Bosch Motorsport

Datalogger C 60

Manual

F 02U 002 642-01

BOSCH
Invented for life

Content

1 Getting started

Important Notes:

Use the C 60 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 C 60 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.

For systems with drive-by-wire additional safety provisions apply. For details please refer to the document „Safety Instructions for Drive-by-Wire Systems in Motorsport Applications“.

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.

Edition: 07 February 2011

Before starting:

Before operating the C 60 for the first time, install the complete software from the installation CD. Bosch Motorsport software is developed for Windows 2000/XP. Connect the Ethernet line to your computer and install the driver. Read the manual carefully and follow the application hints step by step. Don’t hesitate to contact us, contact data can be found on the last page of this document.

2 Power supply

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

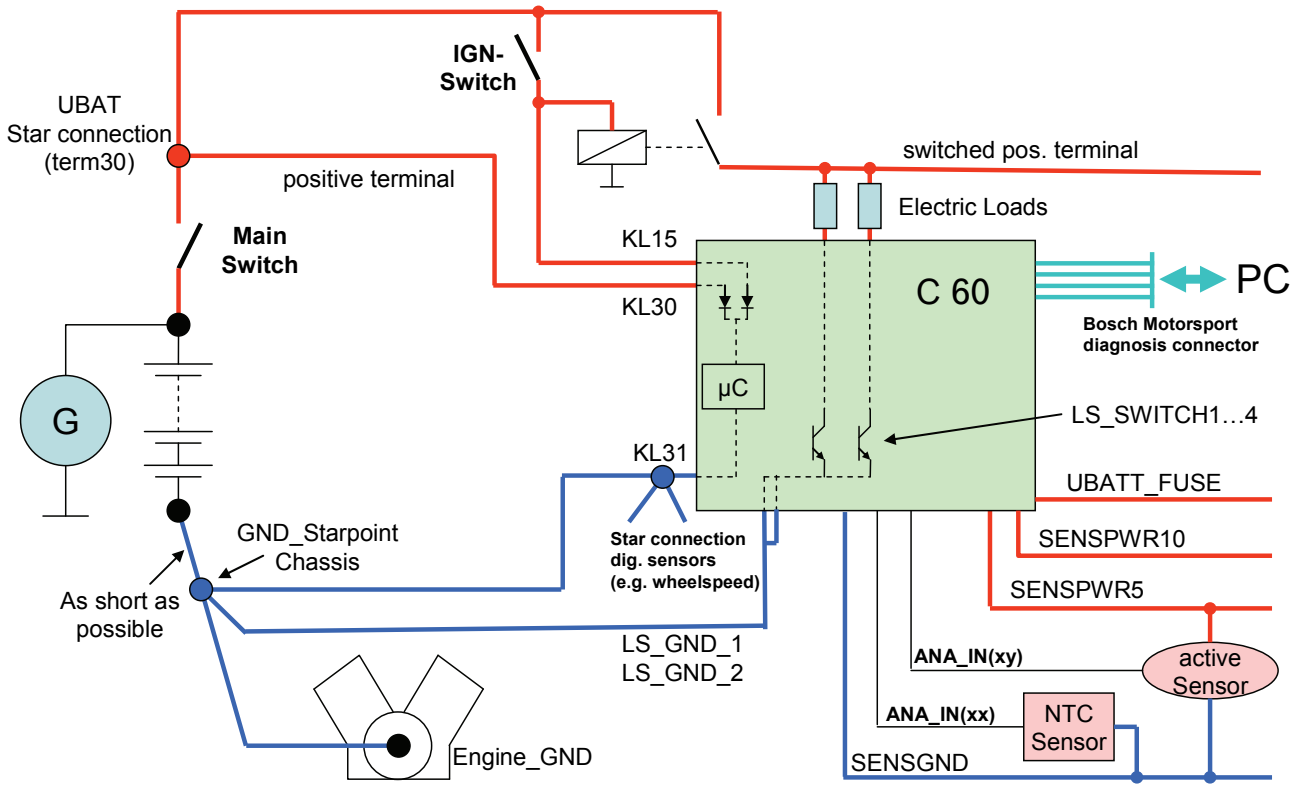
- A ground that has a solid, low resistance connection to the negative battery terminal.
- Connection should be free from dirt, grease, paint, anodizing, etc.
- Use large diameter wire
- More metal-to-metal contact is better!

The following notations for power signals are used:

- term15 is a switched battery rail controlled by the IGN-switch
- term30 is an unswitched battery positive rail (same as battery positive terminal)
- term31 is an unswitched ground rail (same as battery negative terminal)

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

3 Onboard network concept



4 Technical data

The Data Logger C 60 is a compact and light weight data logging system for motorsport applications. This allows for synchronized acquisition of engine data from the ECU, and chassis data from up to 26 analog and 4 digital input channels. Additional input devices can be connected via Ethernet and CAN buses. Recorded data from the internal 2 GB flash memory can be downloaded via high speed Ethernet or via wireless connection with the BT 60 burst telemetry system.

As a base system the C 60 is sold as data logger only. A software upgrade for the C 60 (field upgradable by entering a key) activates additional input channels.

Application
8 kHz AD converters with digital low pass filter
Configurable math channels
User configurable CAN in/out messages
Up to 1,000 Hz acquisition rate for all channels
2 GB storage capacity
Online data compression
Up to 200 KB/s data acquisition rate
Up to 720 recording channels
1,000 KB/s upload rate
3-port network switch
BT 60 WLAN burst telemetry support

Connectors	
Autosport connectors double density	2 x 41 pin
Mating connector I AS DD 6-12-41SN	F 02U 002 216-01
Mating connector II AS DD 6-12-41SA	F 02U 004 180-01

Mechanical Data	
Size	105 x 34.5 x 137.5 (149) mm
Weight	465 g
Dust and splashwater proof aluminium housing	
Operating temperature (internal)	-20 ... +65 °C
Max. vibration (see Appendix or www.bosch-motorsport.com)	Vibration profile 1

Software
Configuration via RaceCon over Ethernet or MSA-Box II

Part Number	
Data Logger C 60	[1] **F 02U V00 553-01**
Software Upgrade 1 additional analog channels and second connector unlocked	[2] **F 02U V00 703-01**

C 60 Feature List		
	C 60 Base Logger	Software Upgrade 1
Application		
Storage capacity	2 GB	2 GB
BT 60 burst telemetry support	•	•
FM 40 long range telemetry support	•	•
GPS input	-	•
Electrical Data		
Supply voltage	8 ... 18 V	8 ... 18 V
Max. power consumption (w/o loads)	10 W at 14 V	10 W at 14 V
Inputs		
Total analog channels	6	26
Input range	0 ... 5 V	0 ... 5 V
Resolution	12 bit	12 bit
Switchable pull up resistor	3 kΩ	3 kΩ
Rotational channels (Input Hall/Inductive)	-	4
Outputs		
PWM outputs (low side switch 2 A each)	4	4
Sensor supply 5 V (350 mA each)	1	4
Sensor supply 10 V (350 mA each)	-	1
Sensor supply 12 V (1 A non regulated)	-	1
Communication interfaces		
CAN interfaces	2	2
Ethernet 100BaseT	3	3
RS232	Telemetry	GPS
Laptrigger input	1	1

5 Inputs and Outputs

5.1 Input Channels

5.1.1 Analog Inputs

The C 60 analog inputs accept an input signal of 0 to 5 V. A 3.01 kOhm pull-up resistor can be activated by software.

5.1.2 Digital Inputs

The digital input of the C 60 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. Support of inductive speed sensors is available as a hardware option. Inductive sensors are connected to the REVn_P and REVn_M pins.

5.2 Output Channels

5.2.1 PWM Output

The C 60 has 4 low side switch outputs controlled by pulse width modulation (PWM). Each switch is rated 2 A max current. Maximum PWM switch frequency is 8 kHz with a 0 % to 100 % duty cycle. Each output is short circuit protected to GND and battery volatage. It is mandatory to connect the LS_PWM pins to vehicle GND as indicated in the circuit diagram when using the PWM outputs.

5.2.2 Sensor power supply

The C 60 has three types of sensor power supply: 12 V unregulated battery voltage, 5 V and 10 V regulated voltage. The 12 V unregulated output is fused and rated 1 A max. The regulated 5 V and 10 V outputs can deliver 350 mA each. They are short circuit protected to battery voltage and GND.

5.3 Communication Channels

5.3.1 CAN Bus

The C 60 has 2 CAN buses configurable as input and output. Different baud rates are selectable. Please note that the C 60 does not contain any CAN termination resistors. Thus the CAN termination restors need to be integrated into the wiring loom.

5.3.2 Ethernet Channels

The C 60 has three 100 MBit full duplex Ethernet communication ports. The ports are internally connected with an Ethernet switch. The ethernet ports have 'cable auto crossover' functionality.

5.3.3 RS232 Ports

The C 60 has two RS232 serial ports. Baudrate 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.

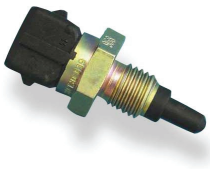
5.3.4 Vehicle Diagnosis Connector

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

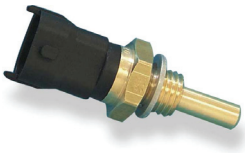
Pin	Name	Description	Used for C 60
Pin 1	Terminal 30	Permanent positive	+
Pin 2	Terminal 15	Switched positive	+
Pin 3	Terminal 31	GND	+
Pin 4	CAN High	Diagnostic CAN bus	
Pin 16	CAN Low	Diagnostic CAN bus	
Pin 10	K-Line	ECU diagnosis	
Pin 8	Ethernet RxD +	Ethernet interface	+
Pin 9	Ethernet RxD -	Ethernet interface	+
Pin 11	Ethernet TxD +	Ethernet interface	+
Pin 12	Ethernet TxD -	Ethernet interface	+
Pin 22	Screen	Cable screen	+

5.4 Sensor recommendation Clubsport

The sensors shown on this page are partly based on production type parts and proved hundreds of times in races all over the world. They offer good value for money.



NTC M12-L



NTC M12-H

TCP-NF

PSA-C

PSS-10

DP-C

PT

Mini-HA-P

RP 86

LP 50

WP 100

RP 308

RHS

AM 600-3

YRS 3

Model	Range of application	Connector Loom	Part No.
NTC_M12-L	Ambient air temperature	D 261 205 288	**0 280 130 039**
NTC-M12-H	Fluid temperature (oil, water, fuel)	D 261 205 337	**0 281 002 170**
TCP-NF	Exhaust gas temperature	D 261 205 357	**B 261 209 825**
PSA-C	Ambient air pressure	D 261 205 289	**0 261 230 037**
PSS-10	Fluid pressure (oil, water, fuel)	1 928 403 968	**B 261 209 341**
DP-C	Air speed	ASL 0-06-05SC-HE	**B 261 209 701**
PT	Pitot static tube		**B 261 209 700**
Mini-HA-P	Wheel speed	D 261 205 335	**F 02U V00 566**
RP 86	Rotary movement	D 261 205 334	**0 280 122 016**
LP 50	Linear movement	KPSE 0E8-33S-DN	**B 261 209 133**
WP 100	Linear movement	ASL 0-06-05SA-HE	**B 261 209 544**
RP 308	Gear detection	ASL 0-06-05SA-HE	**B 261 209 570**
RHS	Vehicle ride height	ASL 0-06-05SD-HE	**B 261 209 674**
AM 600-3	Acceleration	ASL 0-06-05SA-HE	**B 261 209 313**
YRS 3	Yaw rate	F 02U B00 435-01	**0 265 005 838**

5.5 Sensor recommendation Professional

A lot of the sensors shown on this page are developed for high end applications. You can find more motorsports sensors at www.bosch-motorsport.com

NTC M8-HS

TCP-NF

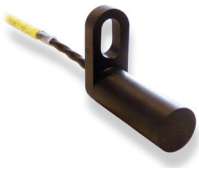
TI-100

PSA-C

PSC-10

PSB-4

Mini-HA-P



HA-M

RP 100

LP 50

DP-C

PT

RHS

AM 600-3

YRS 3

Model	Range of application	Connector Loom	Part No.
NTC M8-HS	Fluid temperature (oil, water, fuel)	ASL 0-06-05SN-HE	**F 02U V00 509**
TCP-NF	Exhaust gas temperature	D261 205 357	**B 261 209 825**
T-100	Brake disk and tire temperature	ASL 0-06-05SD-HE	**F 01T A21 210**
PSA-C	Ambient air pressure	D 261 205 289	**0 261 230 037**
PSC-10	Fluid pressure (oil, water, fuel)	ASL 0-06-05SC-HE	**F 01T A21 304**
PSB-4	Air pressure (manifold, boost)	ASL-0-06-05SC-HE	**B 261 209 348**
Mini-HA-P	Wheel speed	D 261 205 335	**F 02U V00 566**
HA-M	Wheel speed	ASL 0-06-05SN-HE	**F 02U V00 227_01**
RP 100	Rotary movement	ASL 0-06-05SA-HE	**B 261 209 127**
LP 50	Linear movement	KPSE 0E8-33S-DN	**B 261 209 133**
DP-C	Air speed	ASL 0-06-05SC-HE	**B 261 209 701**
PT	Pitot static tube		**B 261 209 700**
RHS	Vehicle ride height	ASL 0-06-05SD-HE	**B 261 209 674**
AM 600-3	Acceleration	ASL 0-06-05SA-HE	**B 261 209 313-01**
YRS 3	Yaw rate	F 02U B00 435-01	**0 265 005 838**

5.6 Pin Layout Life Connector

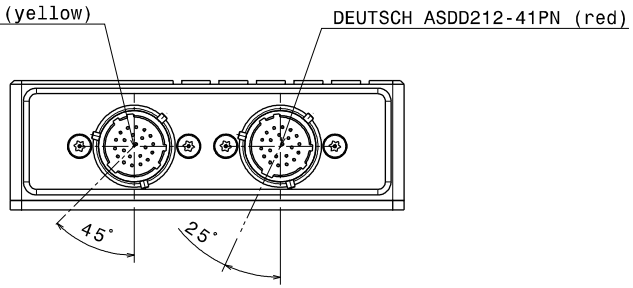
Life Connector ASDD-2-12-41PN (Red)

Pin	Name	Description	Direction	Remark
1	UBATT	power supply Ubat	input	
2	switched positive Kl.15	switched power supply Ubat	input	
3	switched positive Kl.15	switched power supply Ubat	input	
4	unit ground	ground power supply	input	
5	unit ground	ground power supply	input	
6 7 8 9	ETH1_TX+ ETH1_TX- ETH1_RX+ ETH1_RX-	Ethernet interface 1 (10/100BaseT)	bidirectional dataline	
10	ETH_SCR	screen for Ethernet	screen	
11 12 13 14	ETH2_TX+ ETH2_TX- ETH2_RX+ ETH2_RX-	Ethernet interface 2 (10/100BaseT)	bidirectional dataline	
15 16 17 18	ETH3_TX+ ETH3_TX- ETH3_RX+ ETH3_RX-	Ethernet interface 3 (10/100BaseT)	bidirectional dataline	
19 20	CAN1_H CAN1_L	CAN interface 1 (upto 1 MBit/s)	bidirectional dataline	MS 3/MS 4 CardMemory
21 22	CAN2_H CAN2_L	CAN interface 2 (upto 1 MBit/s)	bidirectional dataline	
23	not connected	unused	spare	do not connect
24	not connected	unused	spare	do not connect
25	not connected	unused	spare	do not connect
26	not connected	unused	spare	do not connect
27	SENSPWR5_1	5 V power supply for analog sensors	output	
28	SENSGND_1	sensor ground 1	output	
29	TimeSync	signal of synchronisation	inout	used for timing of system components
30	LS_GND_1	PWM ground	output	
31	LS_SWITCH_1	PWM lowside switch 1	input	
32	LS_SWITCH_2	PWM lowside switch 2	input	
33	LS_SWITCH_3	PWM lowside switch 3	input	
34	LS_SWITCH_4	PWM lowside switch 4	input	
35	LS_GND_2	PWM ground	output	
36	ANA01	analog signal 1	input	
37	ANA02	analog signal 2	input	
38	ANA03	analog signal 3	input	
39	ANA04	analog signal 4	input	
40	ANA05	analog signal 5	input	
41	ANA06	analog signal 6	input	

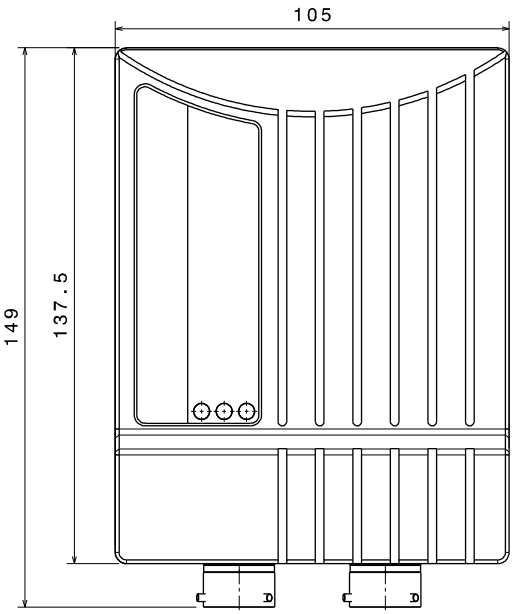
5.7 Pin Layout Sensor Connector

Sensor Connector ASDD-2-12-41PA (Yellow)

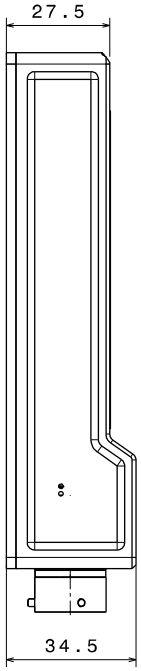
Pin	Name	Description	Direction	Remark
1	UBATT_FUSE1	battery voltage supply	output	
2	SENSPWR10_1	10 V power supply for analog sensors	output	
3	SENSPWR5_2	5 V power supply for analog sensors	output	
4	SENSPWR5_3	5 V power supply for analog sensors	output	
5	SENSPWR5_4	5 V power supply for analog sensors	output	
6	SENSGND_2	sensor ground 2	output	
7	SENSGND_3	sensor ground 3	output	
8 9	RS232_1_TX RS232_1_RX	RS232_1 transmit data RS232_1 receive data	bidirectional dataline	used for telemetry link
10 11	RS232_2_TX RS232_2_RX	RS232_2 transmit data RS232_2 receive data	bidirectional dataline	used for GPS-sensor
12	RS232_GND	RS232 ground		
13 14	REV1_P REV1_M	speed signal 1 positive (ind. and hall) speed signal 1 negative (ind.)	input	
15 16	REV2_P REV2_M	speed signal 2 positive (ind. and hall) speed signal 2 negative (ind.)	input	
17 18	REV3_P REV3_M	speed signal 3 positive (ind. and hall) speed signal 3 negative (ind.)	input	
19 20	REV4_P REV4_M	speed signal 4 positive (ind. and hall) speed signal 4 negative (ind.)	input	
21	ANA07	analog signal 7	input	
22	ANA08	analog signal 8	input	
23	ANA09	analog signal 9	input	
24	ANA10	analog signal 10	input	
25	ANA11	analog signal 11	input	
26	ANA12	analog signal 12	input	
27	ANA13	analog signal 13	input	
28	ANA14	analog signal 14	input	
29	ANA15	analog signal 15	input	
30	ANA16	analog signal 16	input	
31	ANA17	analog signal 17	input	
32	ANA18	analog signal 18	input	
33	ANA19	analog signal 19	input	
34	ANA20	analog signal 20	input	
35	ANA21	analog signal 21	input	
36	ANA22	analog signal 22	input	
37	ANA23	analog signal 23	input	
38	ANA24	analog signal 24	input	
39	ANA25	analog signal 25	input	
40	ANA26	analog signal 26	input	
41	LAP_TRIG	laptrigger input	input	



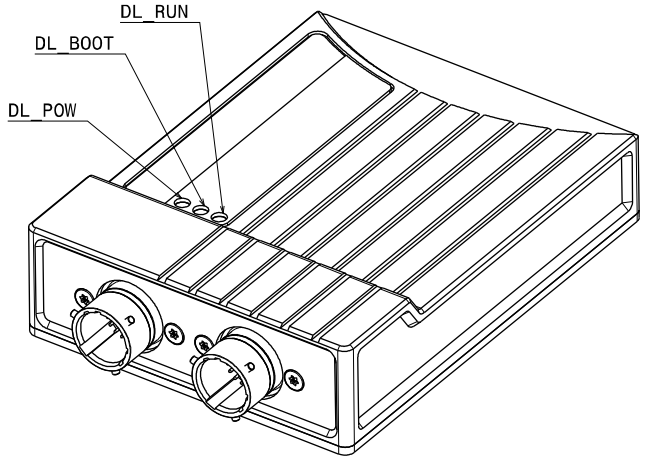
Bottom view
Scale: 1:1



Front view
Scale: 1:1



Left view
Scale: 1:1



Isometric view
Scale: 1:1

Connector Overview	
ECU	Harness
ASDD212-41PA	ASDD212-41SA
ASDD212-41PN	ASDD212-41SN

ISO sys. of limits a. fits/ISO-Sys. Grenzm. u. Pass.
ISO 286-2:1988-06

Size/Mass over/ueber	to/bis	Tol. class T.-kl.	Limit dev./Grenzabm. lower/unter.	upper/oberes
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.

