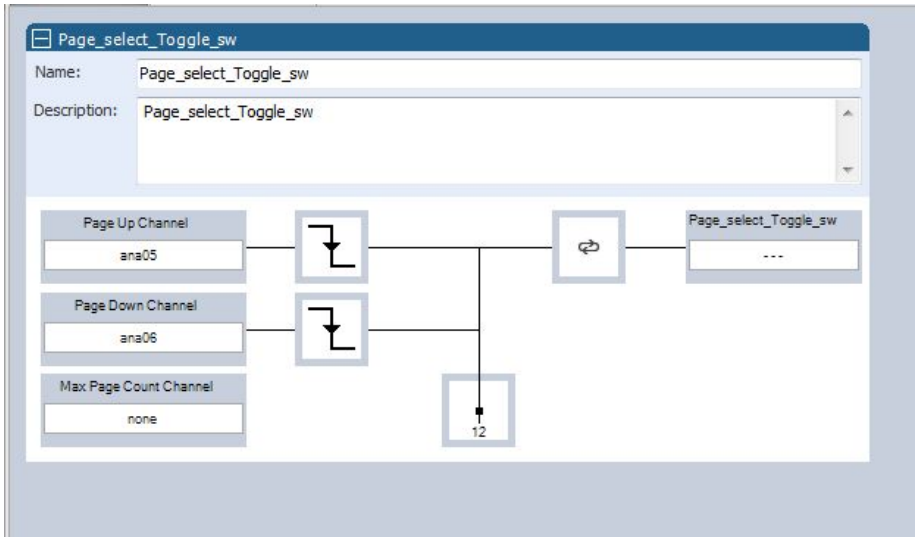


3. Select the Source for signal Up/Down and Edge Falling or Rising.
   Select the Maximum count of steps from signal source or from constant.
   Select “Display switch does wrap around” or “Display switch does not wrap around”.
   “Display switch does wrap around” goes from maximum position to minimum position or the other way around (by switching) in a loop, after the last page it starts again with the first page.
   If you choose “Display switch does not wrap around”, you need two switches to turn the pages in both directions.

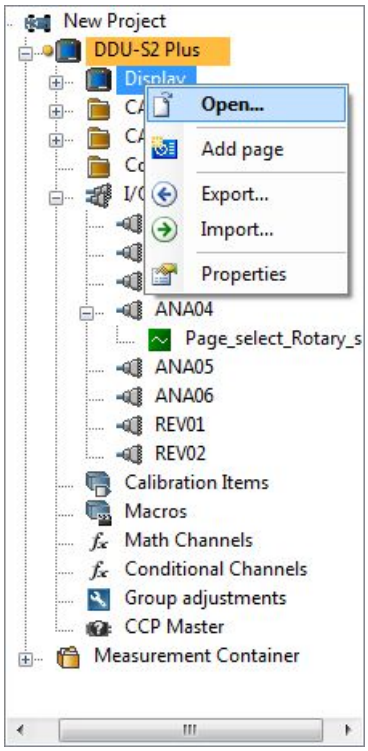


4. Define Name and Description and click on ‘Ok’.



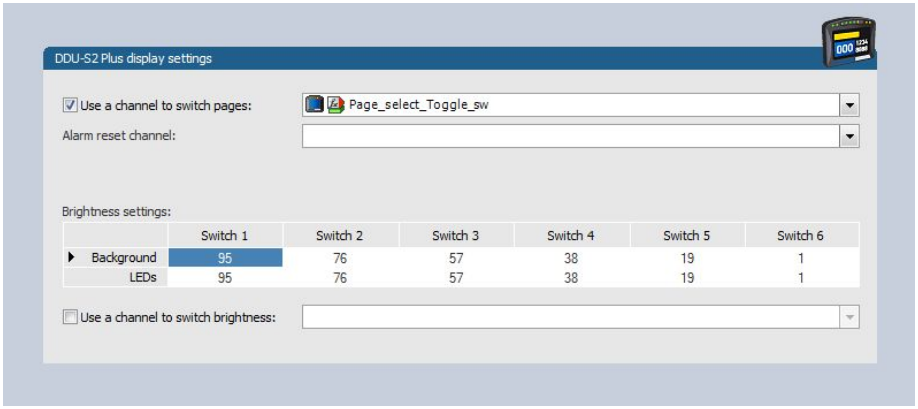


5. In the project tree, select “Display” and then “Open”.

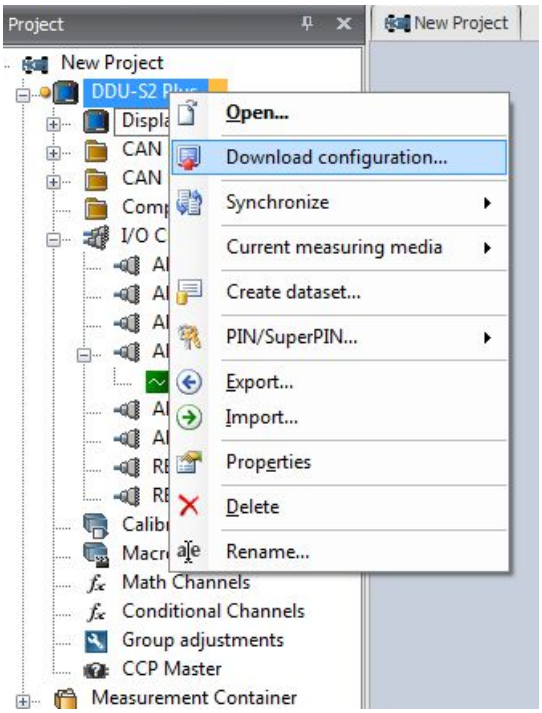


6. To use the channel as a Page Switch, check the box "Use a channel to switch pages" and select the channel configured above.

7. To use the channel as a brightness switch, check the box "Use a channel to switch brightness" and select the channel configured above.

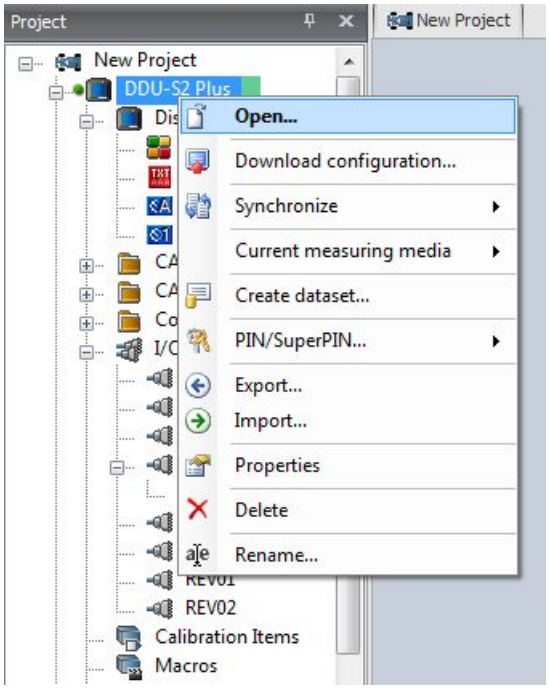


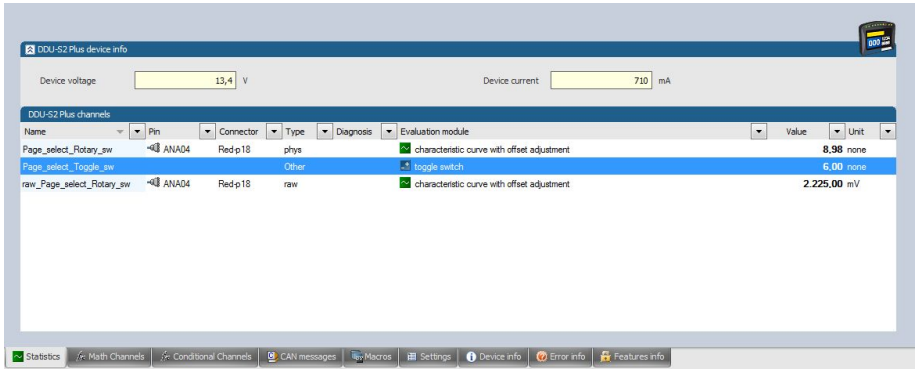
8. In the project tree, select “Download configuration”.



9. If you want to check your configured channel, reassure that the device status is green, double-click on the DDU 10 and select the "Statistics" tab.

   The configured channel position opens.

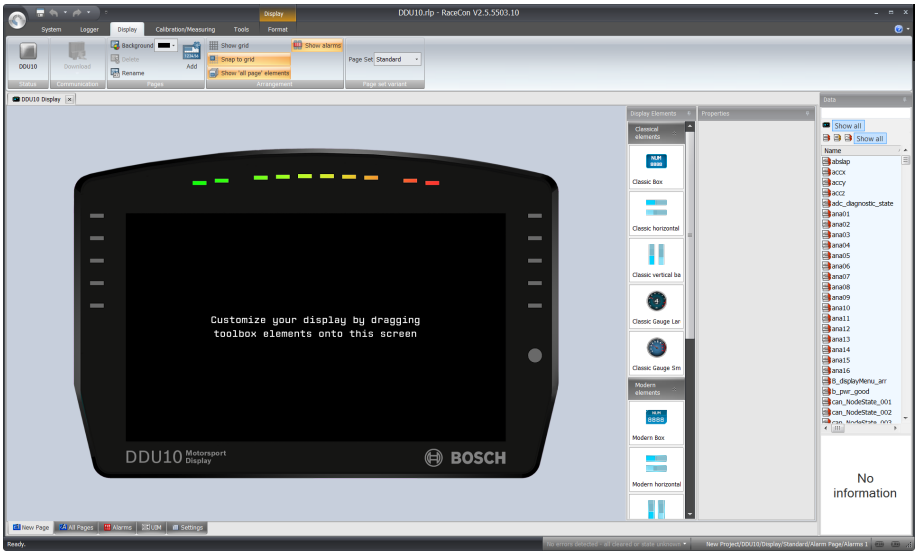




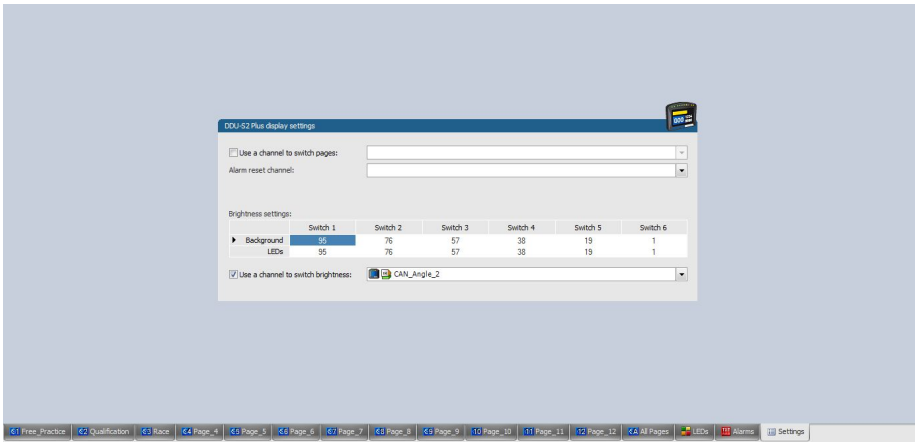
8.4.4 Option 3: CAN input signal, math channel or ANA_IN channel

Define your CAN, math or analog input channel.

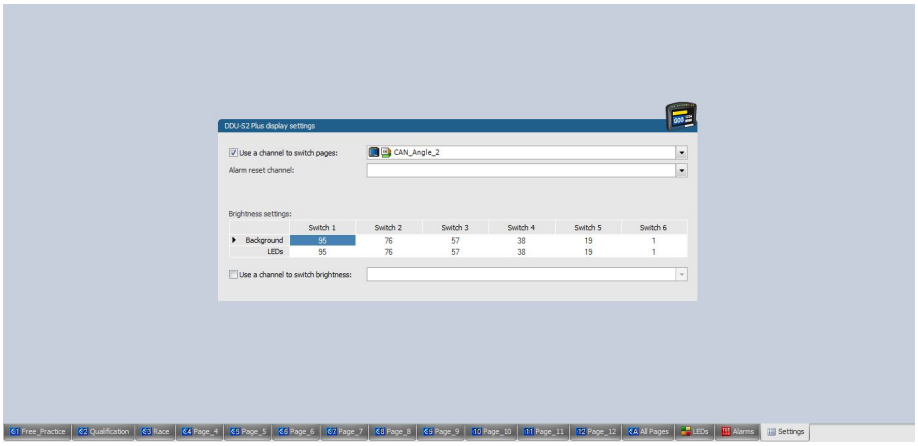
1. Select the 'Display' tab and then the 'Settings' tab at the bottom.



A ‘display settings’ window opens.



2. To use the channel as a brightness switch, check the box "Use a channel to switch brightness" and select the channel configured above.



3. To use a channel as a Page Switch, check the box" Use a channel to switch page" and select the channel configured above.
4. Click on the ‘Download’ button in the upper left corner.

8.5 Math and condition channels

8.5.1 Math 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

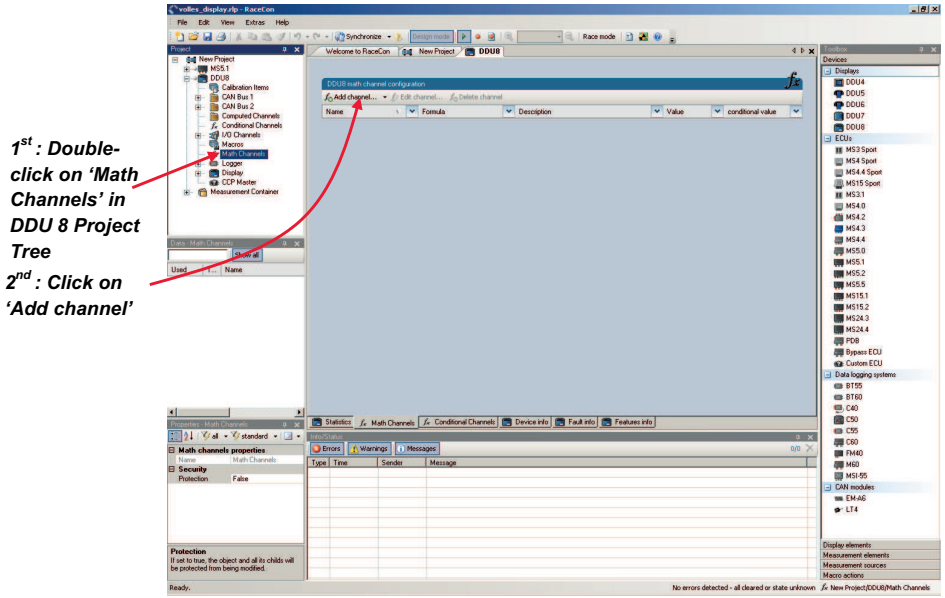
Conditional function

- 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.

8.5.2 Creating a new math channel

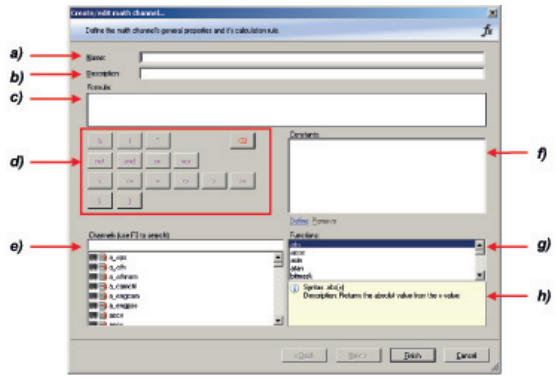
1. Follow the steps shown in the screenshot.



The 'create/edit math channel' window appears.

Create/Edit Math Channel Window

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

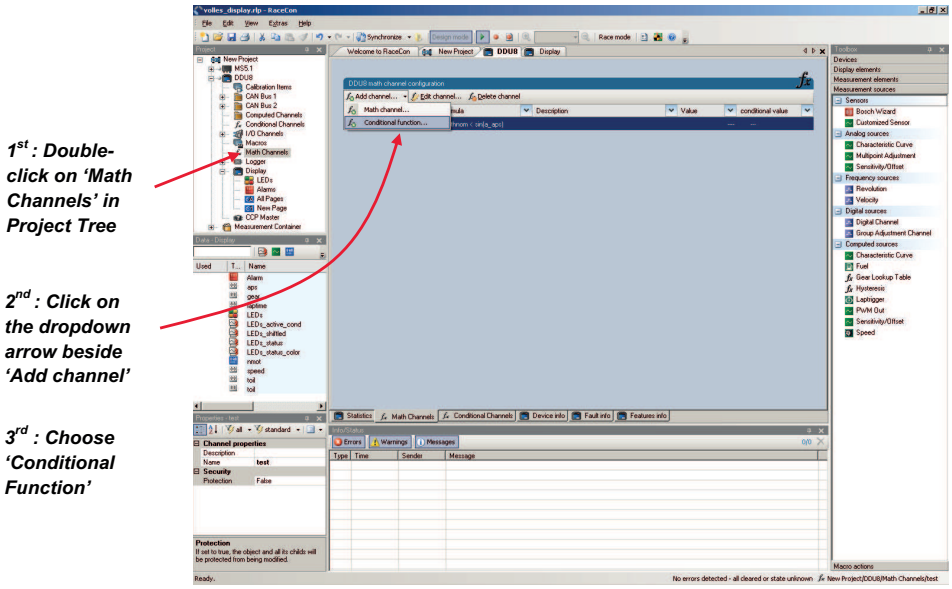


a) Enter the name of the math channel.
b) Enter a description of the math channel.
c) Enter the formula.
d) Select the logical operator.
e) Choose a measurement channel.
f) Define a value that can be used as a constant in the formula.
g) Choose a function.
h) Describes the function selected above.

2. Click 'Finish' when done. The math channel is displayed in the DDU 9 math channel window.

8.5.3 Creating a new conditional function

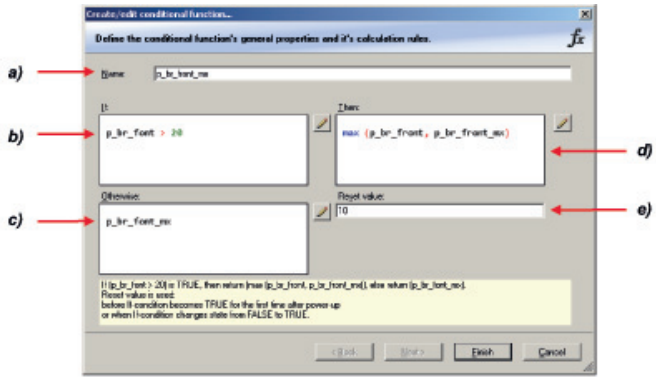
1. Follow the steps shown in the screenshot.



The 'create/edit conditional function' window appears.

Create/Edit Conditional Function Window

1. 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).

2. 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’).

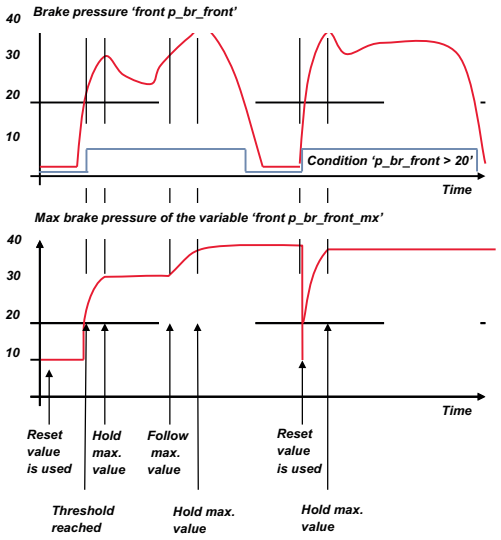
The reset value is always set for the new variable (entered in ‘Name’):

- 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 DDU 9 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.

8.6 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

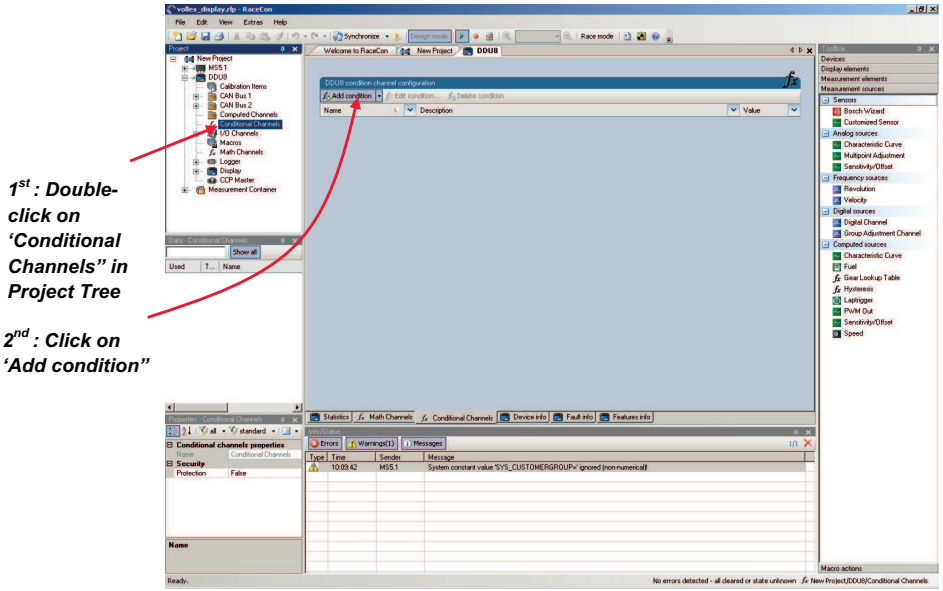
- Combination of several (up to 16) condition channels for more complex calculations

– Logical results

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

8.6.1 Creating a new condition channel

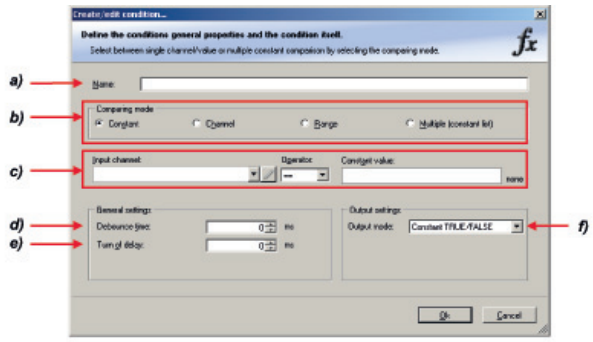
1. Follow the steps shown in the screenshot.



The ‚create/edit condition' window appears.

Create/Edit Condition Window

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



a) Enter the name of the condition 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 constant.
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.

2. Click 'Ok' when done.

The conditional channel is displayed in the DDU 9 condition channel window.

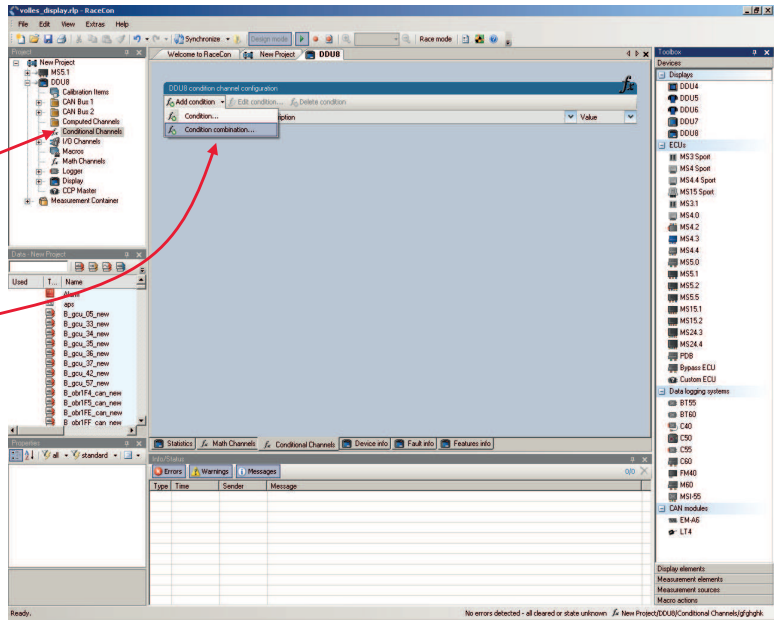
8.6.2 Creating a new condition combination

1. Follow the steps shown in the screenshot.

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

2nd : Click on the dropdown arrow beside 'Add condition'

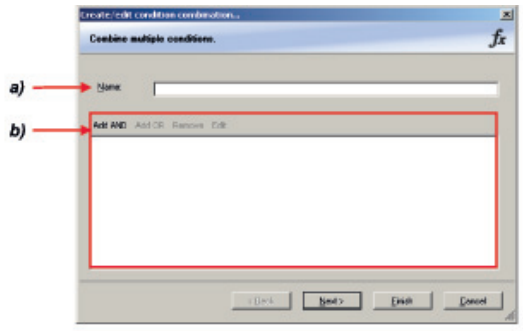
3rd : Choose 'Conditional combination'



The ‚create/edit condition combination' window appears.

Create/Edit Condition Window

1. 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.

2. Click 'Next' to got 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.

3. Click 'Finish' when done.

The conditional combination is displayed in the DDU 9 condition channel window.

8.7 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 setups, please consider reducing the demands on the DDU 9 adapting the influencing factors mentioned above.

9 CAN Bus

The DDU 9 has two fully configurable CAN buses.

- Baudrate (125 kbaud to 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 RaceCon measurement variables to CAN messages, output frequency and row counter are configurable, CAN gateway functionality (transfer from one bus to another).

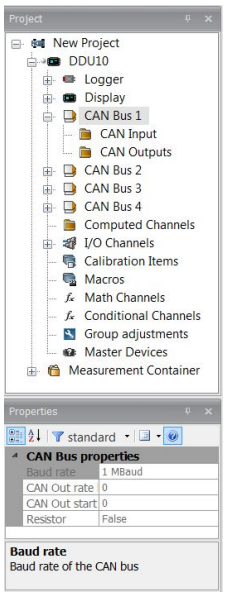
9.1 CAN bus trivia

CAN message

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

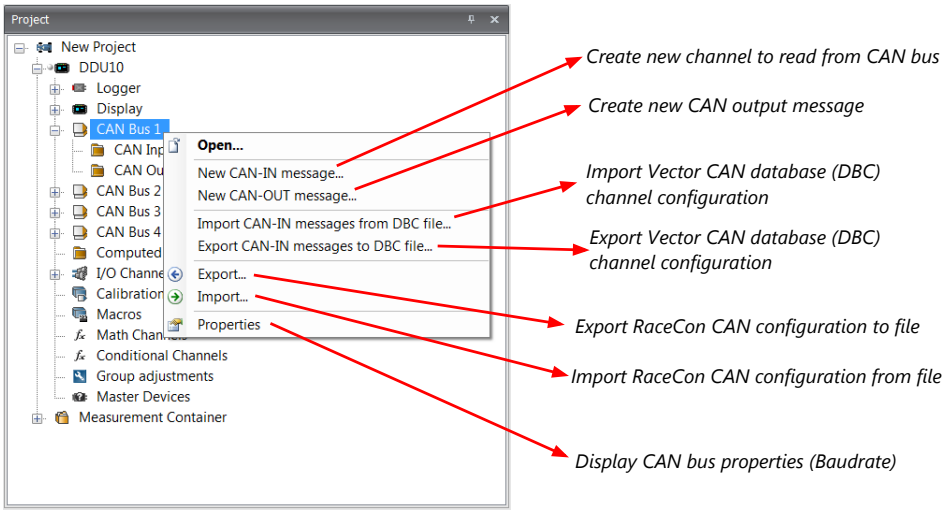
CAN bus

- 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 the 'CAN messages overview' menu. To access the menu, double-click on one of the CAN bus items of the project tree (1 Mbaud, 500 kbaud, 250 kbaud, 125 kbaud).



CAN item drop-down menu

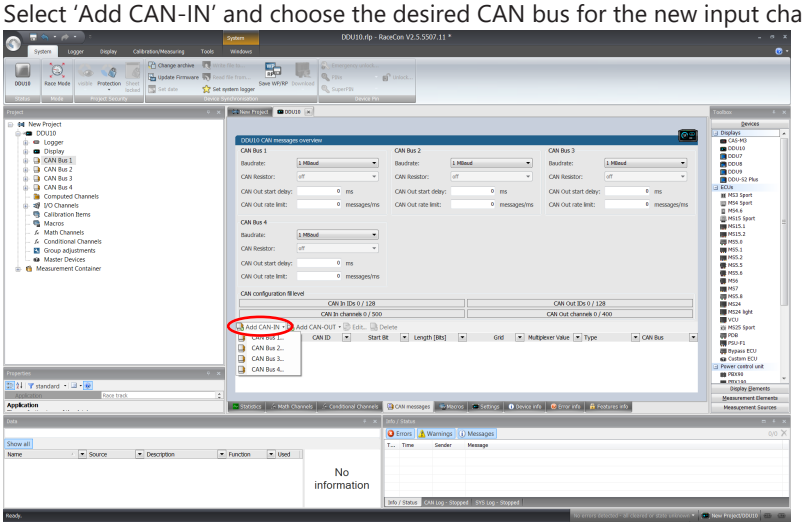
Click with the right mouse button on the desired CAN bus to open the CAN bus drop-down menu.



9.2 CAN input

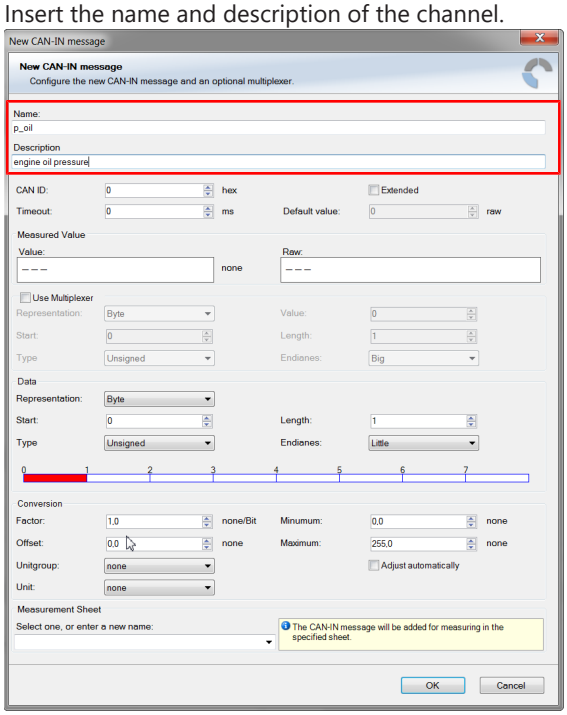
9.2.1 Create new CAN Input channel

1. Double-click on any CAN bus item, to open the "CAN messages overview".
2. Select 'Add CAN-IN' and choose the desired CAN bus for the new input channel.

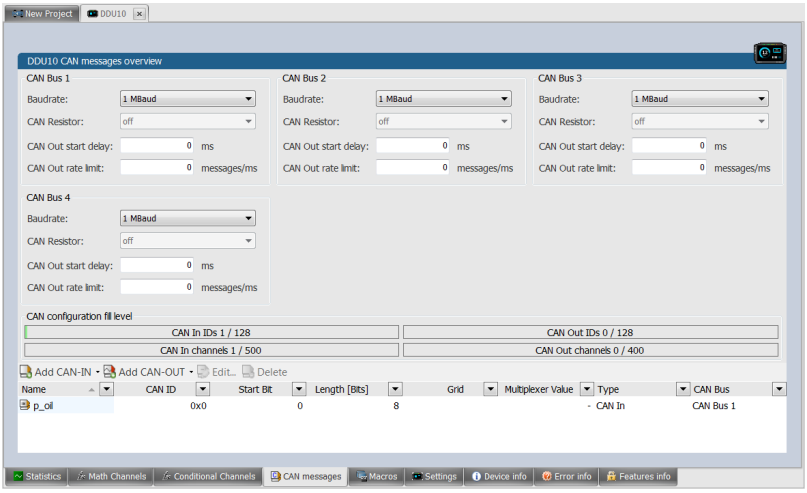


A CAN channel configuration window opens.

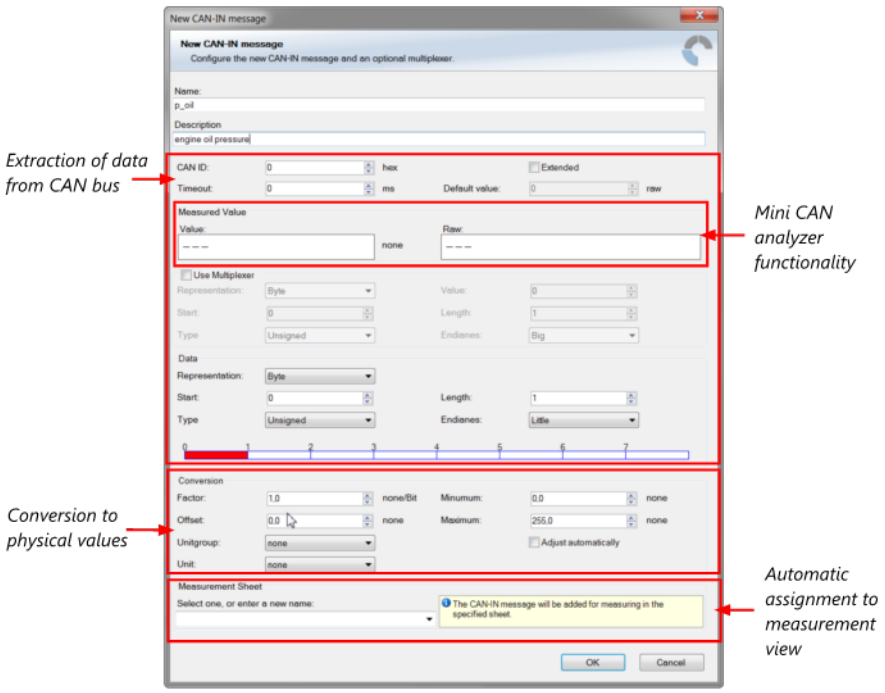
3. Insert the name and description of the channel.



4. Click ‘OK’ when done.
The channel is listed in the Data window.



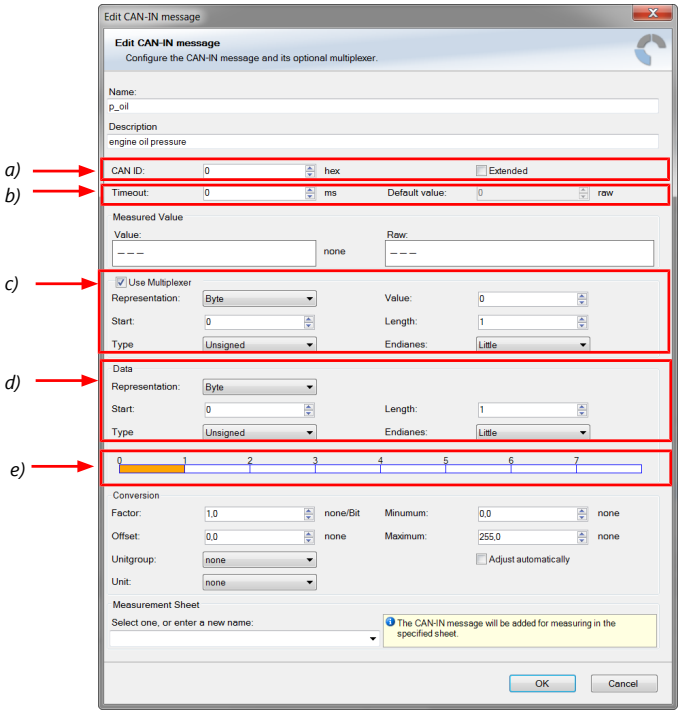
CAN channel configuration



Extracting data from CAN bus

Representation: Byte

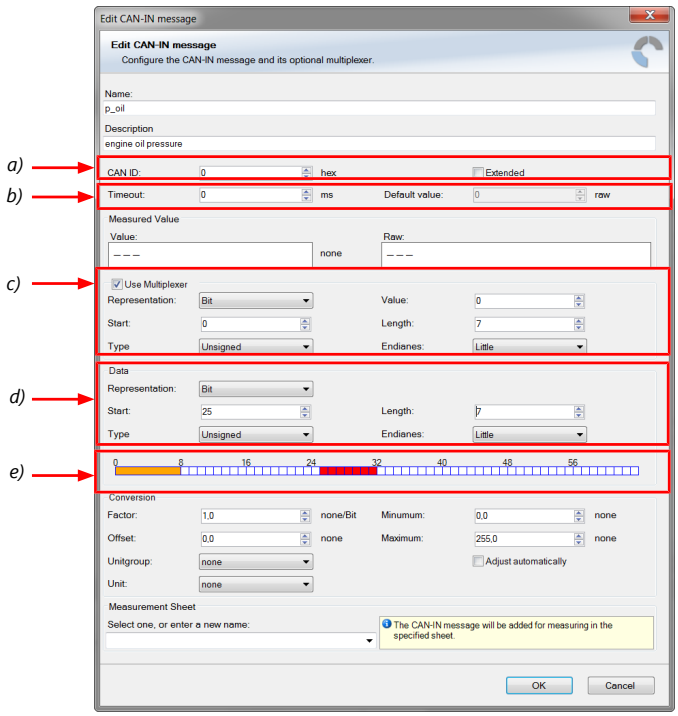
Some CAN devices need to be addressed by a byte represented CAN channel. The address can be assigned in this window and is illustrated by a bar graph.



a) Enter CAN message ID. If extended IDs (29 bit) are used, check the box.
b) If replacement values are used, specify timeout period and raw value.
c) If a multiplexer (row counter) is used, check the box.
d) Enter data position, length and format.
e) 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.



a) Enter CAN message ID. If extended IDs (29 bit) are used, check the box.
b) If replacement values are used, specify time-out period and raw value.
c) If a multiplexer (row counter) is used, check the box.
d) Enter data position, length and format.
e) The bargraph 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.

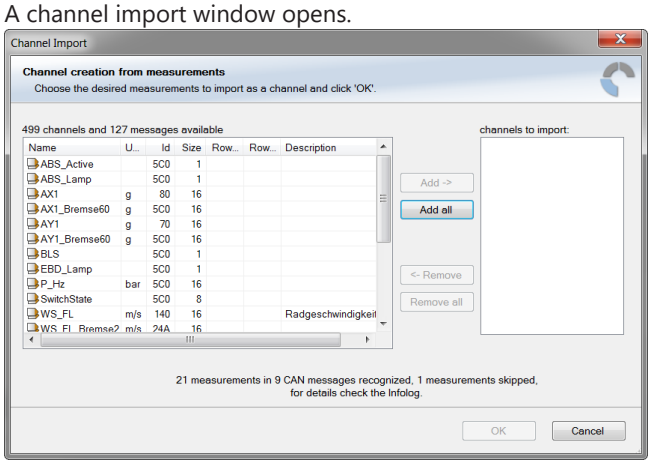
Conversion to physical values

Special features

9.2.2 Import a CAN database (DBC) file

1. Click with the right mouse button on any CAN bus item.
2. Select ‘Import CAN-IN messages from DBC file...’ from menu.
3. A file browser opens.
4. Select the DBC file to import and click ‘Open’ when done.

5. A channel import window opens.

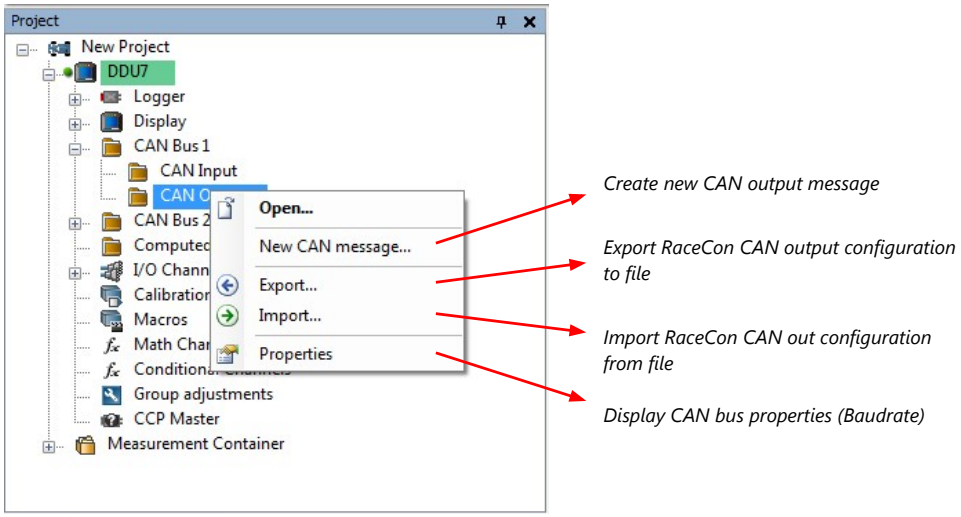


6. Select the desired channels on the left and use the ‘Add’ button to add them to the import list.
7. Click ‘OK’ when done.

   The channels are inserted in the Data window.

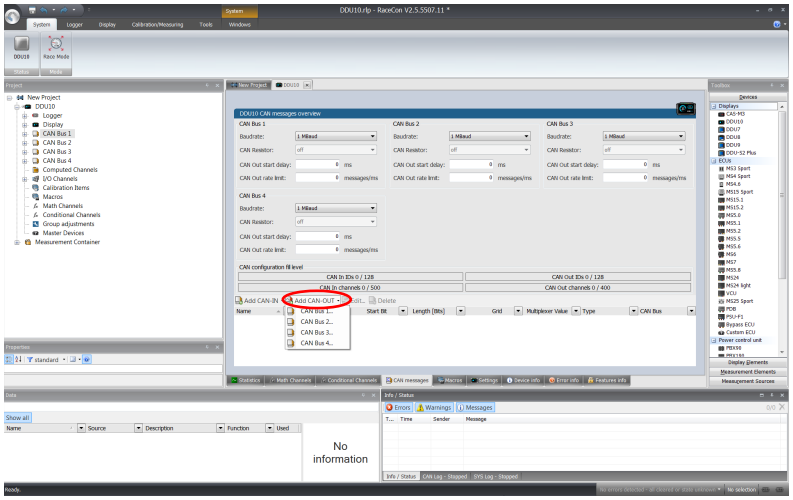
9.3 CAN output

9.3.1 Output configuration

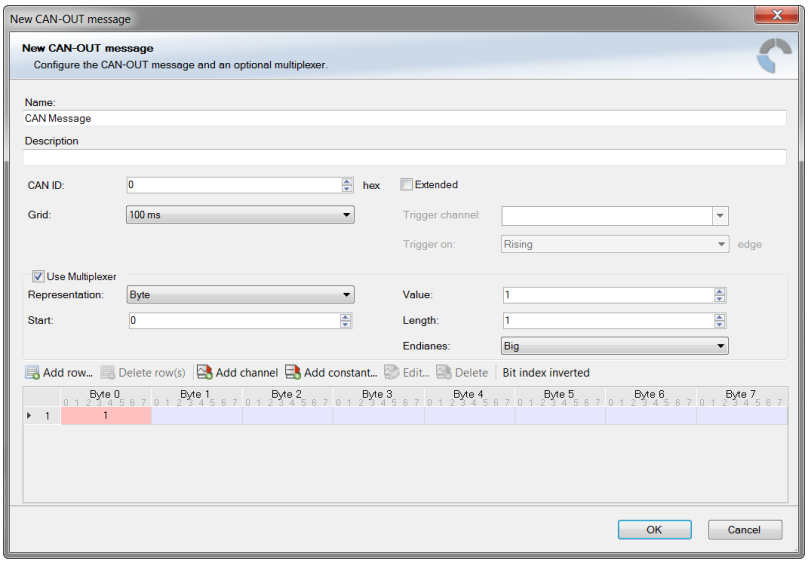


9.3.2 Create a new CAN output message channel

- Double-click on any CAN bus item, to open the "CAN messages overview".
- Select ‘Add CAN-OUT’ and choose the desired CAN bus for the new output channel.

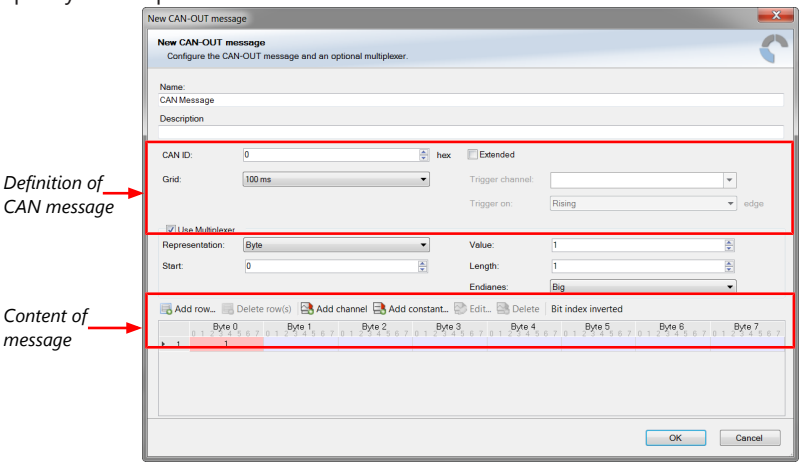


The ‘New CAN-OUT message’ window opens.



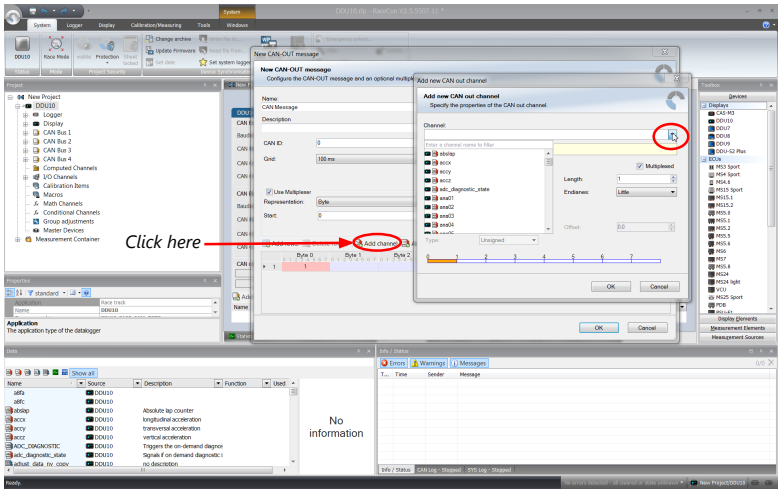
–

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



– Click on ‘Add channel’ or ‘Add constant’, this opens the ‘Add new CAN out channel’ window.

– Select the desired measurement channel and specify the message settings.

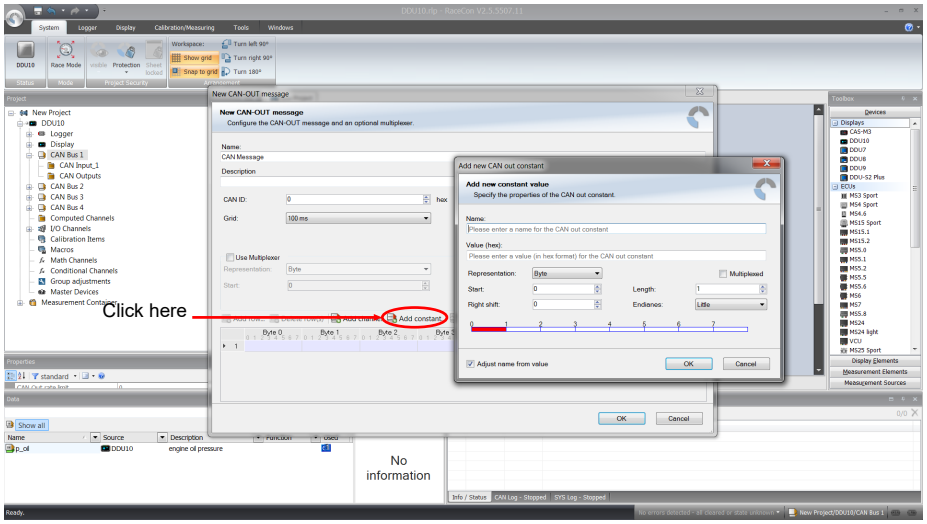


The measurement channel is now assigned to the CAN message.

9.3.3 Add CAN out constant

To send a constant value on the CAN, perform the following steps:

1. Create a new CAN output message or edit an existing message.
2. Click ‘Add constant’. The ‘Add new CAN Out constant’ window appears.
3. Define the name of the constant, the required value in hex and define the CAN channel settings.
4. Click ‘OK’ when done.



10 Analog and Frequency Inputs

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

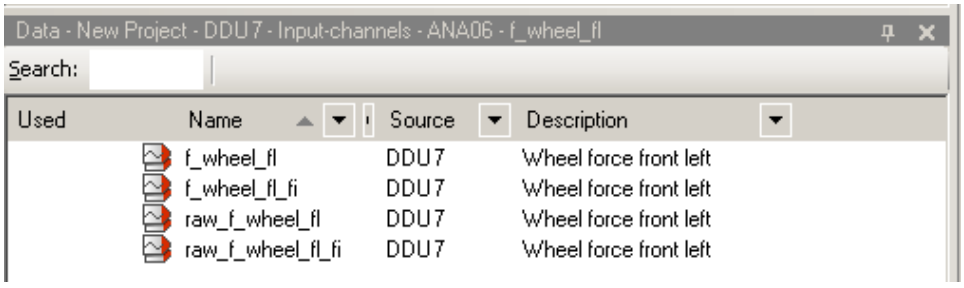
Frequency inputs

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

10.1 Analog inputs

10.1.1 Measurements channels

For each analog channel, several ‘subchannels’ are available.



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

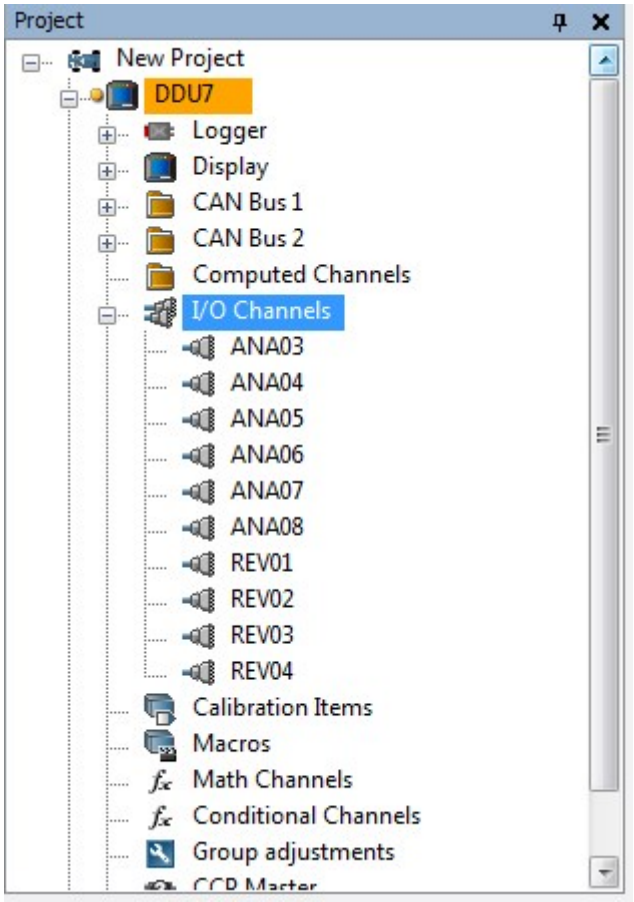
Filtered channels are routed through digital low pass filters:

- 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

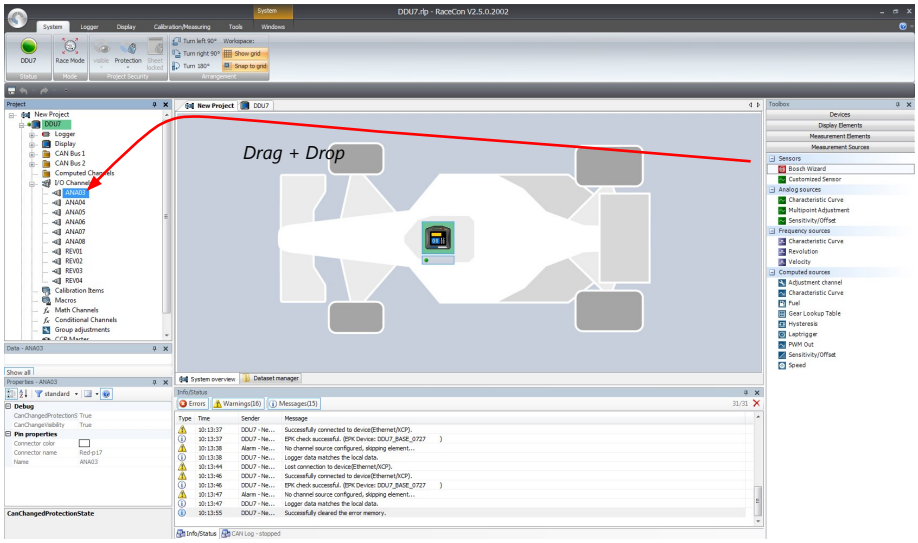
10.2 Configuring inputs

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

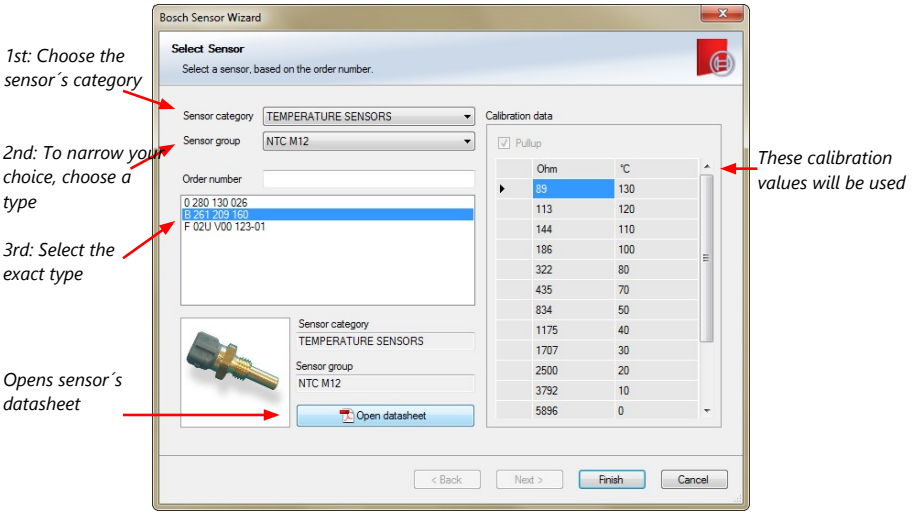
1. Click on ‘Measurement Sources’ in the Toolbox.
2. To expand the list of ‘I/O Channels’, click on ‘+’ in the DDU 9 Project Tree.



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

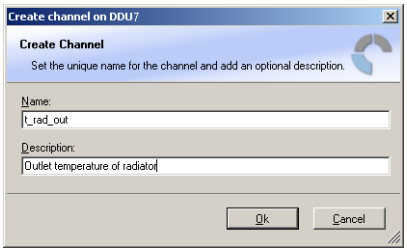


The “Bosch Sensor Wizard” opens.

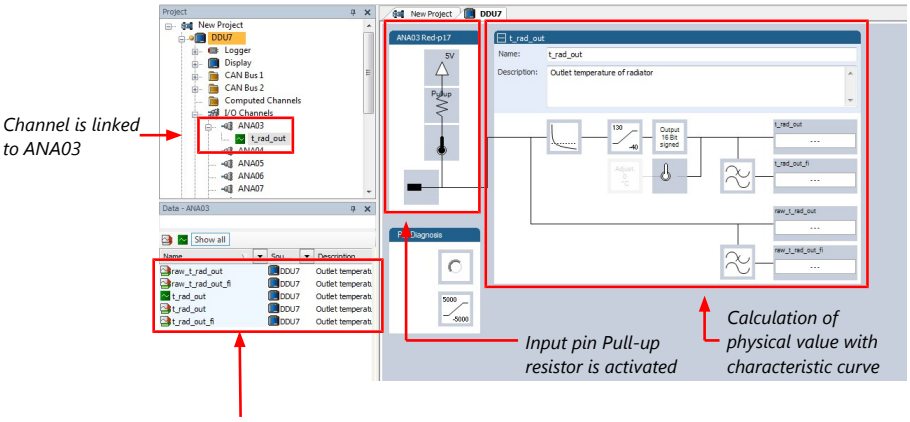


4. Click ‘Finish’ when done.
   The “Create channel” window opens.

5. Enter the 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

10.2.2 Configuring a generic linear sensor

Example: Acceleration sensor 5 g

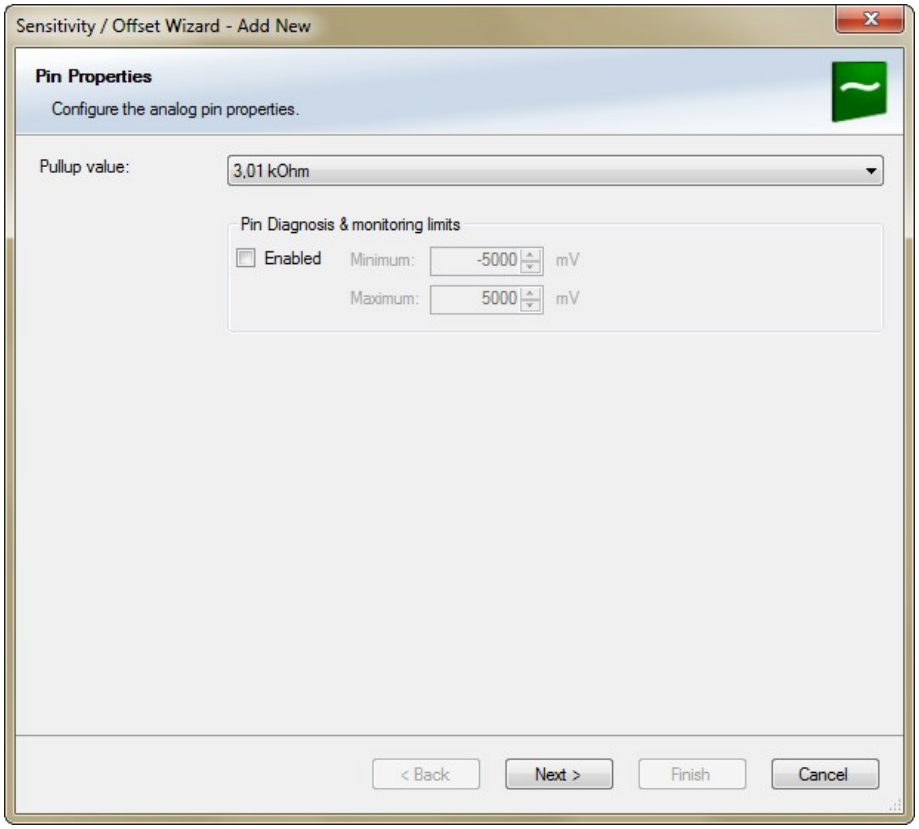
– From sensor data sheet - operating characteristics:

Output Signal					
Zero g (T_A = 25°C, V_{DD} = 5.0 V)(4)	V_{OFF}	2.25	2.5	2.75	V
Zero g (V_{DD} = 5.0 V)	V_{OFF}	2.0	2.5	3.0	V
Sensitivity (T_A = 25°C, V_{DD} = 5.0 V)(5)	S	380	400	420	mV/g
Sensitivity (V_{DD} = 5.0 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

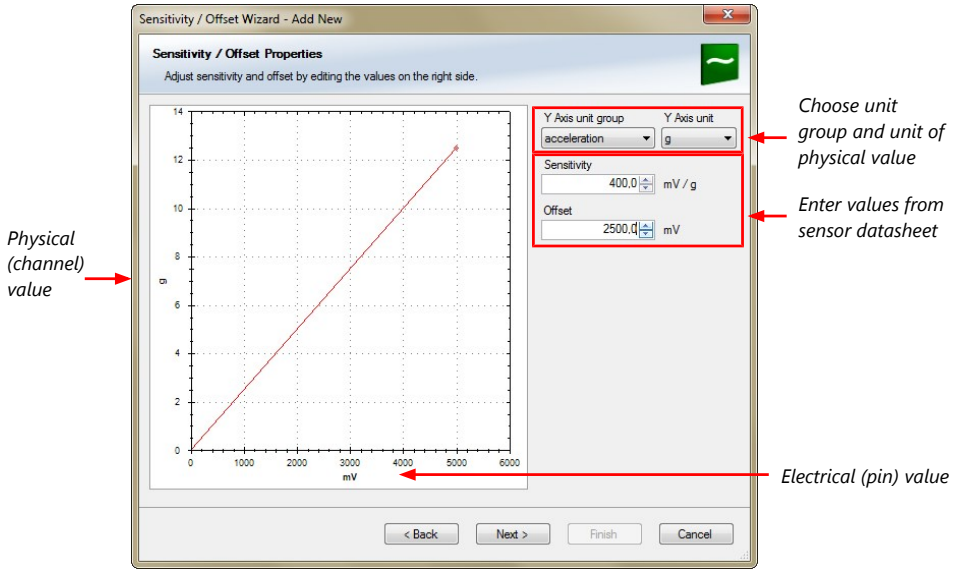
– Sensitivity 400 mV/g, Offset 2,500 mV

– The sensor has a linear output signal with sensitivity and offset

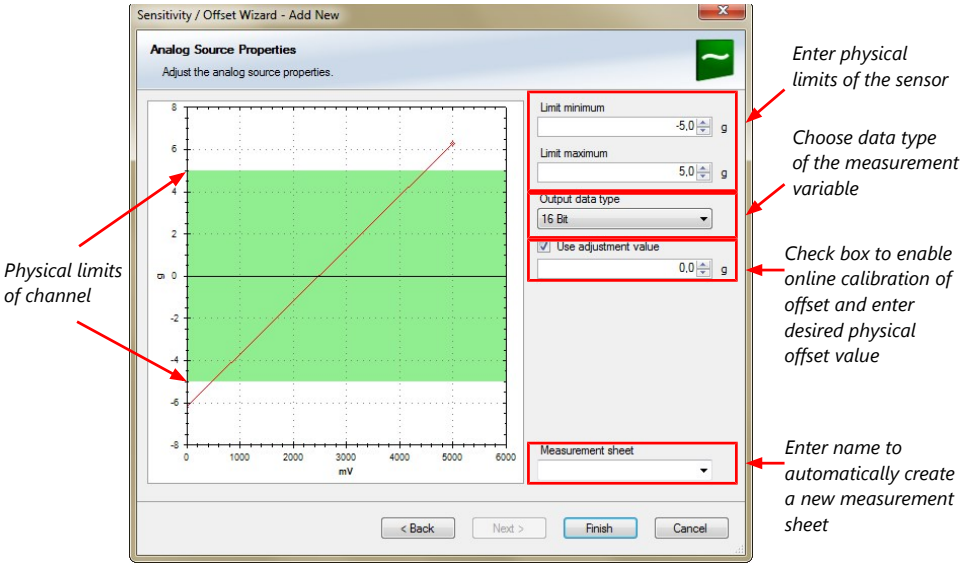
1. Click on ‘Measurement Sources’ in the Toolbox.
2. To expand the list of ‘I/O Channels’, click on ‘+’ in the DDU 9 Project Tree.
3. Drag the “Sensitivity/Offset” analog signal source from the Toolbox and drop it on the desired analog input channel in the DDU 9 Project Tree. A “Sensitivity/Offset Wizard” opens.
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 3,010 Ohm. If using an additional external pullup-resistor, set up the overall resistance.



5. Click ‘Next’ when done.
   The second part of the “Sensitivity/Offset Wizard” opens.



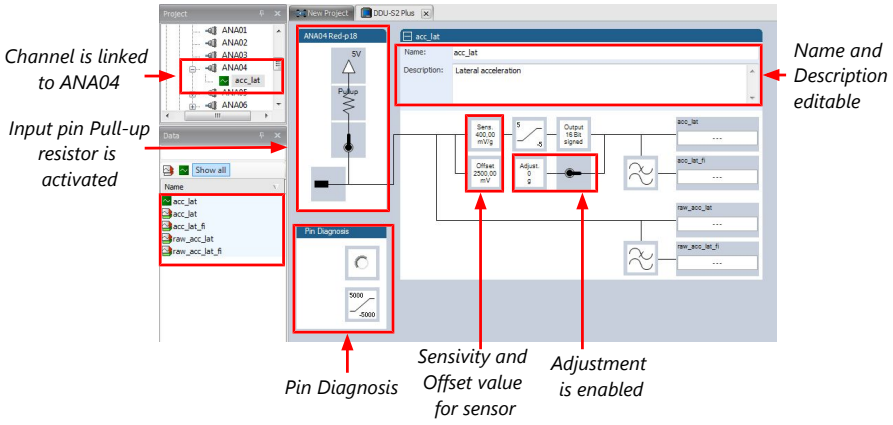
6. Click ‘Next’ when done.
   The third part of the “Sensitivity/Offset Wizard” opens.



NOTICE

Working with automatically created measurement sheets is explained in chapter ‘Setting up an online measurement [▷ 83]’.

7. Click ‘Finish’ when done.
8. Enter a channel name and a 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

10.2.3 Configuring a generic nonlinear sensor

Example: Thermistor 5 kOhm

– From sensor data sheet - resistance values over temperature:

PART NR.: 2381 640 502
HTCLE100E3502

Toper [°C]	RT [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

Toper [°C]	RT [Ω]
0	16 277
5	12 669
10	9 936
15	7 849
20	8 244
25	5 000
30	4 030
35	3 267

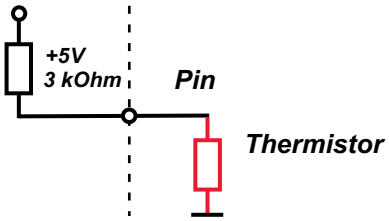
Toper [°C]	RT [Ω]
40	2 685
45	2 166
50	1 903
55	1 494
60	1 245
65	1 024
70	876
75	740

Toper [°C]	RT [Ω]
80	628
85	535
90	457
95	399
100	338
105	292
110	251
115	221

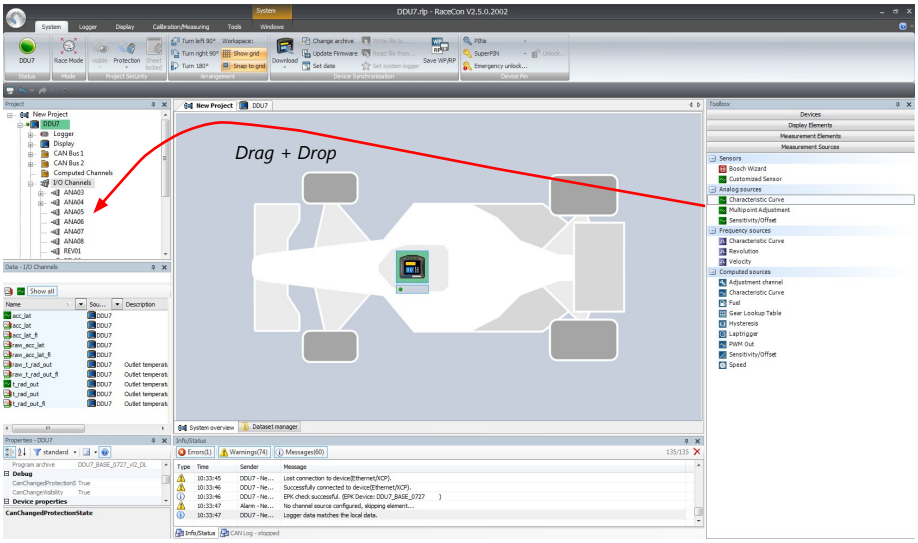
– The sensor has a nonlinear behavior

– Use characteristic curve for linearization

– Input voltage is the ratio between pull-up resistor and thermistor

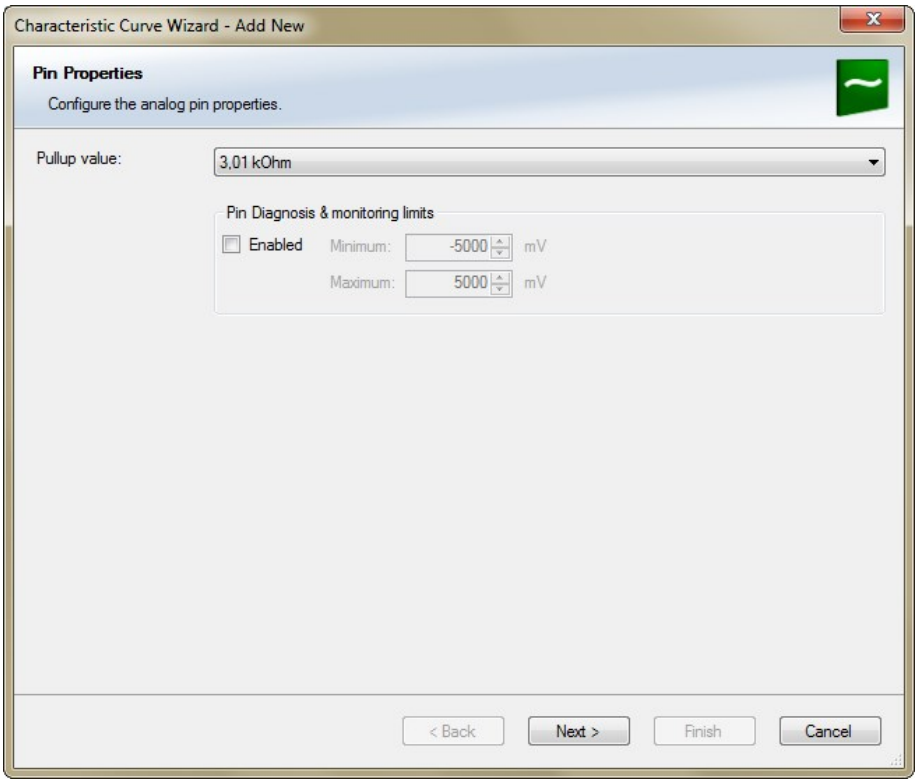


1. Click ‘Measurement Sources’ in the Toolbox.
2. To expand the list of ‘I/O Channels’, click on ‘+’ in the DDU 9 Project Tree.
3. Drag the “Characteristic Curve” analogue signal source from the Toolbox and drop it on the desired analogue input channel in the DDU 9 Project Tree.