General tolerances for/Allgemeintoleranzen fuer

lin. dim./L.masse	radii/Radien	angles/Winkel
.	.	.

Ind.	Change/Aenderung	YYYYMMDD	Drawn/Gez.	Checked/Gepr.	Releas./Freig.	Resp. dept./Verantw.Abt.	Add. info./Zus. info.
-	First Edit	20090922	HrS			TOGE BEG/EMS2	

Lang./Spr.	Syst.	Wght./Gew.	Sheet/Bl.
en/de	CAT	465g	1/1
A		Scale/M.stab 1:1	

BOSCH

DATA LOGGER C60

OFFER DRAWING
ANGEBOTSZEICHN.

Doc.type AGZ | F02U V00 553 01 | DP/TD . | Ind. . | Format A2

MNR .

Repl. for . Repl. by .

Starting up the C 60:

Start-Up

Feature activation

First recording

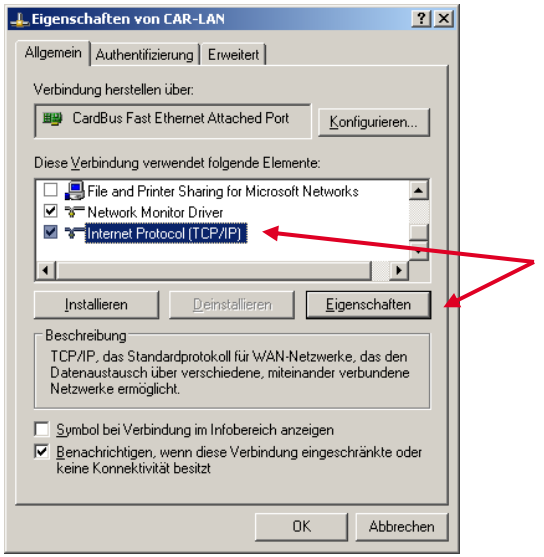
C 60 Start-Up

- Install the software required for C 60 operation
  - RaceCon – C 60 setup, configuration and calibration
  - WinDARAB – Measurement data analysis

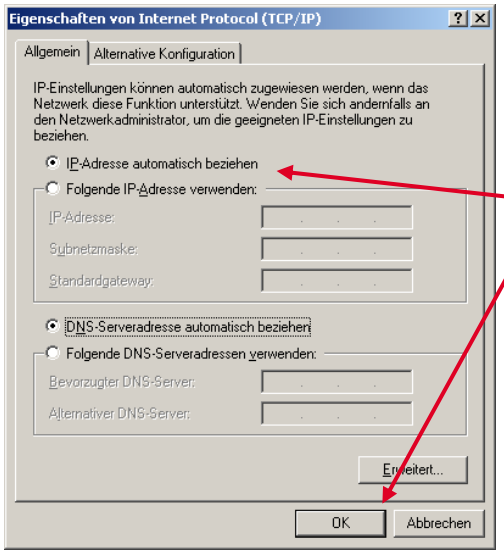
- Set up the online connection to the C 60
  - 100MBit Ethernet connection to the C 60
    - All three Ethernet ports of C 60 internally connected by a network switch
    - All Ethernet ports have ‘cable auto crossover’ functionality
    - Minimum wiring loom:
      - Life connector (red)
        - Pin 1+2+3 12V supply voltage
        - Pin 4+5 GND supply voltage
        - Pin 6 Ethernet Tx+
        - Pin 7 Ethernet Tx-
        - Pin 8 Ethernet Rx+
        - Pin 9 Ethernet Rx-
        - Pin 10 Ethernet Screen

C 60 Startup

- Network interface setup
  - The C 60 contains a DHCP server, network addresses can assigned automatically to the configuration PC
  - The C 60's IP address is 10.10.0.205
  - Switch off the PC's firewall
  - Set up the PC's network interface



Select TCP/IP and click 'Properties'

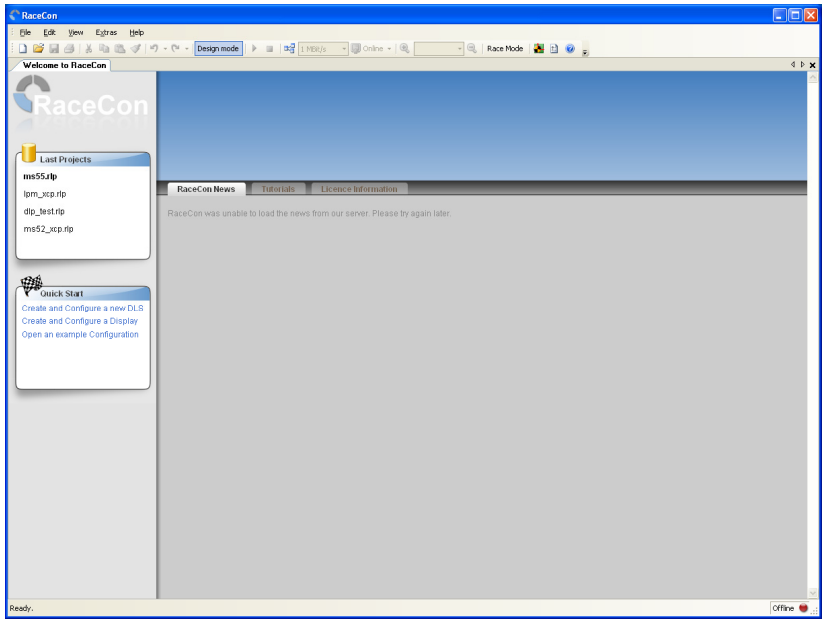


Select 'Acquire automatically' Click 'OK' when done

C 60 Startup

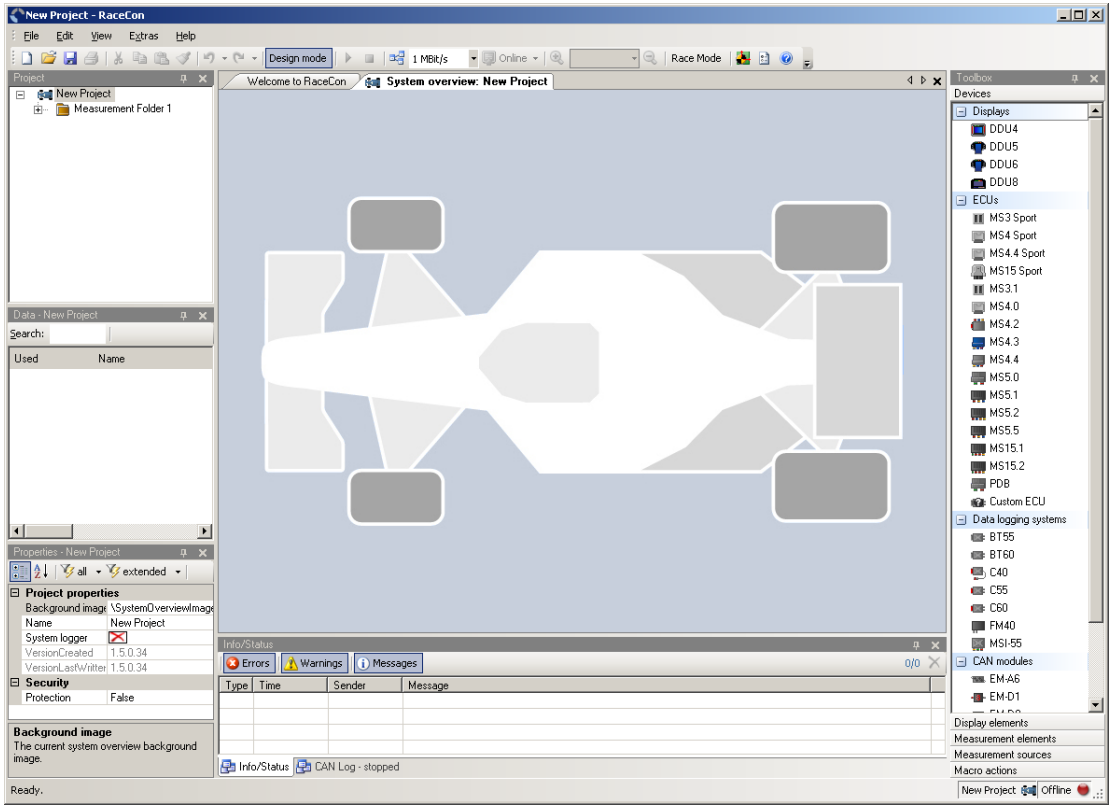
- Power up the C 60
- The C 60 LEDs will illuminate
- The ‘Link LED’ at the PC’s network adapter will illuminate
  - If the LED is off, check the wiring harness

- Start the RaceCon Software



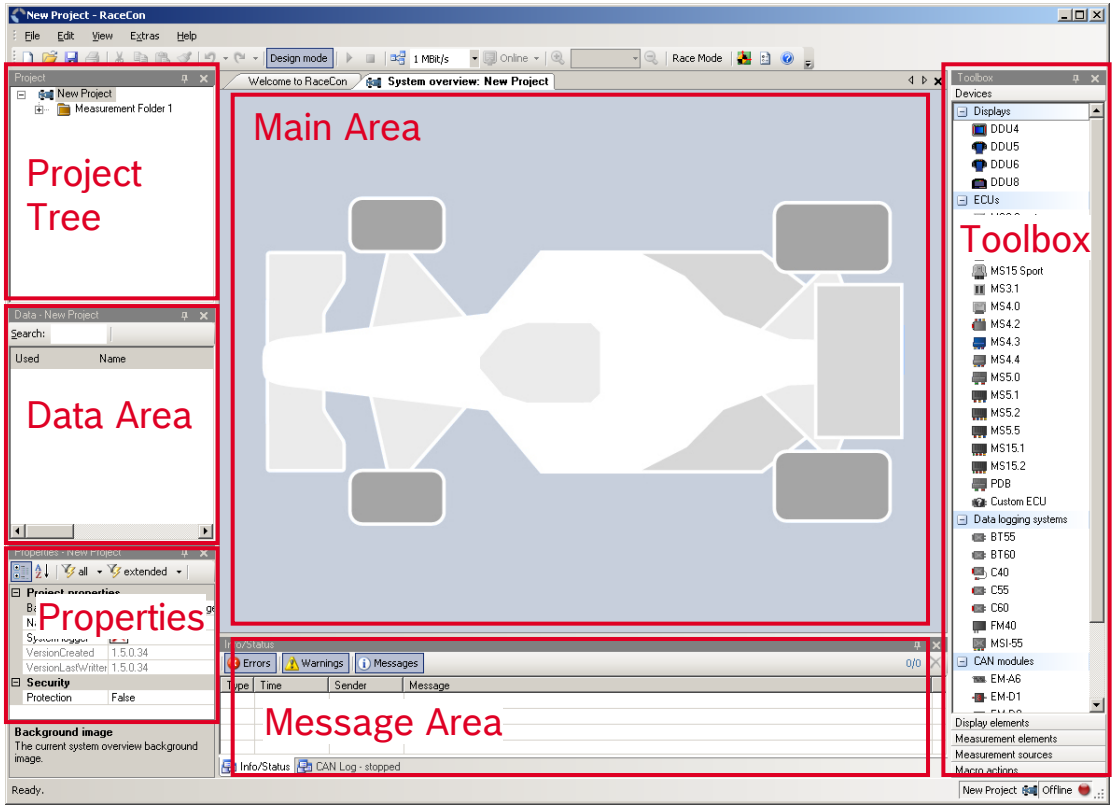
C 60 Startup

- In the ‘File’ menu select ‘New’ to create a new project



C 60 Startup

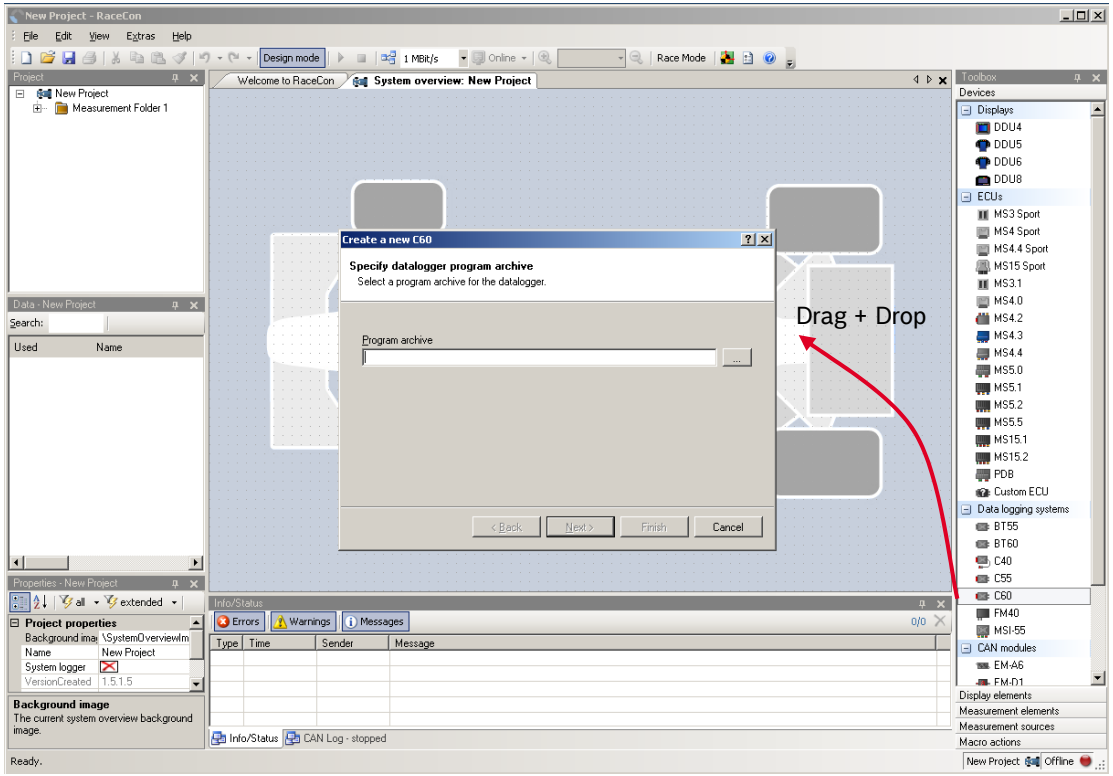
- RaceCon Main Screen Overview



All (sub-) windows are resizable and dockable

C 60 Startup

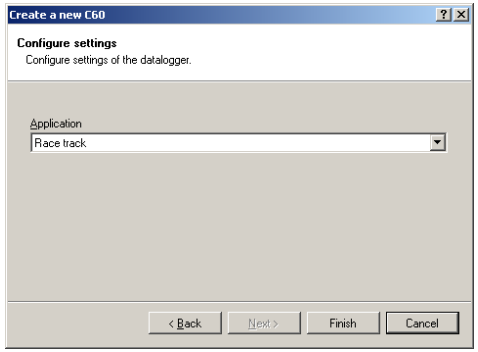
- In the Toolbox select the C 60 and drag into the main area



- A pop up window to specify the C 60 program archive appears

C 60 Startup

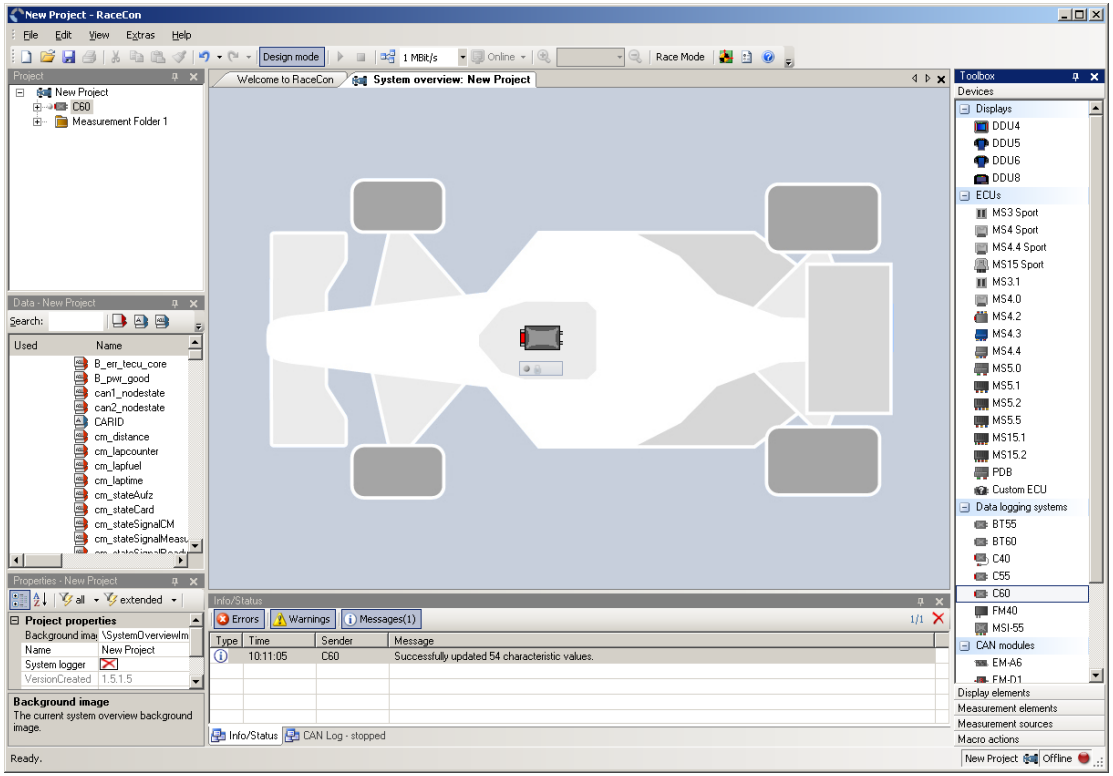
- Select the program archive delivered with the C 60 (.PST file)
- Click ‘Next’



- Select ‘Racetrack and click ‘Finish’