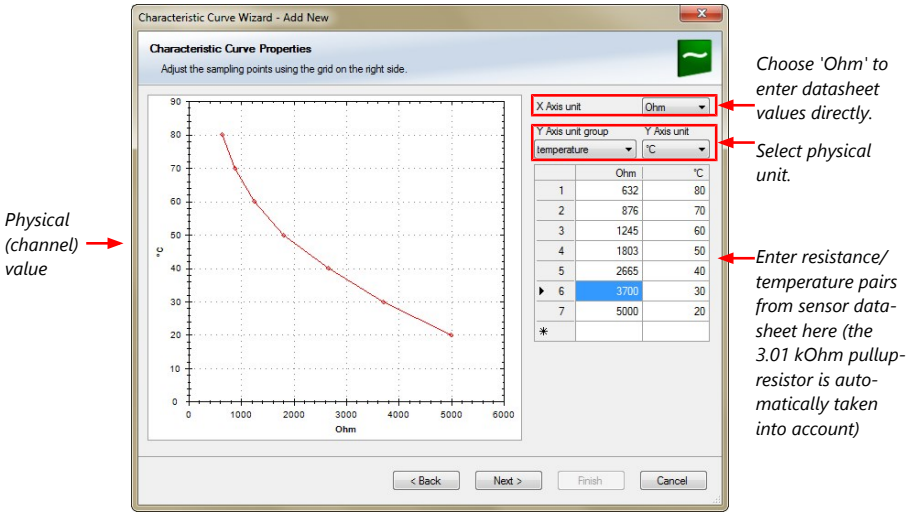


A “Characteristic Curve Wizard” opens.

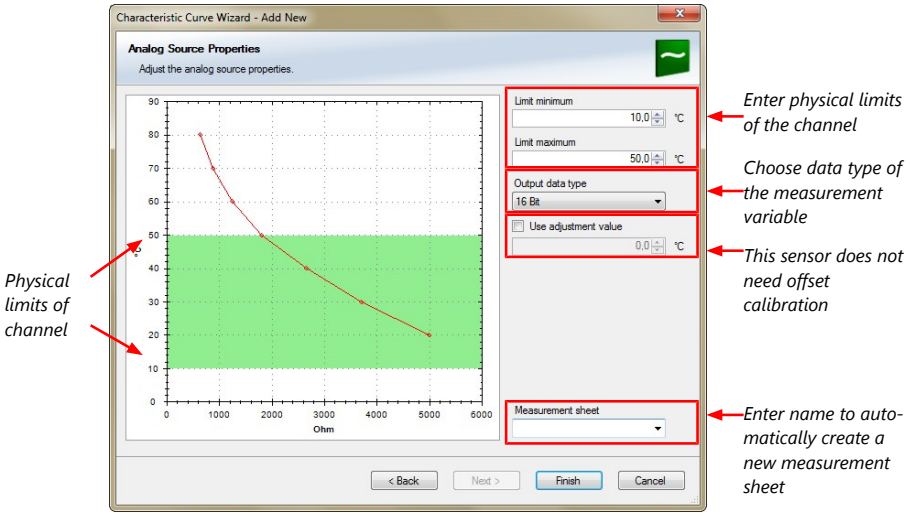
4. To activate the internal pull up-resistor, check the box. The DDU 9 pull up-resistor is used to get a 5 V signal at the analogue channel of the DDU 9. It allows you, to use a push-button. The fixed value of the internal pull up-resistor is 3,010 Ohm. If using an additional external pull up-resistor,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



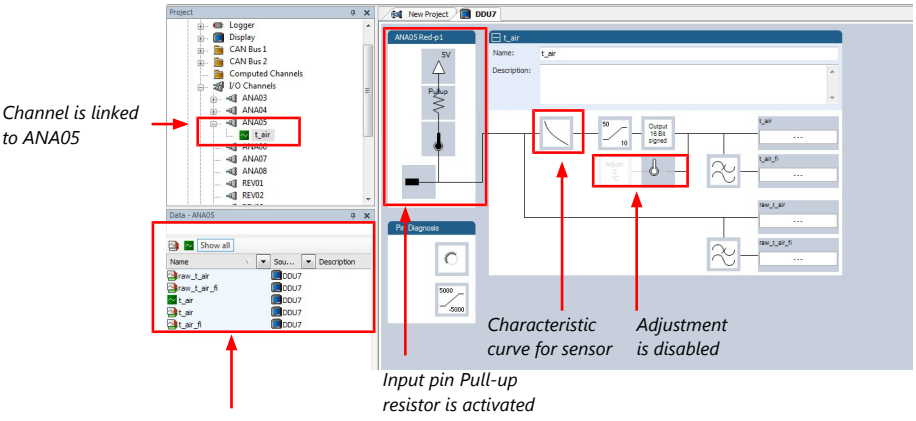
5. Click ‘Next’ when done.
The second part of the “Sensitivity/Offset Wizard” opens.



6. Click ‘Next’ when done.
   The third part of the “Characteristic Curve Wizard” opens.



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

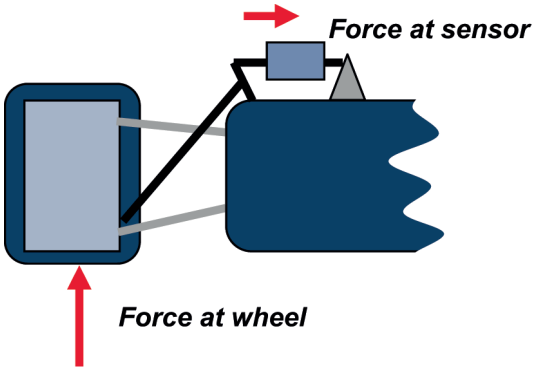
NOTICE

Working with automatically created measurement sheets is explained in chapter 'Setting up an online measurement [▷ 83]'.

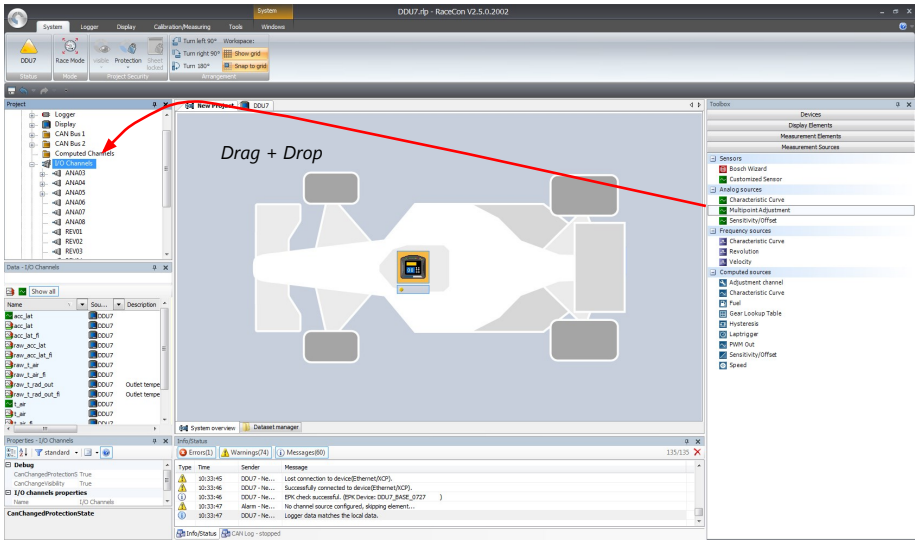
10.2.4 Configuring a multipoint adjustment

Example: Measurement of wheel force

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

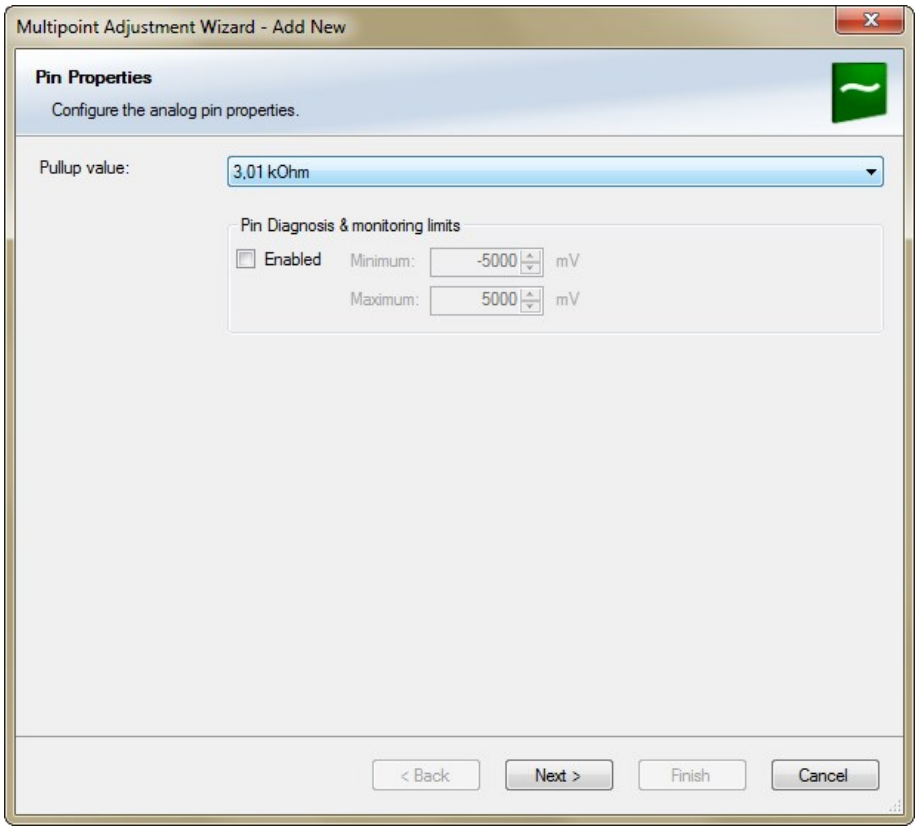


1. Click on 'Measurement Sources' in the Toolbox.
2. Expand the list of 'I/O Channels' by clicking on '+' in the DDU 9 Project Tree.
3. Drag the 'Multipoint Adjustment' analog signal source from the Toolbox and drop it on the desired analog input channel in DDU 9 Project Tree.

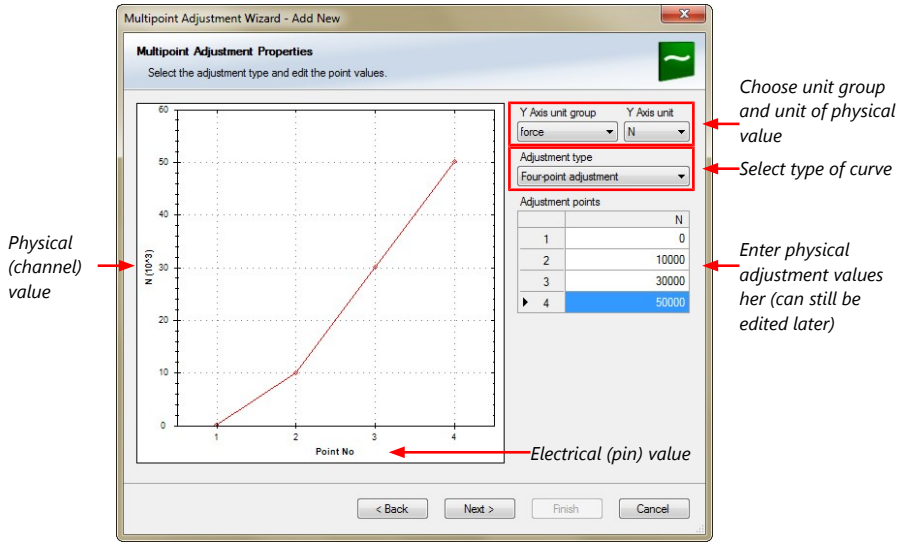


A ‘Multipoint Adjustment Wizard’ opens.

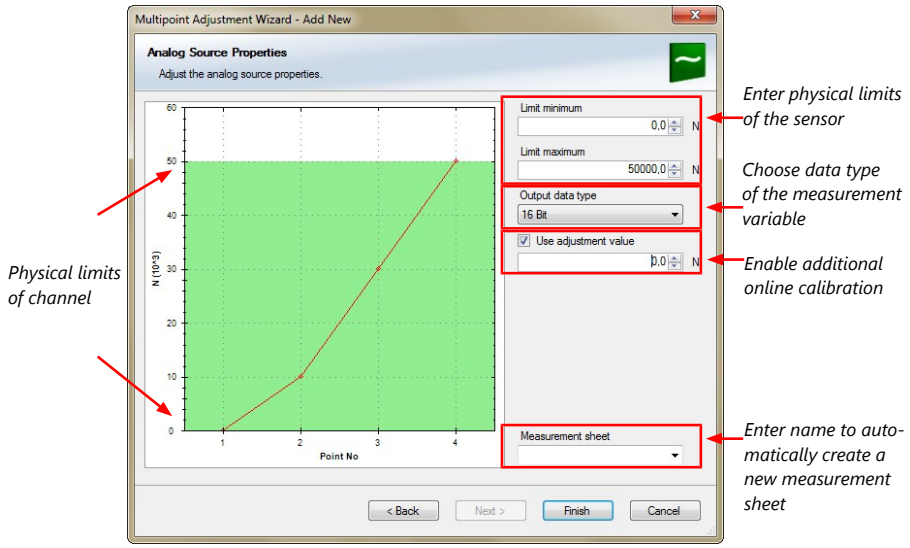
4. To activate the internal pullup-resistor, check the box. The internal pullup-resistor is used to get a 5 V signal at the analog channel of the DDU 9. It allows you to use a push-button. The fixed value of the internal pullup-resistor is 3.01 kOhm. If using an additional external pullup-resistor, set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



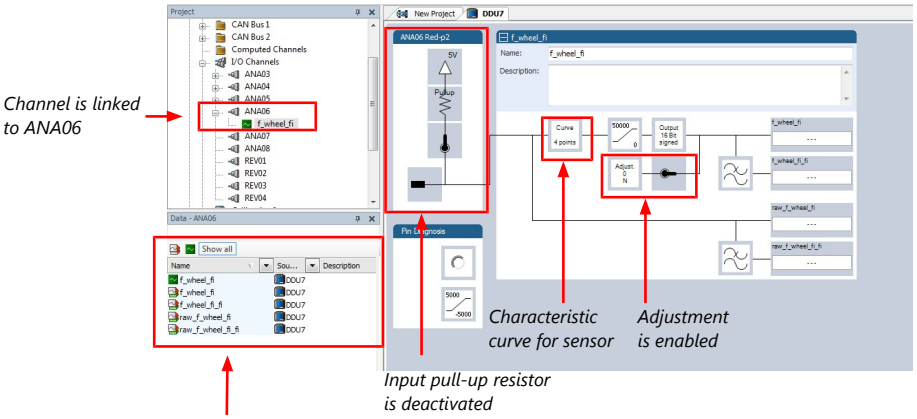
5. Click ‘Next’ when done.
   The second part of the ‘Multipoint Adjustment Wizard’ opens.



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



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

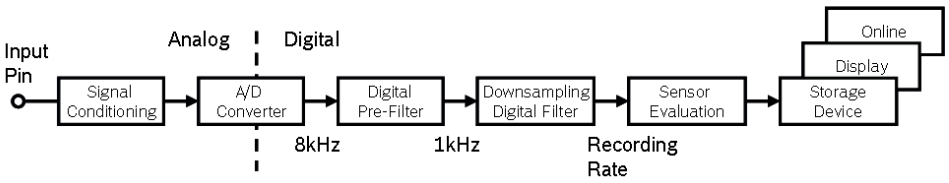
Online definition of the curve is covered in the chapter 'Online calibration of measurement channels [▶ 88]' of this manual.

NOTICE

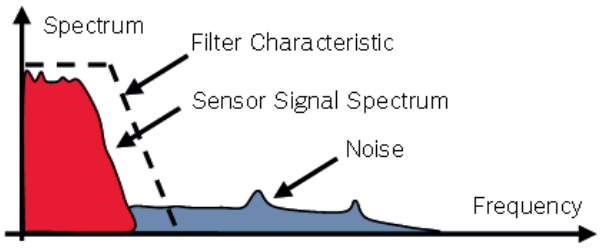
Working with automatically created measurement sheets is explained in chapter 'Setting up an online measurement [▶ 83]'.

10.2.5 Digital filter details

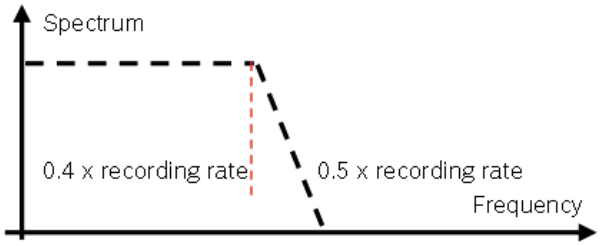
DDU 9 uses A/D converter oversampling and digital filtering to recording rate.



Digital filters eliminate 'out-of-band' noise



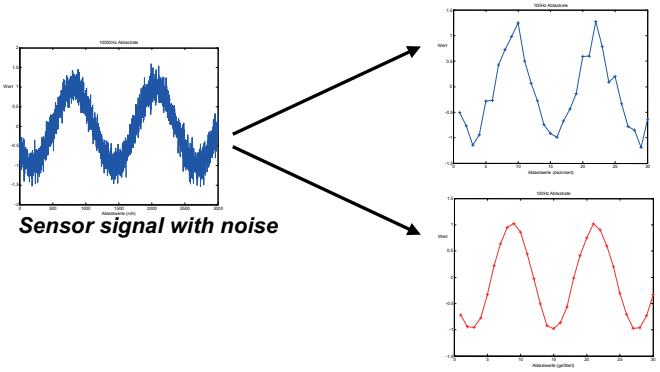
Cut-off frequency automatically adjusted to recording rate



Example:

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

Linear phase – no signal distortion



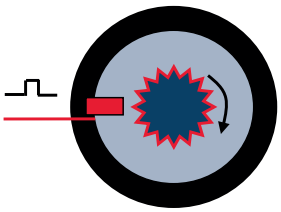
Latency compensation – no filter delay in recorded data

- 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

10.2.6 Configuring a frequency input

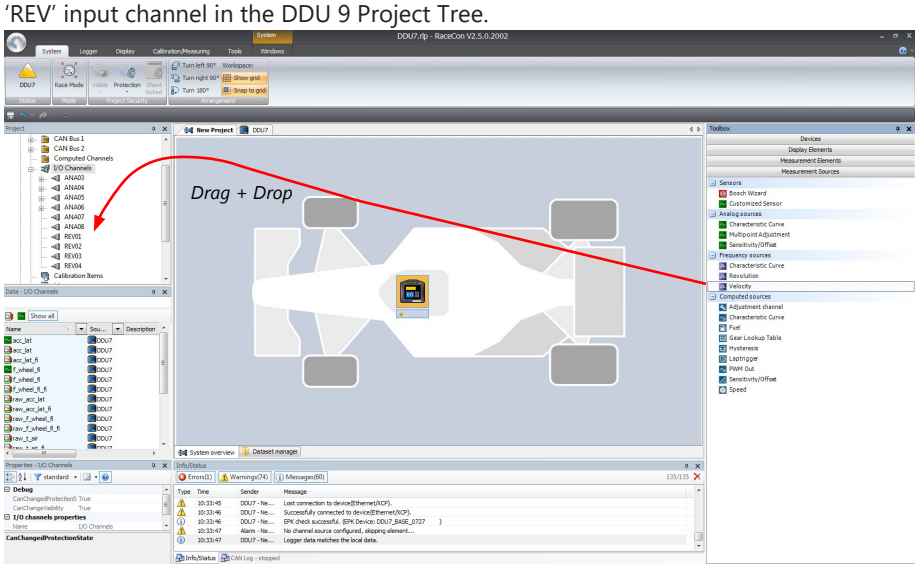
Example: measurement of wheel speed

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



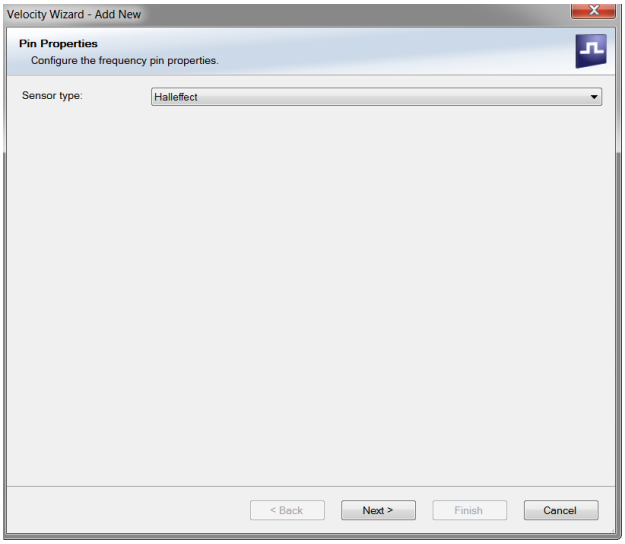
1. Click on ‘Measurement Sources’ in the Toolbox.
2. To expand the list of ‘I/O Channels’, click on the ‘+’ in the DDU 9 Project Tree.

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.

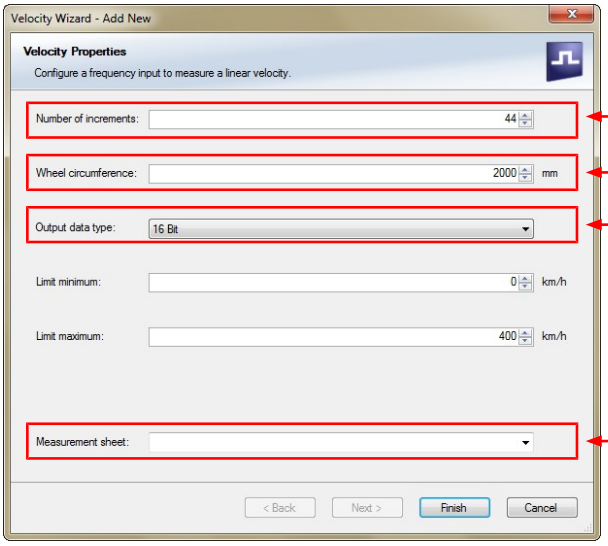


The ‘Velocity Wizard’ opens.

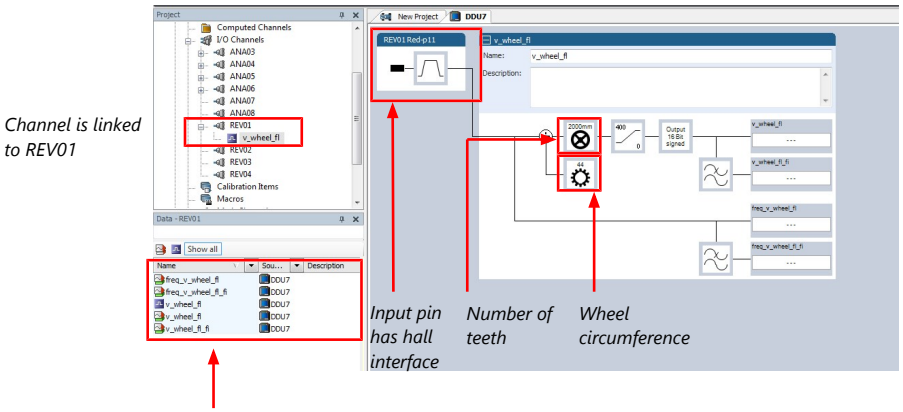
4. Select the sensor type. The DDU10 works with Halleffect and DF11 sensors.



5. Click ‘Next’.
6. Define the settings for the sensor.



7. Click ‘Finish’ when done.
8. Enter the 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

NOTICE

Measurement of ‘Revolution’ is similar.

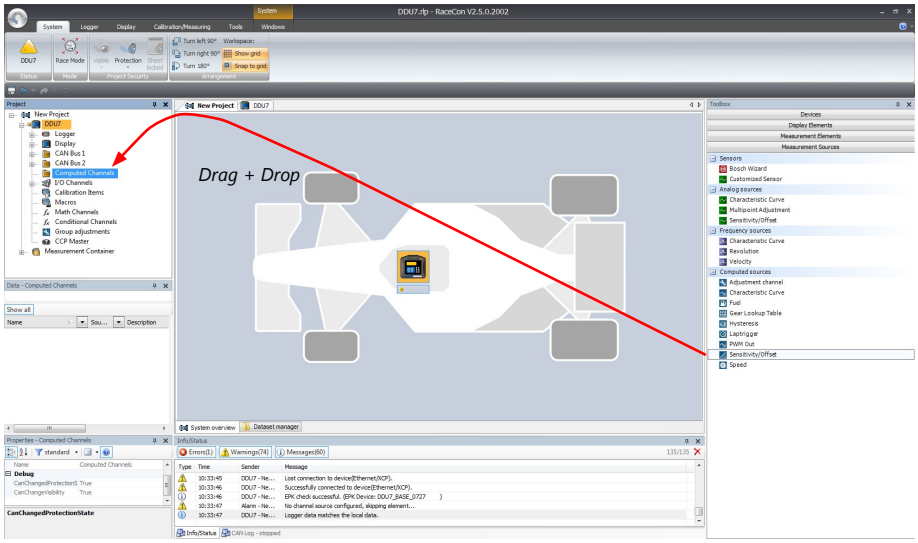
10.3 Configuring computed sources

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

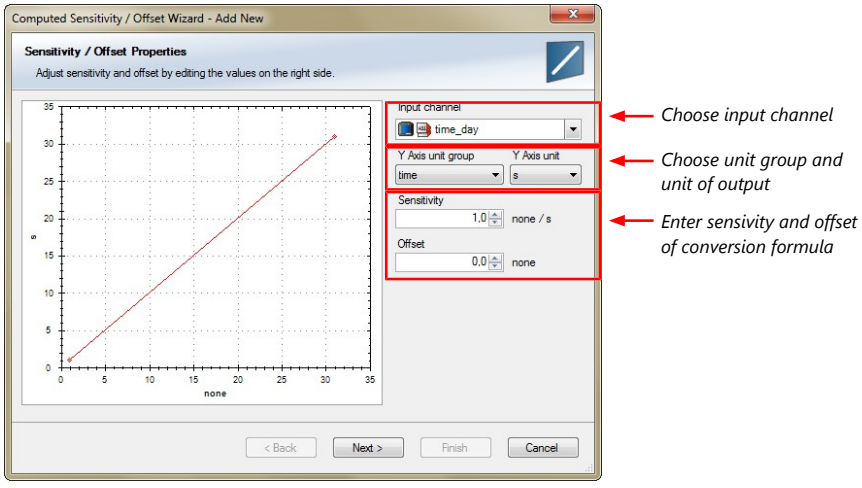
- Sensitivity/Offset calculation on input channel
- Characteristic curve calculation on input channel
- Computed vehicle speed
- Lap trigger (covered in a special separate section)

Example: Sensitivity/offset calculation on input channel

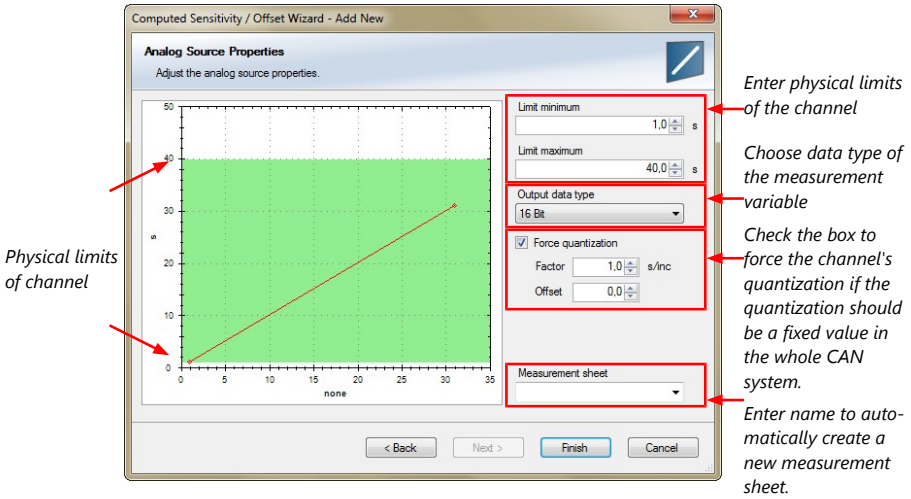
1. Click ‘Measurement Sources’ in the Toolbox.
2. Drag the ‘Sensitivity/Offset’ computed source from the Toolbox and drop it on ‘Computed Channels’ in the DDU 9 Project Tree.



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

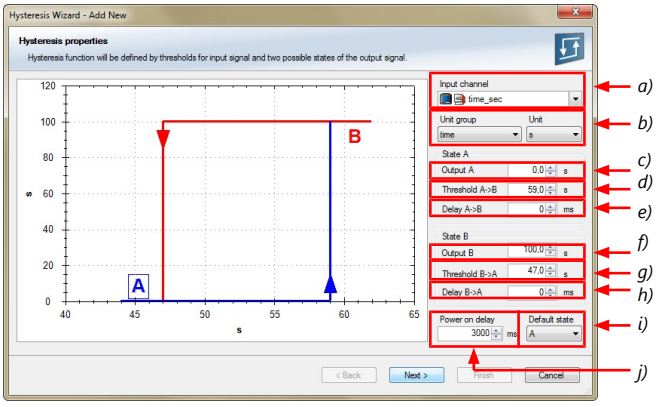
Working with automatically created measurement sheets is explained in chapter ‘Setting up an online measurement’.

10.4 Hysteresis

The hysteresis function avoids the high-frequent 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).

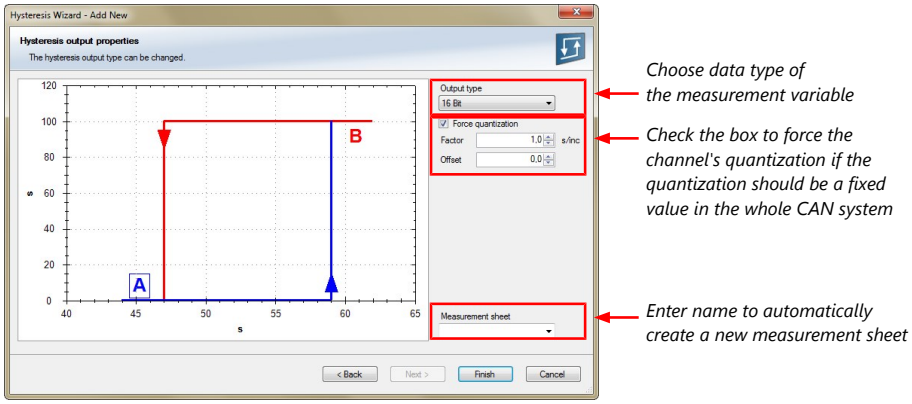
g) Enter threshold value when state changes from B to A.

h) Enter delay time when state changes from B to A.

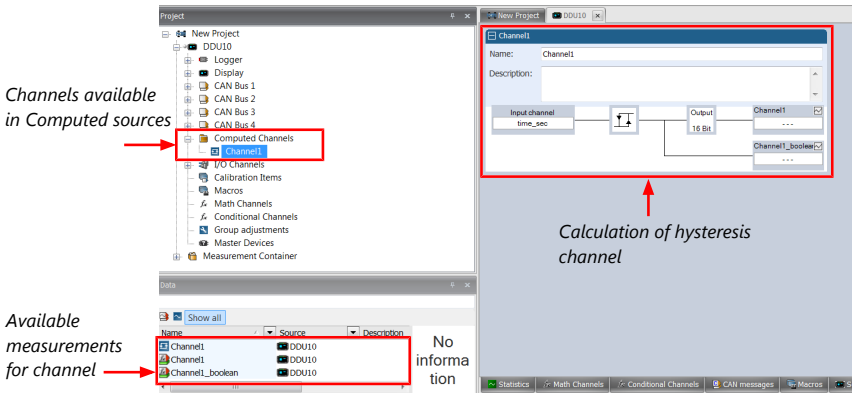
i) Enter time when the hysteresis function is activated after vehicle´s startup.

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.



10.4.1 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.

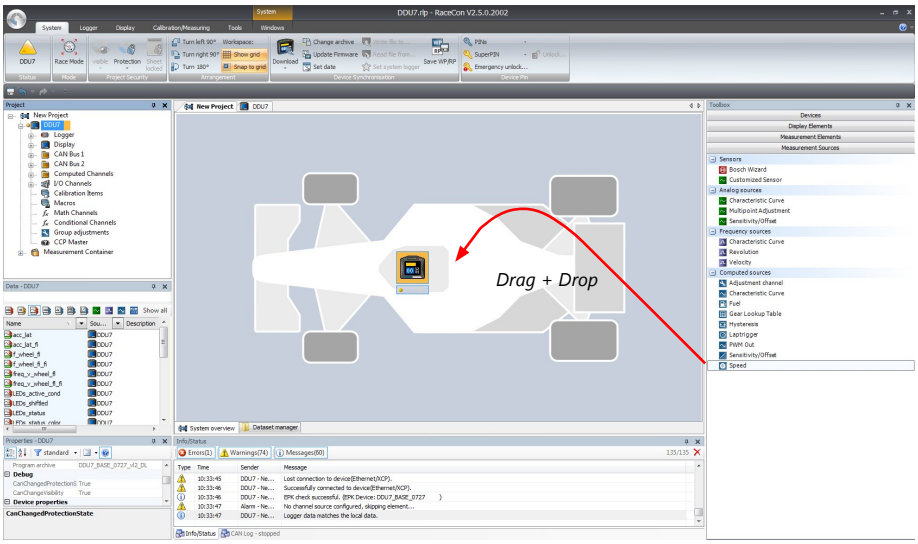
Calculated speed is maximum of both speeds if speed difference between wheels > limit.

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

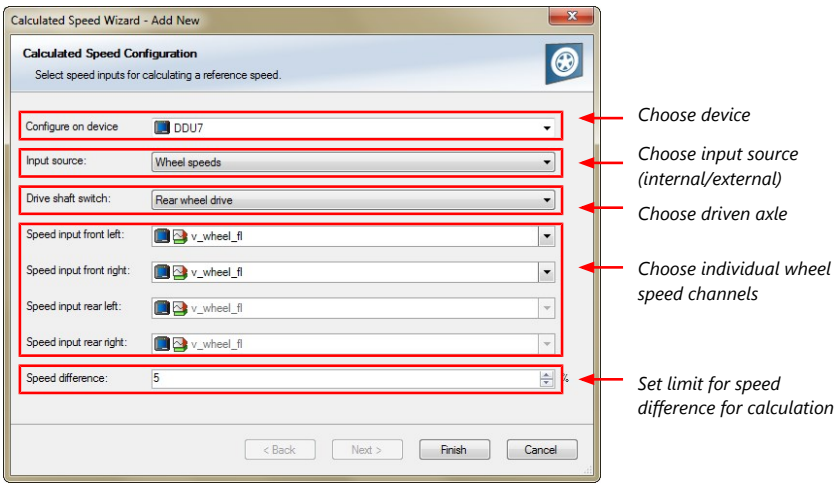
Calculated speed is speed of 2nd fastest wheel.

10.4.2 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 the project name in the DDU 9 Project Tree. Do not drop it on 'DDU 9'!



A 'Calculated Speed Wizard' opens.



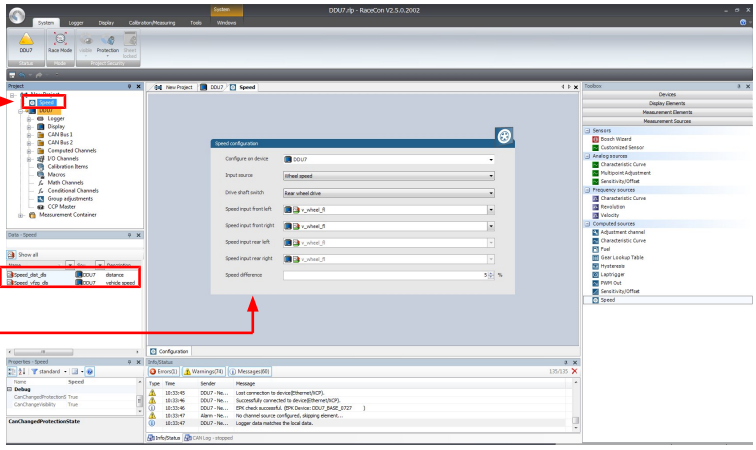
4. Click 'Finish' when done.

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

Speed calculation in DDU Project Tree

Measurement channels calculated speed and calculated distance

Configuration window



11 Online Measurement

DDU 9 configuration

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

Online measurement + calibration

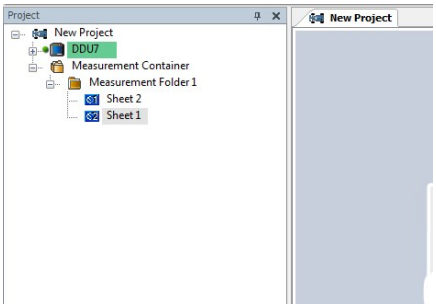
- System status and diagnosis
- Check and calibrate sensors in the vehicle
- Live display of sensor values on the PC
- Use RaceCon for diagnosis, online measurement and calibration
- Communication interface: Ethernet
- Communication protocol: XCP

11.1 Setting up an online measurement

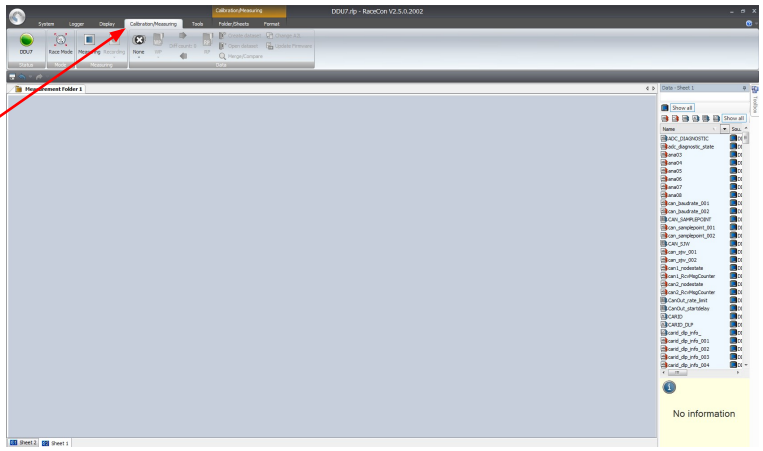
DDU 9 supports online measurement of sensor values and diagnostic variables.

1. Expand ‘Measurement Container’ and ‘Measurement Folder 1’ in the Project Tree and double-click on ‘Sheet1’. Alternatively, click on the ‘Calibration/Measuring’ tab to open the window directly.

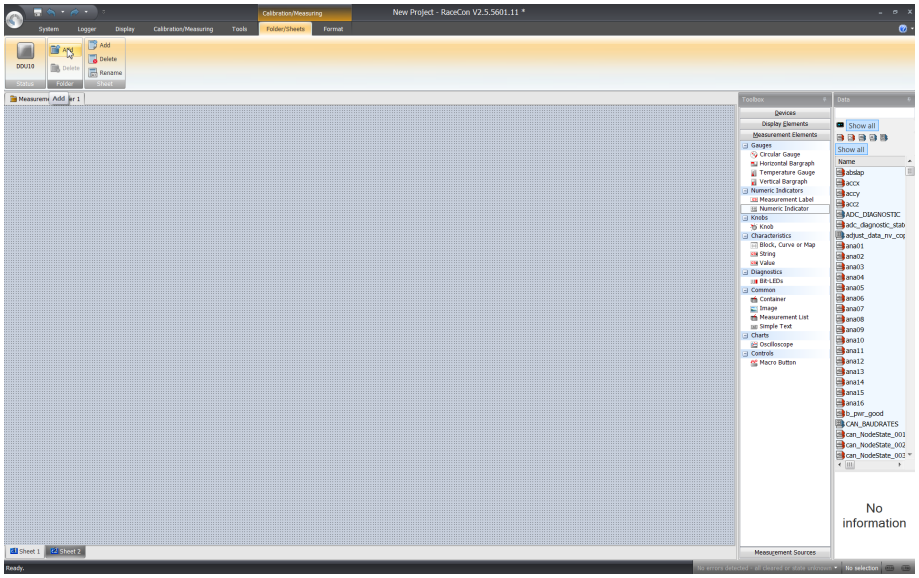
   ‘Sheet 1’ opens in a new ‘Calibration/Measuring’ window.



RaceCon changes automatically to "Calibration/ Measuring"

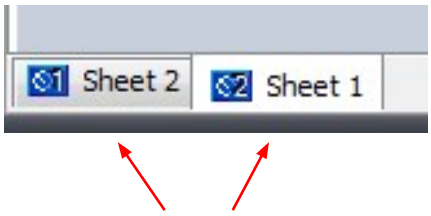


2. Click on the ‘Folder/Sheets‘ tab, which appears when you are in the ‘Calibration/ Measurement‘ window, to create a new measurement folder.
3. Click on the ‘Add‘ button for folders in the upper left corner.



In the menu for sheets, you will find buttons to add, delete and rename new sheets

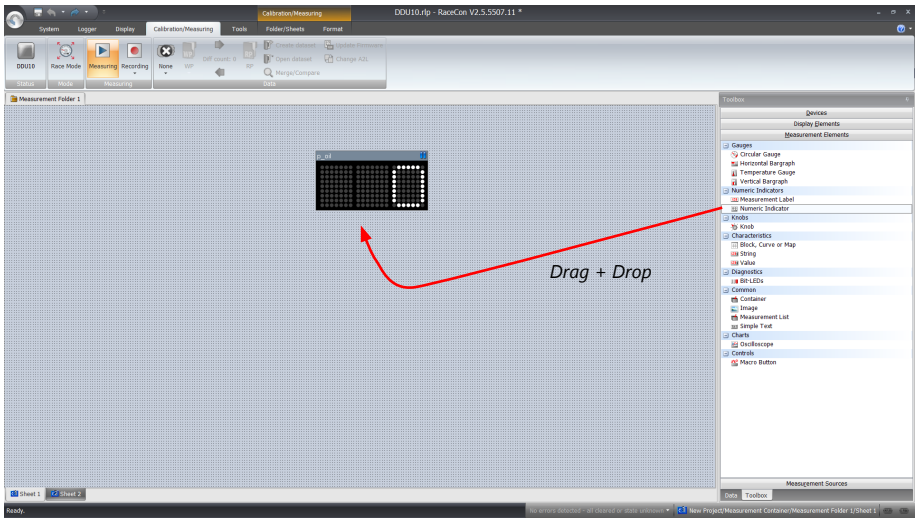
4. To change between different sheets, click on the tabs on the bottom of the ‘Calibration/Measuring‘ window.



Tabs to switch between sheets

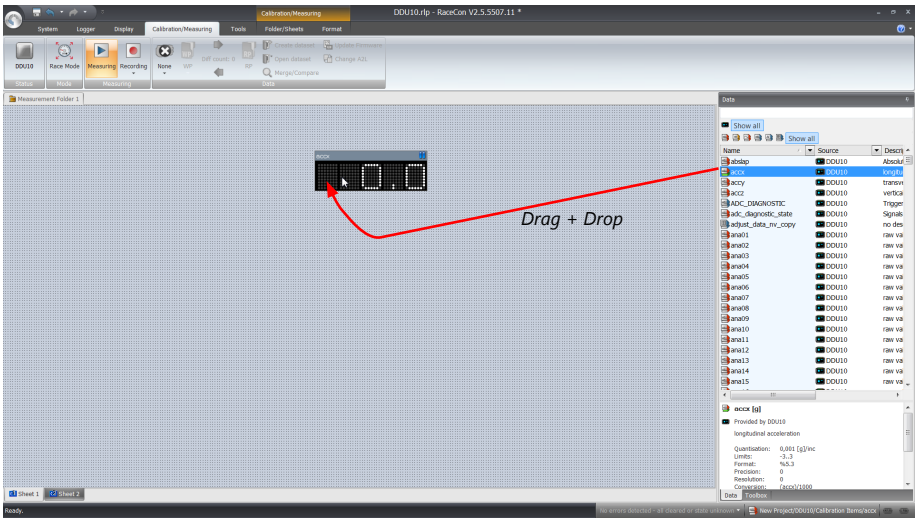
To add an element to a measurement sheet, perform the following steps:

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



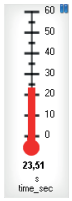
6. Select the desired measurement channel from the ‘Data‘ area and drop it on the measurement element.

If the DDU 9 shows the green status, the value is displayed.

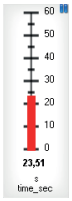


RaceCon offers different types of measurement elements:

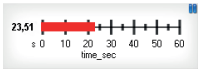
Circular gauge



Temperature gauge

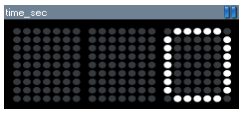


Vertical Bar graph style

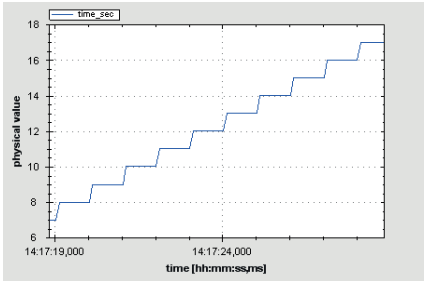


Horizontal Bar graph style

Measurement label



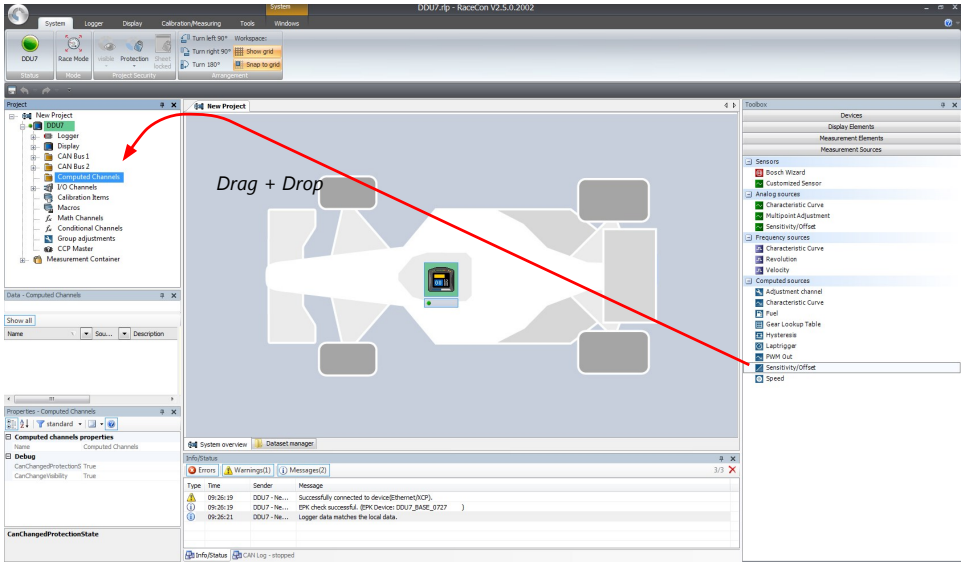
Numeric indicator



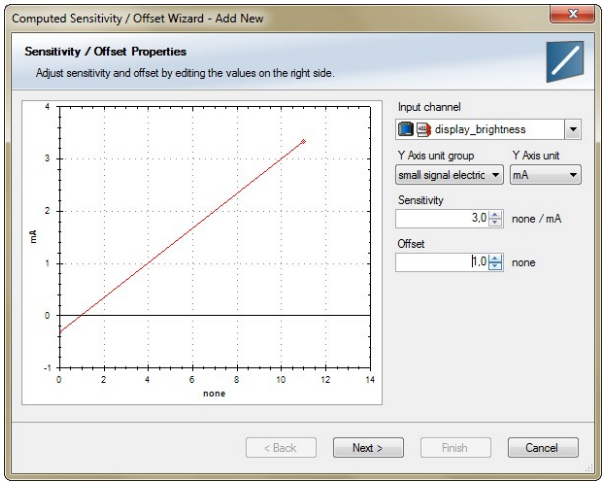
Oscilloscope (Chart)

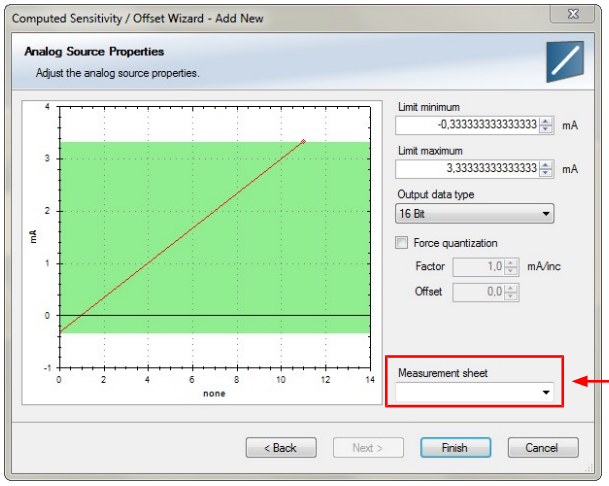
11.1.1 Automatic creation of measurement sheets

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.

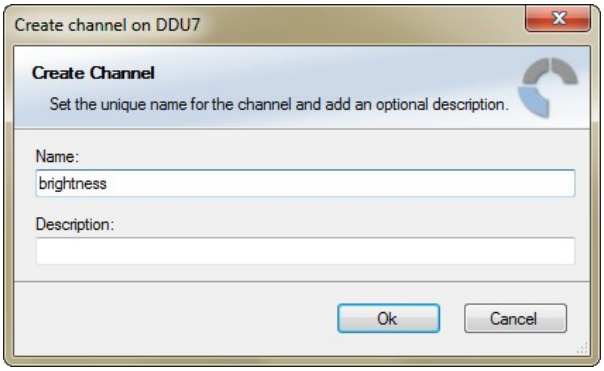


1. During the configuration of a measurement channel, select a measurement sheet from the list box or enter a name for a new measurement sheet.

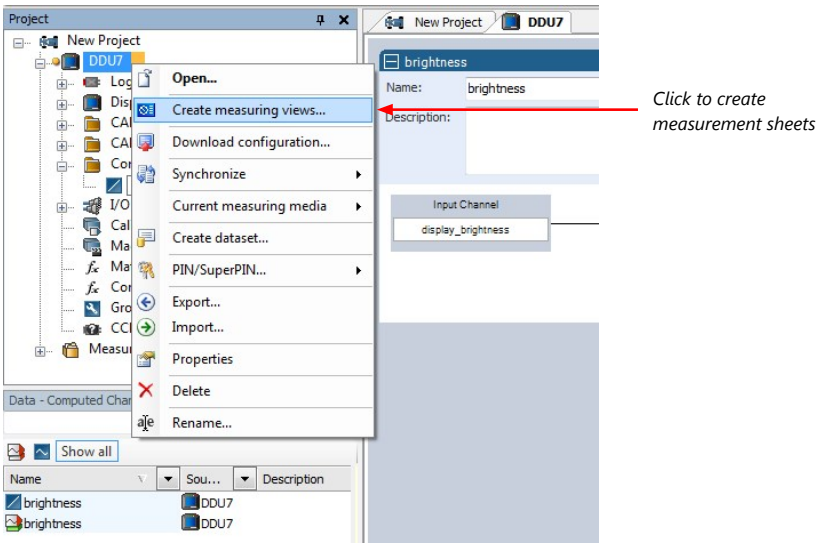




Select existing sheet from list or enter name of new sheet



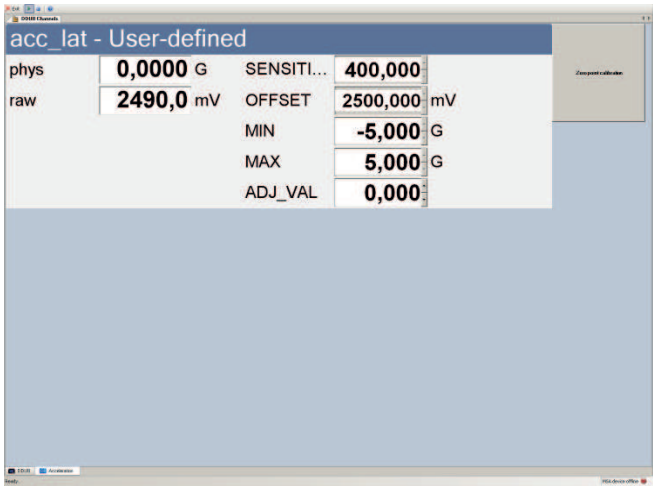
2. To create the sheets, right-click on DDU 9 and select ‘Create measurement views…’ from the DDU 9 context menu.



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

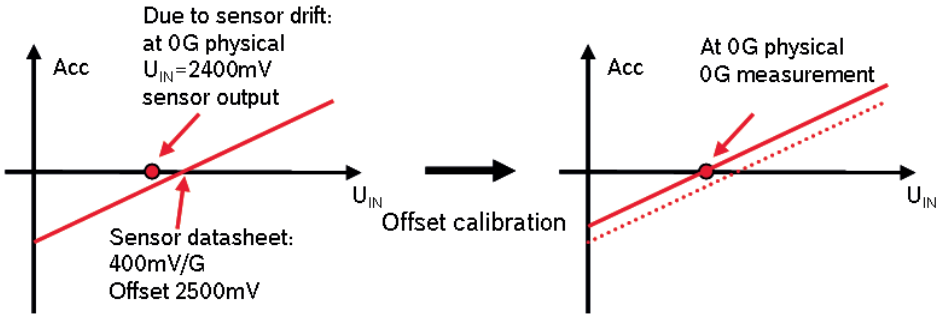
11.1.2 Using the measurement sheets

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 window.
3. Press the ‘Esc’ key to return to ‘Design Mode’.



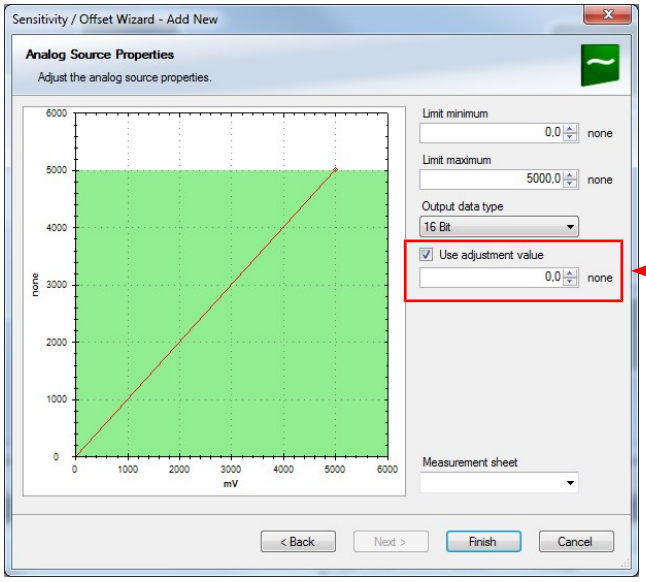
11.2 Online calibration of measurement channels

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



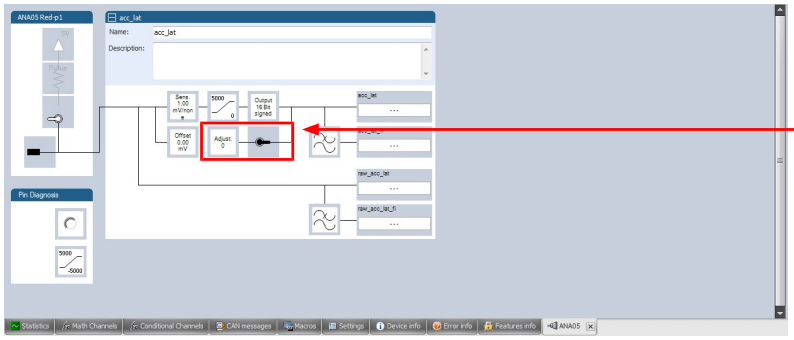
11.2.1 Enable online offset calibration for measurement channel

During creation of the measurement channel



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

In the channel view

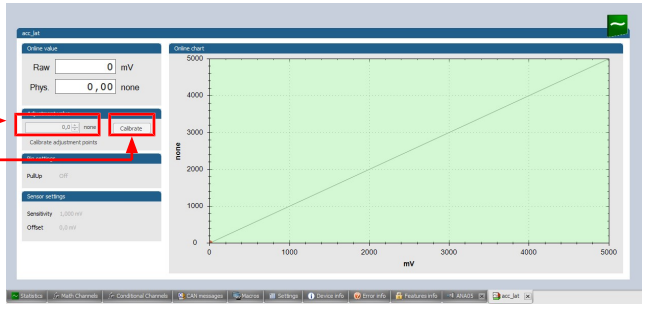


Activate switch to enable online calibration

11.2.2 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.



Calibration target value

Initiate calibration

The sensor's offset is now calibrated.

11.3 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.

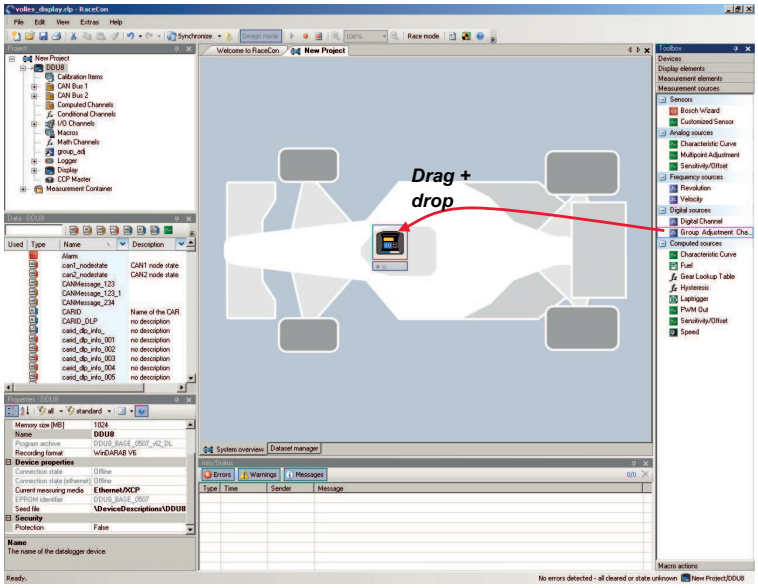
11.3.1 Configuration of group adjustment

Group adjustment consists of two components:

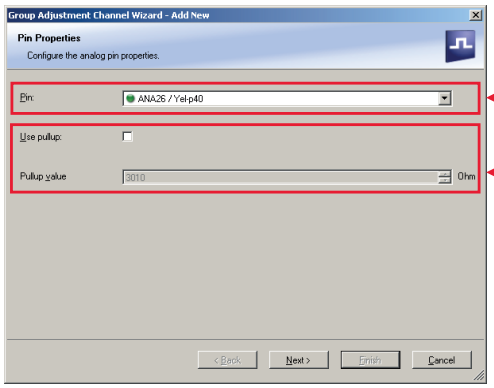
- An input channel which triggers the adjustment event
- A group of input channels linked to the group adjustment event

11.3.2 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.



Select the pin to which the sensor shall be connected

Check the box to activate the internal DDU 8 pullup-resistor and set the resistor value

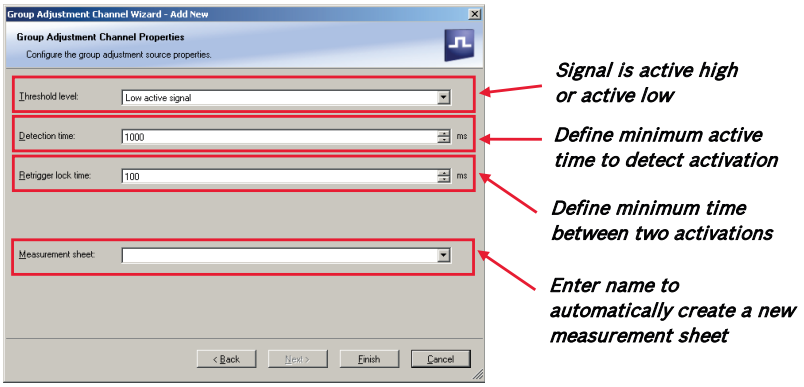
NOTICE

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' for further information concerning the pull-up-resistor.

3. Click 'Next' when done.

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



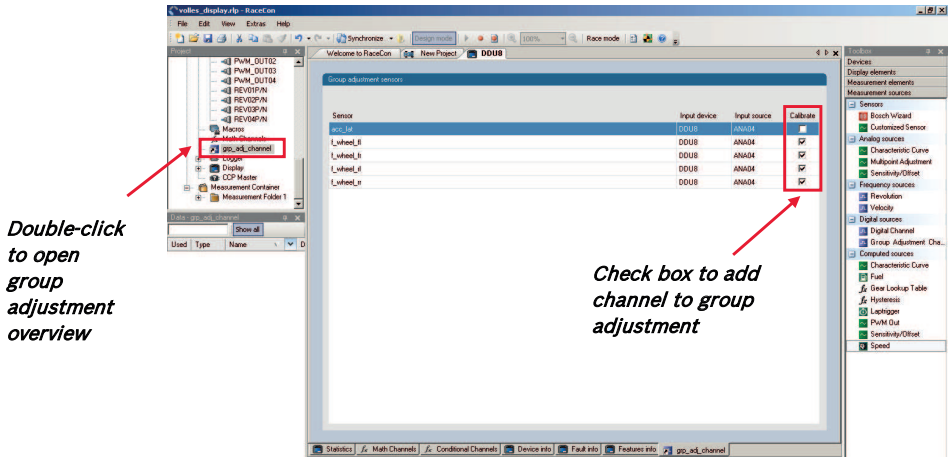
NOTICE

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

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

11.3.3 Assigning channels to the group adjustment

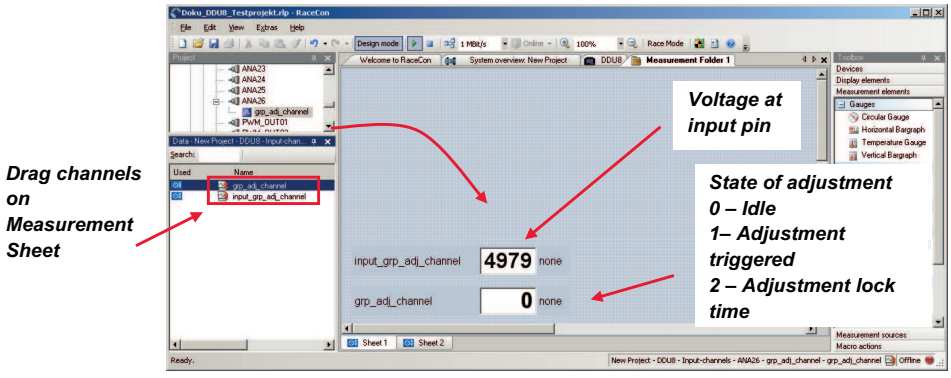
1. Double-click on the created channel (e.g. 'grp_adj_channel') in the Project Tree.
2. In the Main Area, an overview of the available adjustment channels opens.
3. To add measurement channel(s) to the group adjustment event, check the 'Calibrate' box of the desired channel(s).



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

11.3.4 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 RaceCon, see chapter 'Connecting the Unit to RaceCon'.
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.



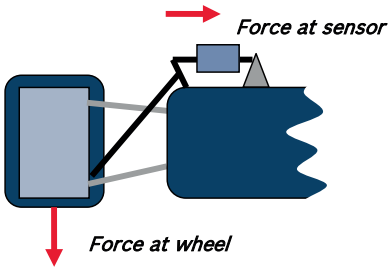
NOTICE

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

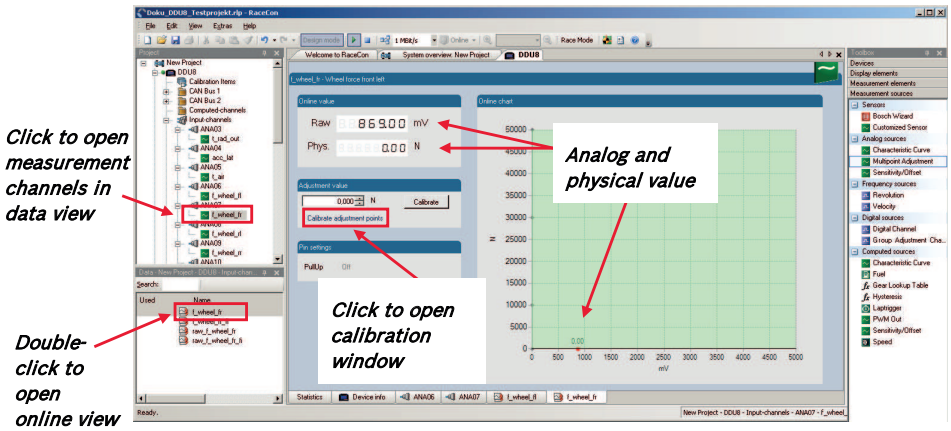
11.4 Online calibration of multipoint adjustment channels

Example: measurement of wheel force

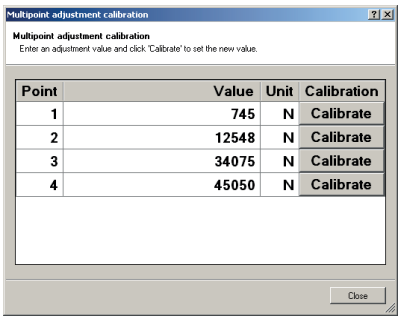
- Physical property ‘wheel force’ not directly measureable
- Load transfer through suspension kinematics
- Physical value at sensor position defined by vehicle
- Curve definition by online adjustment at vehicle



1. Create a multipoint adjustment measurement channel. To create a multipoint channel, see chapter ‘Configuring a multipoint adjustment’.
2. Download the configuration on the DDU 9. To connect the DDU 9 to RaceCon, see chapter ‘Connecting the Unit to RaceCon’.
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.



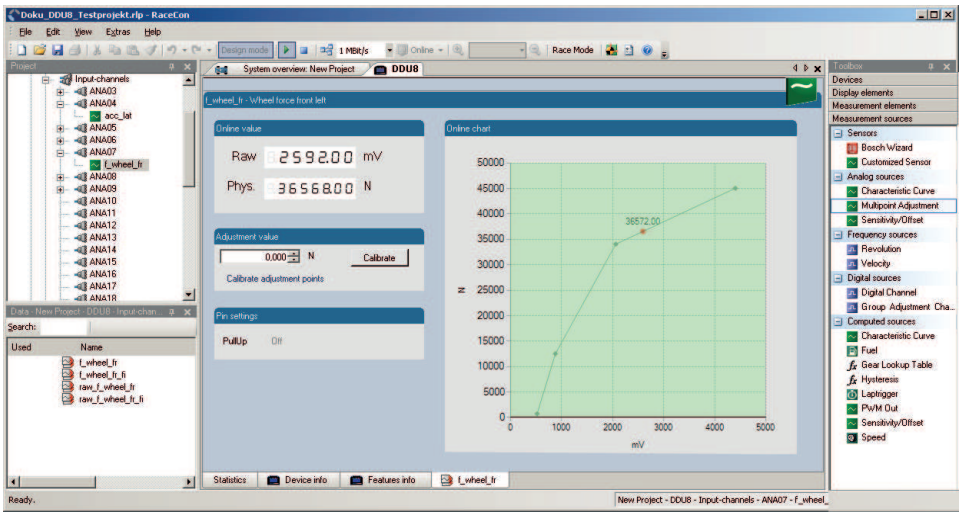
5. Click on ‘Calibrate adjustment points’ to open calibration window.



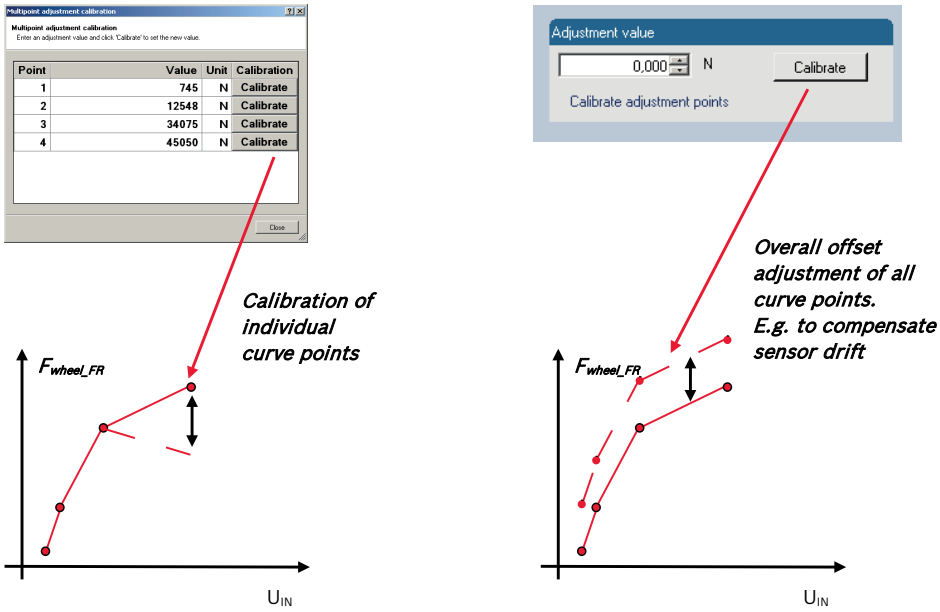
6. Apply the desired physical condition to the sensor (e.g. by applying a force on the wheel).