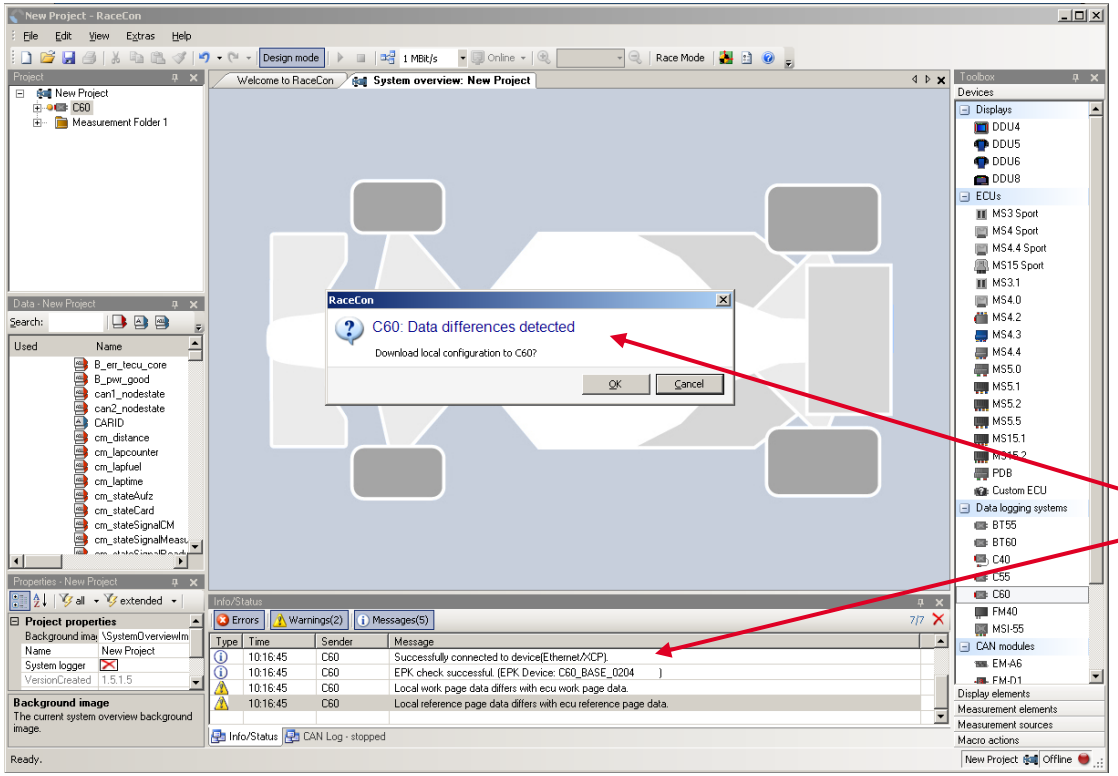
C 60 Startup

- The C 60 is inserted into the project and RaceCon tries to connect to the device



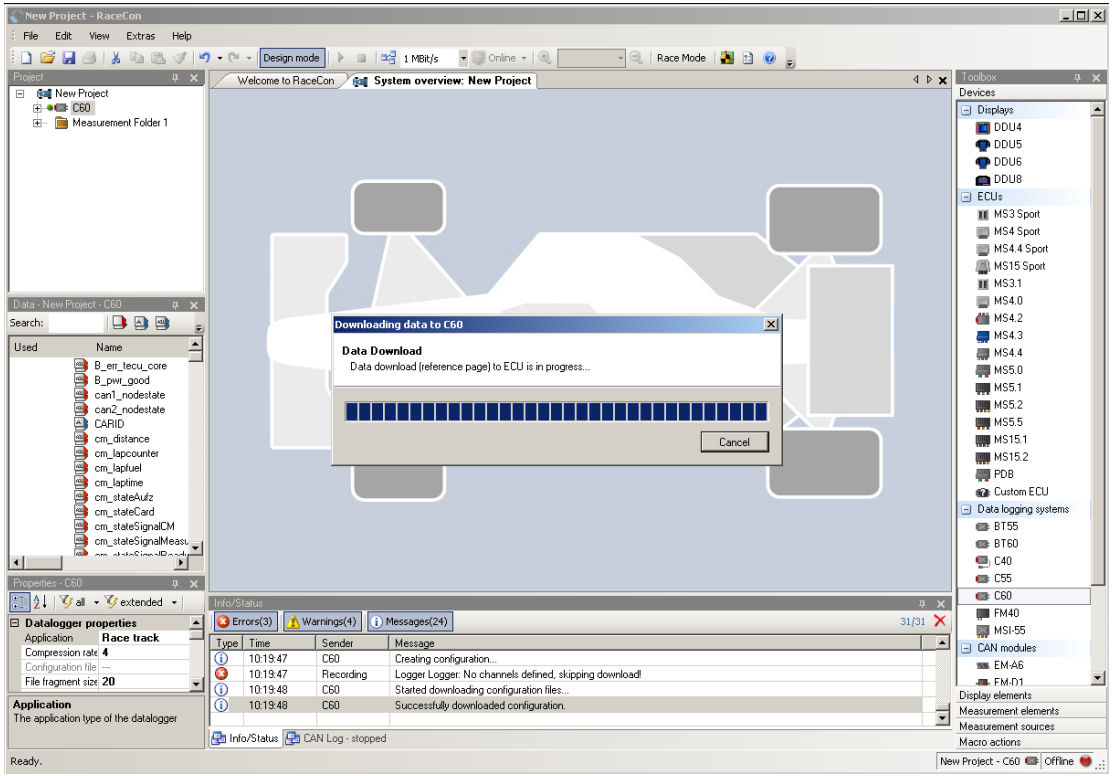
C 60 Startup

- RaceCon detects configuration differences between the C 60 and the RaceCon project and asks for permission for data download. Click ‘OK’ to proceed.



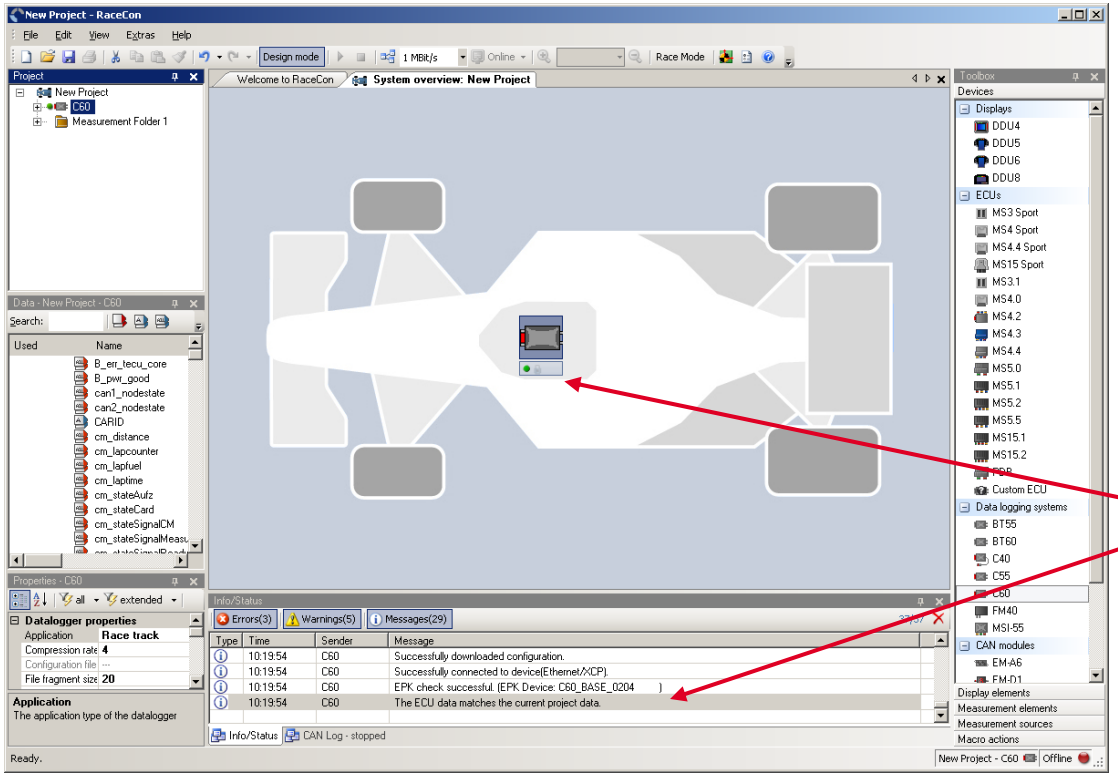
C 60 Startup

- The download starts and the C 60 carries out a reset.



C 60 Startup

- After the reset, RaceCon reconnects to the C 60. Local configuration on both the PC and C 60 match. (Indicated by a green dot)



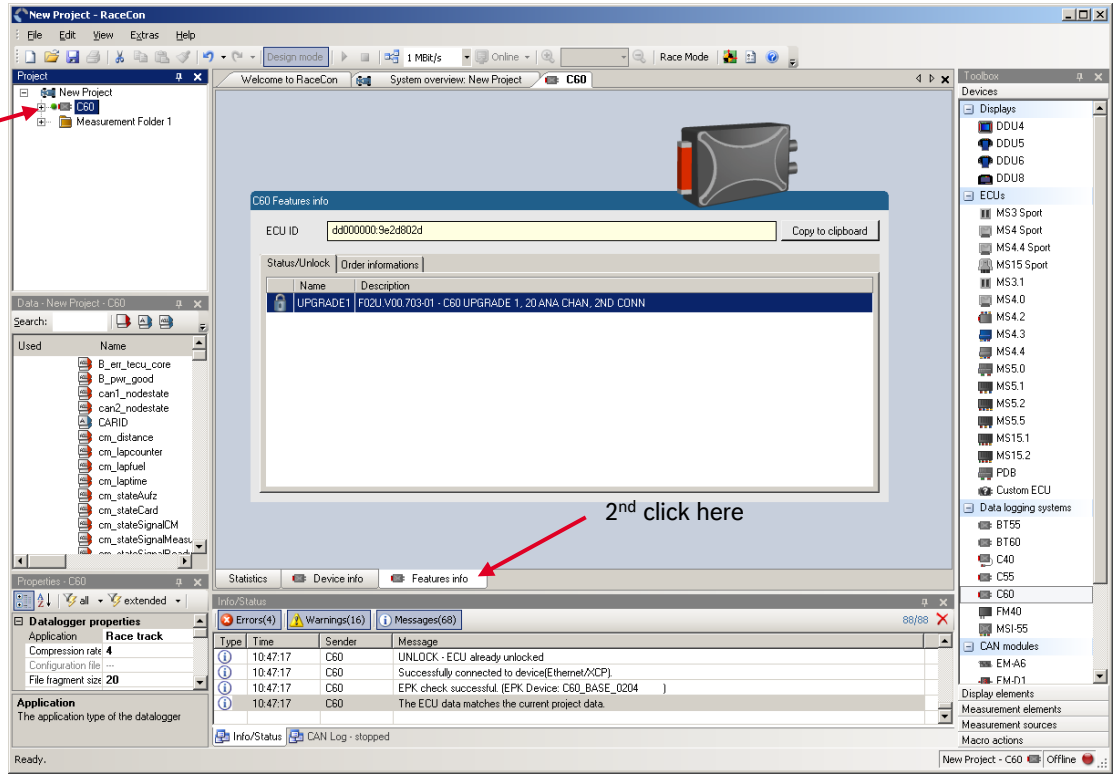
C 60 Feature Activation

- Optional software feature packages are available for the C 60.
- 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 C 60 does not work on any other C 60
- If you have not purchased an option package, the next steps can be skipped.

C 60 Feature Activation

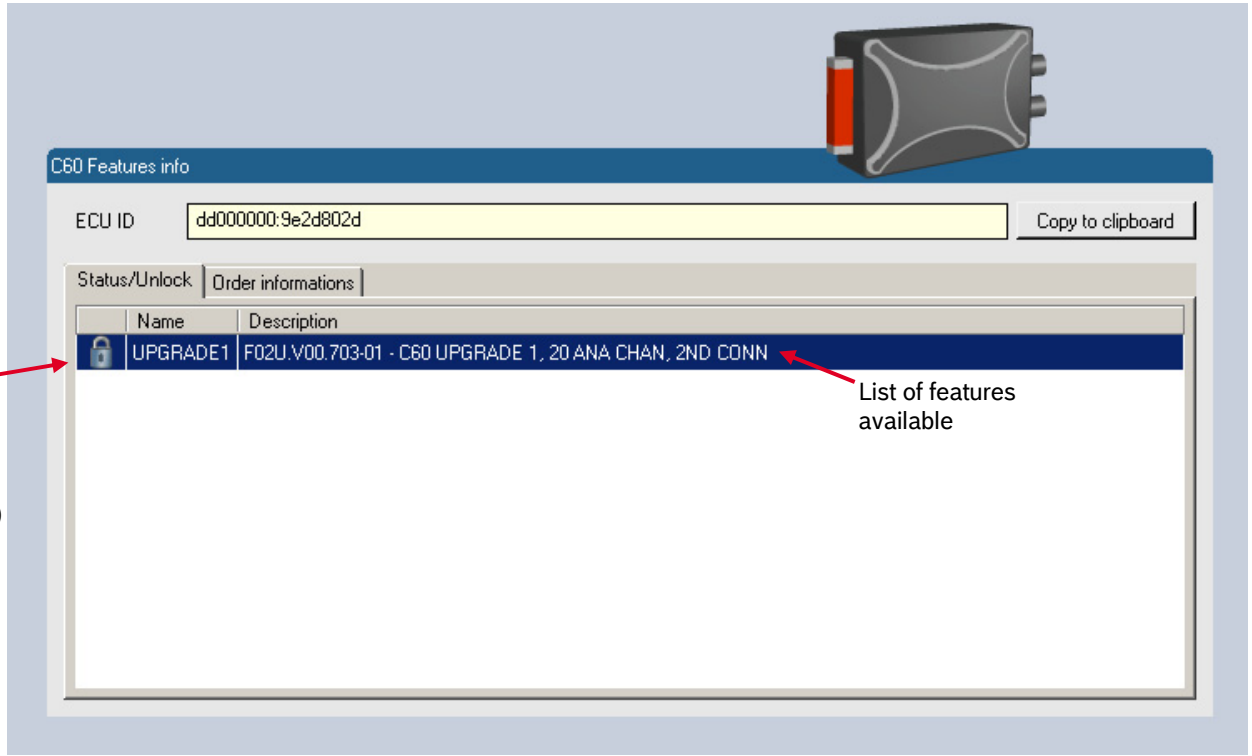
- To activate a feature, double click on ‘C 60’ in the project tree and click on the ‘Features Info’ tab in the main area

1st double click here



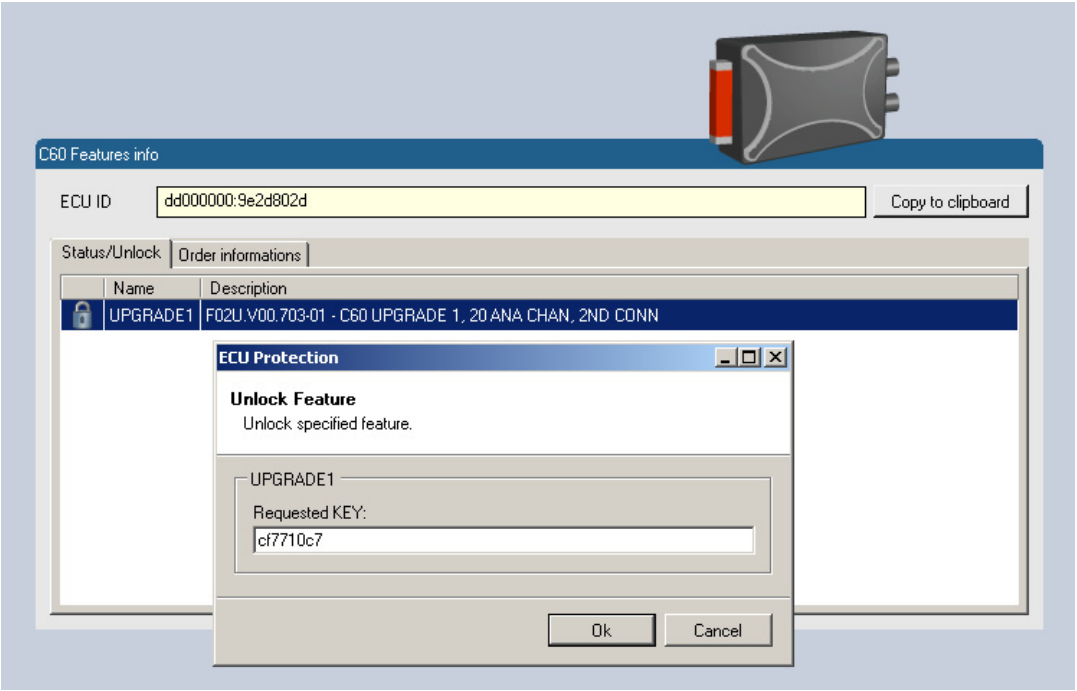
C 60 Feature Activation

- In the main area, the available features and their status are listed



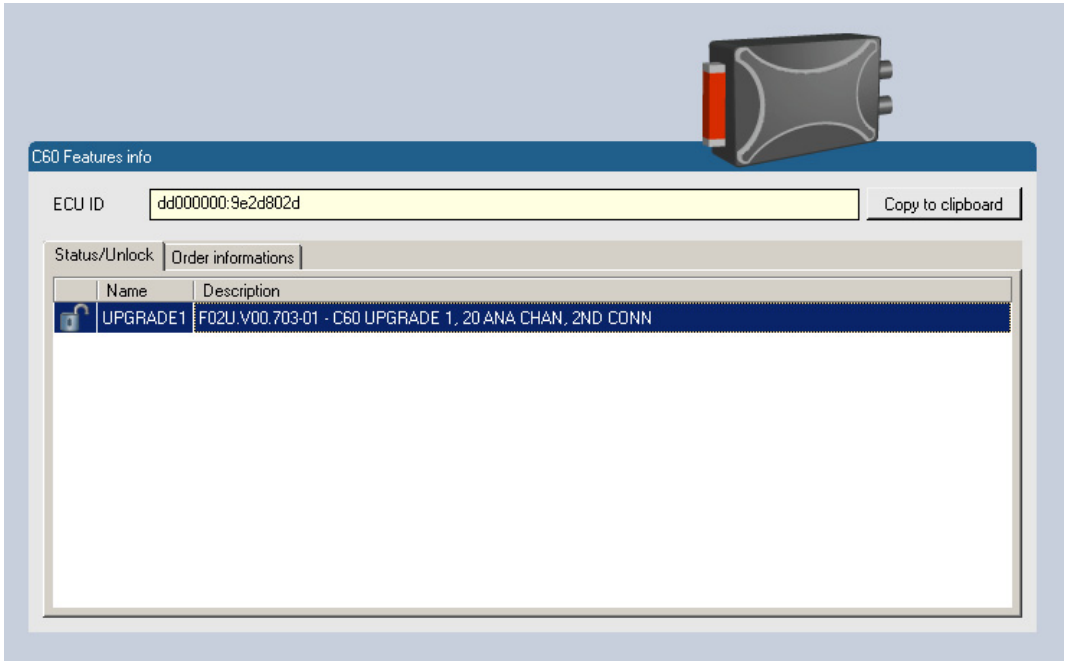
C 60 Feature Activation

- Double click on the feature you want to activate.
- A pop-up window appears
- Enter the activation key you received for this feature on this device and click ‘OK’ when done