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

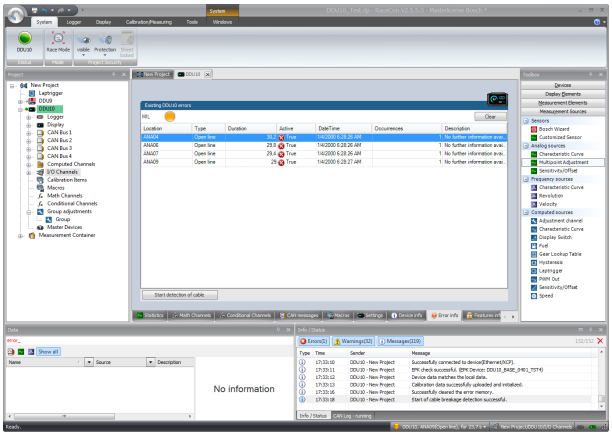


12 Error Memory

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.

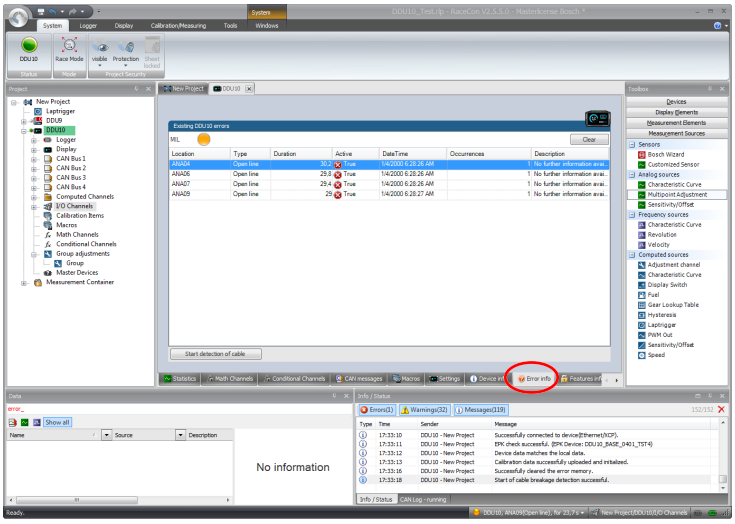
12.1 Error memory representation in RaceCon

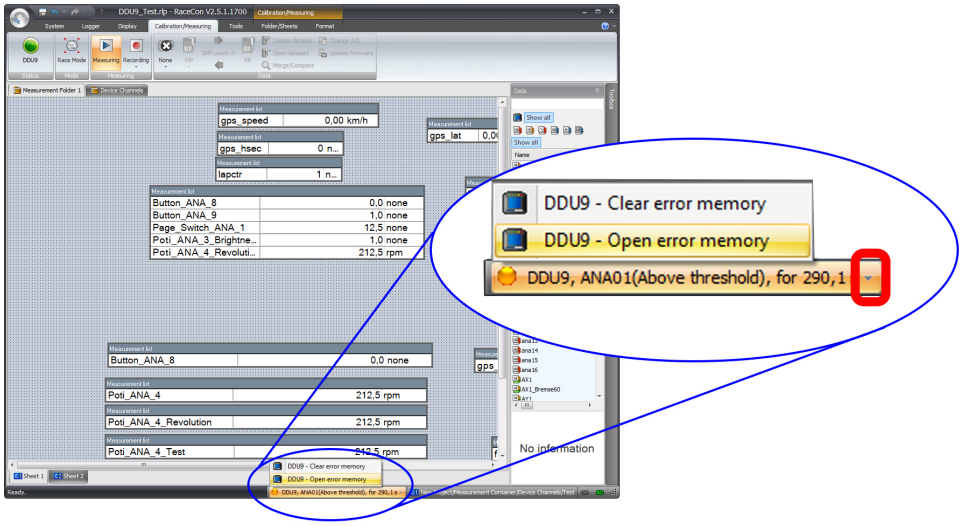
Bosch Motorsport devices feature an error memory. Information on errors can be visualized via RaceCon (online measurement) or can be transmitted via telemetry.



12.1.1 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.

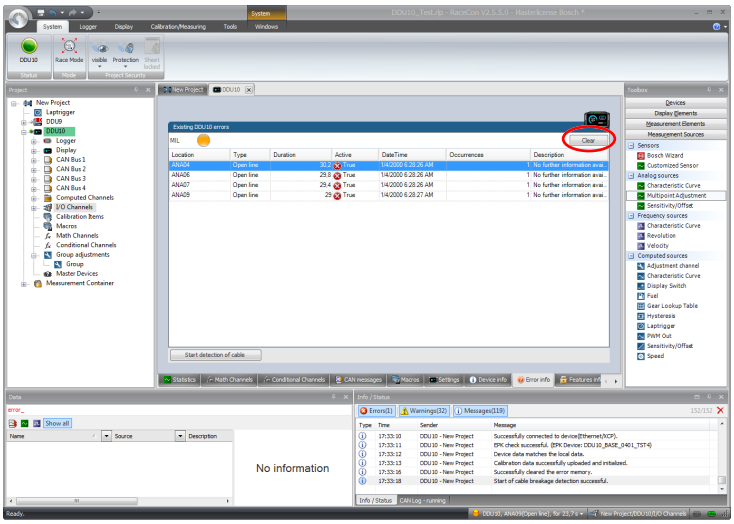
An error is deleted from the list when

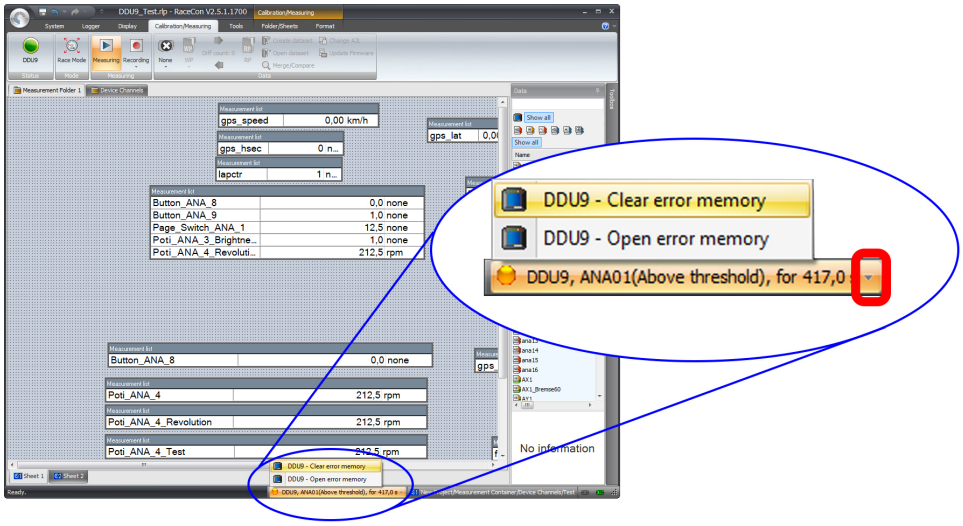
- the user actively clears the error memory
- the user updates the firmware

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

12.1.2 Clearing the error memory

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





12.2 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.

12.2.1 Error Memory Properties

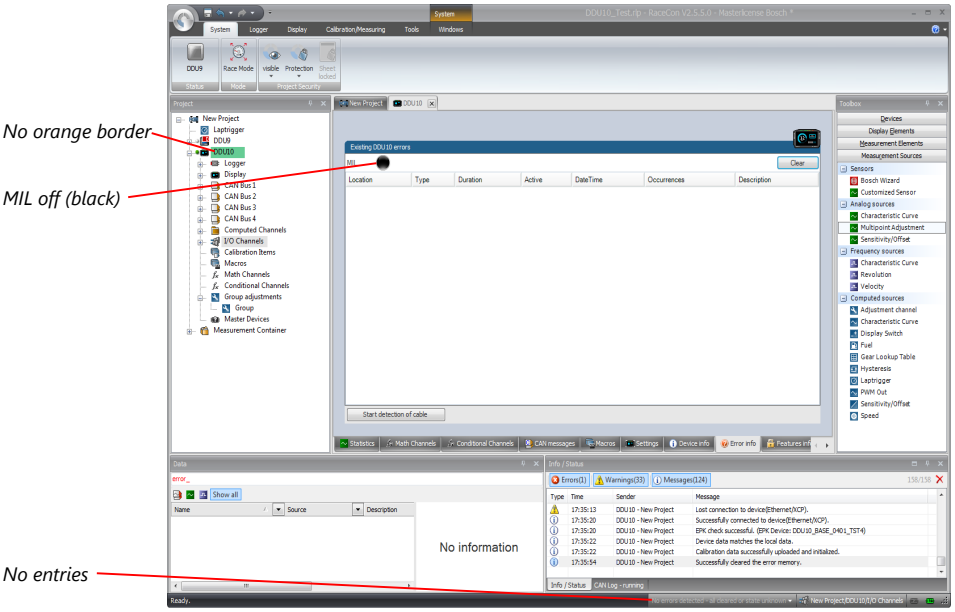
The following property is available for the error memory itself:

- 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

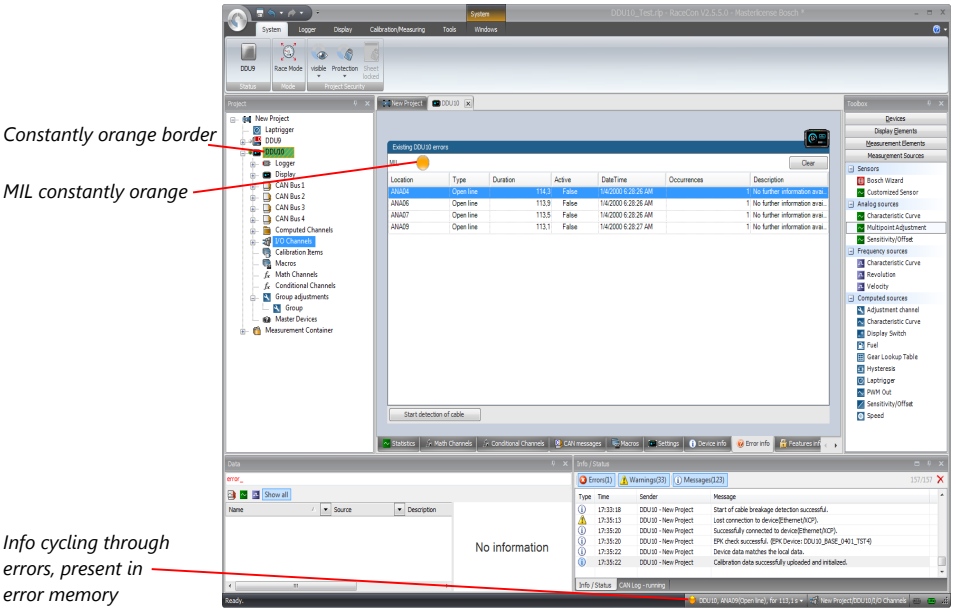
If displayed in a measurement sheet, this property’s value (0, 1 or 2) is translated into a verbal description:

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

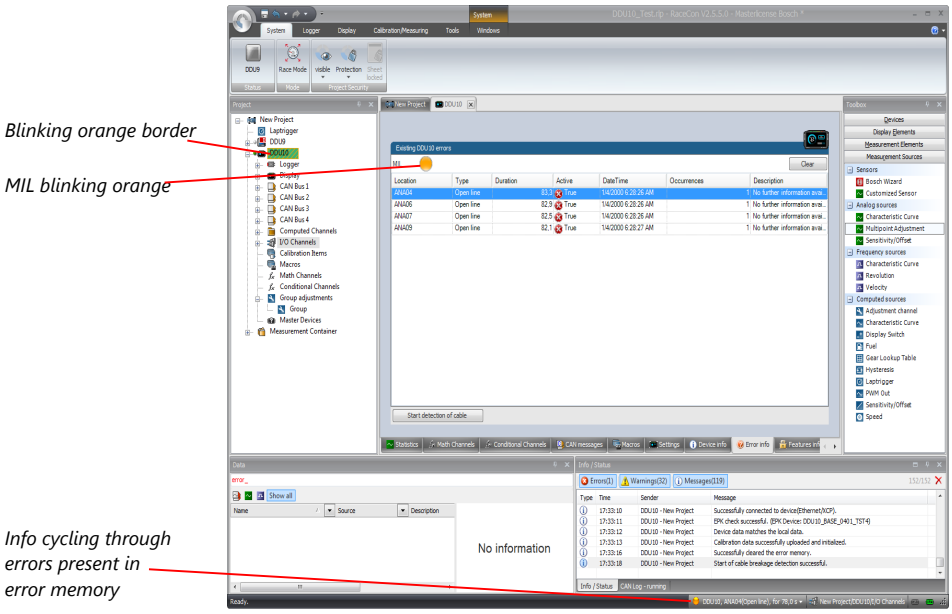
0 (no error present in memory):



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

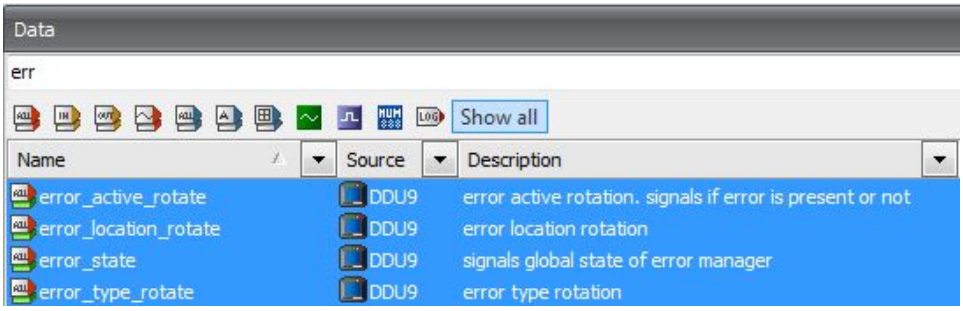


2 (at least one active error present in memory):



12.2.2 Error Properties

The following channels are recognized and memorized inside the devices:

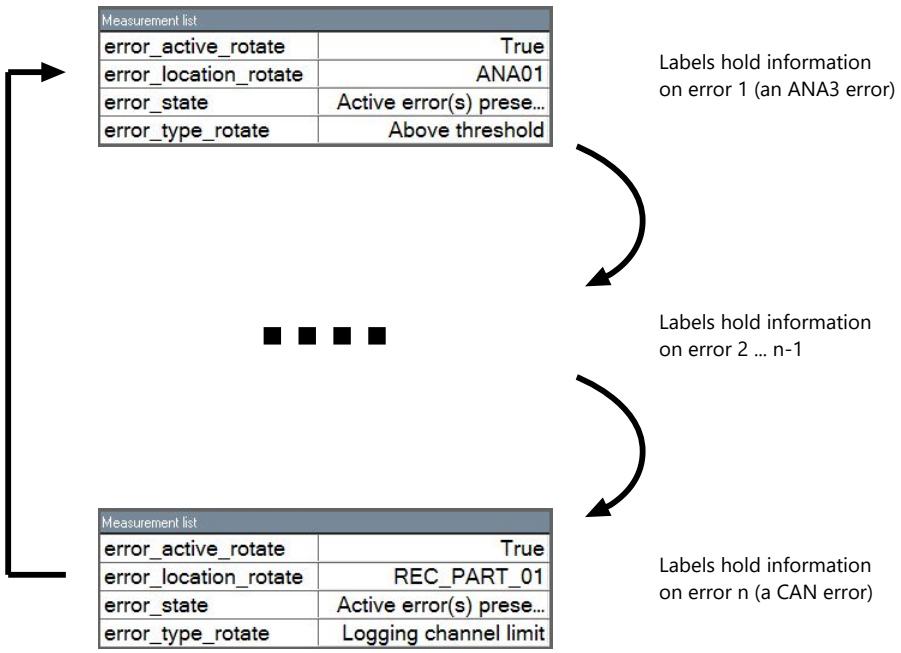


- Error type (device label “error_type_rotate”):
  e.g. “below_threshold” for a violation of the minimum voltage range defined in the configuration, “shortcut_Batt” for a shortcut to battery voltage etc.
- Error locations (device label “error_location_rotate”):
  e.g. “ANA01” for an error concerning the first ANA channel
- Error durations
  How long 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 channels (error_active_rotate, error_location_rotate, error_type_rotate) are device specific properties (e.g. C 60) and are not related to the complete RaceCon project (e.g. “error no. 3 from the error memory”). Therefore, 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.

The following screenshot shows error properties, which can be displayed or logged:

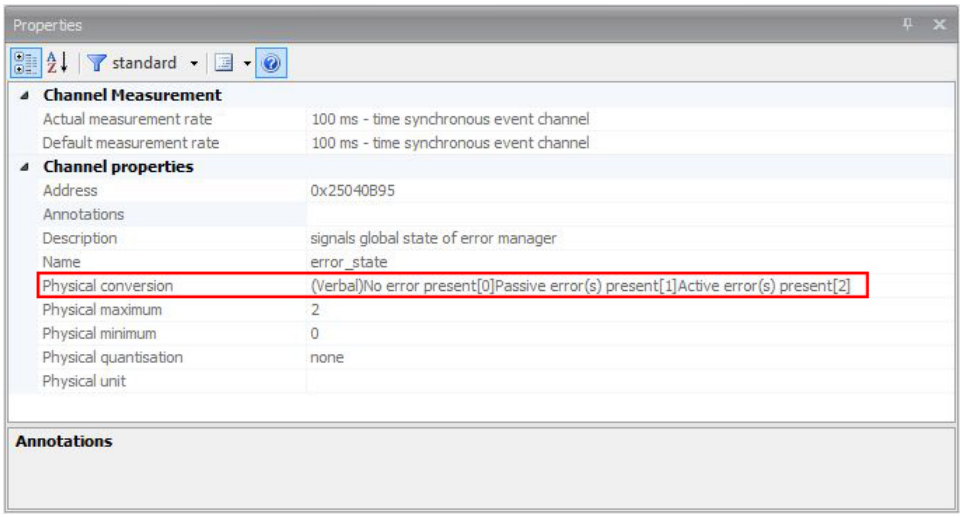


After the last error and its error properties have been displayed, the labels will start again with the first error in the error memory stack and its error properties will be displayed again. Therefore, monitoring these labels over a sufficiently long period provides the information on all individual 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

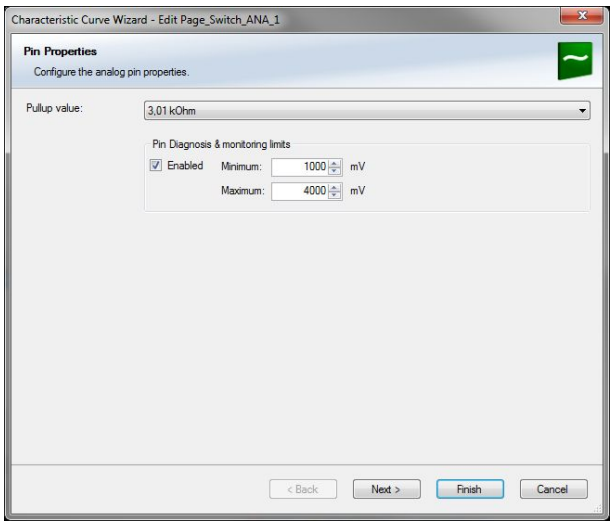
The verbal representation of the numerical codes of these labels can be visualized in the properties window of the measurement page:

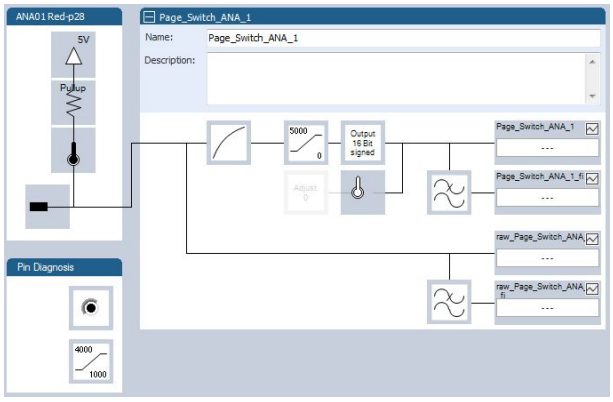


12.3 Analog Input Diagnosis

12.3.1 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 and cable breakage, a minimum / maximum has to be defined.

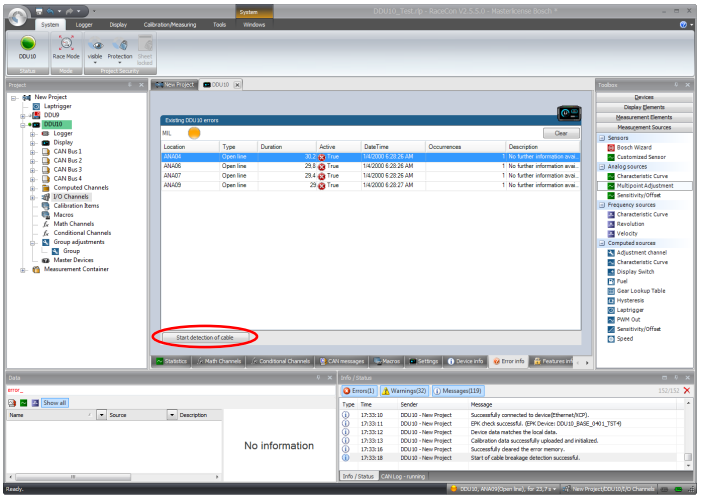




12.3.2 Open Line Detection

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

1. Open the Error Memory of the Device.
2. Click "start detection of cable".
3. Check the Error Memory for new fault entries, regarding "Open line errors".



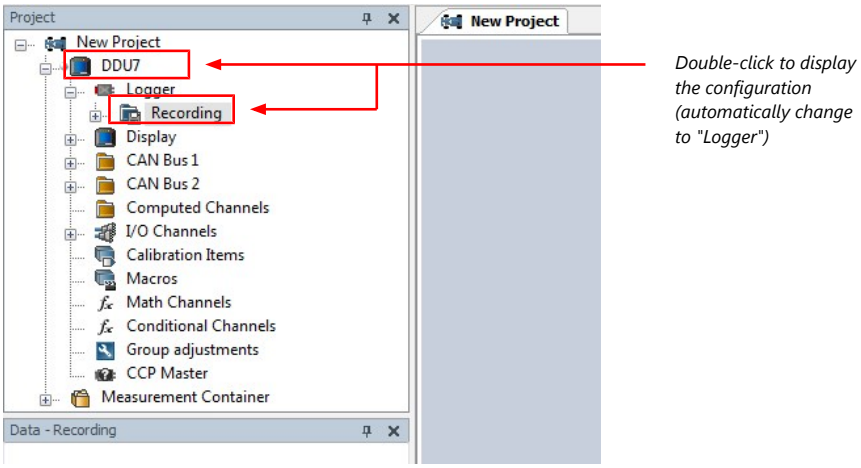
13 Recording

13.1 Features

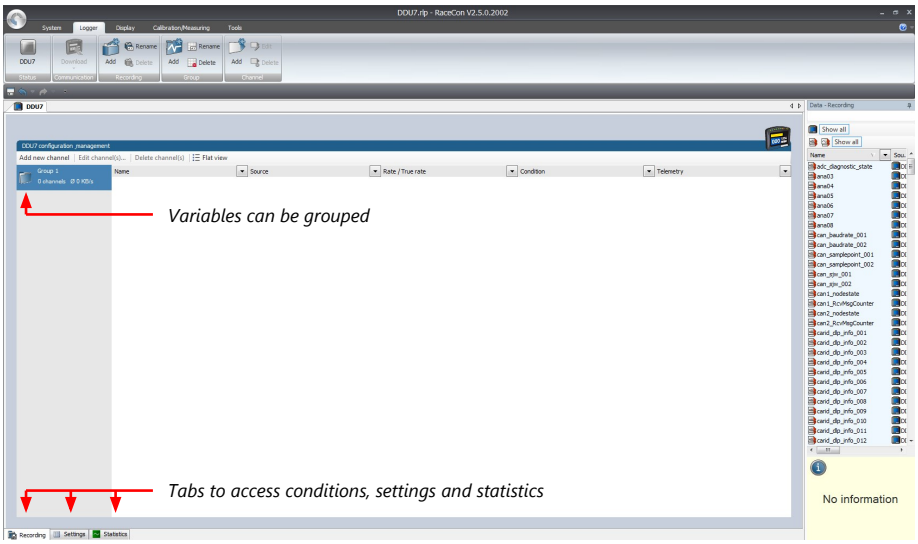
- Synchronized recording of DDU 9 analog and digital input channels, DDU 9 internal measurement channels, ECU data, Data from external sensor interfaces
- Up to two independent recordings
- Measurement rate 1 ms to 1 s
- Two global start conditions (thresholds)
- Up to 16 measurement conditions (fast-slow-switches)

13.2 Configuration of recordings

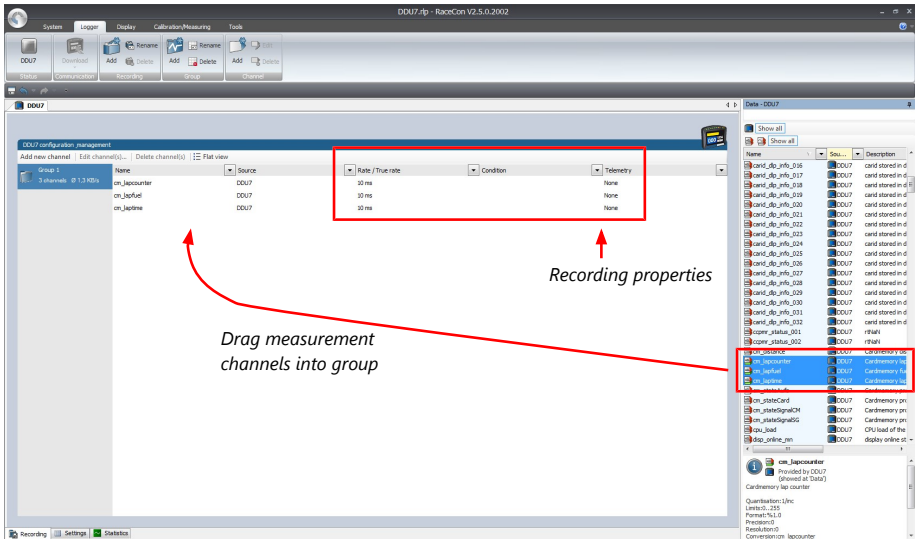
1. Expand the list of 'Loggers' by clicking on '+' in the DDU 9 Project Tree.



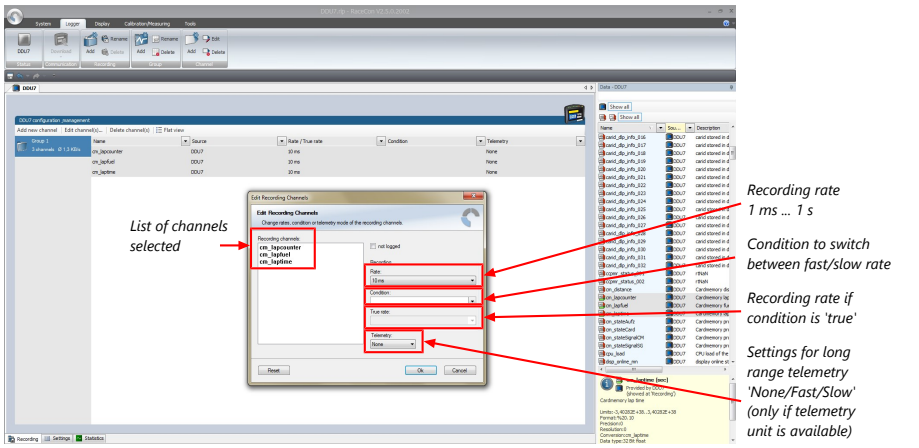
2. Double-click on 'Recording' in DDU 9 Project Tree. The recording configuration is displayed in the Main Area.



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).

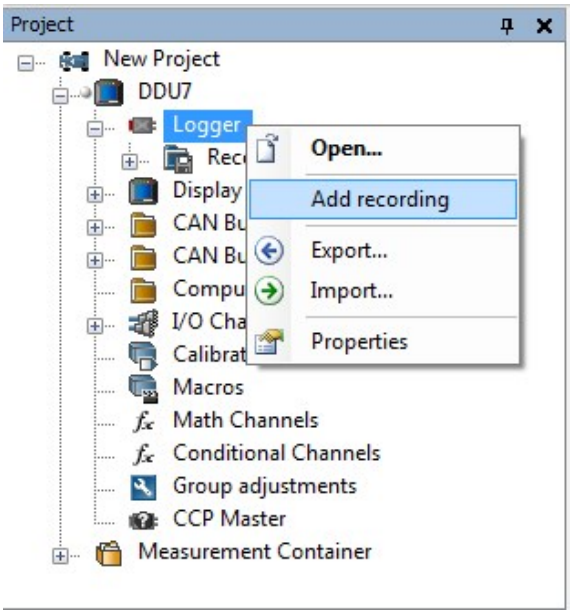
Transmission Scheme

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 [▶ 107]' 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.

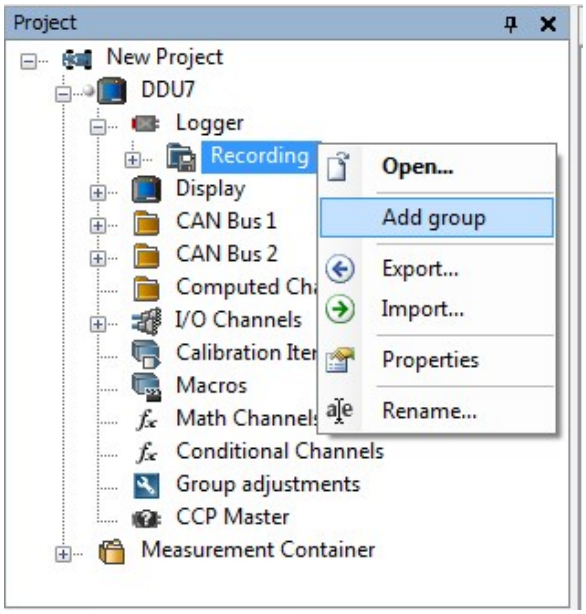


Maximum two recordings are possible. In the device software the 2nd recording is reserved for scruteneering data. This recording is invisible (protected).

13.2.2 Adding a recording group

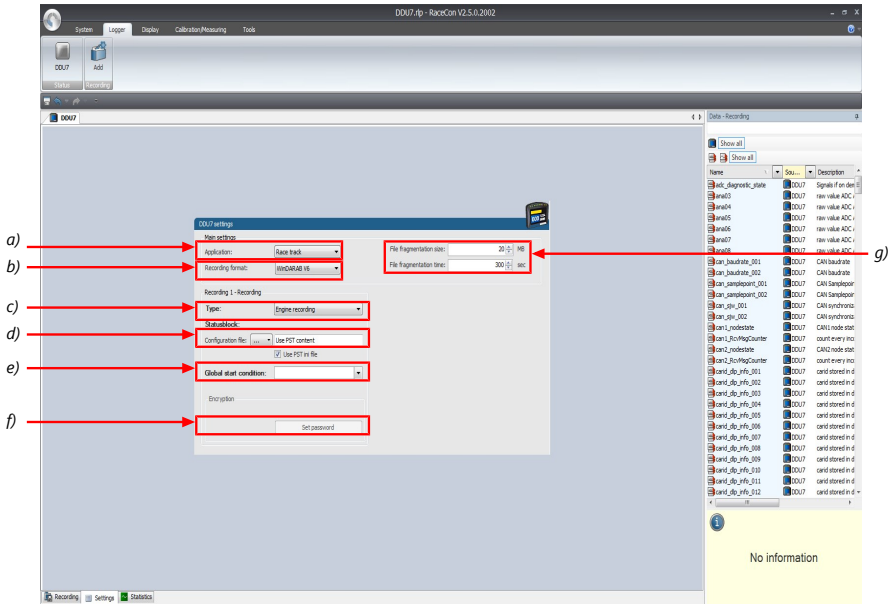
Recording channels can be grouped.

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.



a) Choose setting for outing counter mode:

- For testbench (without lap trigger) select ‘Testbench’.
- For racetrack (with lap trigger) select ‘Racetrack’.

b) 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).

c) Recording Type (Engine or Chassis).

d) Statusblock configuration file for custom Statusblock definition.

e) Choose or create the condition to start recording.

f) If selecting WinDarab V7 in b), enter a password hint and a password (optional).

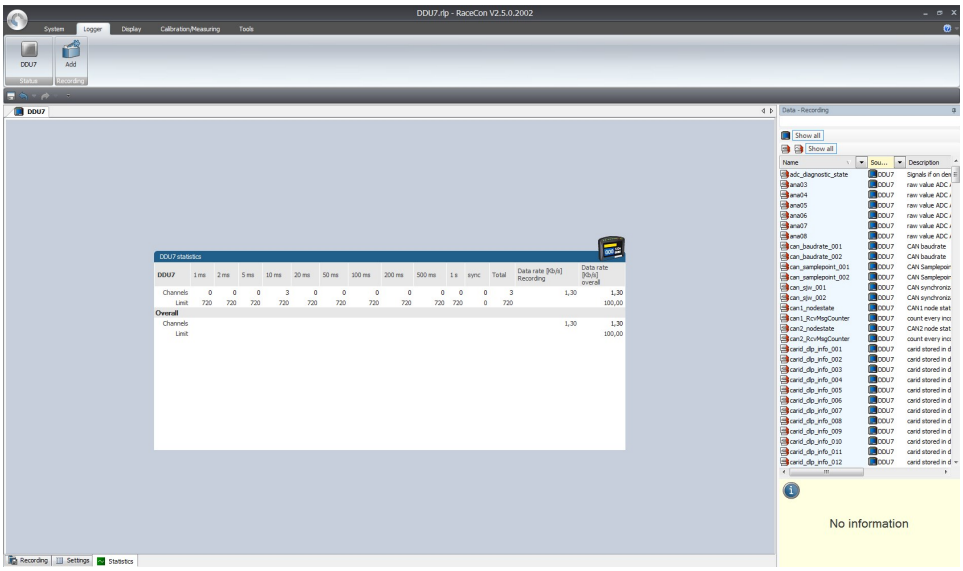
g) Setting for automatic fragmentation. Do not change!

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	-

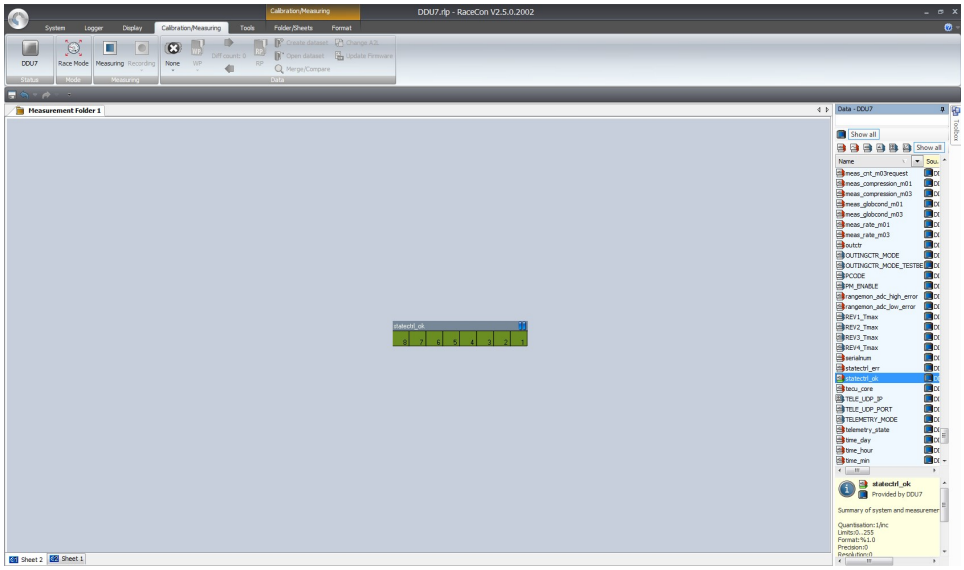
Content of status bits

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.

Name	Bitset	Bit cleared
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.

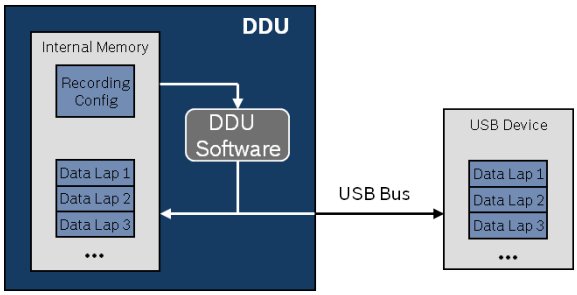


The ‘Bit-LED’ element shows the state of received channel data in bit-representation. A green highlighted channel means 0, a red highlighted channel means 1.

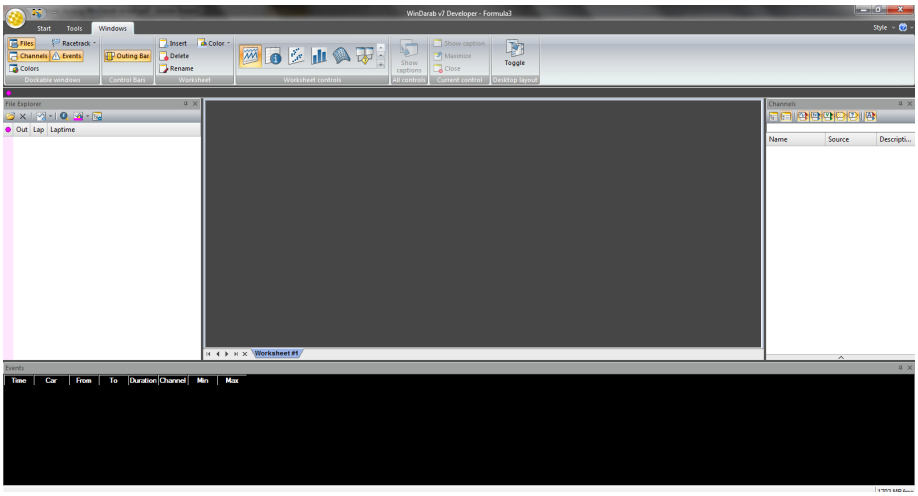
- Measurement correctly initialized, but recording threshold(s) not reached: 254
- Measurement correctly initialized, DDU 9 is recording data: 255
- Values less than 254 indicate an error state
- ‘statectrl_ok’ can be linked to an alarm on the display. See chapter ‘'Alarm' display element’ for details.

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.

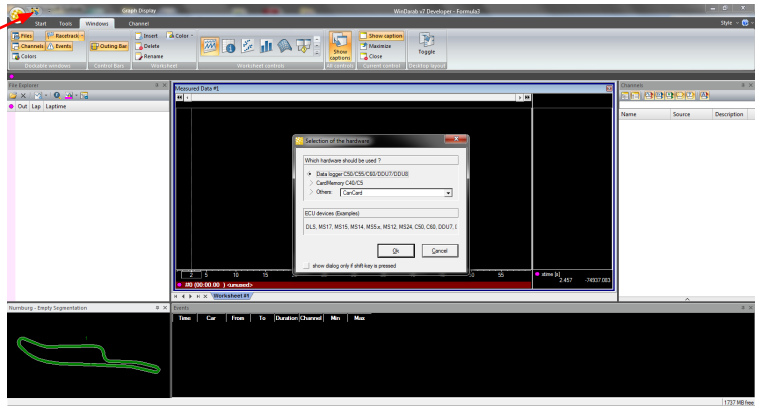


6. Power off the system.
7. Remove USB device from the vehicle.
8. Start the WinDarab software.

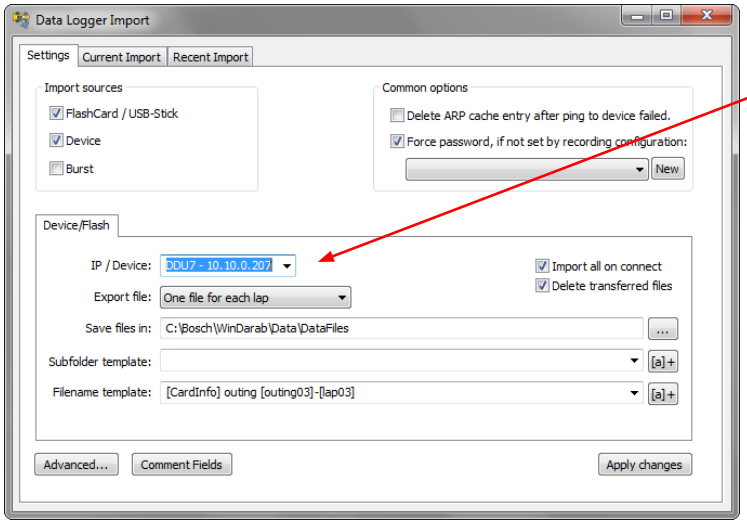


9. Click on the ‘Import/Export’ icon.
10. Select ‘Data logger CXX/DDUX/MSX and click ‘OK’ when done. The ‘Read measurement data’ dialog opens.

Click 'read data from logging device'



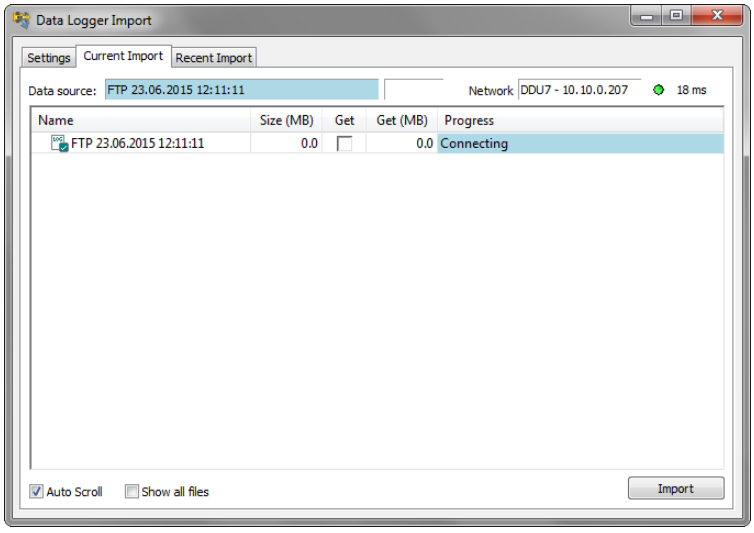
11. Click on ‘Settings’ tab and select the option ‘Flash Card/USB Stick’.

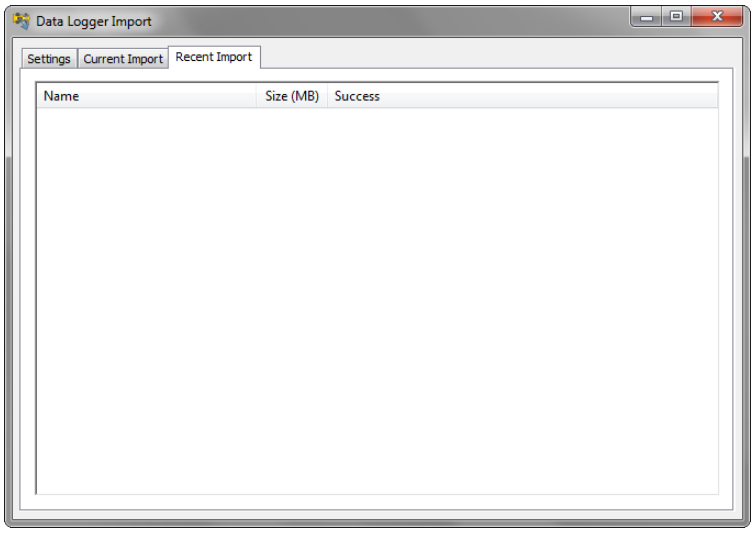


Choose your DDU from dropdown list

12. Activate ‘Apply changes’.

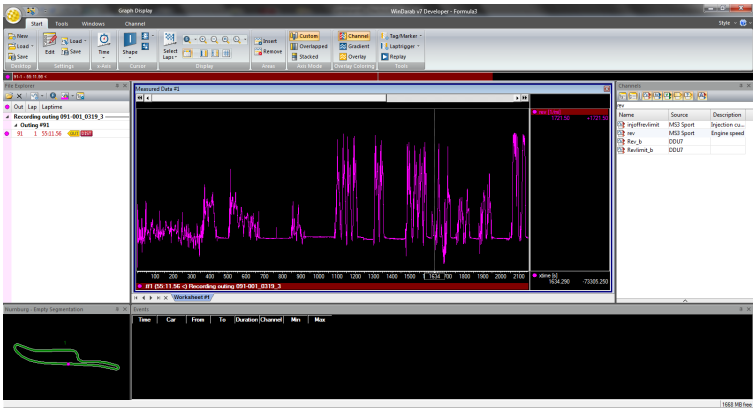
    Insert the USB device into the PC. Data transmission from device starts automatically. Measurement files are stored automatically in the base folder.





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, only the current data 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.
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 Telemetry

14.1 Features

Telemetry

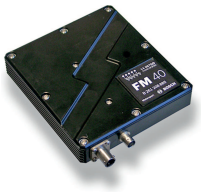
- Support for long-range online telemetry
- Individual programmable team code
- Fast block – slow block mechanism
- Programmable data rate

Burst telemetry

- Support for burst telemetry (BT 60)
- Programmable IP configuration
- BT 60 diagnosis via DDU 9

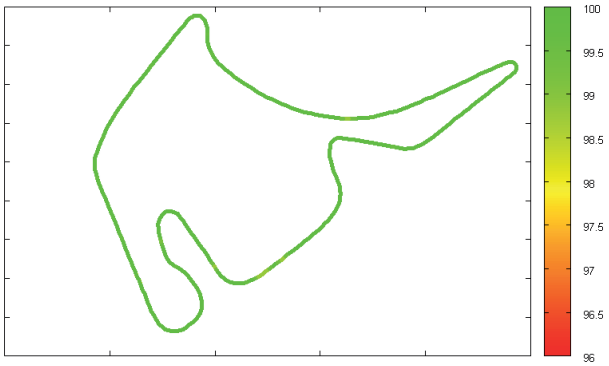
14.2 Configuration of Online Telemetry

14.2.1 Long range telemetry system FM 40

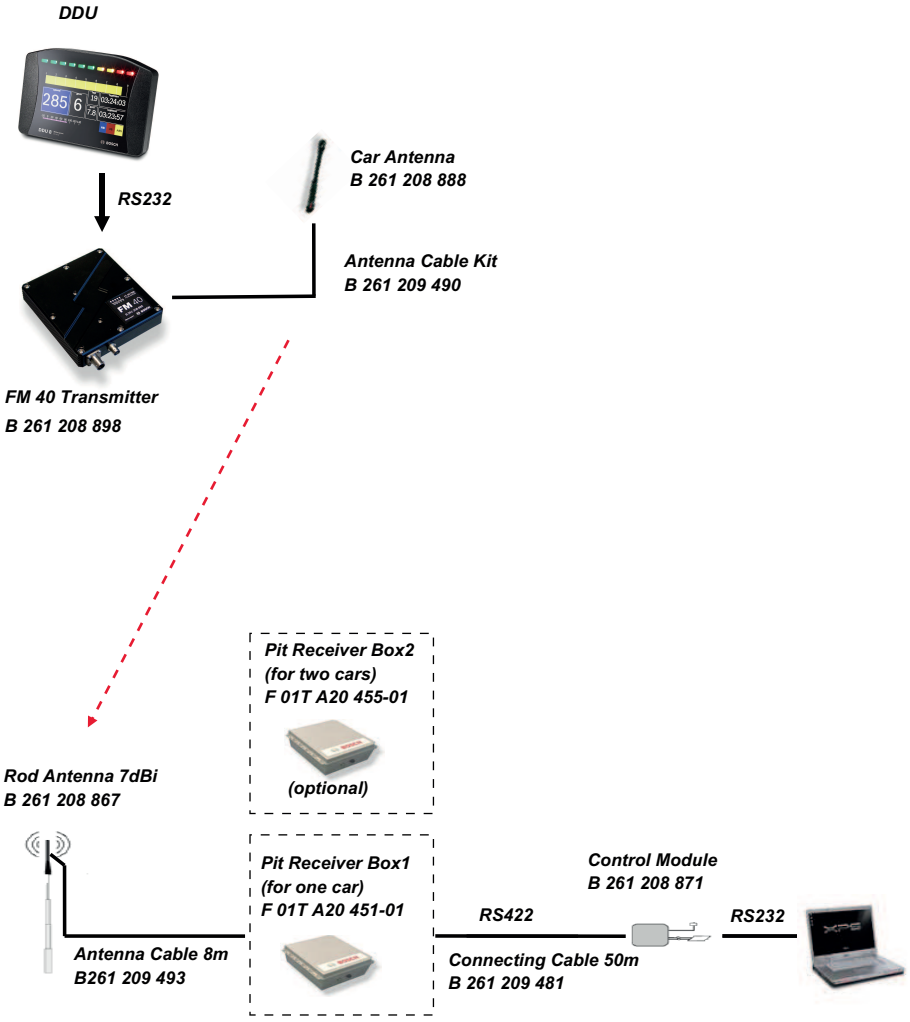


- 440 MHz band
- 25 KHz bandwidth
- 10 W max. RF output
- 19.2 kBit/s data rate - unidirectional
- RS232 interface
- Full online track coverage on almost all tracks

Link quality at Hockenheim

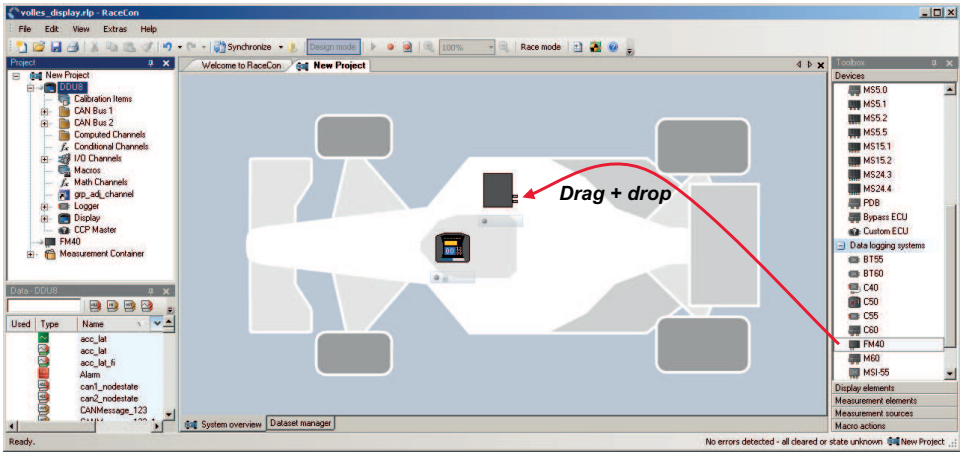


14.2.2 Hardware setup

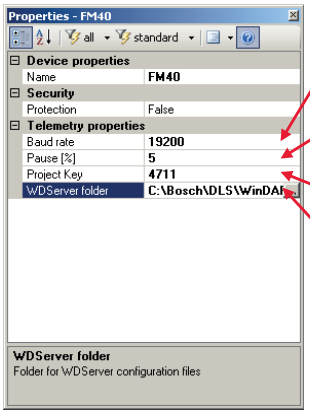


14.2.3 Software setup

1. Drop FM 40 from Toolbox into system overview.



2. Click on FM 40 in Project Tree to display the Properties Menu.



Baudrate of DDU (must match baudrate of FM 40)

Transmission pause (5% recommended for improved re-synchronisation)

Project Key (1111…9999)

Path to configuration folder of WDServer on receiver PC (usually ….\WDServer\DCP) to store telemetry configuration file

Adding channels to telemetry

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. Click 'Edit channel(s)'.

   The 'Edit Recording Channels' window appears.
4. Choose between 'Fast/Slow block' transmission.

Using fast block/slow block transmission

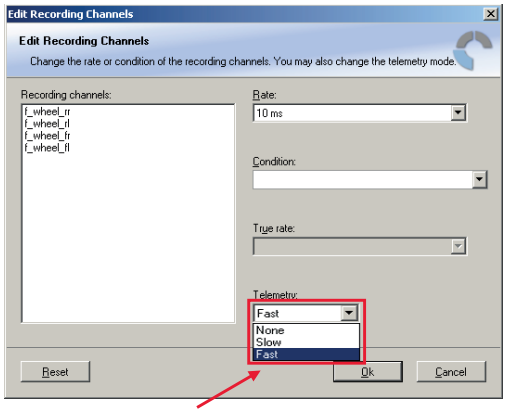
DDU 9 telemetry uses available bandwidth of Telemetry Unit FM 40 (19,200 baud -> approx. 1,700 bytes/s). The bandwidth has to be divided into channel information to be transmitted high-frequently and low-frequently using the 'fast/ slow block' setting.

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).

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.



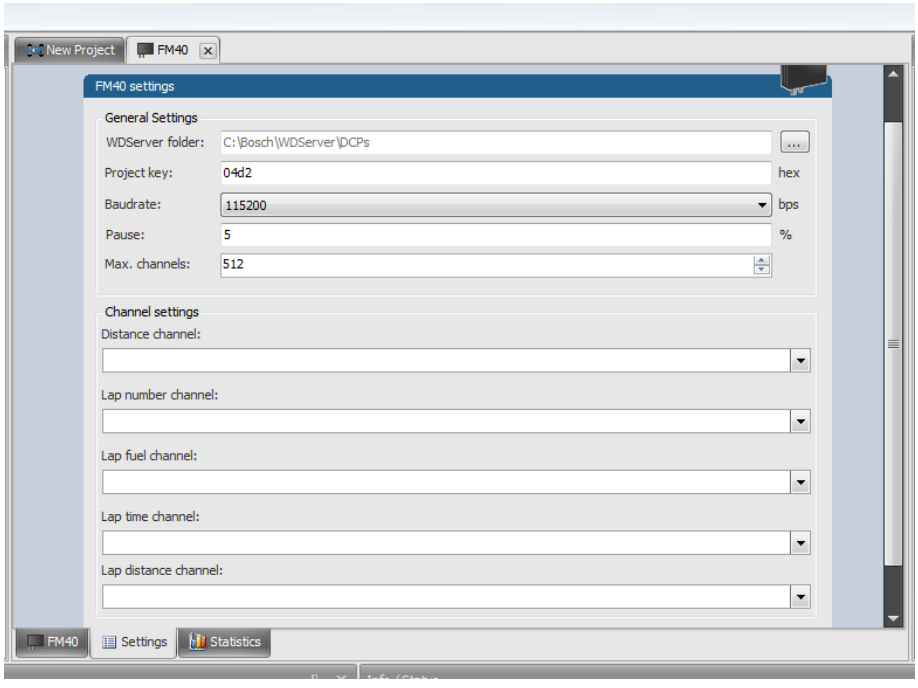
None – channel(s) are not transferred
Slow – channel(s) are transferred in the slow telemetry block
Fast – channel(s) are transferred in the fast telemetry block

14.2.4 Telemetry channels with special functionality

The FM40 allows the transmission of special information such as running distance of current lap, lap number of current lap and lap time, fuel consumption of last lap completed. You have to assign the channel type to the telemetry channel so that it is recognized accurately by RaceCon.

Channel's names are e.g.: distlap, fuelcons, lapctr, laptime. Different channel names are possible between different devices (e.g. ECU MS 3 Sport, ECU MS 5.1).

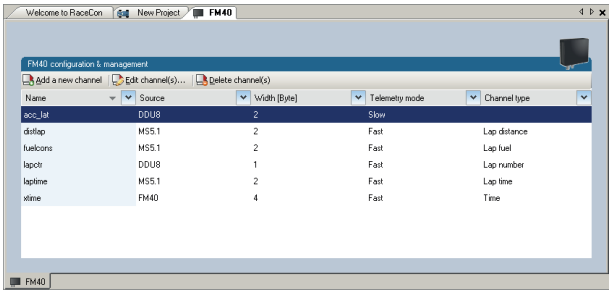
1. Double-click on FM40 in the project tree. An overview of all available telemetry channels is displayed.
2. Click on the 'Settings' tab at the bottom, to edit the channels.



3. Assign the desired channels to the channel types. The table below shows the function of the available channel types.
4. Click ‘Ok‘ when done.

Measurement channel	Function
Distance	Running distance of current lap
Lap number	Lap number of current lap
Lap fuel	Fuel consumption of last lap completed
Lap time	Exact lap time of lap completed

The telemetry channels and their assigned channel types are displayed in the overview list.



14.3 Configuration of Ethernet Telemetry

The usage of ethernet telemetry requires the software upgrade ETHER_TELE (Enable ethernet telemetry).

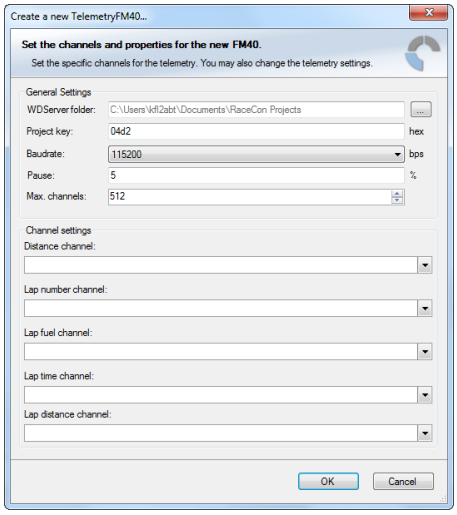
14.3.1 Hardware Setup

You can use ethernet telemetry to connect a transmitter on an ethernet line of your device, to send the data to a pit unit and from there to your computer. It is also possible to connect the ethernet line directly to your computer, for example when you use the device on a dyno.

14.3.2 Software Setup

The following steps will show you how to insert an FM40 telemetry device in the RaceCon project for your vehicle. Please note that, in order for this action to be available, first you have to configure a data logger in RaceCon.

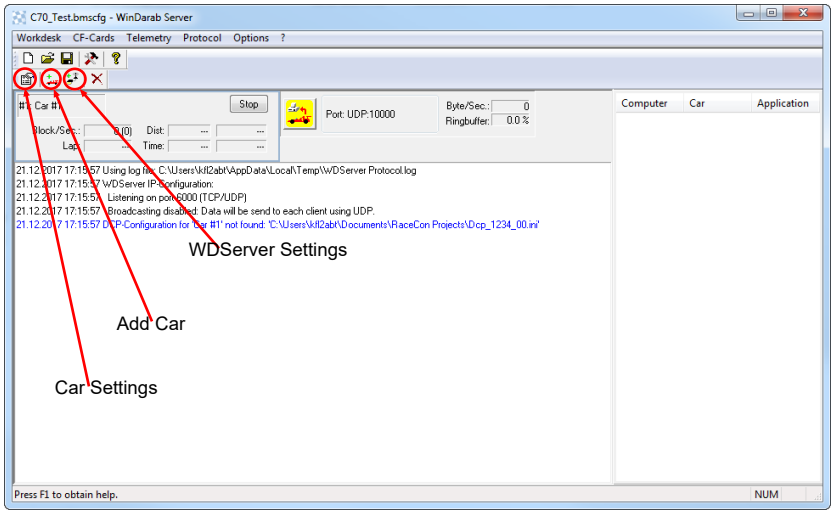
1. In the toolbox of the device, click on an FM40 telemetry device and drag it into the project window.
   Please note that at this point, an ethernet module has not been integrated into the RaceCon software, yet. However, ethernet telemetry setup within RaceCon is identical to that of the FM40.
2. Adding a FM40 should open up the FM40 settings window. If this window does not show up, select FM40 - Settings.



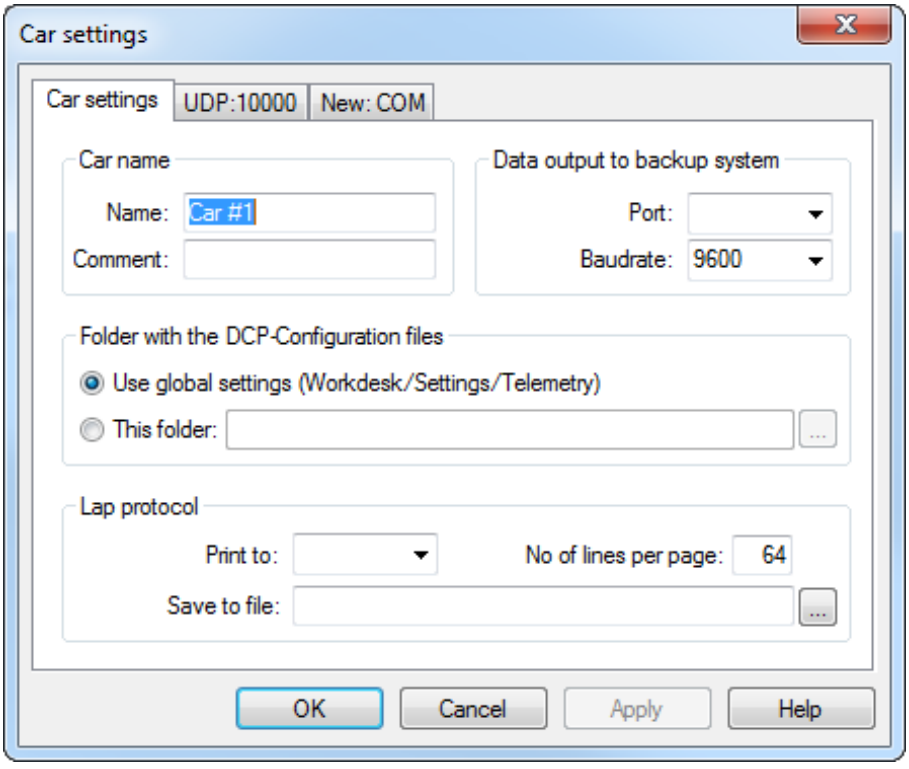
3. Define the settings as described below:
   - WDServer folder: This is the folder where the ".INI" files for the WDServer are stored. Please make note of this folder path, as this path will need to be referenced by WDServer in order to enable telemetry live viewing and logging.
   - Project Key: The project key is a data security function, that is used by Darab to differentiate data from different users. This key should always be 4 digits long.
   - Baudrate: Set to 115,200 bps.
   - Channel settings: Select the needed channels for the FM40 configuration.
4. Change to a calibration/measuring page and drag and drop the following channels to the measurement sheet:
   - TELE_UDP_IP,
   - TELE_UDP_PORT,
   - TELEMETRY_MODE.
5. Change the TELEMETRY_MODE to UDP.
6. Set the TELE_UDP_IP to the IP address of the receiving device.
7. Set the TELE_UDP_PORT to a unique value for each unit. This will be relevant when connecting to WDServer.
8. Define your telemetry channels.

14.3.3 Setting up car in WDServer

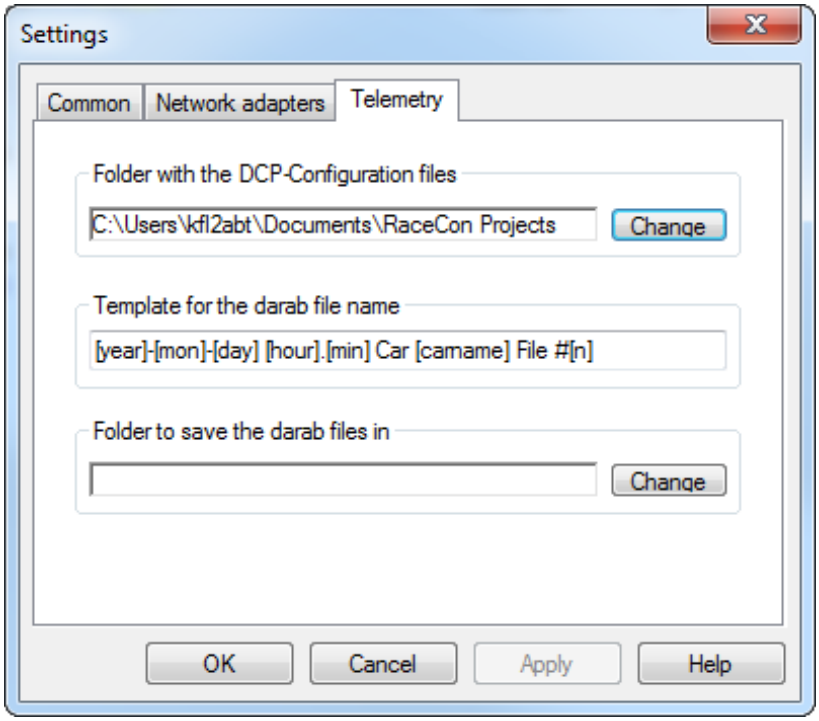
WDServer is a program used to capture data streaming from a transmitter and convert to WinDarab; WDServer also creates a log of the data received over telemetry.



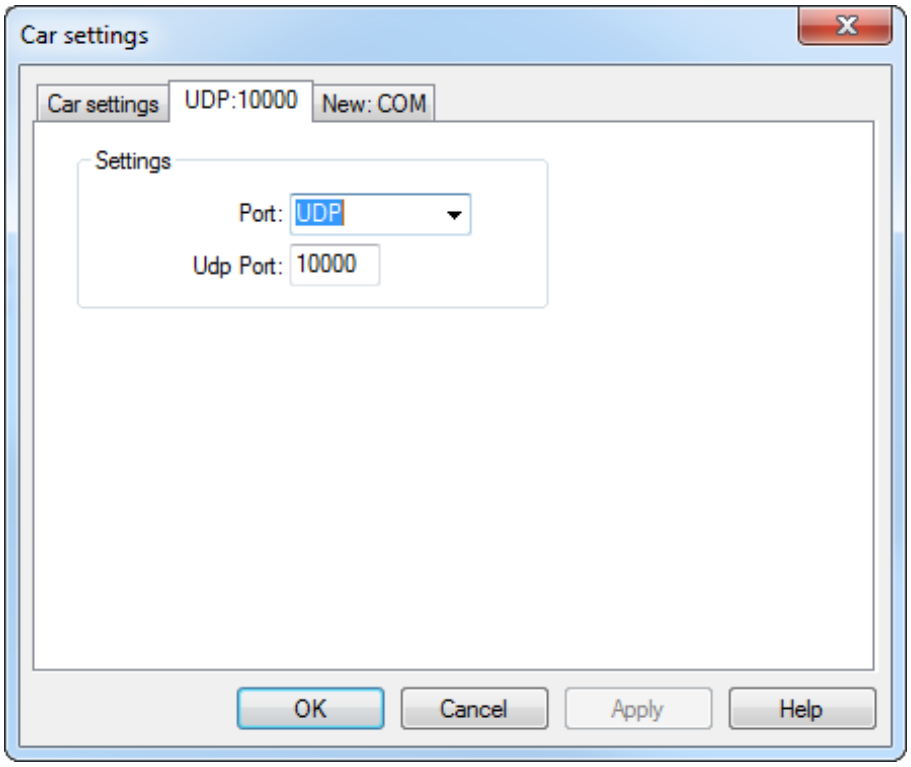
1. To set up a new car, select ‘Add Car’.
2. In the Car settings tab, enter a name for the new vehicle.
   This name will be used as a part of the file name for WDServer’s log of received telemetry data and will show up in WinDarab, when searching for the telemetry stream in the Network folder.



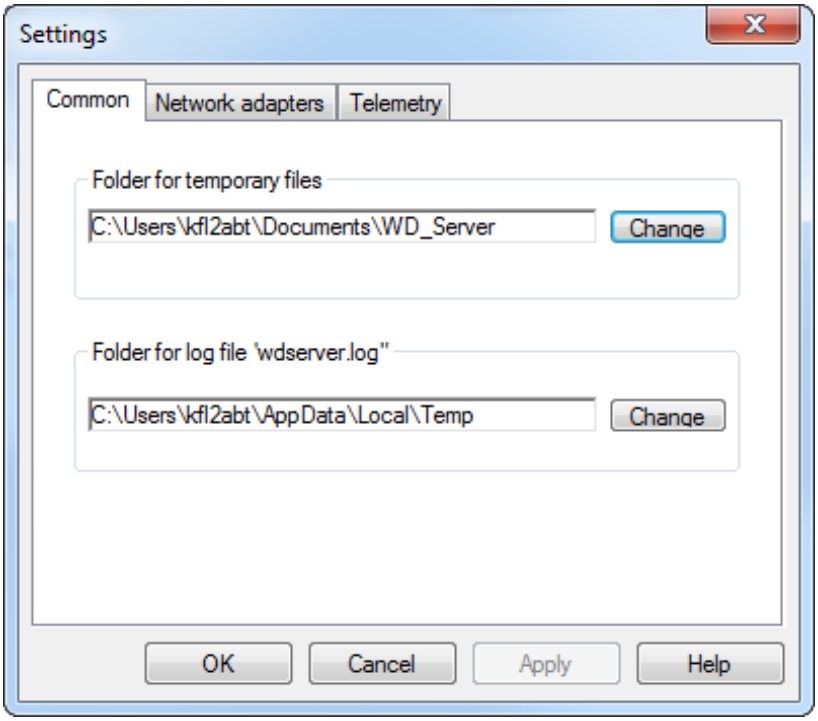
   You are now at the final step of configuring the telemetry stream. In order for the data to be decrypted by WDServer, two *.ini files must be referenced by WDServer. After the configuration is sent to the logger, these two different *.ini files will be created in the base folder. You can find the base WDServer folder, if you right-click the FM40 and select ‘Properties’. You can change this folder location for easier access if desired.
3. Define the link to the folder of the *.ini files for each car or define it in the general WDServer settings, under the ‘Telemetry’ tab.



4. Under the 'UDP' tab, select the drop-down menu and type in "UDP".
5. For the UDP Port, type in the port number assigned to the device in RaceCon.
   Each vehicle being read by a single receiver device must have a unique port number.
   This information will be provided by Bosch upon delivery of the devices.