C 60 Feature Activation

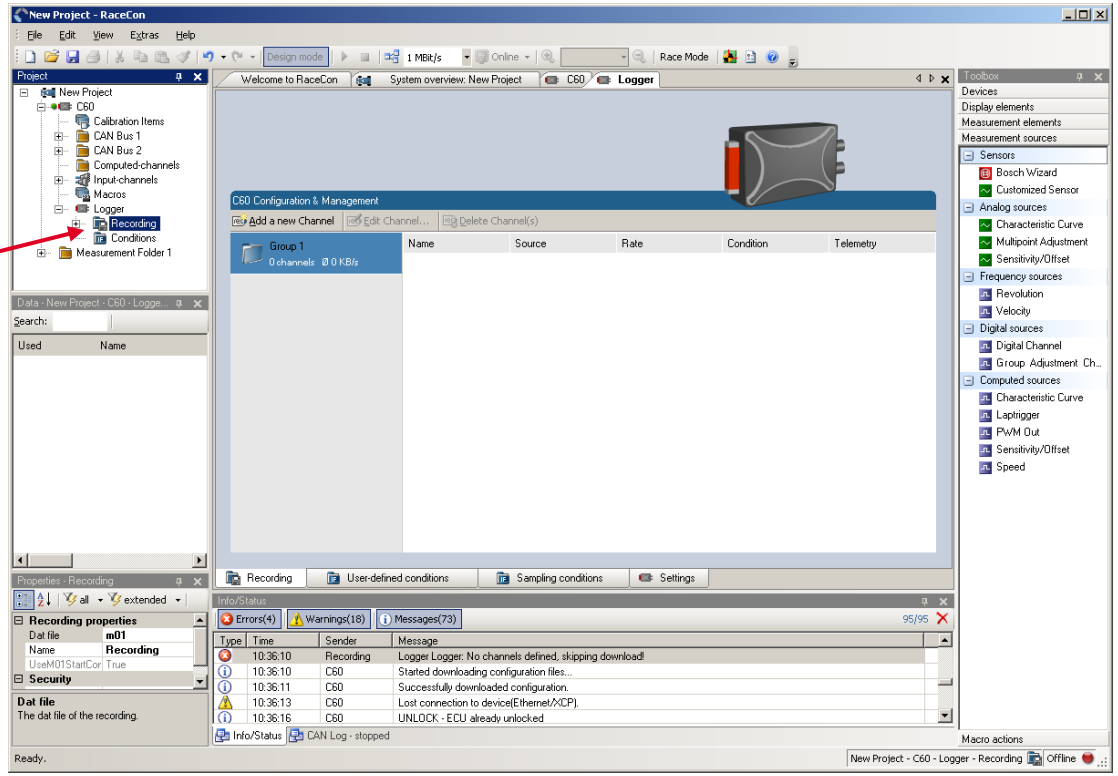
- The feature's status changes to 'unlocked'
- Perform these steps to activate other features you purchased
- Carry out a power-cycle to reset the device



C 60 1st Recording

- Expand the Project tree and double click on ‘Recording’
- The C 60 recording configuration area opens

Double click here

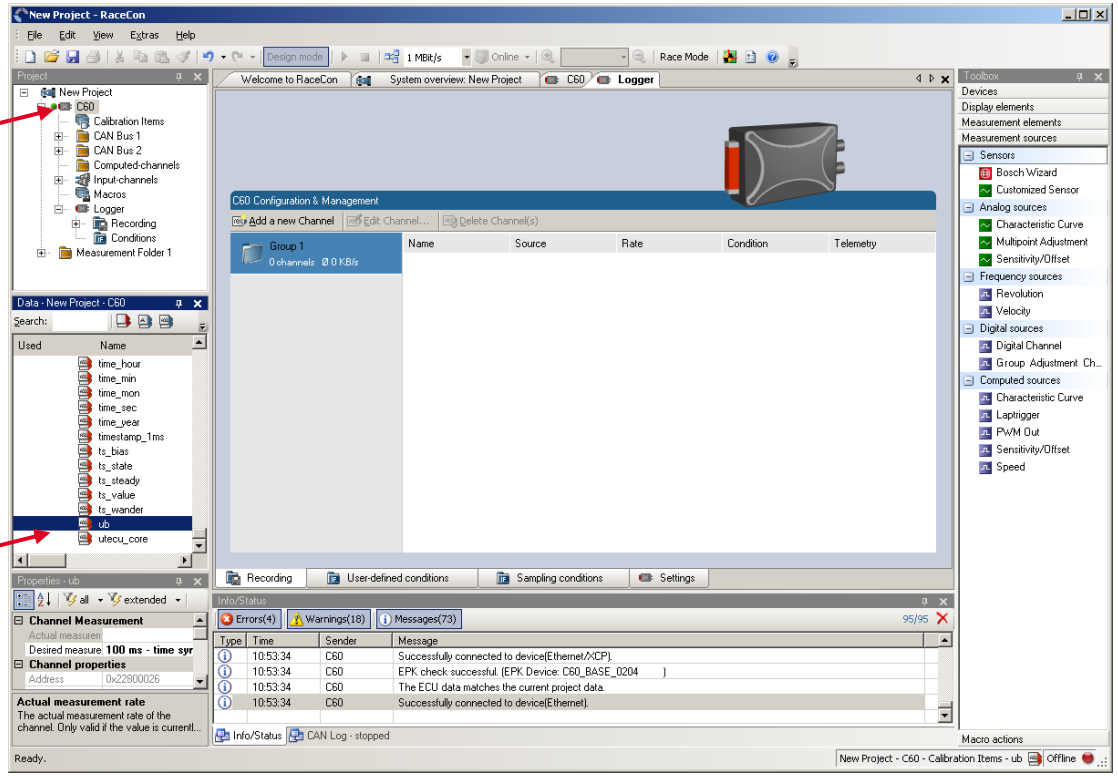


C 60 1st Recording

- In the project tree, click on ‘C 60’ to display the available measurement channels
- In the data window, scroll down to ‘ub’

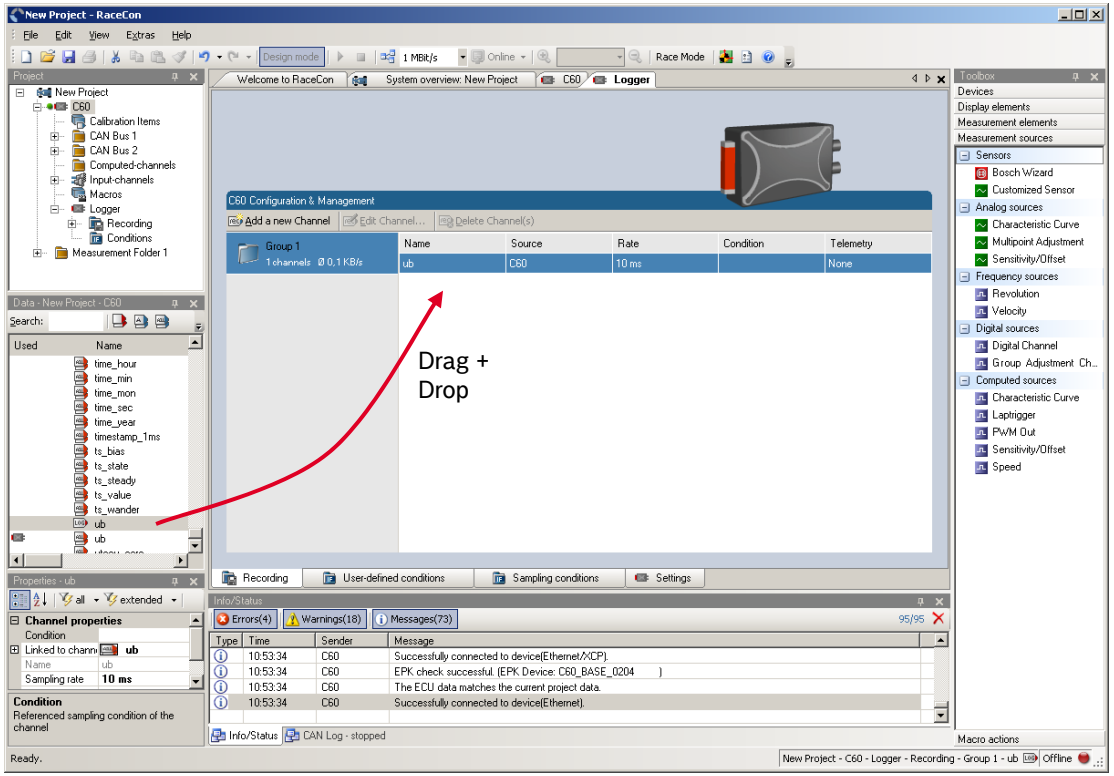
Click here

Scroll down to ‘ub’
(Battery voltage)



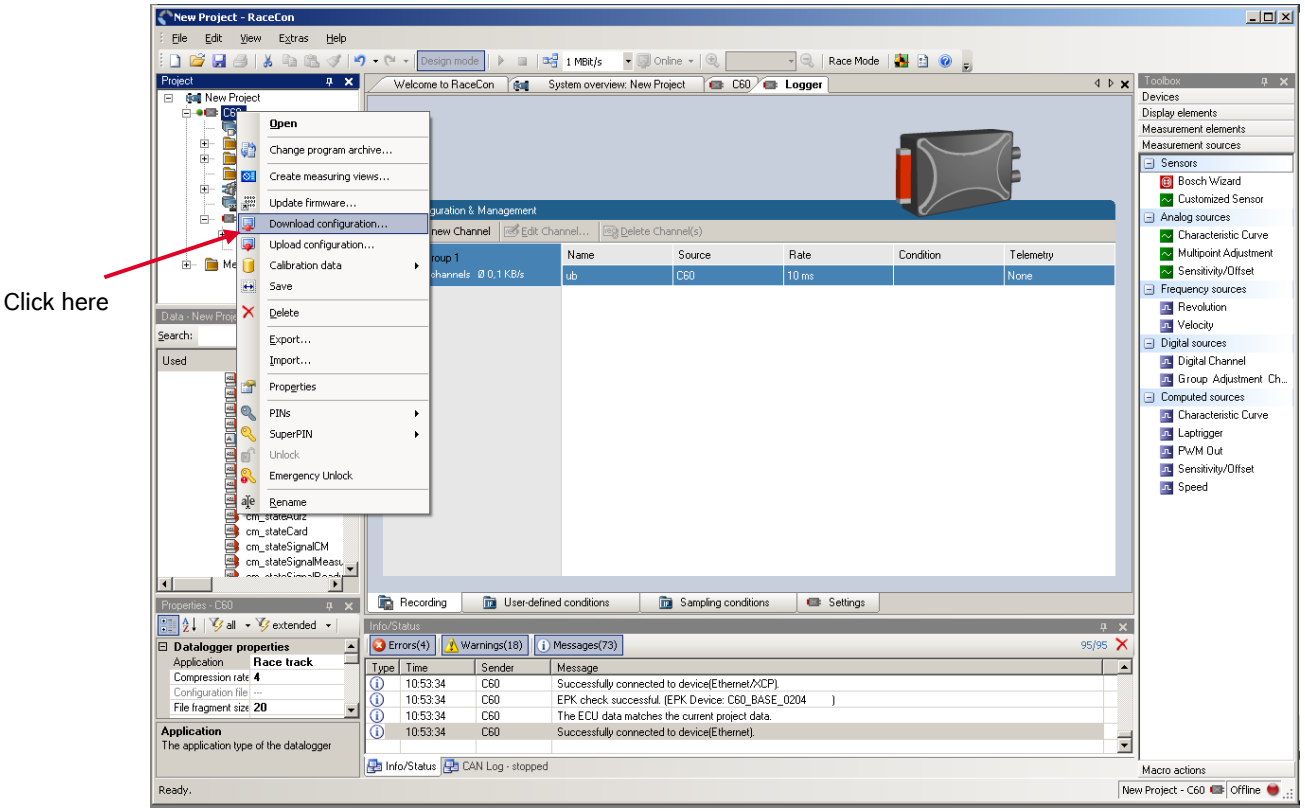
C 60 1st Recording

- Click on ‘ub’ (measurement channel for battery voltage)
- Drag + drop the channel into the recording area



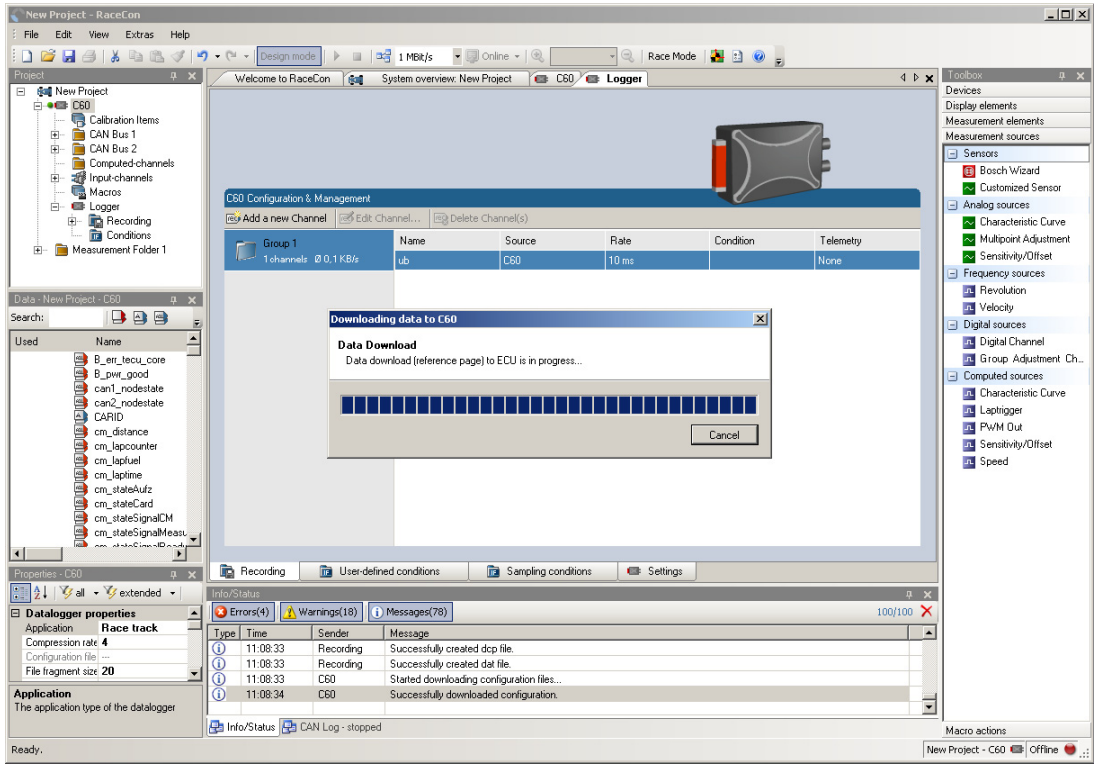
C 60 1st Recording

- Right click on ‘C 60’ in the project tree and choose ‘Download Configuration’

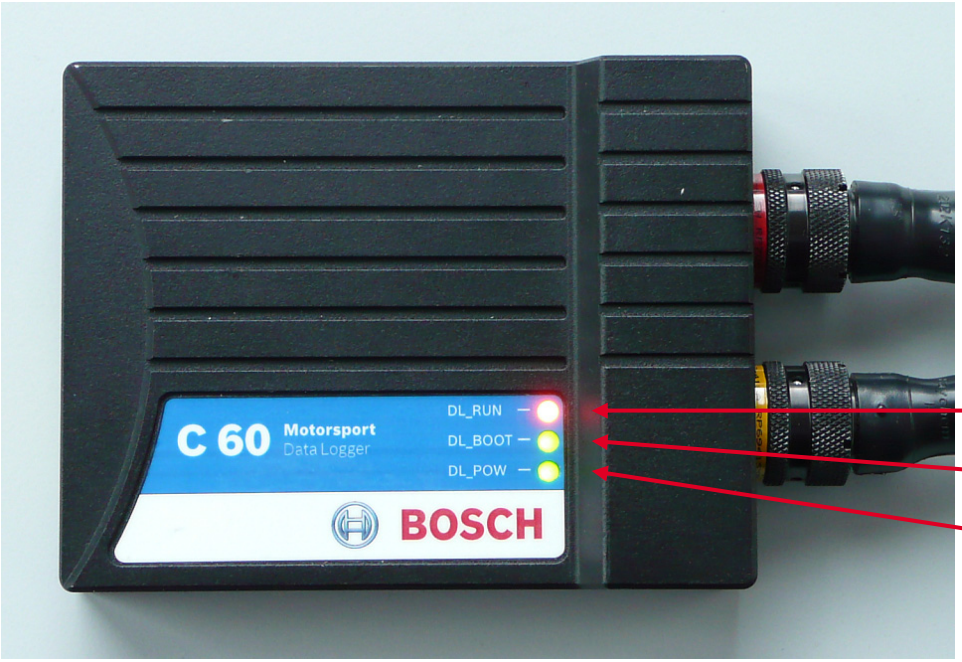


C 60 1st Recording

- The configuration download starts and the C 60 carries out a reset
- As we did not define global start conditions, recording starts immediately (This is indicated by the 'DL_RUN' LED blinking 'green and fast')



C 60 Status LEDs



Recording status LED (green / amber / red)

Boot status LED (always green)

Power status LED (always green)

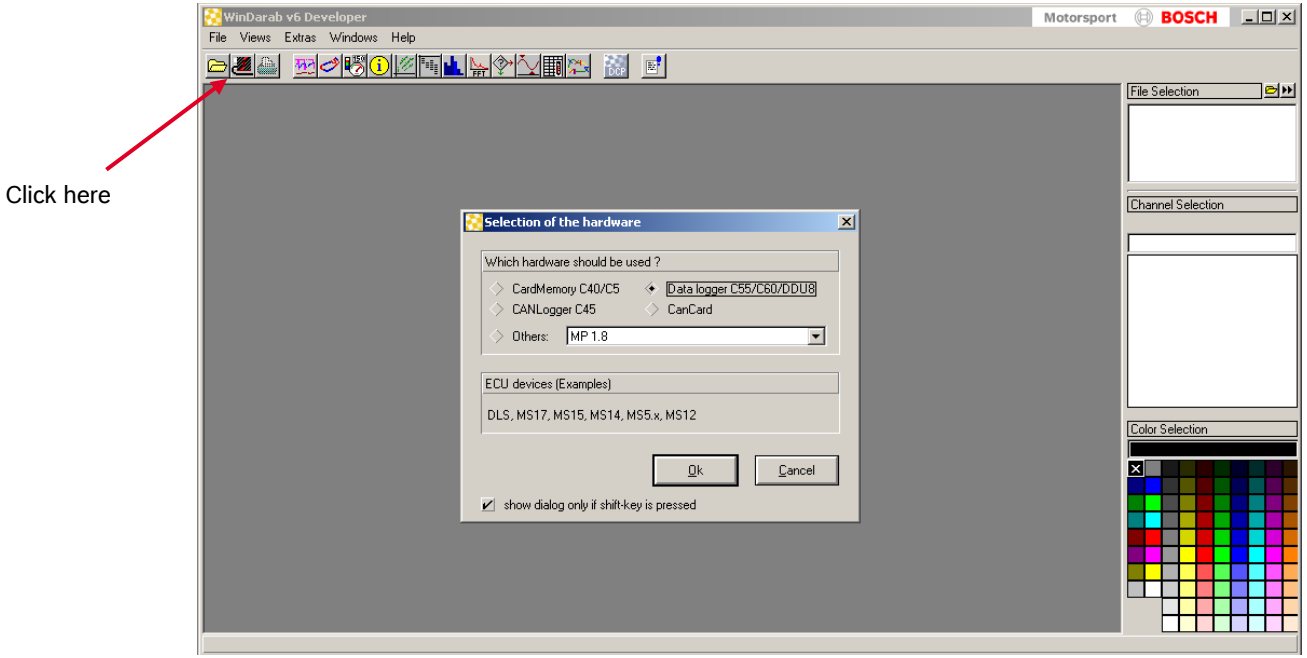
C 60 Recording Status LED

		Recorded Data	Telemetry
	**Amber constant** • No measurement configuration on C 60	No	No
	**Blinking green slow** • Measurement configuration loaded • Start condition(s) not fulfilled	No	Yes
	**Blinking green fast** • Measurement configuration loaded • Start conditions fulfilled • C 60 is recording data	Yes	Yes
	**Blinking amber slow** • Measurement configuration loaded • Measurement setup error (external device missing) • Start condition(s) not fulfilled	No	Yes (but some missing)
	**Blinking amber fast** • Measurement configuration loaded • Measurement setup error (external device missing) • Start conditions fulfilled, C 60 is recording data	Yes (but some missing)	Yes (but some missing)
	**Blinking red fast** • Firmware update in progress • Do not power off C 60	No	No
	**Blinking red slow** • Firmware update has finished	No	No
	**Red constant** • Error during firmware update	No	No