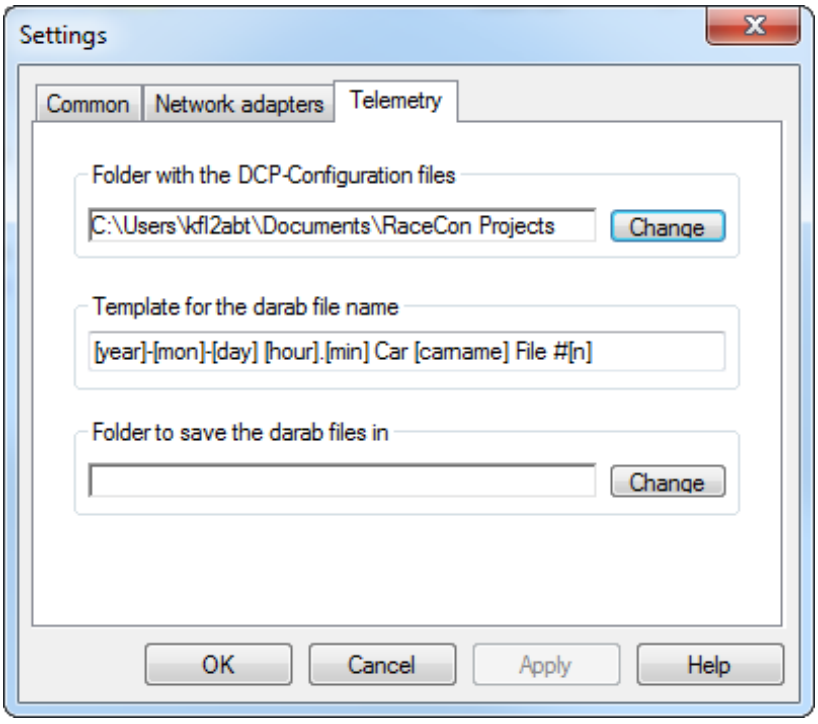


6. Click 'OK', to close the window.
7. Select the button 'WDServer Settings'.
8. Under the 'Common' tab, choose directories where WDServer can store its temporary files and log files. These are created during telemetry reception and can be used to help diagnose issues.



Under the 'Telemetry' tab, the first section requests a folder path for the DCP- Configuration files. This is the folder path where RaceCon stored the *.ini files required by WDServer.

9. Click on the "Change" button next to this section and navigate to this folder.
   A template can also be specified for the file nomenclature for logged telemetry as well as a save location.



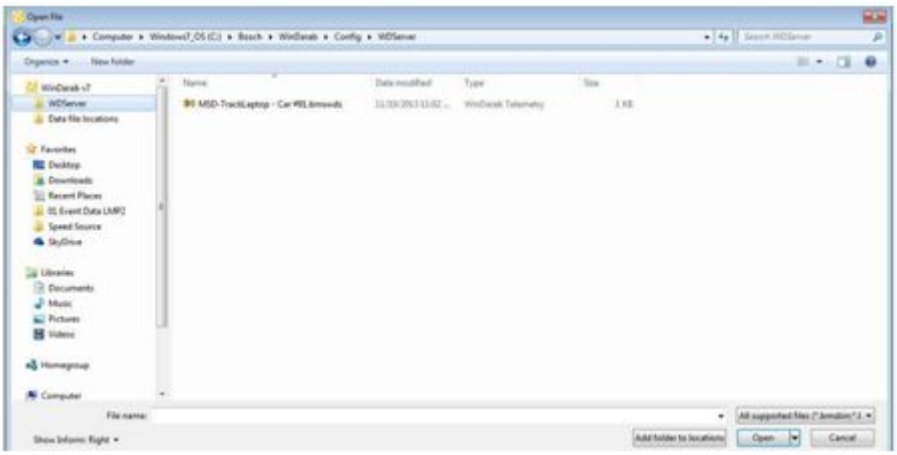
– To insure proper communication between WDServer and the receiver, do not delete any old *.ini files from this folder path. As mentioned in section 5, RaceCon will generate a new *.ini file each time a project is synchronized; each new *.ini file instance has

an incremented file name. Retaining all of these *.ini file iterations will insure that WD-Server always has a reference to whichever configuration is programmed into your vehicle's logger system.

– If the RaceCon project for the vehicle resides on a different computer, than that which is used for telemetry, then all *.ini files for a given project should be transferred to the telemetry computer after every data synchronization in RaceCon. WDServer may have trouble recognizing *.ini files stored on removable media, so best practice is to copy these files to the telemetry computer's hard drive.

14.3.4 Loading the telemetry data

The following is an example of a file name and data format for Car #91. File is typically located in WinDarab/Config/WDServer:



In the File Explorer, click 'Open' and navigate to the data set. Under 'Network', search for the car or cars that are required for viewing.

15 Lap Trigger

15.1 Lap trigger (timing beacon)

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

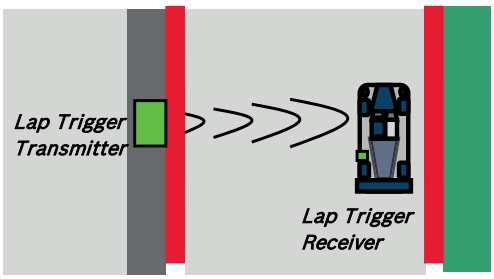
- Vehicle lap time measurement
- Calculation of lap-dependent functions (lap fuel consumption, min/max values)
- Calculation of lap distance dependent functions
- Control of data logging system

Types of Systems

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

IR and RF based Systems consists of

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



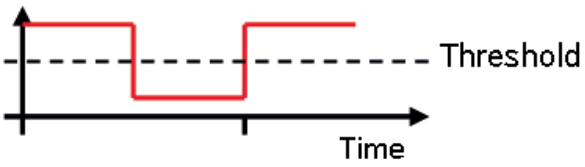
15.1.1 Electrical trigger signal

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

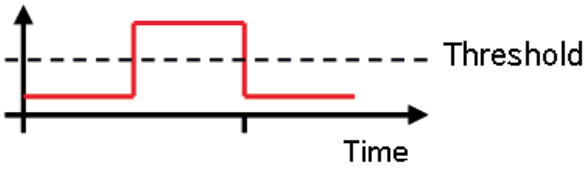
- Analog input
- Digital input
- CAN input

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)

15.1.2 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) 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-klick 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.

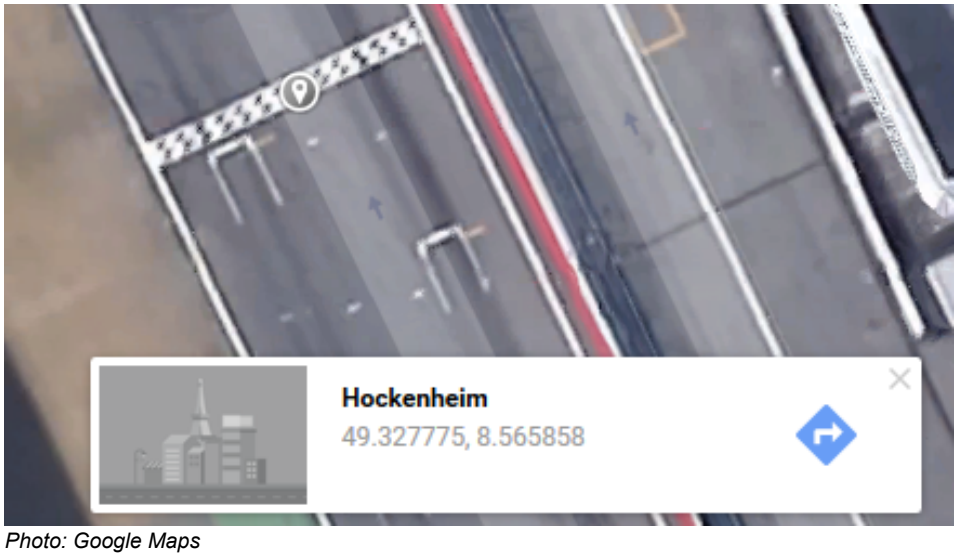


Photo: Google Maps

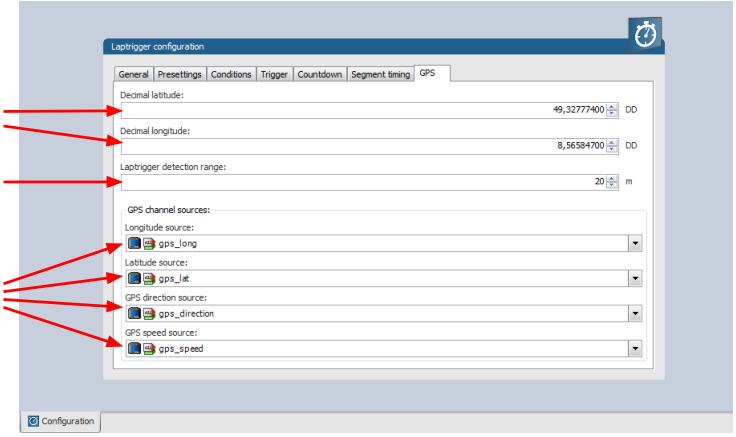
The detection range defines the radius of a circle around the detection point in which the lap trigger can be set. The lap trigger will be set as soon as the distance between the car and the detection point has reached its smallest peak. By this function an imaginary finishing line is calculated inside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

15.1.3 Prevention of false triggers

- Race track topology and transmitter location frequently cause false triggers.
- Software functionality prevents acceptance 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.

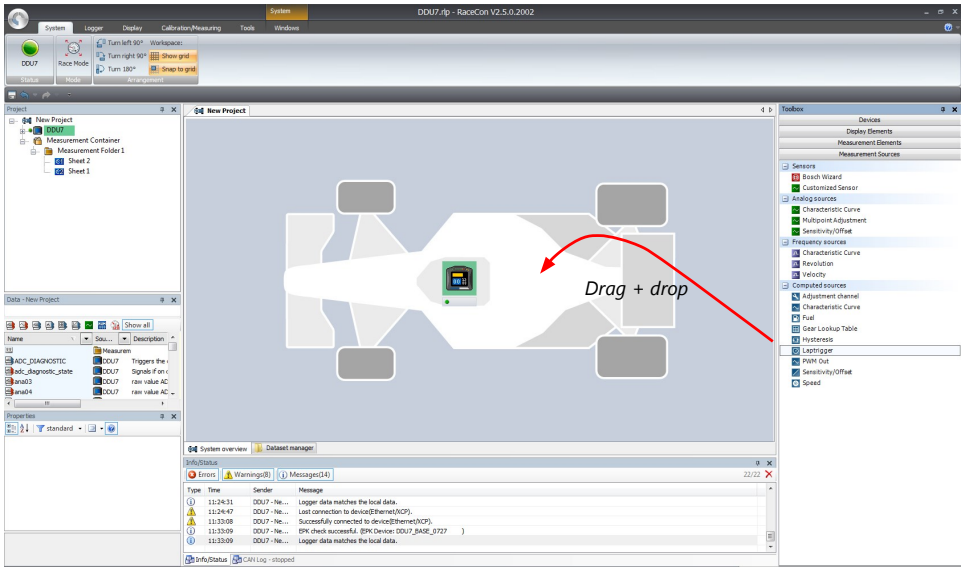
15.1.4 Forced triggers

Lap distance based insertion of ‘forced trigger‘.

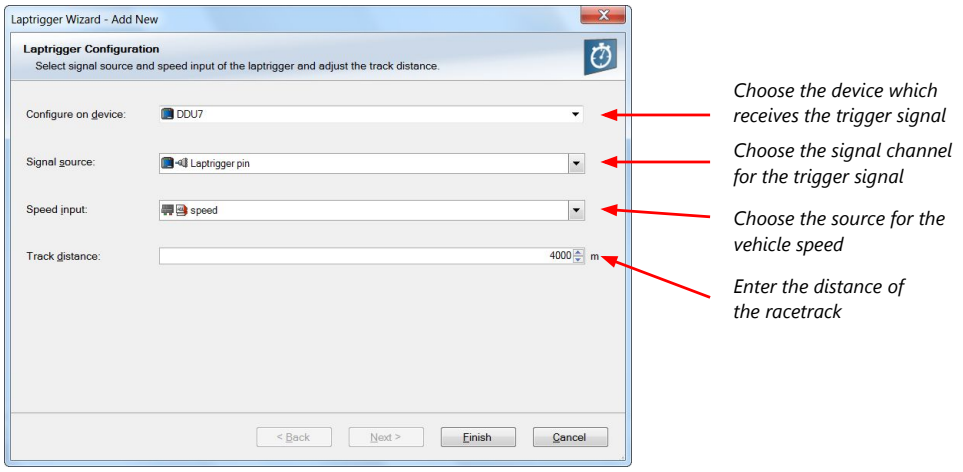
Under race conditions, trigger signals are sometimes missed. Software functionality introduces ‘forced trigger‘.

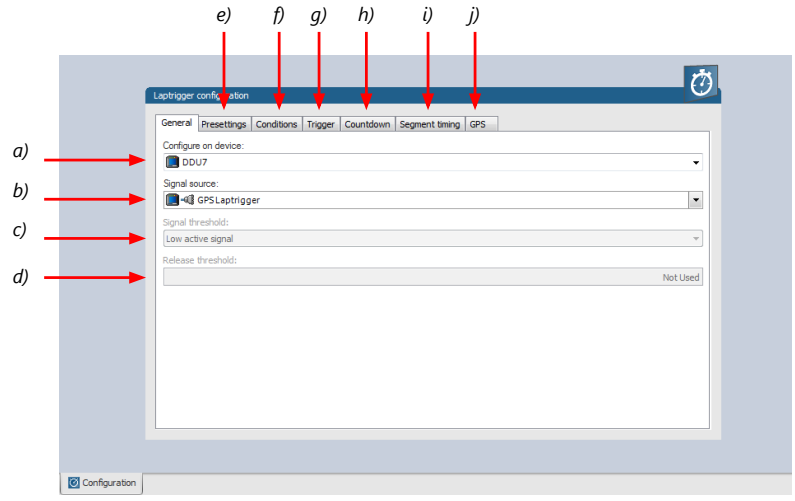
15.1.5 Setting up a lap trigger

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



A ‘Laptrigger Wizard‘ 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 presettings for trigger. See chapter 'Lap trigger presettings' 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 counddown timer. See chapter 'Countdown timer' for details.

i) Define settings for sub trigger. See chapter 'Segment timing' for details.

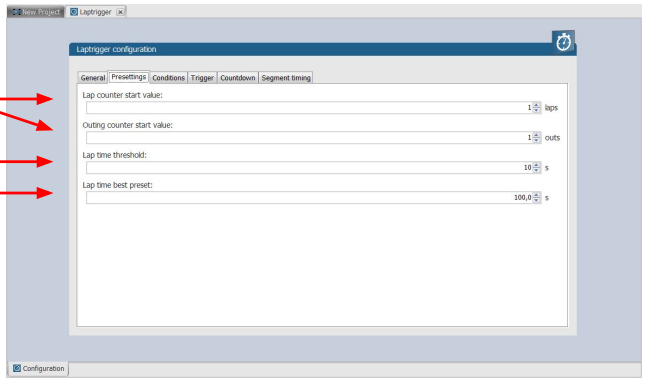
j) Define settings for a GPS lap trigger. See chapter 'GPS lap trigger' for details. Only applicable if the signal source is set to 'GPS lap trigger'.

Click ‘Finish’ to complete the operation. A pre-configured lap trigger window opens.

Preset values for lap counter and outing counter

Minimum laptime that a new 'best laptime' is accepted

Preset value for 'best laptime'

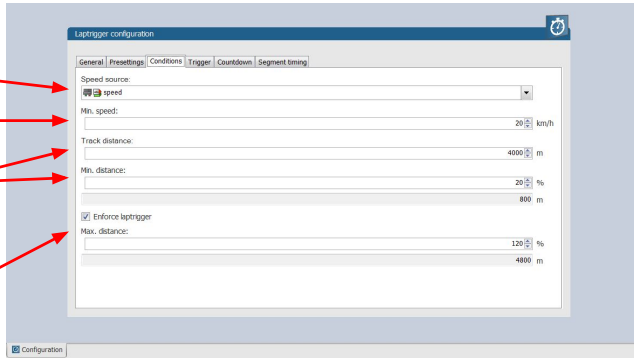


Change signal for vehicle speed, if desired.

Enter minimum speed for trigger release.

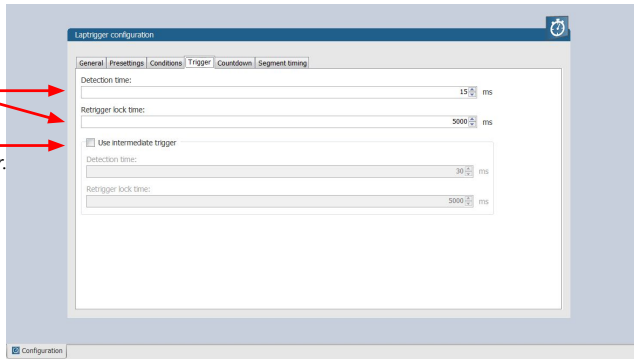
Define settings for distance based retrigger protection.

Define settings for distance based forced trigger.

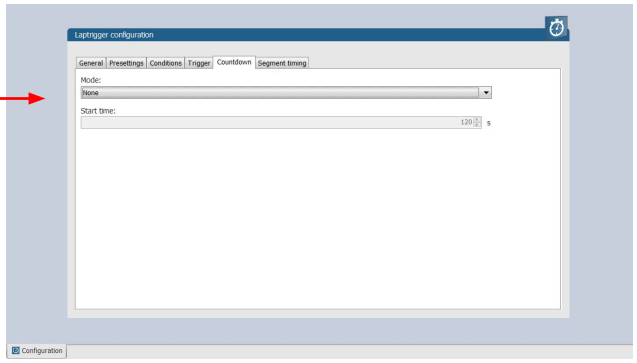


Define settings for lap timing (main trigger).

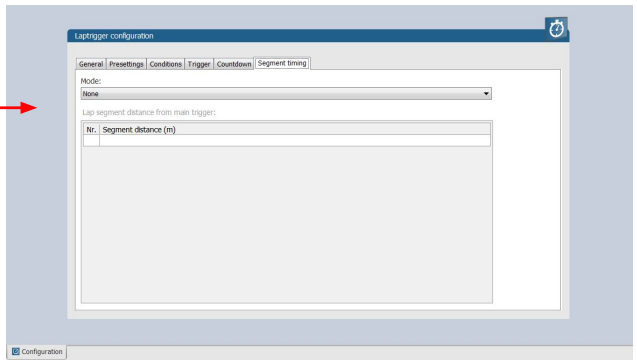
Define settings for sub trigger. Not applicable with a GPS lap trigger.



Define settings for countdown timer.



Define settings for segment timing.

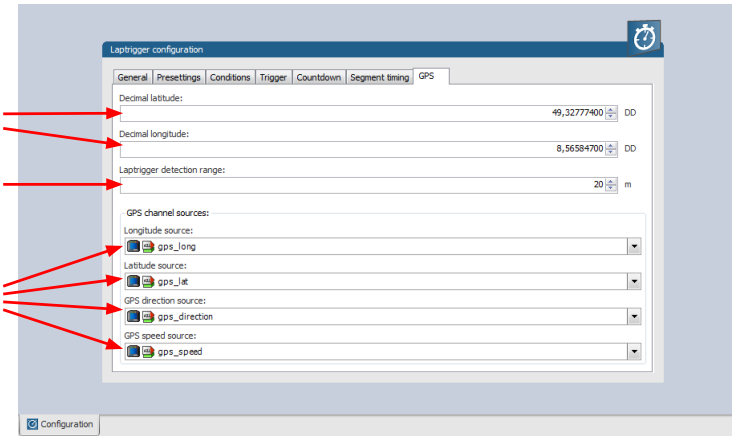


Only applicable for a GPS Laptrigger

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.

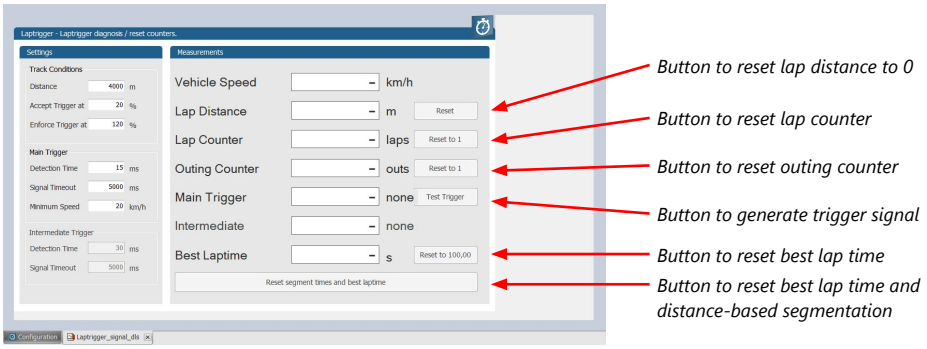


15.1.6 Lap trigger channel diagnosis/counter reset

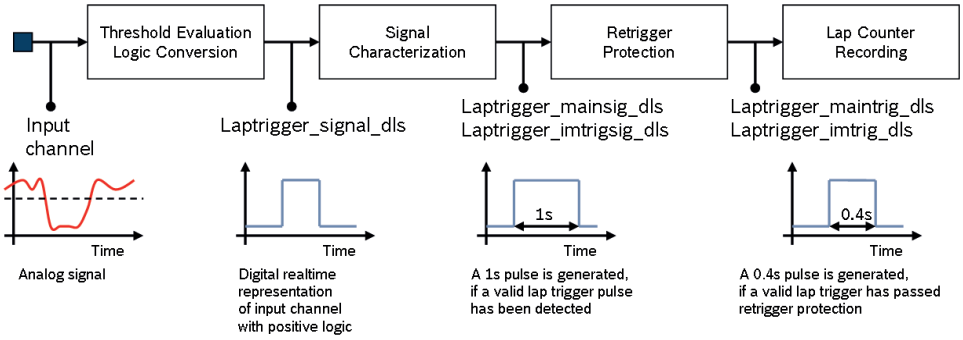
To display a quick lap trigger channel diagnosis and to reset counters use the diagnosis page in RaceCon. Any ‘Laptrigger_xxx’ channel can be displayed.

Double-click on any ‘Laptrigger_xxx’ channel in the Data Area. Example: ‘laptrigger_lap-dist_dls’

A diagnosis window opens in Main Area.

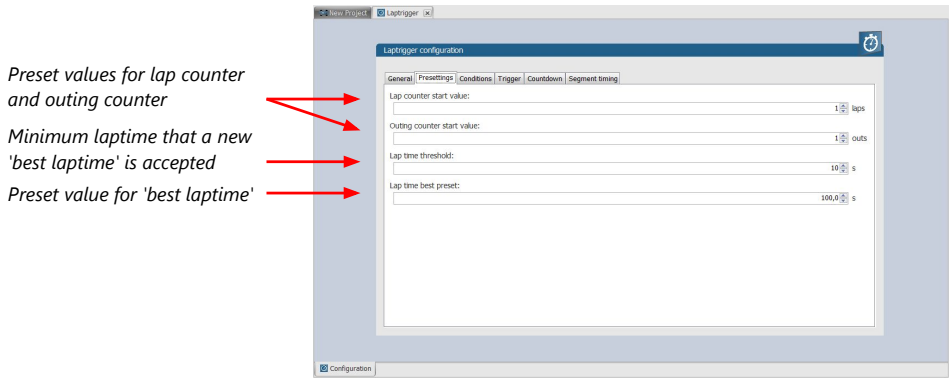


Lap trigger diagnosis scheme

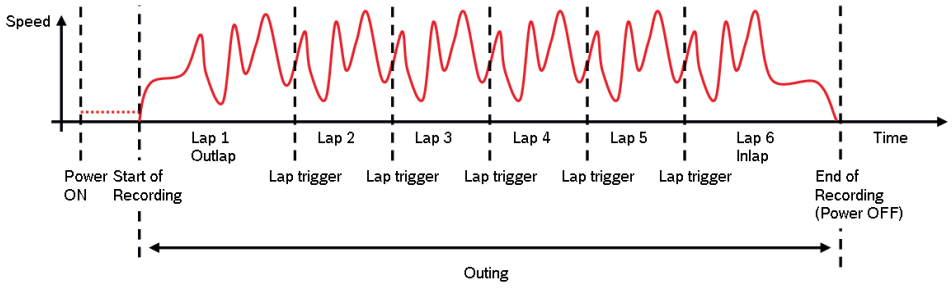


15.1.7 Lap trigger presettings

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



15.2 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 [▶ 132])

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
[lap]	Value of lap counter
[fragment]	Value of fragment counter

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

15.3 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

Channel	Function
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

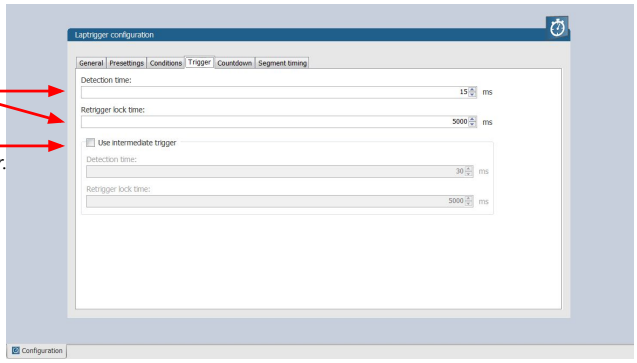
15.3.1 Time based retrigger protection

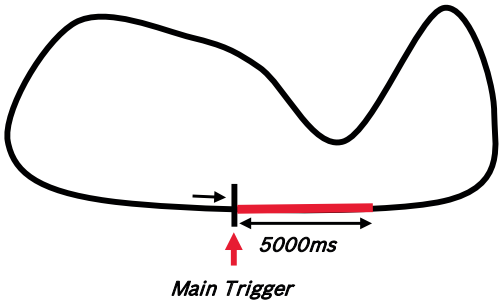
Trigger is locked for 5 s after main trigger was received.

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.





15.3.2 Distance based retrigger protection

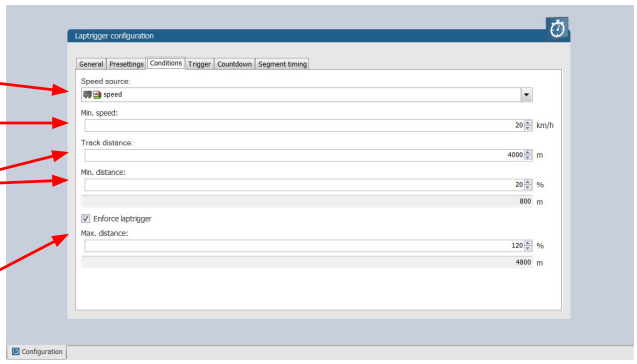
Trigger is locked until configured min distance (i.e. 80 % → 3200 m) of track distance (i.e. 4000 m) has been covered. To deactivate distance based retrigger protection, set min distance to 0 %.

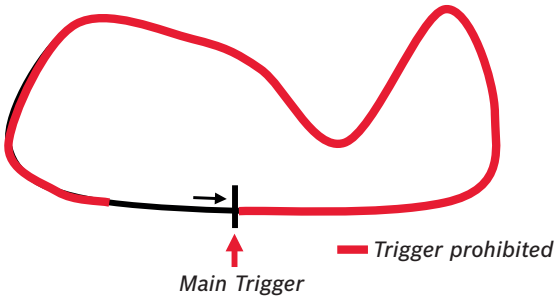
Change signal for vehicle speed, if desired.

Enter minimum speed for trigger release.

Define settings for distance based retrigger protection.

Define settings for distance based forced trigger.

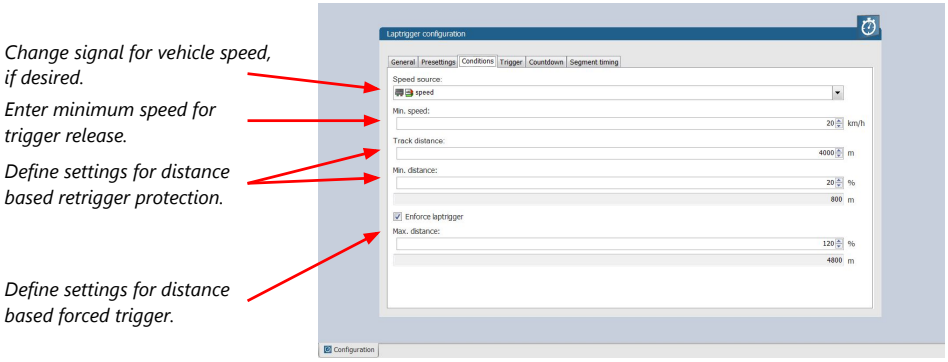




15.3.3 Distance based forced trigger

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.



15.4 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

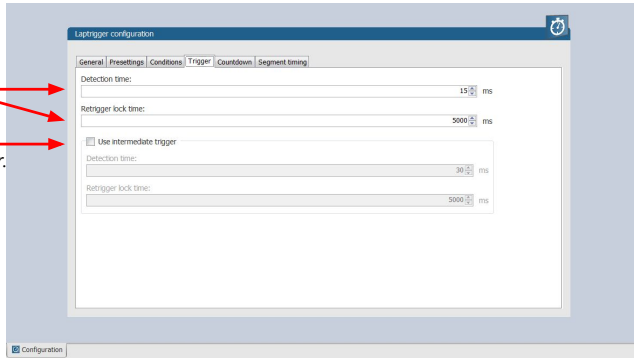
15.4.1 Sub trigger mode

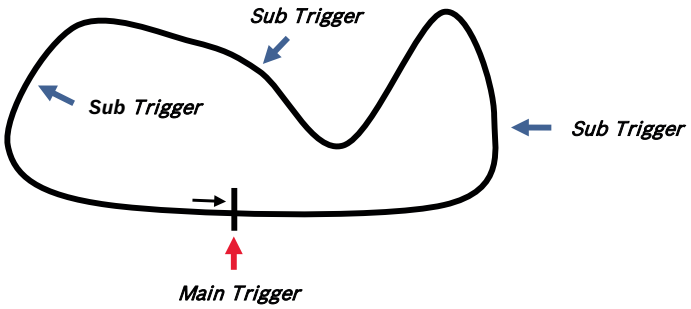
Using main trigger (20 ms pulse) at Start-Finish-Line. 3 sub triggers (40 ms pulse) positioned at 1,000 m, 2,000 m and 3,000 m.

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.

15.4.2 Distance mode

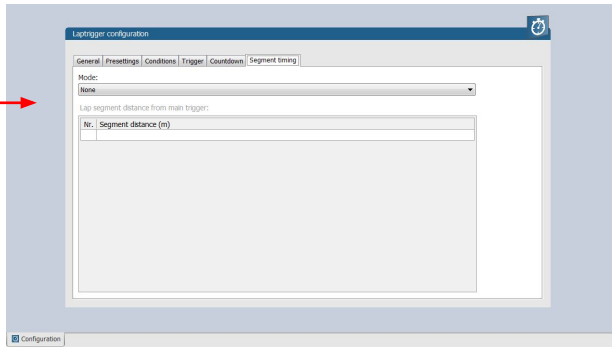
Using main trigger (20 ms pulse) at Start-Finish-Line.

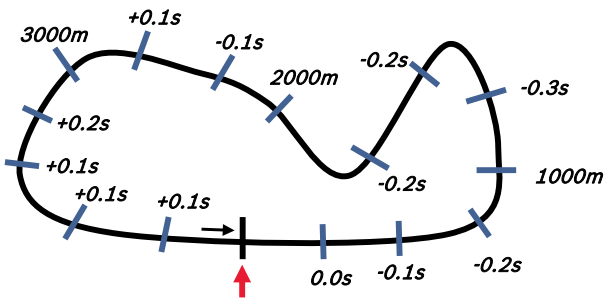
Set ‘Mode’ to ‘Distance’ and enter desired segment distances.

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.



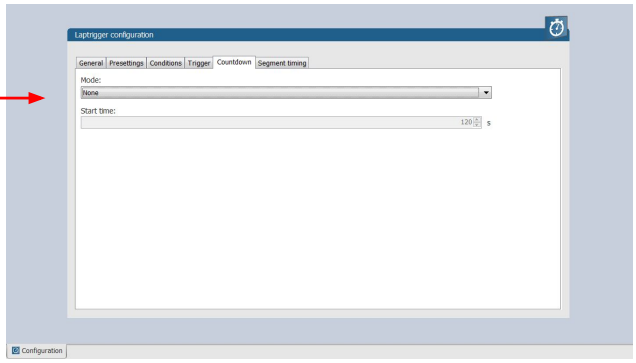


15.5 Countdown timer

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.

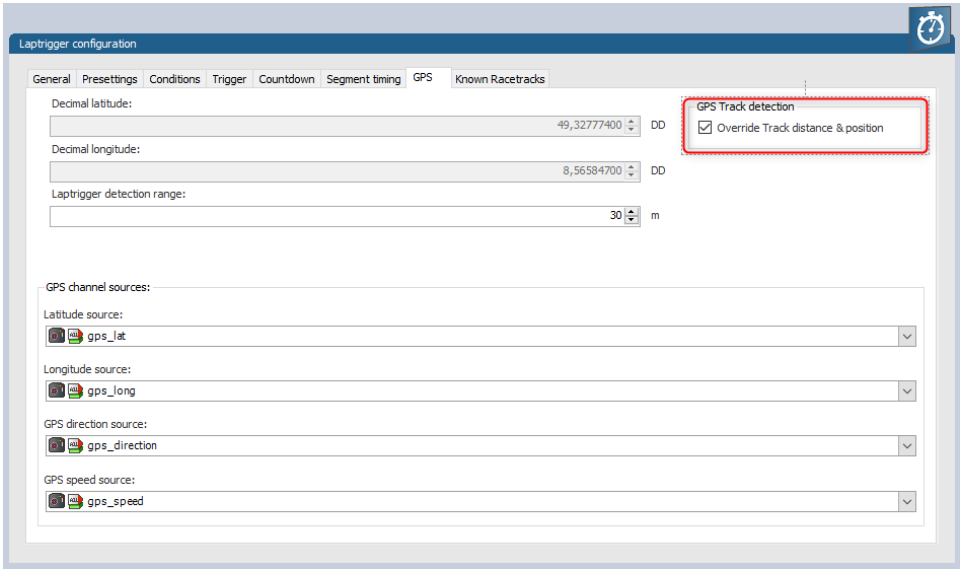


15.6 Automatic GPS Track Detection

With the GPS lap trigger, an automatic track detection can be activated by checking the highlighted box in the lap trigger configuration at the GPS tab.

Activating this functionality will overwrite the GPS trigger point coordinates and the track length with the values of a detected racetrack. The coordinates and the track length will be grayed out in the tool.

The function will compare the current GPS position with the coordinates of the known Racetracks list and use the closest GPS trigger point. If there are track variants with different track length, the system will adapt itself to the correct variant, if it is in the known racetrack list, after ~three detected laps. Please note that the track length needs to be quite accurate, within +/- 100 m, to adapt itself to another variant.

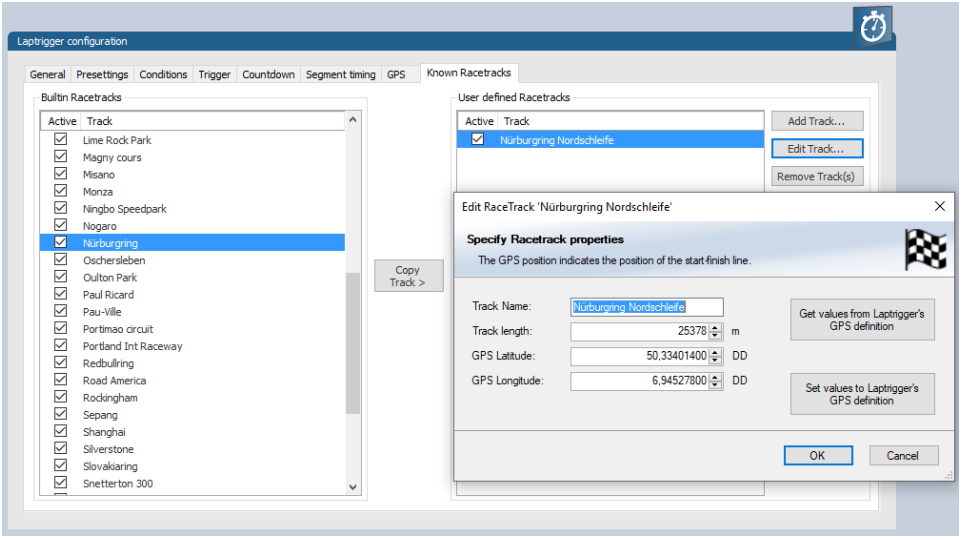


The known Racetrack list can be found in the lap trigger configuration menu within the Known Racetracks tab. It contains a built-in list and a user-defined list. Each track can be activated or deactivated with the checkbox to manually set the variant if needed.

User defined tracks can either be added from scratch with the Add Track button or with the Copy Track button as a modified version of a built in track. Both buttons will open the same Edit Race Track menu.

In the menu a track name, length and the coordinates of the detection point is required. The coordinates can be pulled from the GPS tab with the button “Get values …” or sent to the GPS tab with the button “Set values …”. This allows an easy interaction with the manual GPS lap trigger mode.

The user-defined tracks will be part of the project. If the tracks are required in another project, the lap trigger module can be ex-/imported into another project.



Following signals are assigned to the function:

Laptrigger_trackdet_id	Signal will show the track name from the Racetracks list as an enumeration or can show the ID number as raw value. The enumerated name will also be visible in the logging.
Laptrigger_trackdet_laplen	Track length of the used track variant
Laptrigger_trackdet_lat	Latitude GPS coordinate of the used GPS trigger point
Laptrigger_trackdet_long	Longitude GPS coordinate of the used GPS trigger point

16 Firmware

16.1 Firmware and configuration

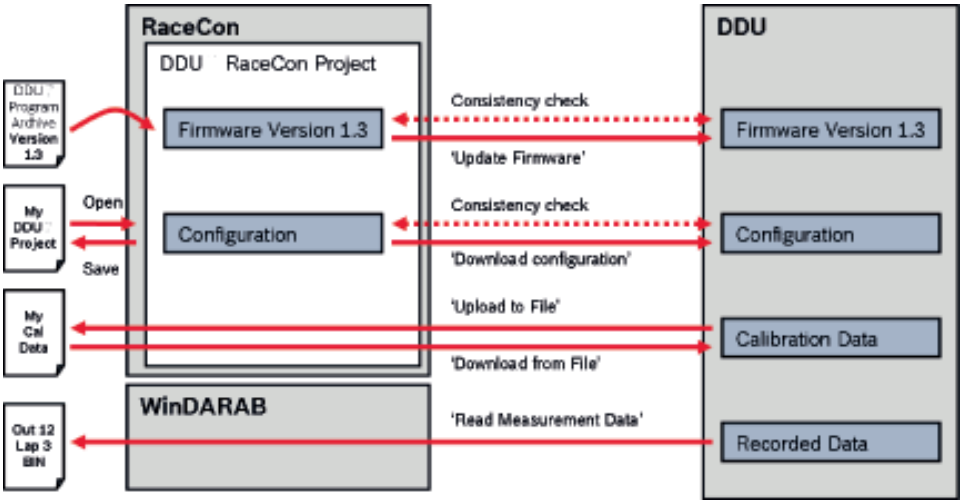
DDU 9 holds 4 types of data:

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.

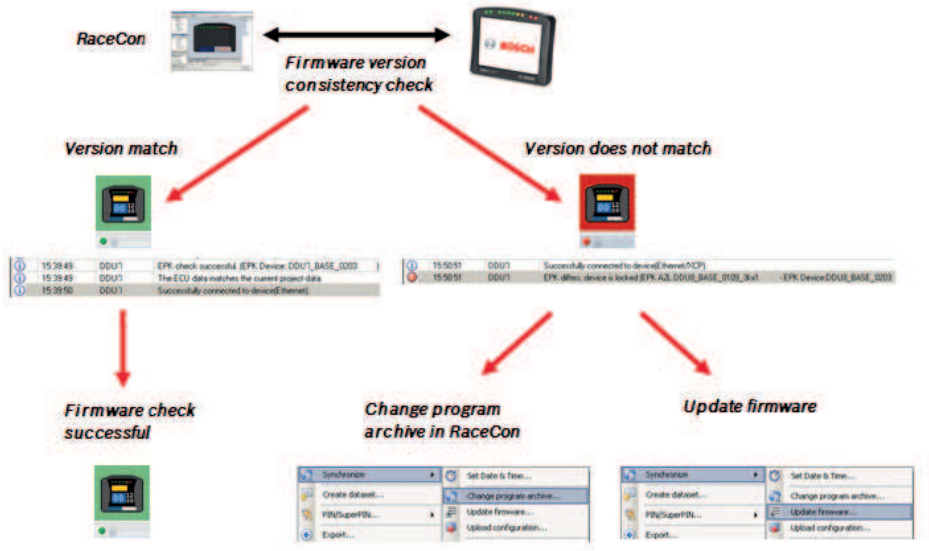
Calibration data: Characteristic curves and offsets created by online calibration at the vehicle.

Recorded data: Measurement data recorded during vehicle operation.



16.2 Firmware update

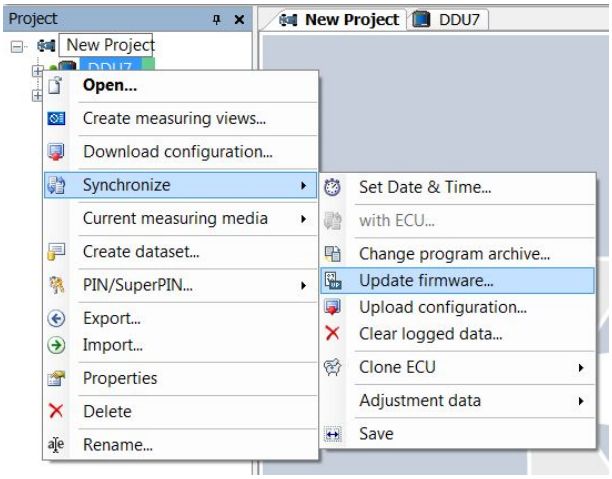
The scheme shows the process during each connection between RaceCon and DDU 9.



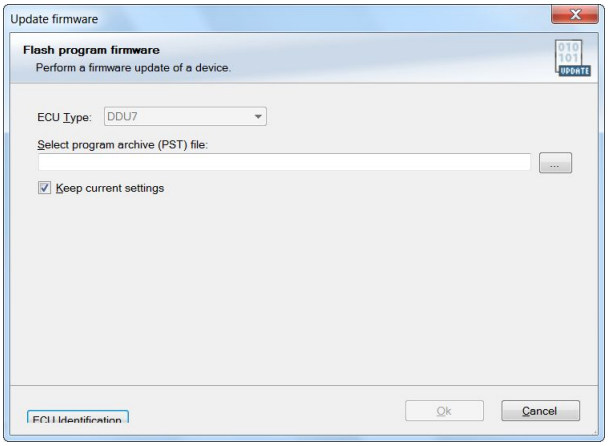
16.2.1 Performing the firmware update

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.

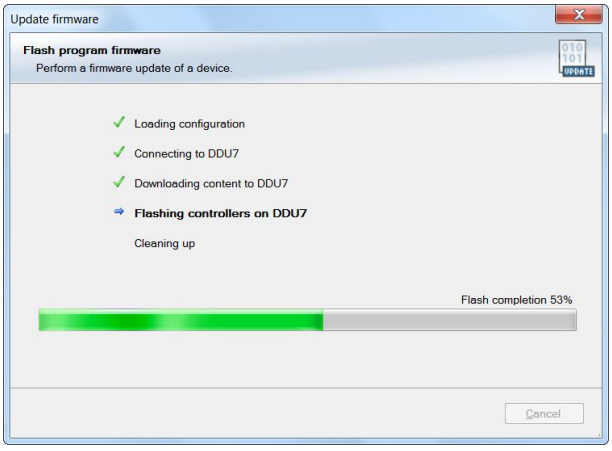
1. In the DDU 9 Project Tree, right-click on 'DDU 9' and choose 'Synchronize' then 'Update firmware'. A pop-up menu opens.



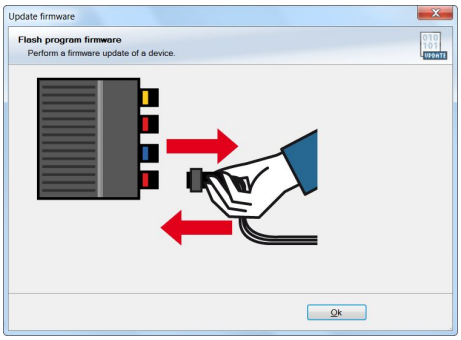
2. Select the destination of the firmware archive (PST). You can find the latest firmware for the device at the Bosch Motorsport homepage.



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.

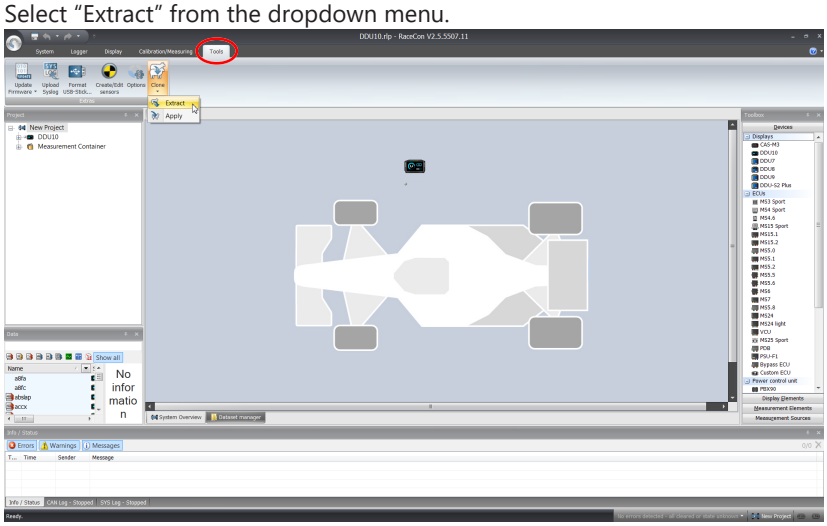


17 Cloning the Unit

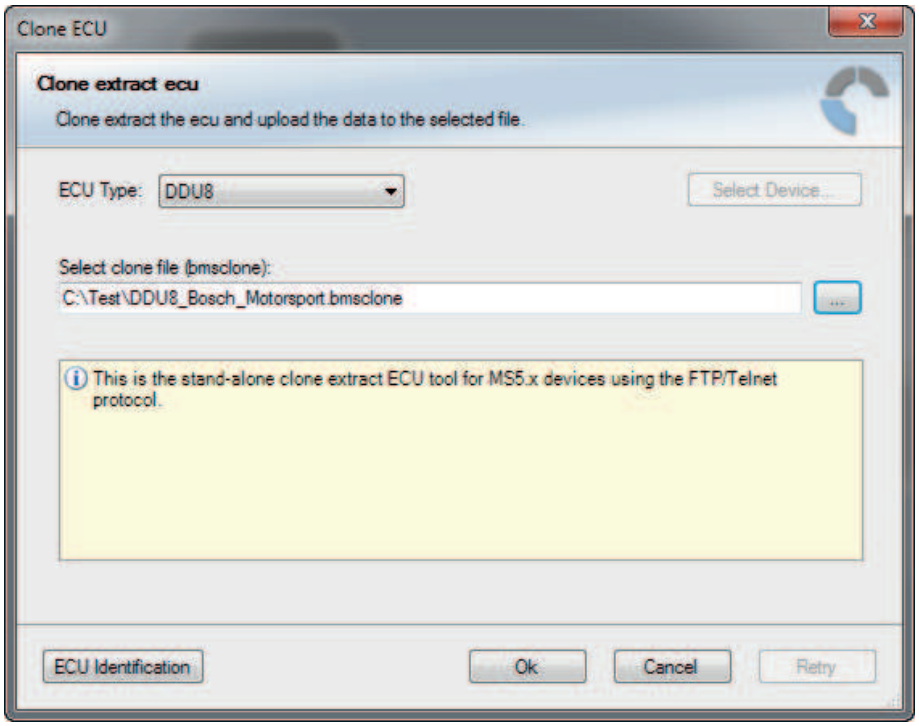
To replace a DDU 9 by another device, it is possible to clone it. A clone is a 1:1 copy of a device. This can be useful for copying specific data, like sensor-offset calibration to a spare unit for a specific car.

Creating a clone file

1. Open the 'Tools' window and click on the 'Clone' button in the 'Extras' menu.
2. Select "Extract" from the dropdown menu.



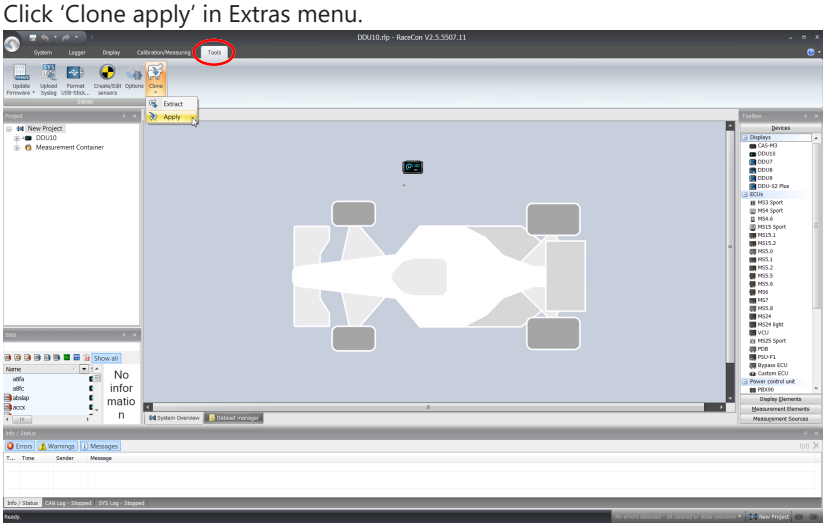
3. Choose the hardware device, which should be cloned.
4. Define destination and filename.



5. Click 'OK' to start procedure.

Applying a clone file to a 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

This function requires the installation of Software Upgrade 2.

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.

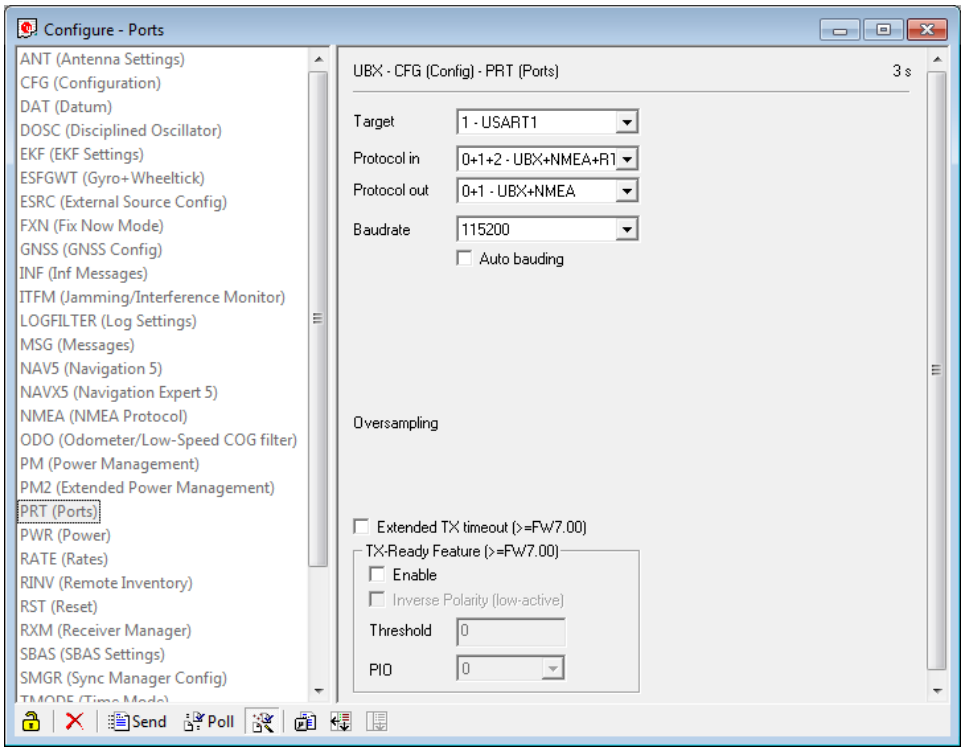
18.3.1 Configuration of the recommended Navilock NL-8004P MD6 Serial PPS Multi GNSS Receiver

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.

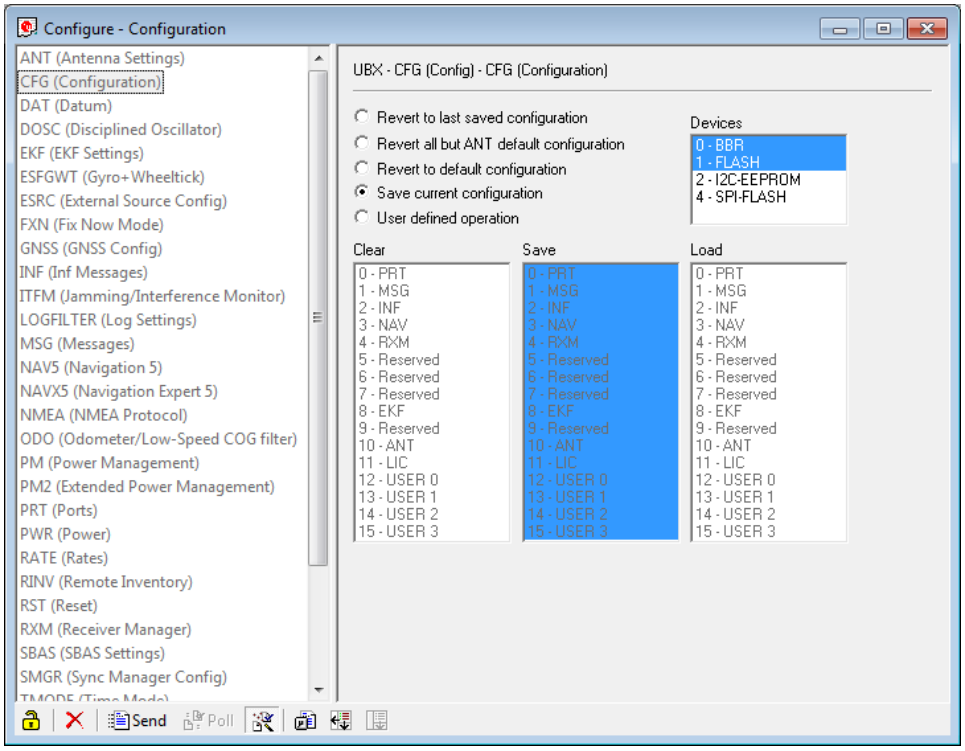
In "U-Center" click **"View"** – **"Configuration View"** to start the configuration. The following 3 points have to be changed:

Transfer Rate

- Click on "**PRT (Ports)".**
- Change the baud rate to a fixed 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".

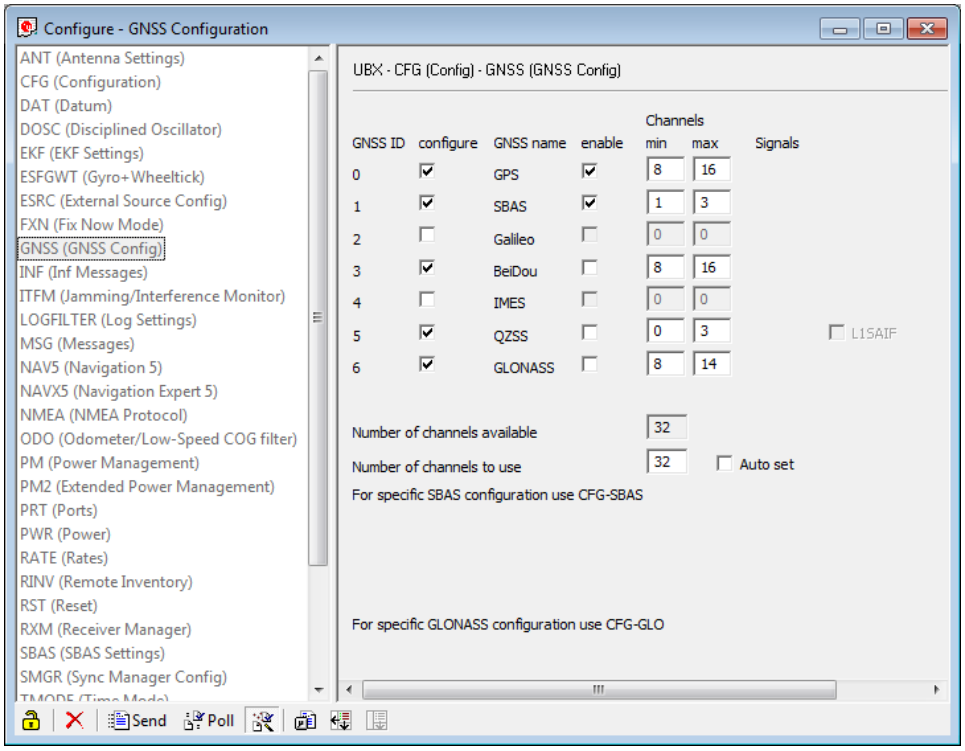


- Click on **"CFG (Configuration)".**
- Click on **"Send"** to save the new setting on the sensor.



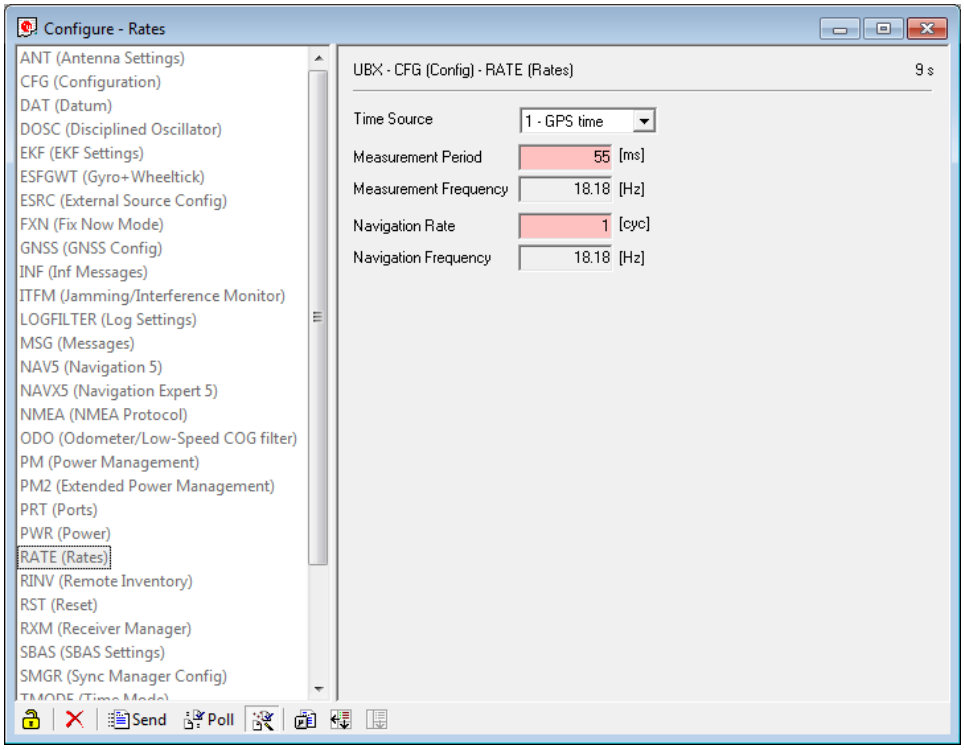
Satellite System

- 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_satsigstrength[ ]	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’.

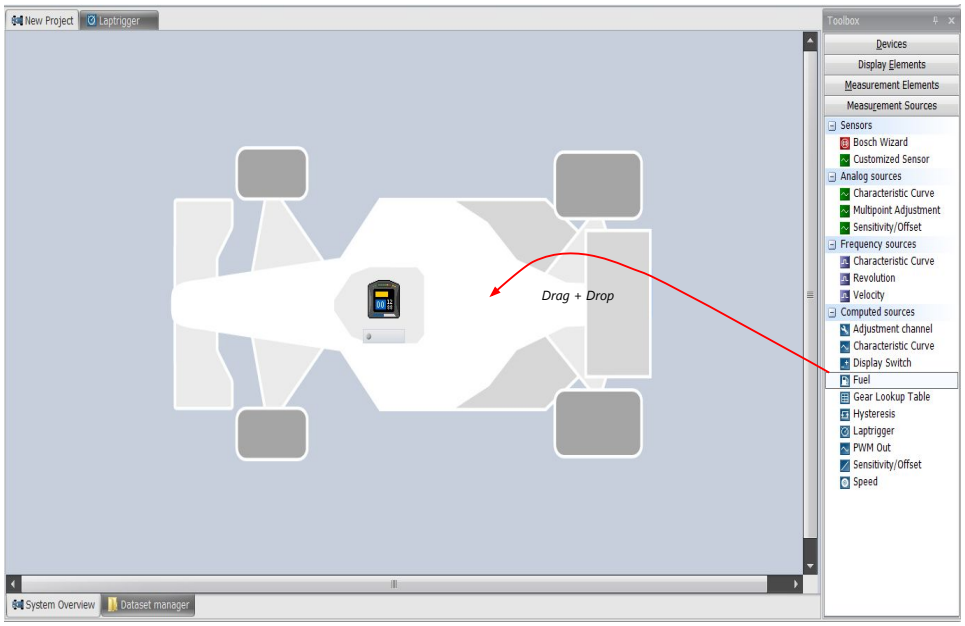
GPS sensor values are frozen

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

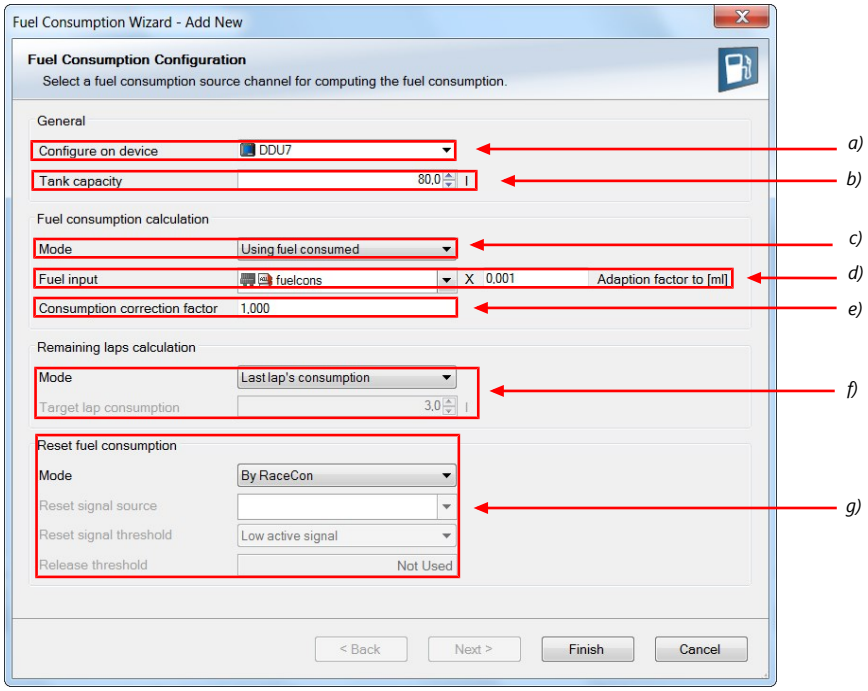
19 Fuel Consumption Calculation

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)

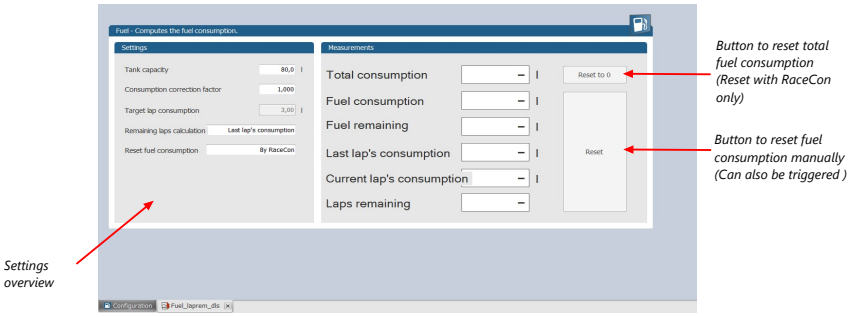
Press 'Finish' when done.

19.2 Fuel consumption diagnosis/counter reset

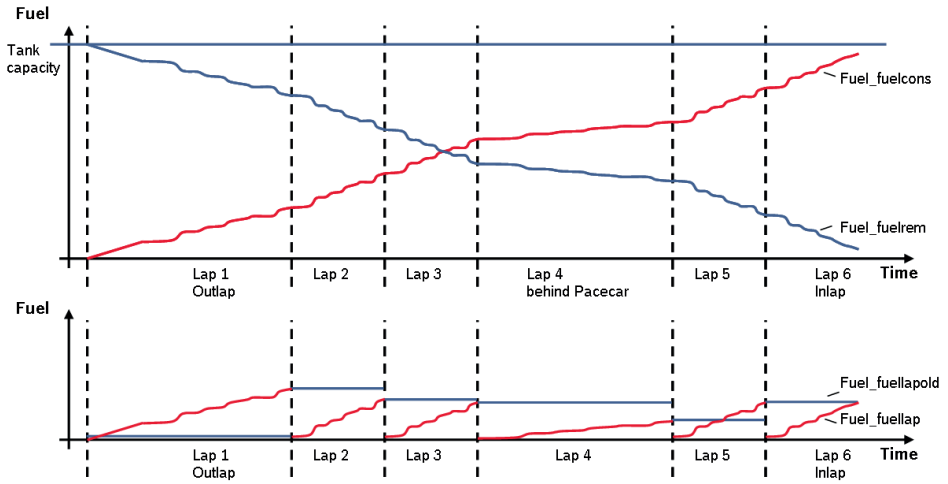
To display a fuel consumption diagnosis and to reset counters, use the diagnosis page in RaceCon.

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

A diagnosis window opens in Main Area.

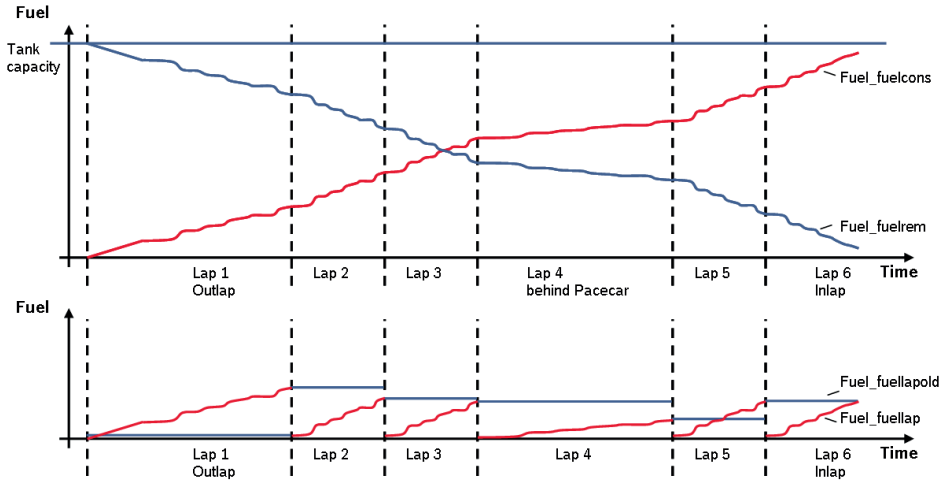


Example



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

19.3 Example



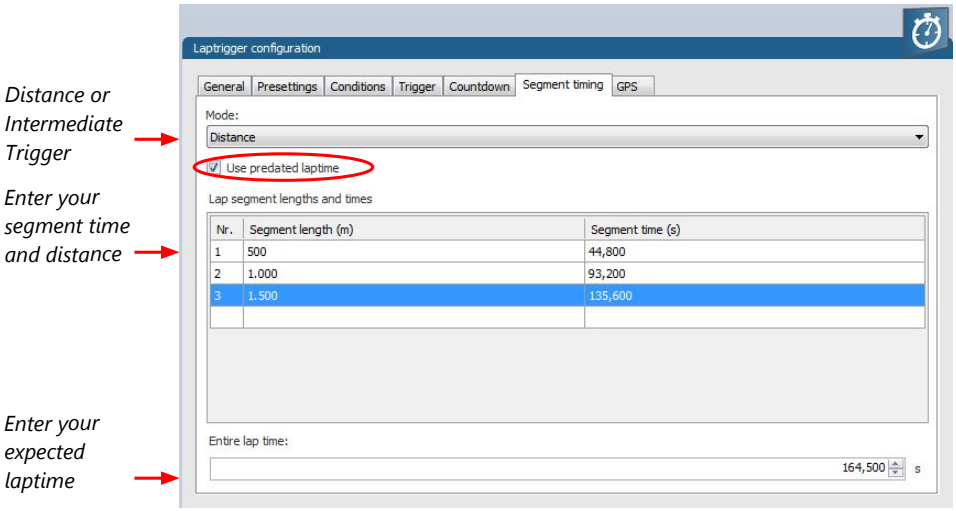
Measurement label	Function
Fuel_fuelcons_dls	Running fuel consumption, starting at '0'
Fuel_fuelrem_dls	Remaining fuel in tank, starting at tank capacity
Fuel_fuellap_dls	Fuel consumption for current lap, starting at '0'
Fuel_fuellapold_dls	Fuel consumption of last lap completed
Fuel_laprem_dls	Remaining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

20 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.

20.1 Setting up the predated laptime

To use the predated laptime function you need to set up a laptrigger as described in the chapter Lap Trigger [▶ 123]. Under the ribbon “Segment timing” you need to choose your segmentation mode which can either be distance or intermediate trigger based.



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 an 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.

20.2 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.

21 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 seleted 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

22 Disposal

Hardware, accessories and packaging should be sorted for recycling in an environment-friendly manner.

Do not dispose of this electronic device in your household waste.

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