BOSCH

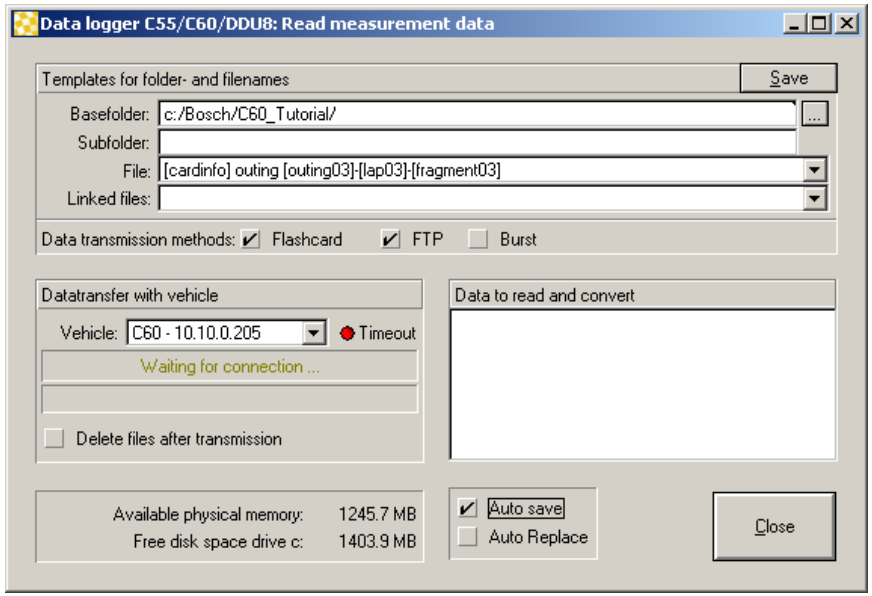
C 60 1st Recording

- Start the WinDARAB software
- Disconnect the C 60 network cable
- Hold the ‘Shift’ key and click on the ‘Import Measurement Data’ Icon
- Select the ‘Data logger C 60’ and click ‘OK’ when done



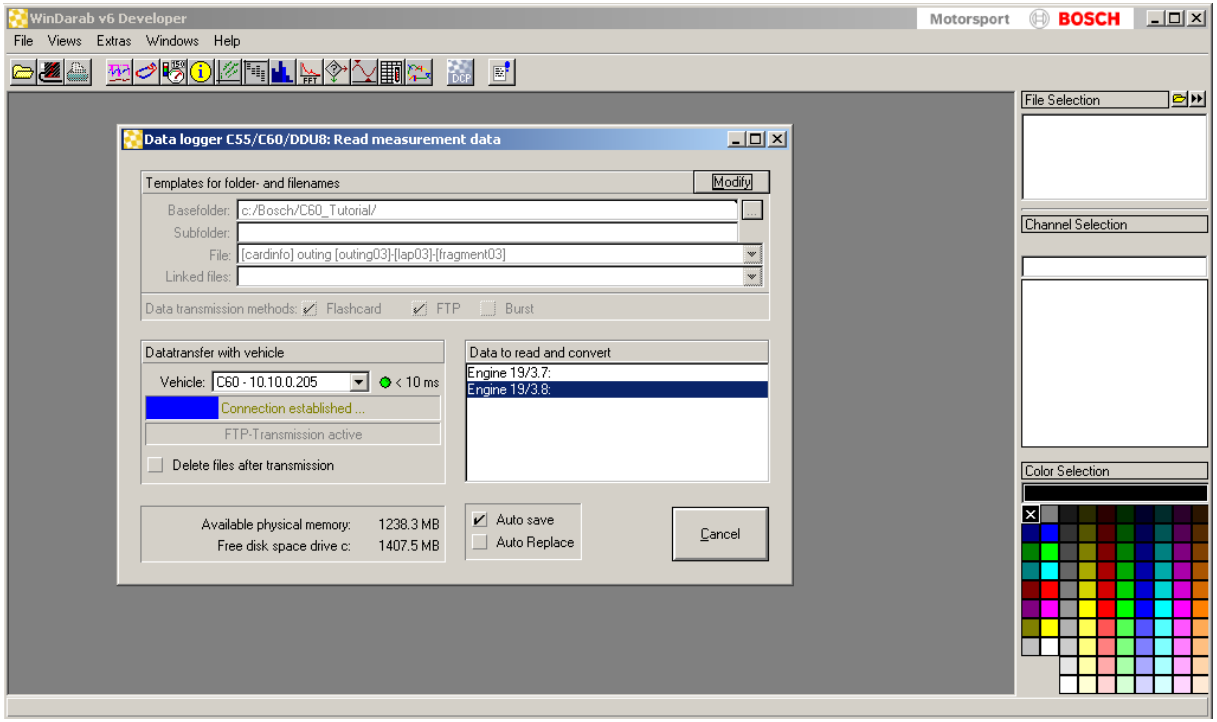
C 60 1st Recording

- The ‘Read Measurement Data’ dialog opens
- Click ‘Modify’ button and select the base folder
- Choose ‘FTP’ as data transmission method
- Enter ‘C 60 10.10.0.205’ in the vehicle field
- Activate ‘Auto save’
- Click ‘Save’ when done



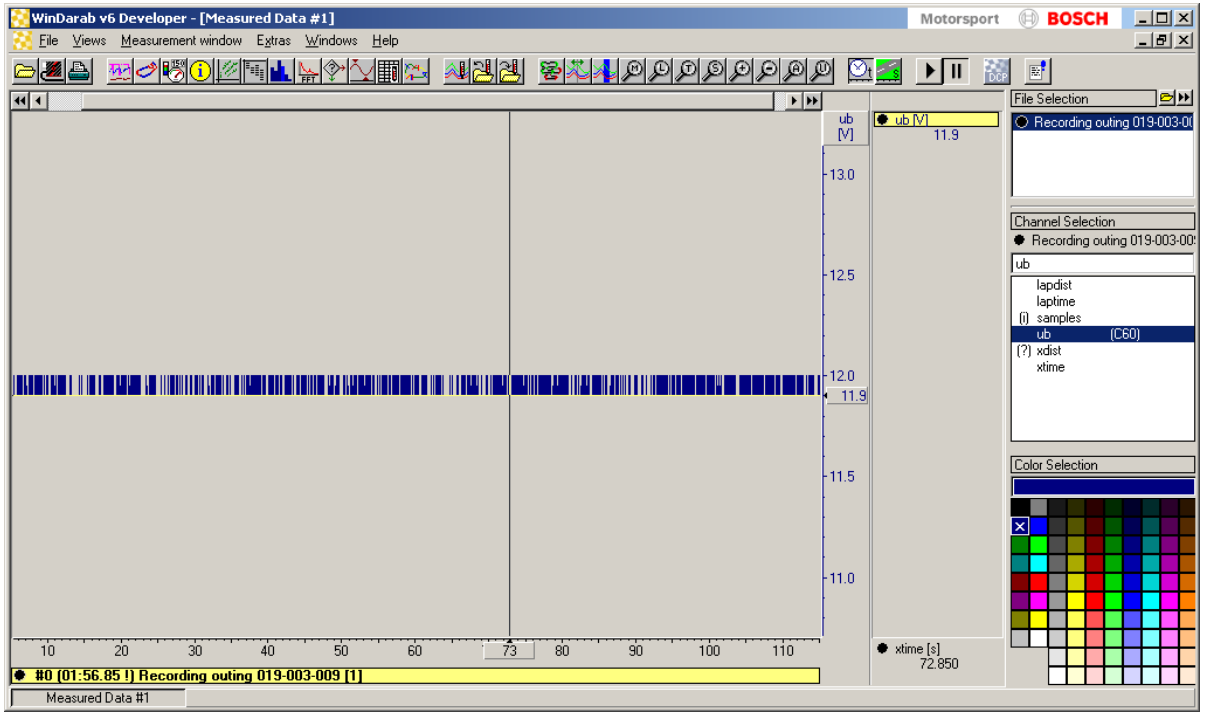
C 60 1st Recording

- Connect the C 60 network cable
- Data transmission from the C 60 starts automatically
- Measurement files are stored automatically
- Click ‘Close’ when transmission has finished



C 60 1st Recording

- Click on ‘Open Measurement Data’
- Select the measurement files from the storage folder
- Click on ‘Open as linked files’
- Open a measurement window and display the ‘ub’ measurement channel



Details of the C 60

CAN-Bus
Analog and Frequency
Online measurement
Recording and Telemetry
Lap Trigger
Firmware
GPS

CAN-Bus

CAN Input

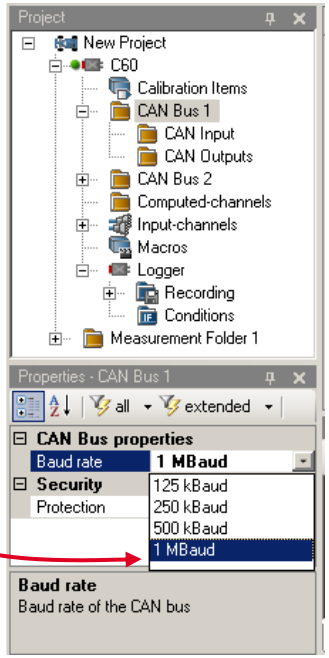
CAN Output

C 60 CAN Bus

- C 60 has two CAN buses
  - Both buses are fully configurable
    - Baudrate (125kBit ... 1MBit)
    - 11Bit or 29Bit identifiers
    - Input configuration
      - Read messages from CAN bus and convert to C 60 measurement / display variables
      - Supports row counter configuration
    - Output configuration
      - Write C 60 measurement variables to CAN messages
      - Output frequency and row counter configurable
      - CAN gateway functionality (transfer from one bus to the other)

CAN Bus Trivia

- CAN Message
  - 11Bit (standard) or 29 Bit (extended) identifier
  - Up to 8 bytes of data payload
- CAN Bus
  - Needs termination resistors (120Ohm) in wiring harness
  - All devices connected to the bus **must use identical** data rate
  - Configuration of C 60 bus data rate in ‘Properties’ menu
- Row Counter Concept
  - Re-use (multiplex) of message identifiers
  - One byte of message contains row counter
  - 7 bytes payload remaining
  - Position of row counter is configurable

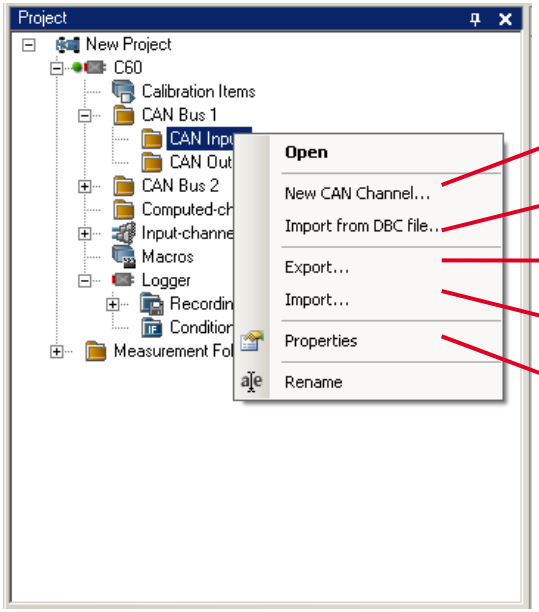


	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x100	0	p_oil		t_oil				
0x100	1	s_dam_fl		s_dam_fr				
0x100	2	s_dam_rl		s_dam_rr				

Message Id | Row Counter | Payload Area

C 60 CAN Input

- Input Configuration



Create new channel to read from CAN bus

Import Vector CAN database (DBC) channel configuration

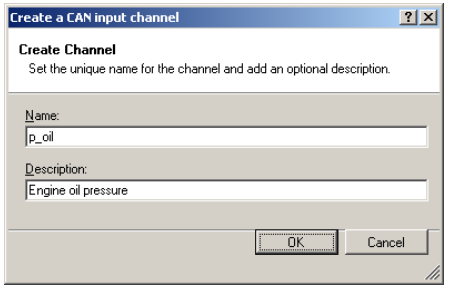
Export RaceCon CAN input configuration to file

Import RaceCon CAN input configuration from file

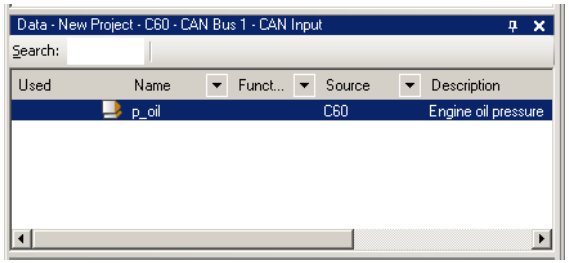
Display CAN bus properties (Baudrate)

C 60 CAN Input

- Create new CAN channel
  - Right click on CAN Input of desired bus (CAN1 or CAN2)
  - Select ‘New CAN Channel’ from menu
  - Insert name and description of channel
  - Click ‘OK’ when done

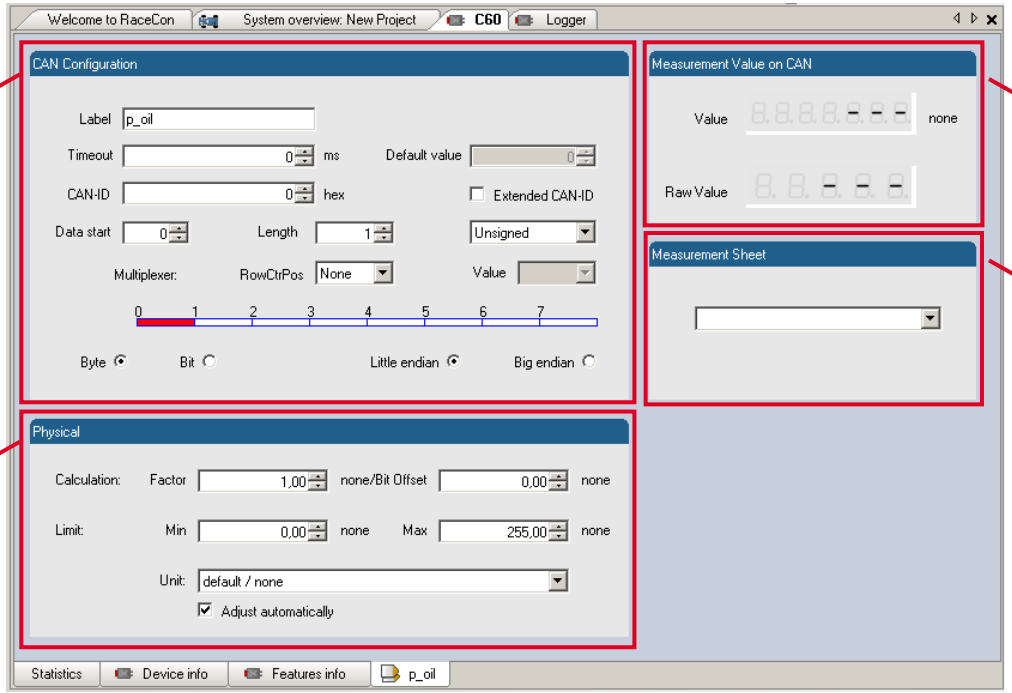


  - The channel is listed in the data window and a configuration window opens



C 60 CAN Input

- CAN channel configuration window



Extraction of data from CAN bus

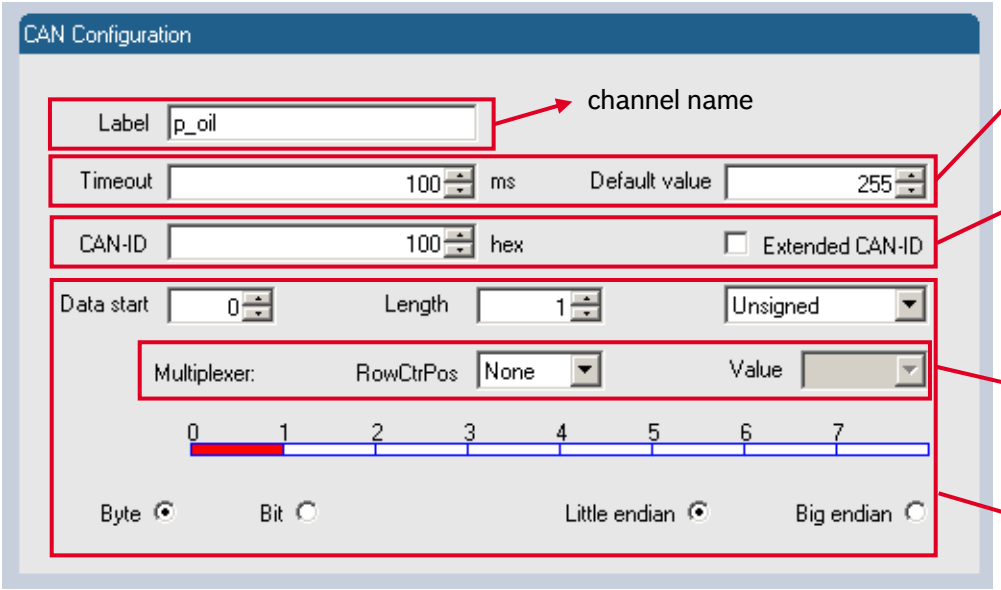
Conversion to physical values

Mini-CANalyzer functionality

Automatic assignment to measurement view

C 60 CAN Input

- Extracting data from CAN bus



If replacement values are used, specify time-out period and raw value here

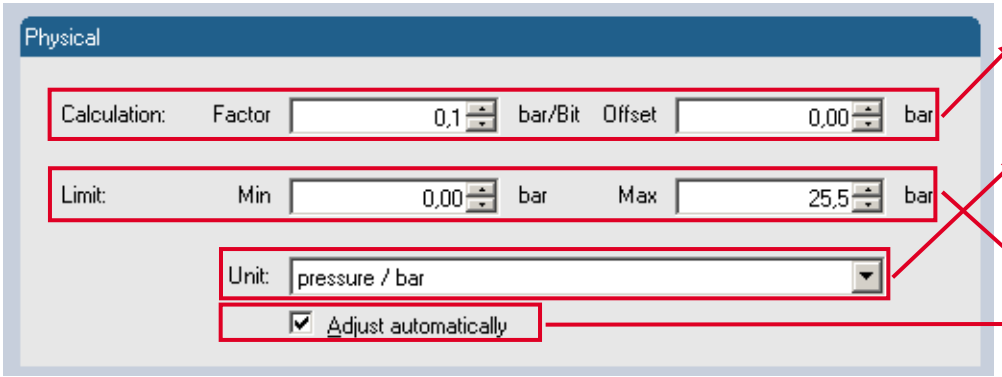
Specify ID of the CAN message here. If extended IDs (29bit) are used, check box

If a multiplexer (row counter) is used, specify position and value here

Specify data position, length, and data format here

C 60 CAN Input

- Conversion to physical values



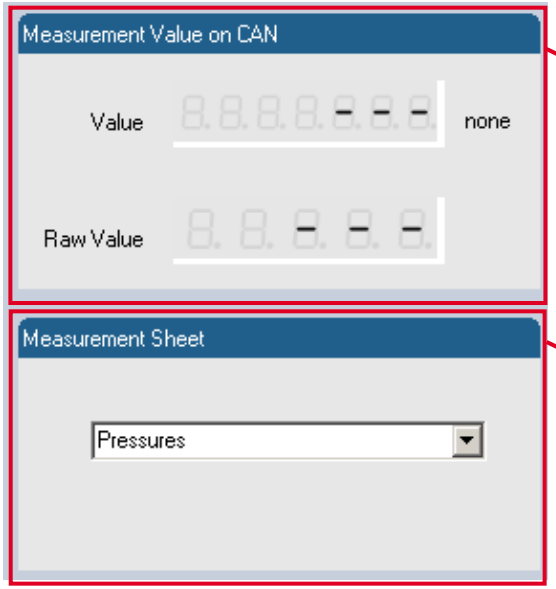
Specify factor (gain) and offset for conversion to physical value here

Select type and unit of physical value here

Check box to automatically adjust physical limits of channel or specify limits manually

C 60 CAN Input

Special features



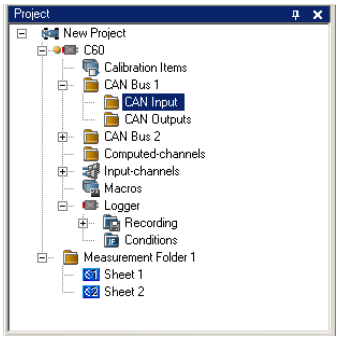
CAN analyzer functionality:
If the PC is directly connected to the CAN bus for which the C 60 is configured, the raw value and the converted physical value are displayed here

Please note:
For an online view of the value measured by the C 60, insert the channel in an online measurement sheet

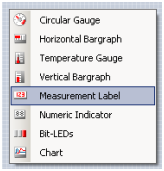
Automatic creation of online measurement sheets:
The CAN channel can be automatically inserted to a measurement sheet. Insert a name for a new sheet or select an existing sheet from the listbox.

C 60 CAN Input

- Online view of CAN variables in vehicle
  - Double click on ‘Sheet 1’ in project tree



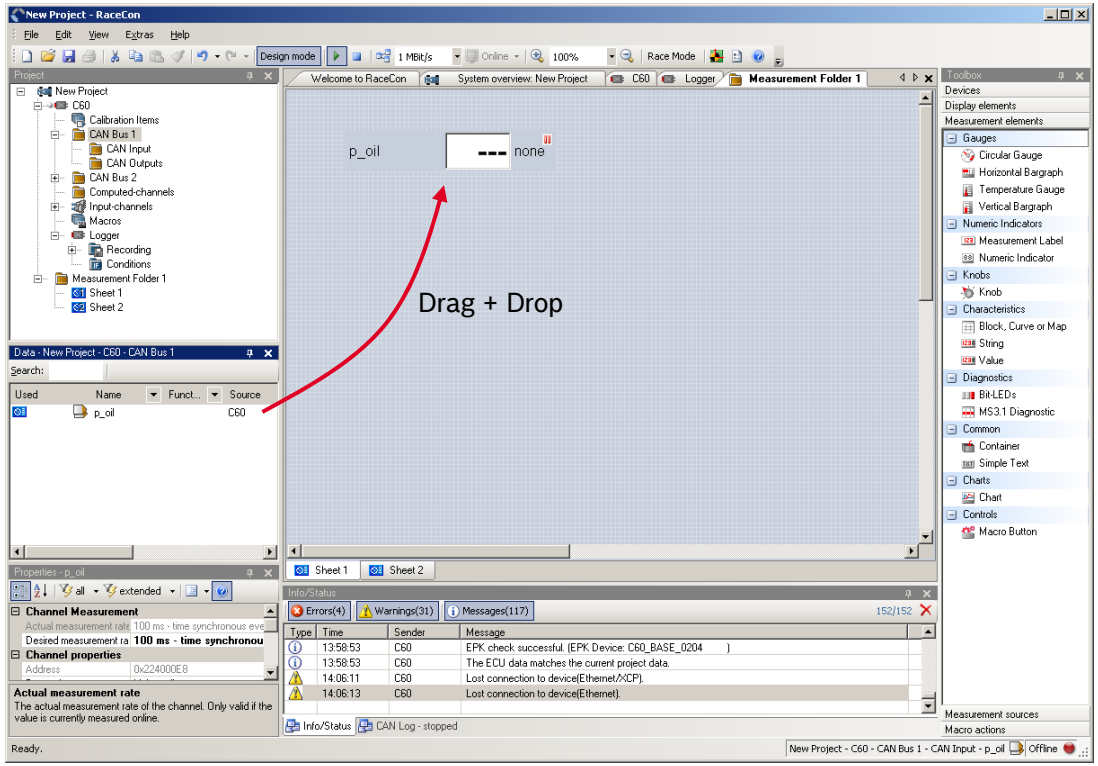
  - Measurement Sheet 1 is displayed in main area
  - Click on ‘CAN Input’ of desired CAN bus to display variables
  - Drag and drop desired variable into measurement sheet
  - A menu opens



  - Select desired display element (e.g. measurement label) for the variable

C 60 CAN Input

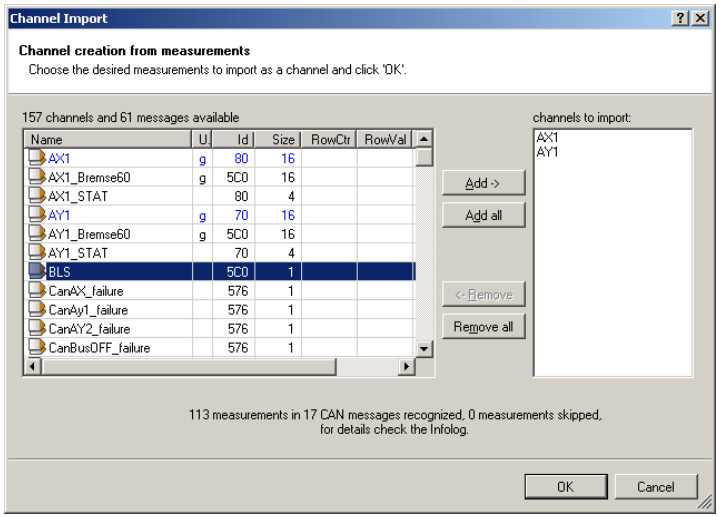
- Online view of CAN variables in vehicle (2)



- Connect PC to the vehicle and switch to ‘Race Mode’ to display online data

C 60 CAN Input

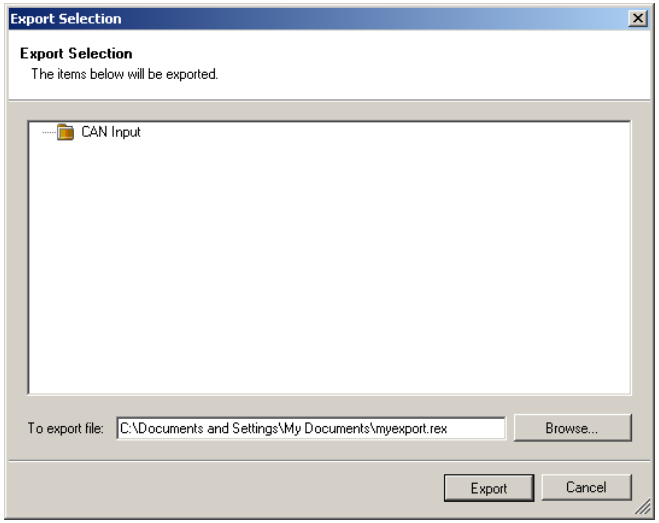
- Import a CAN database (DBC) file
  - Right' click on CAN Input of desired bus (CAN1 or CAN2)
  - Select 'Import DBC file' from menu
  - A file browser opens. Select DBC file to import and click 'OK' when done
  - An channel import window opens



  - Select desired channels on the left and use 'Add' button to add to import list
  - Click 'OK' when complete

C 60 CAN Input

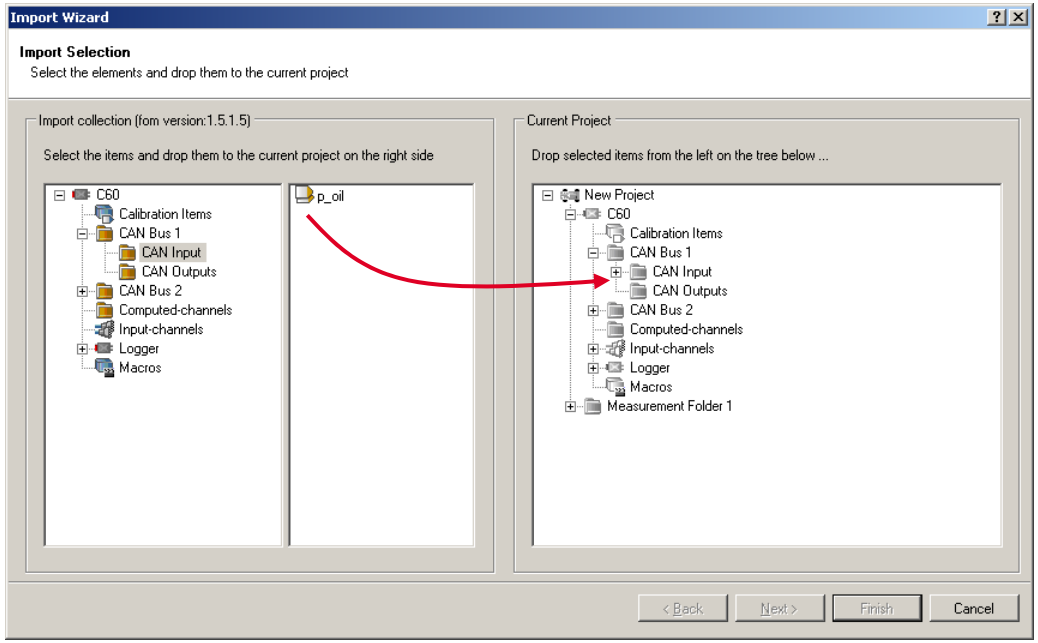
- Export RaceCon CAN configuration
  - Right click on CAN Input of desired bus (CAN1 or CAN2)
  - Select ‘Export…’ from menu
  - An ‘Export Selection’ window opens. Specify the filename.



  - Click ‘OK’ when done

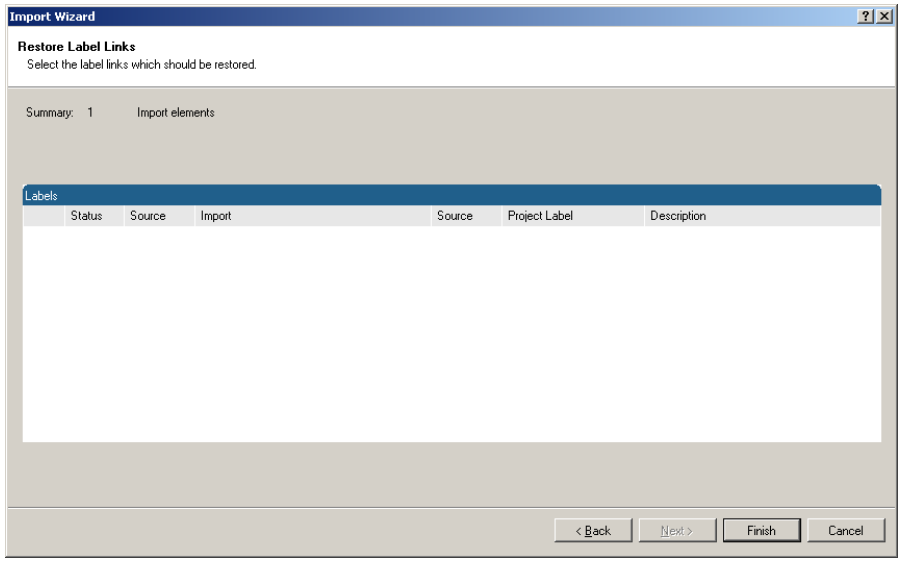
C 60 CAN Input

- Import RaceCon CAN configuration
  - Right click on CAN Input of desired bus (CAN1 or CAN2)
  - Select ‘Import…’ from menu
  - A file browser opens. Select the input file and click ‘OK’.
  - An ‘Import Selection’ window opens



C 60 CAN Input

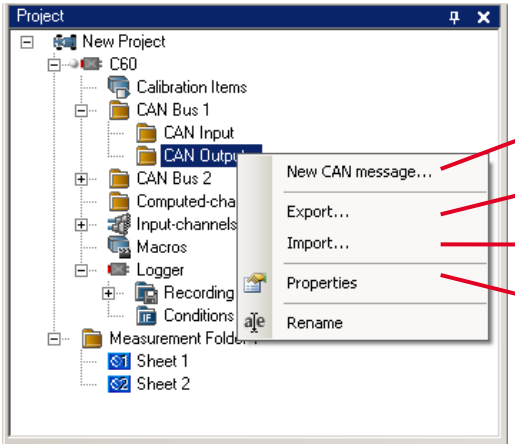
- Import RaceCon CAN configuration (2)
  - Select channels to import
  - Drag-and-drop to ‘CAN Input’ of desired CAN bus on right hand side
  - Click ‘Next’
  - A ‘Restore Label Links’ window opens



  - Click ‘Finish’

C 60 CAN Output

- Output Configuration



Create new CAN output message

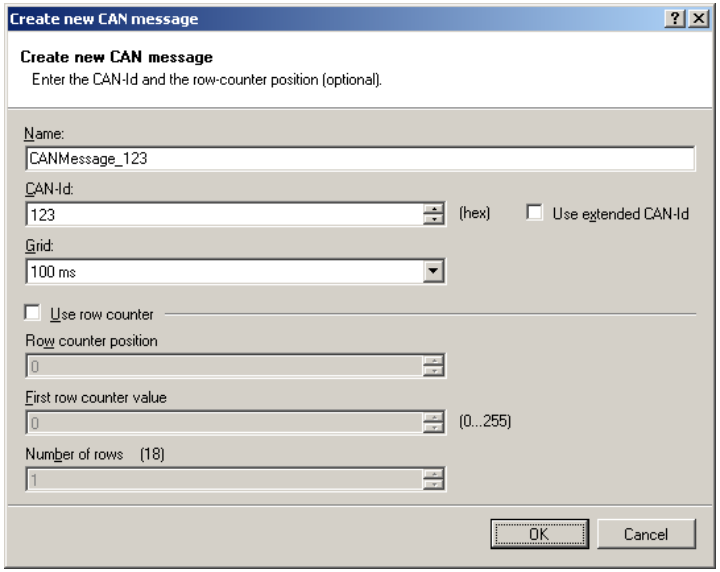
Export RaceCon CAN output configuration to file

Import RaceCon CAN output configuration from file

Display CAN bus properties (Baudrate)

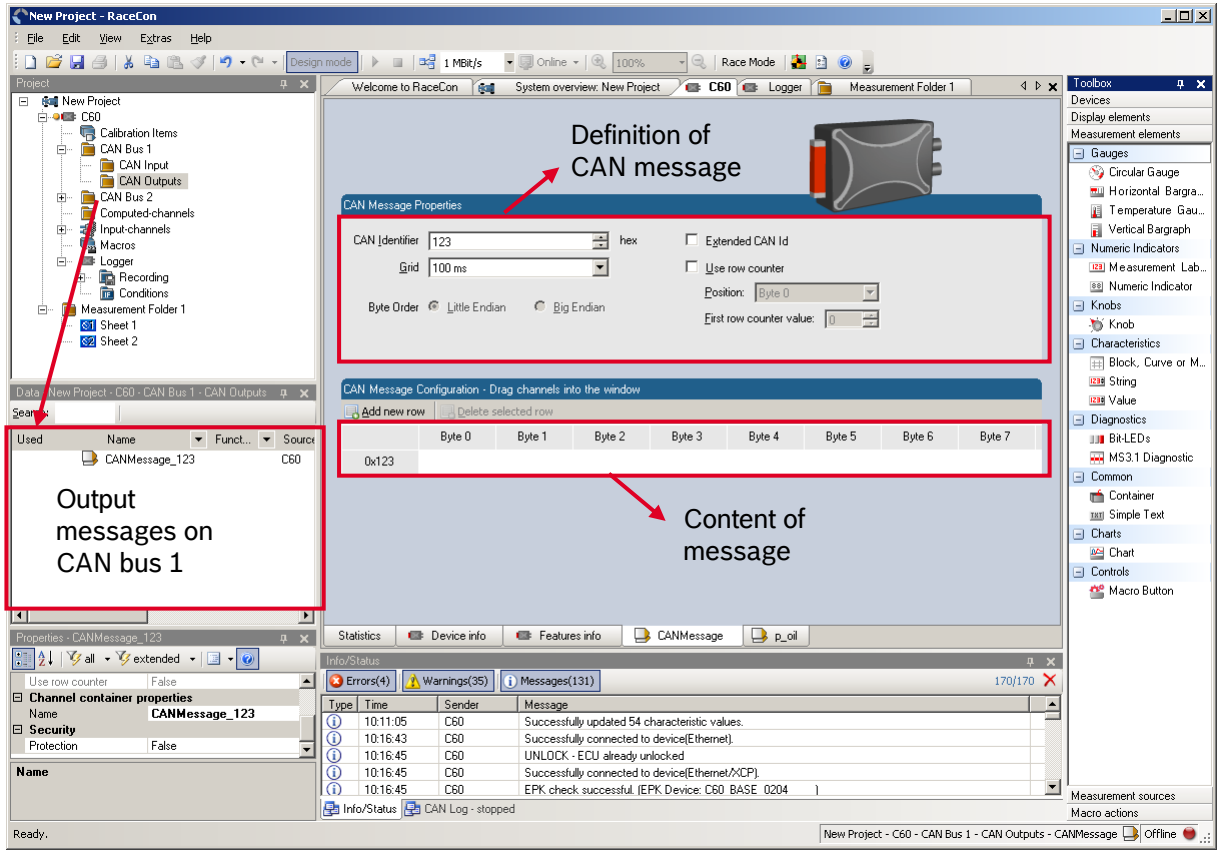
C 60 CAN Output

- Create new CAN output message channel
  - Right click on CAN Output of desired bus (CAN1 or CAN2)
  - Select ‘New CAN Message’ from menu
  - Insert CAN-Id, Grid (output interval) and name of message
  - A row counter can be specified optionally
  - Click ‘OK’ when done



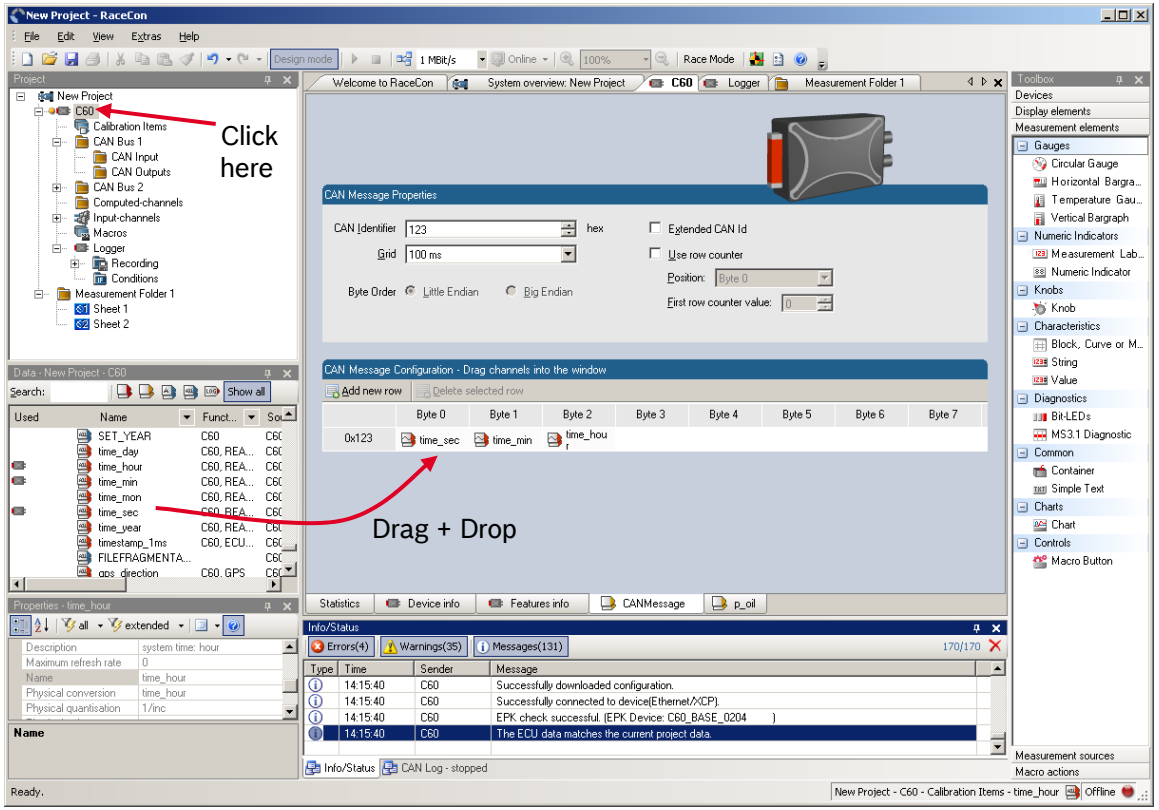
C 60 CAN Output

- A configuration window for the message opens in the main area



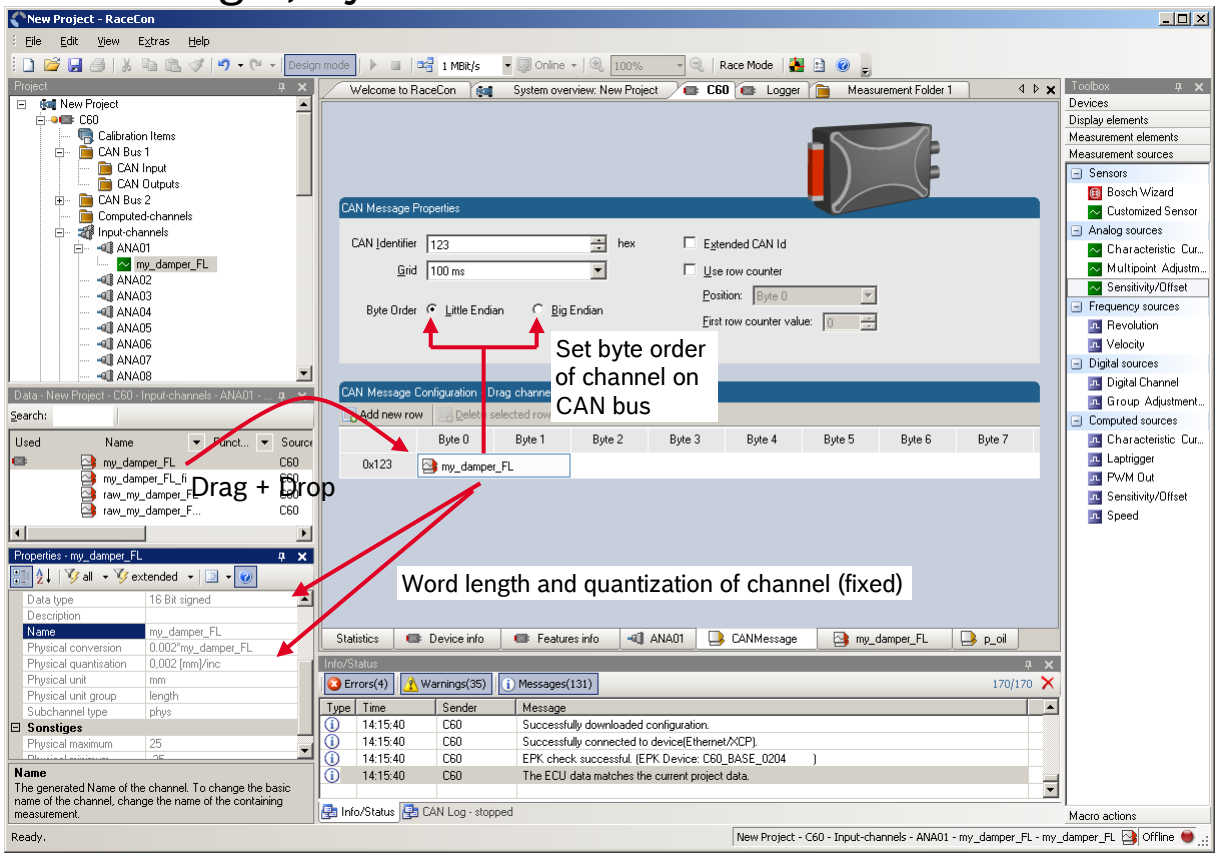
C 60 CAN Output

- To add a measurement channel to a message, click on ‘C 60’ in the project tree to display all labels, select the desired measurement channel and drop it on message



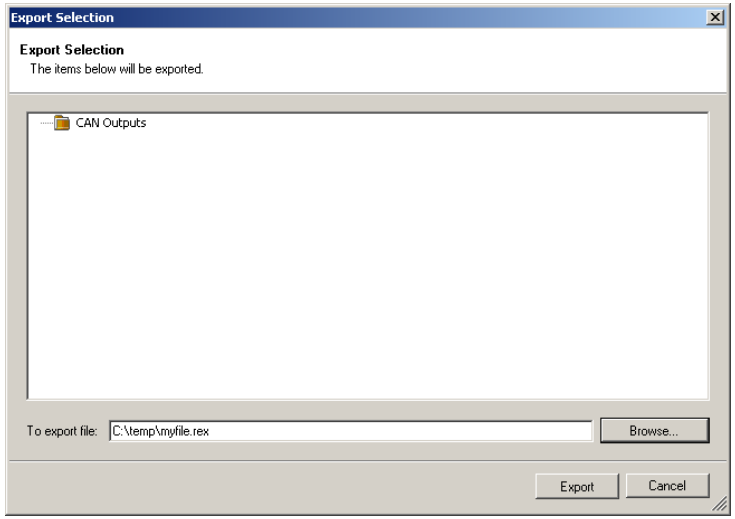
C 60 CAN Output

- Word Length, Byte Order and Quantization



C 60 CAN Output

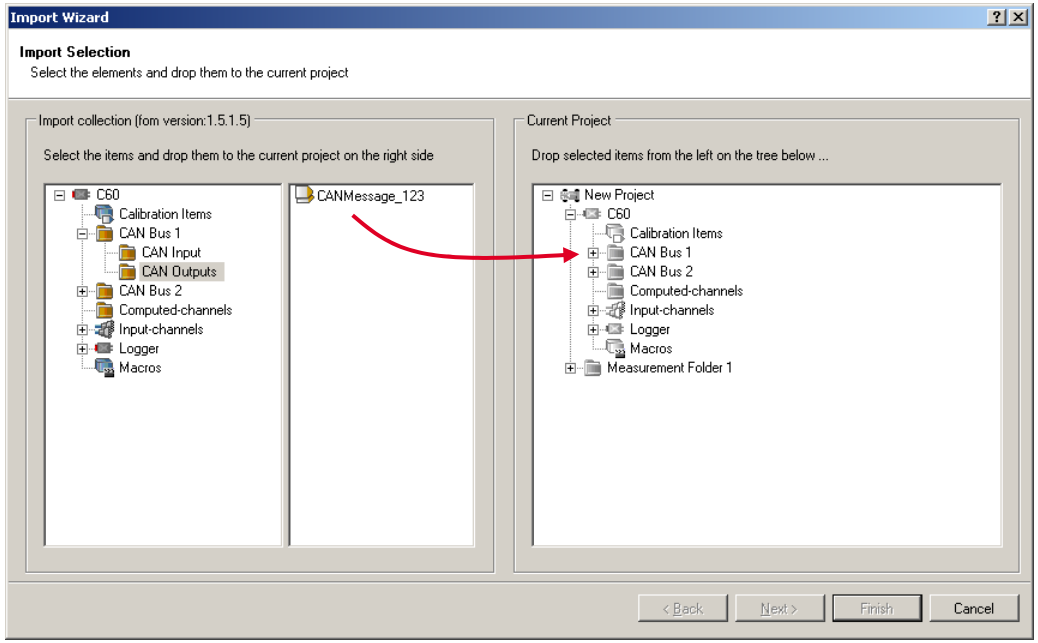
- Export RaceCon CAN configuration
  - Right click on CAN Output of desired bus (CAN1 or CAN2)
  - Select ‘Export…’ from menu
  - An ‘Export Selection’ window opens. Specify the filename.



  - Click ‘OK’ when done

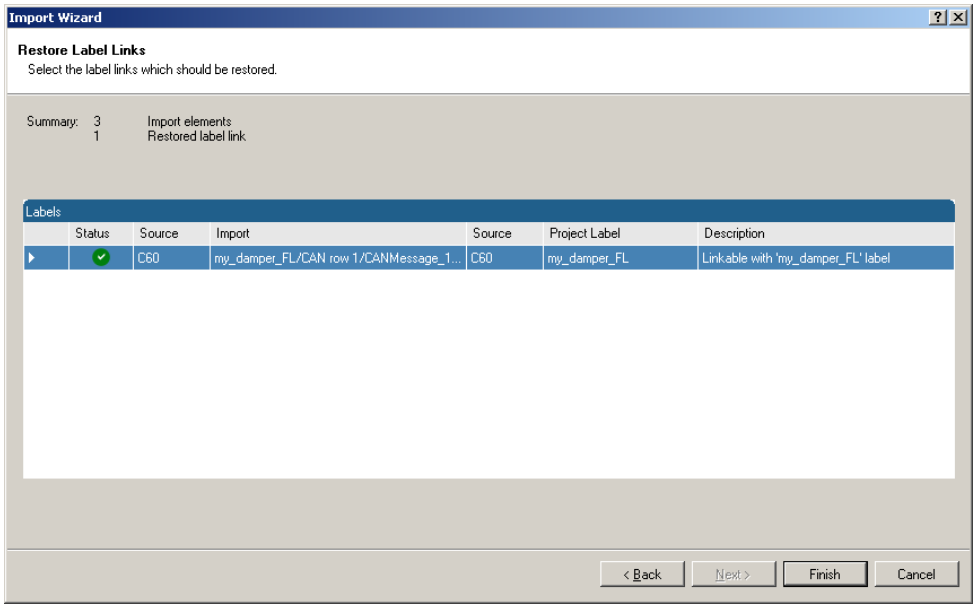
C 60 CAN Output

- Import RaceCon CAN configuration
  - Right click on CAN Output of desired bus (CAN1 or CAN2)
  - Select ‘Import…’ from menu
  - A file browser opens. Select the input file and click ‘OK’.
  - An ‘Import Selection’ window opens



C 60 CAN Output

- Import RaceCon CAN configuration (2)
  - Select channels to import
  - Drag-and-drop to ‘CAN Output’ of desired CAN bus on right hand side
  - Click ‘Next’
  - A ‘Restore Label Links’ window opens



  - Click ‘Finish’

Analog and Frequency Inputs

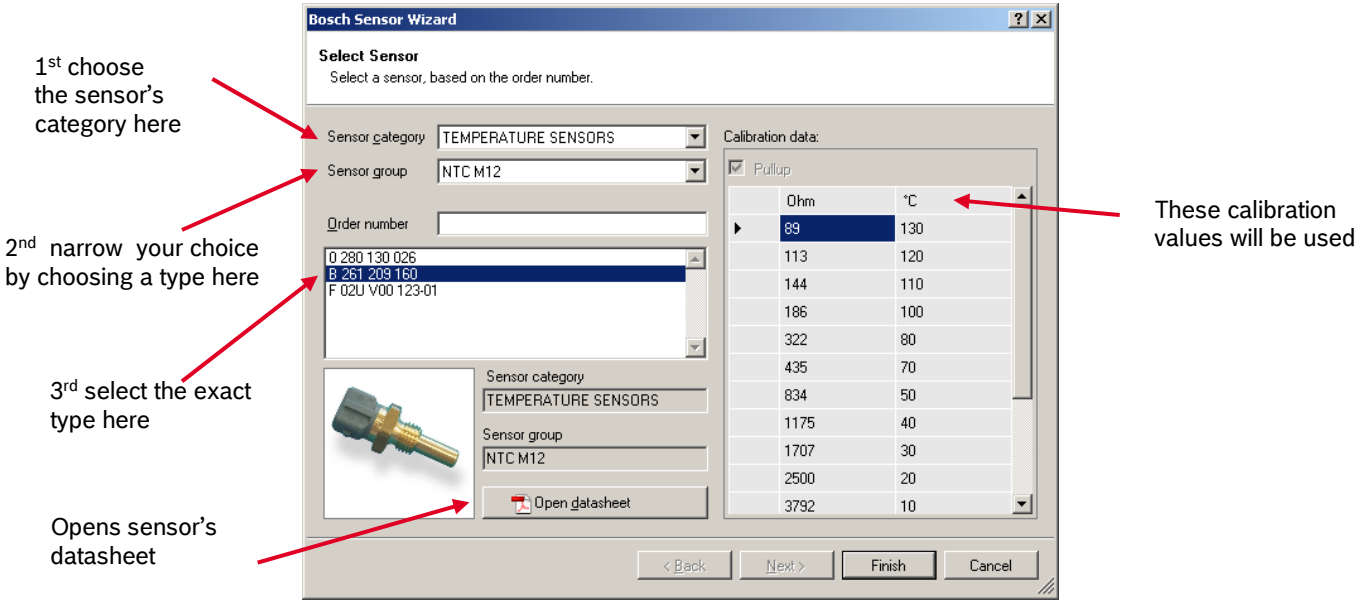
Configuring Inputs
Computed Sources
Special functionality: Vehicle speed
Configuring PWM Outputs

C 60 Analog and Frequency Inputs

- C 60 features
  - 24 analog inputs (with Software Upgrade 1; 6 analog inputs without upgrade)
    - 0...5V
    - 12 bit A/D converter
    - Switchable 3.01kOhm pull-up resistor
    - 8kHz acquisition rate, up to 1kHz recording rate
    - Linear phase digital filter
  - 4 frequency inputs (with Software Upgrade 1; no frequency inputs without upgrade)
    - 5V Hall-effect type, 2.5V trigger level
    - 20kHz max. frequency
    - 10ms measurement window
  - 4 PWM outputs
    - Low-side switch
    - Up to 2A each
    - Output frequency selectable

Configuring Inputs – Bosch Sensor Wizard

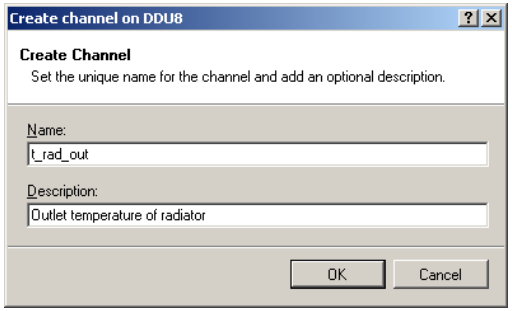
- Configuring a predefined Bosch sensor with the ‘Bosch Sensor Wizard’
  - Drag the ‘Bosch Sensor Wizard’ from the Toolbox and drop it on the desired analog input channel in the C 60 project tree
  - The ‘Bosch Sensor Wizard’ opens



  - Click ‘Finish’ when done

Configuring Inputs – Bosch Sensor Wizard

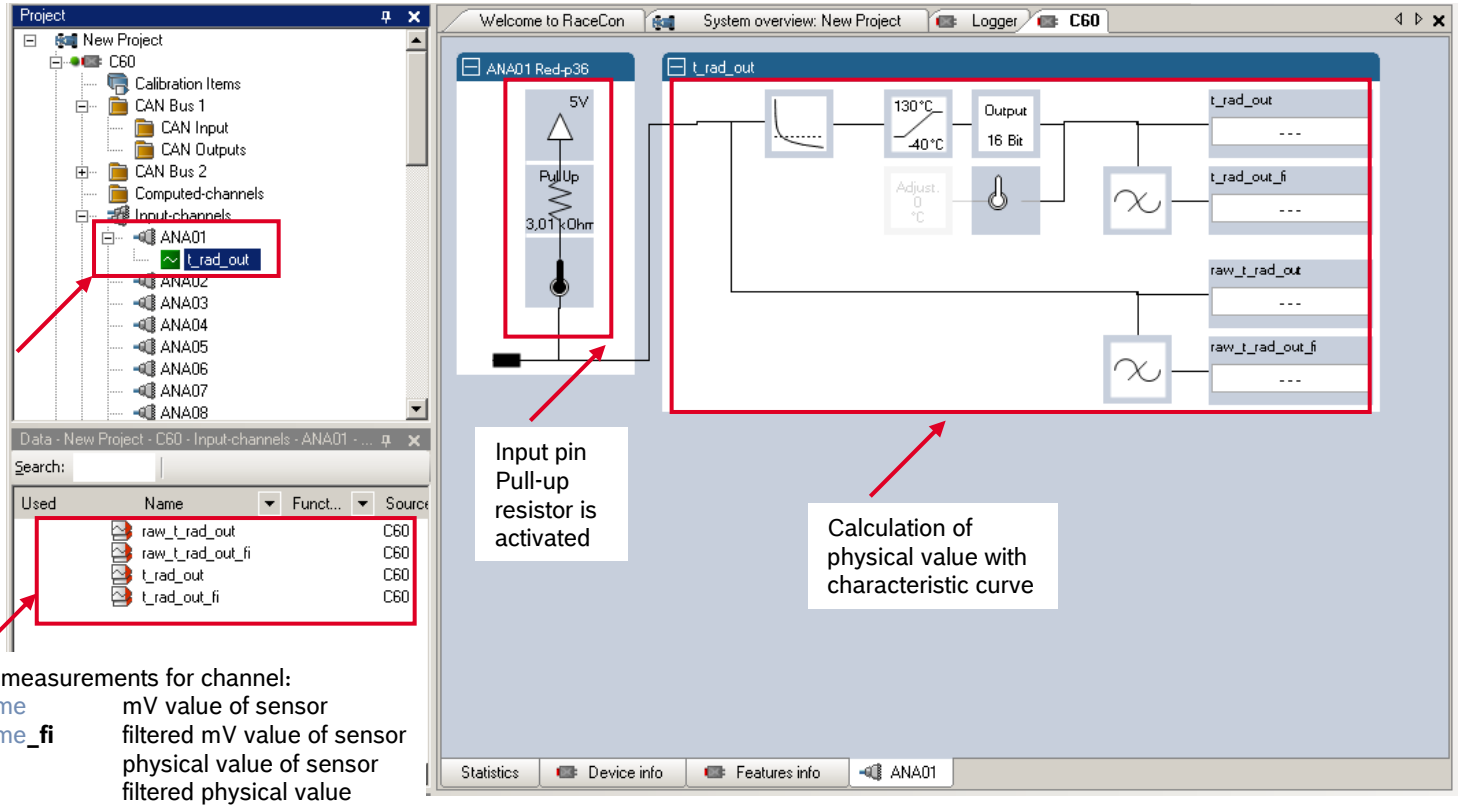
- Another pop-up window opens
- Enter channel name and description



- Click ‘Ok’ when done

Configuring Inputs – Bosch Sensor Wizard

- The channel is inserted into the C 60 project tree



Channel is linked to ANA01

Input pin Pull-up resistor is activated

Calculation of physical value with characteristic curve

Available measurements for channel:

- **raw_**name mV value of sensor
- **raw_**name**_fi** filtered mV value of sensor
- name physical value of sensor
- name**_fi** filtered physical value

Configuring Inputs – Generic Linear Sensor

- Configuring a generic linear sensor
  - Example: Acceleration sensor 5g
    - From sensor data sheet – operating characteristics

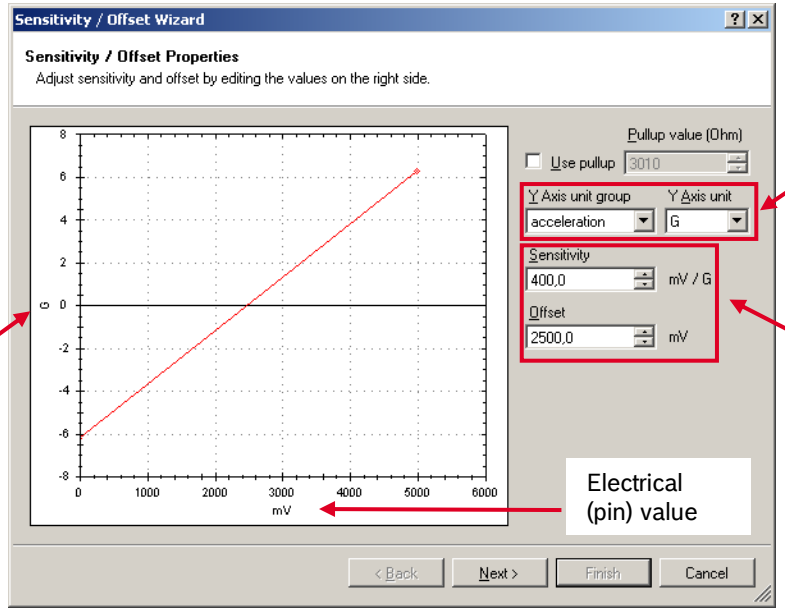
Output Signal					
Zero g (T_A = 25°C, V_{DD} = 5.0 V)(4)	V_{OFF}		2.5		V
Zero g (V_{DD} = 5.0 V)	V_{OFF}		2.5		V
Sensitivity (T_A = 25°C, V_{DD} = 5.0 V)(5)	S		400		mV/g
Sensitivity (V_{DD} = 5.0 V)	S		400		mV/g
Bandwidth Response	f_{-3dB}		50		Hz
Nonlinearity	NL_{OUT}		—		% FSO

    - Sensitivity 400mV/g Offset 2500mV
    - The sensor has a linear output signal with sensitivity and offset

  - Drag the ‘Sensitivity/Offset’ analog signal source from the Toolbox and drop it on the desired analog input channel in the C 60 project tree
  - A ‘Sensitivity/Offset Wizard’ opens

Configuring Inputs – Sensitivity / Offset

- A ‘Sensitivity/Offset Wizard’ opens



Physical (channel) value

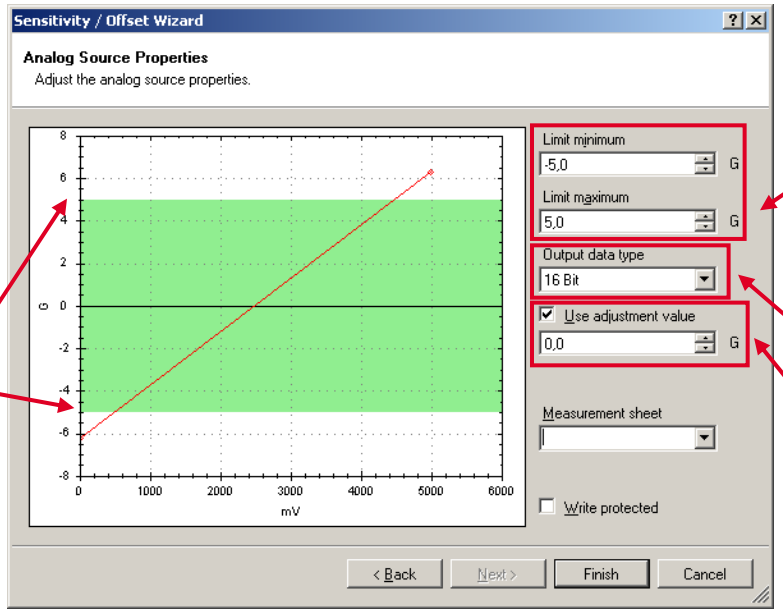
Choose unit group and unit of physical value here

Enter values from sensor datasheet here

- Click ‘Next’ when done

Configuring Inputs – Sensitivity / Offset

- The second part of the ‘Sensitivity/Offset Wizard’ opens



Physical limits of channel

Enter physical limits of the sensor here

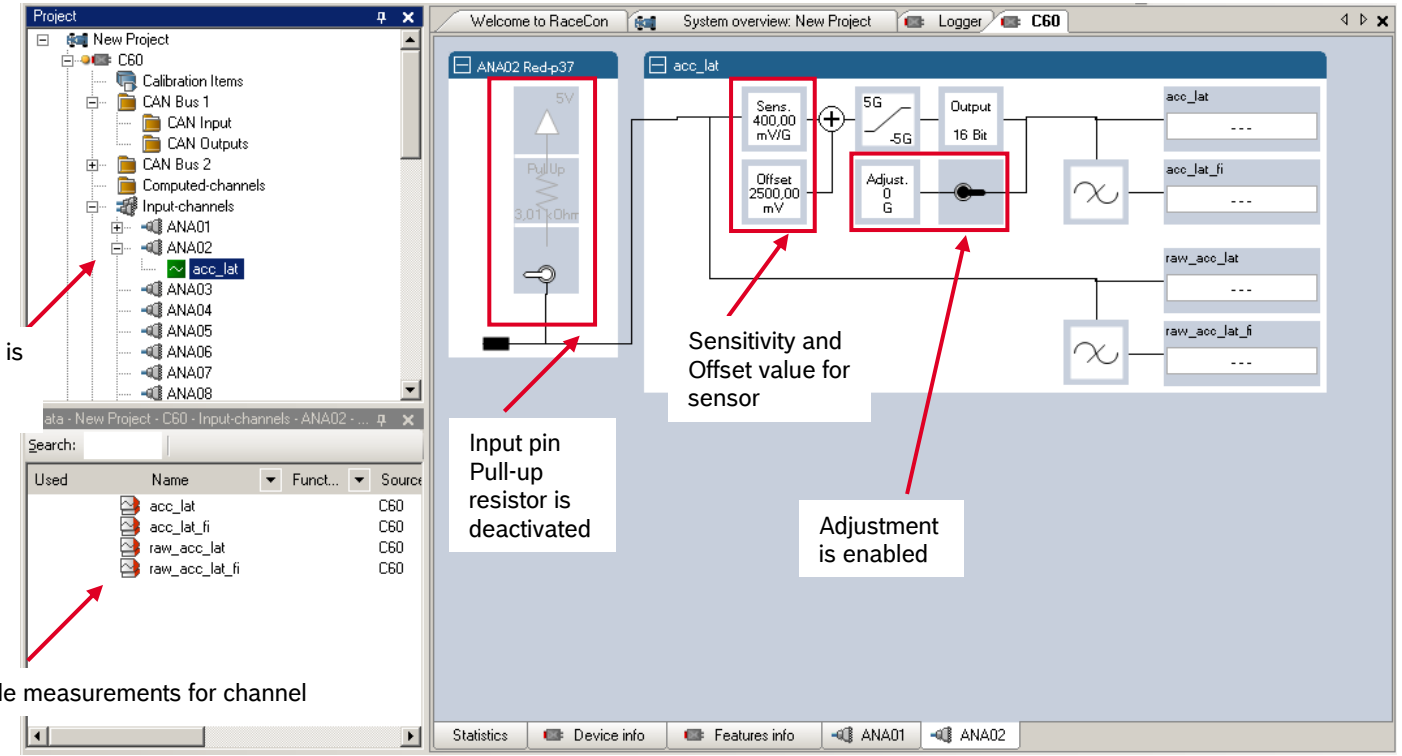
Choose data type of the measurement variable here

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

- Click ‘Finish’ when done
- Enter channel name and description
- Click ‘OK’ when done

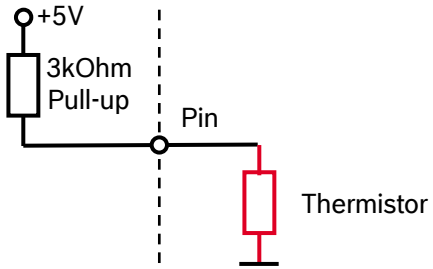
Configuring Inputs – Sensitivity / Offset

- The channel is inserted into the C 60 project tree



Configuring Inputs – Generic Nonlinear Sensor

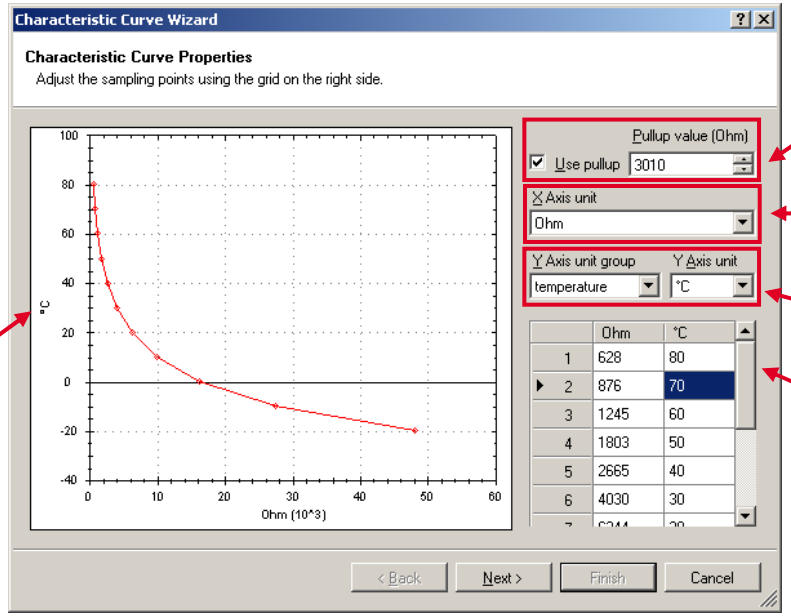
- Configuring a generic nonlinear sensor
  - Example: Thermistor 5kOhm
    - From sensor data sheet: resistance values over temperature
    - The sensor has a nonlinear behavior
    - Use characteristic curve for linearization
    - Input voltage is the ratio between pull-up resistor and thermistor
  - Drag the ‘Characteristic Curve’ analog signal source from the Toolbox and drop it on the desired analog input channel in the C 60 project tree
  - A ‘Characteristic Curve Wizard’ opens



T_{oper} [°C]	PART NR. 2381 640 **502 NTCLE100E3502*** R_T [Ω]
- 40	166 047
- 35	119 950
- 30	87 600
- 25	64 643
- 20	48 179
- 15	36 250
- 10	27 523
- 5	21 078
0	16 277
5	12 669
10	9936
15	7849
20	6244
25	5000
30	4030
35	3267
40	2665
45	2186
50	1803
55	1494
60	1245
65	1042
70	876.5
75	740.5
80	628.2
85	535.2
90	457.7
95	393.0
100	338.6
105	292.9
110	254.2
115	221.3
120	193.3

Configuring Inputs – Characteristic Curve

- A ‘Characteristic Curve Wizard’ opens



Physical (channel) value

Activate Pull-up Resistor in C 60

Choose ‘Ohm’ to enter datasheet values directly

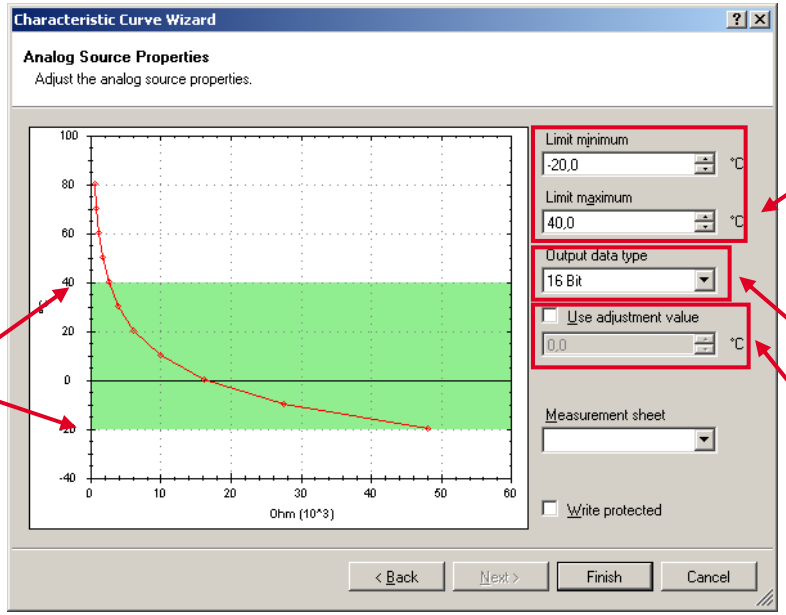
Select physical unit here

Enter resistance/temperature pairs from sensor datasheet here (The 3.01kOhm pull-up resistor is automatically taken into account)

- Click ‘Next’ when done

Configuring Inputs – Characteristic Curve

- The second part of the ‘Characteristic Curve Wizard’ opens



Physical limits of channel

Enter physical limits of the channel here

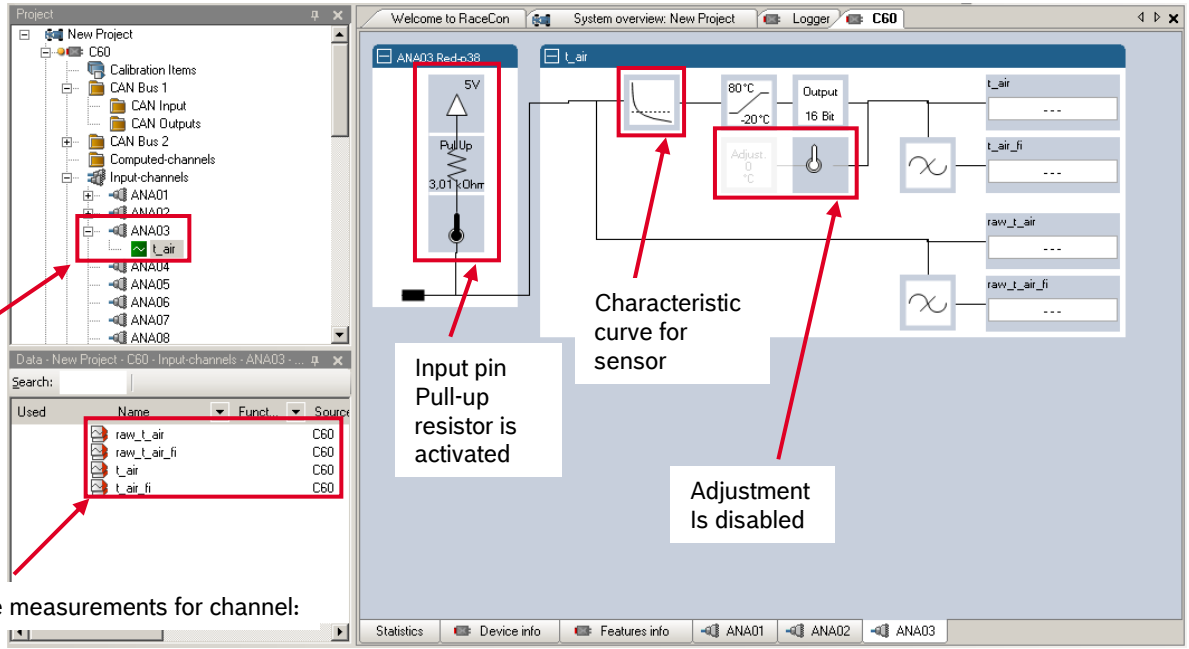
Choose data type of the measurement variable here

This sensor does not need offset calibration

- Click ‘Finish’ when done
- Enter channel name and description
- Click ‘OK’ when done

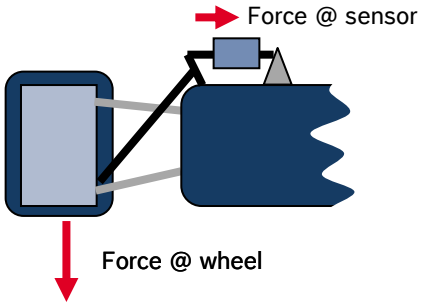
Configuring Inputs – Characteristic Curve

- The channel is inserted into the C 60 project tree



Configuring Inputs – Multipoint Adjustment

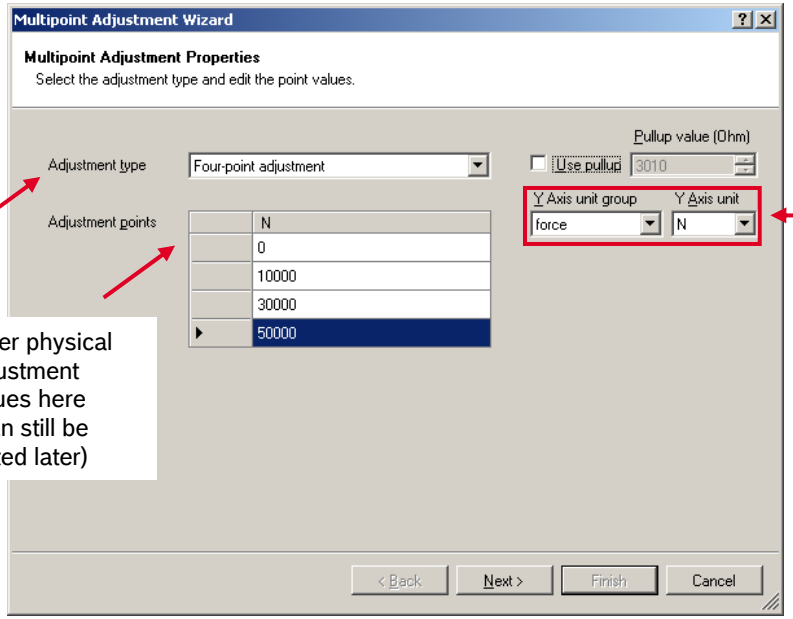
- Configuring a multipoint adjustment
  - Example: measurement of wheel force
    - Physical property ‘wheel force’ not directly measureable
    - Load transfer through suspension kinematics
    - Physical value at sensor position defined by vehicle
    - Curve definition by online adjustment at vehicle



- Drag the ‘Multipoint Adjustment’ analog signal source from the Toolbox and drop it on the desired analog input channel in the C 60 project tree
- A ‘Multipoint Adjustment Wizard’ opens

Configuring Inputs – Multipoint Adjustment

- A ‘Multipoint Adjustment Wizard’ opens



Select type of curve here

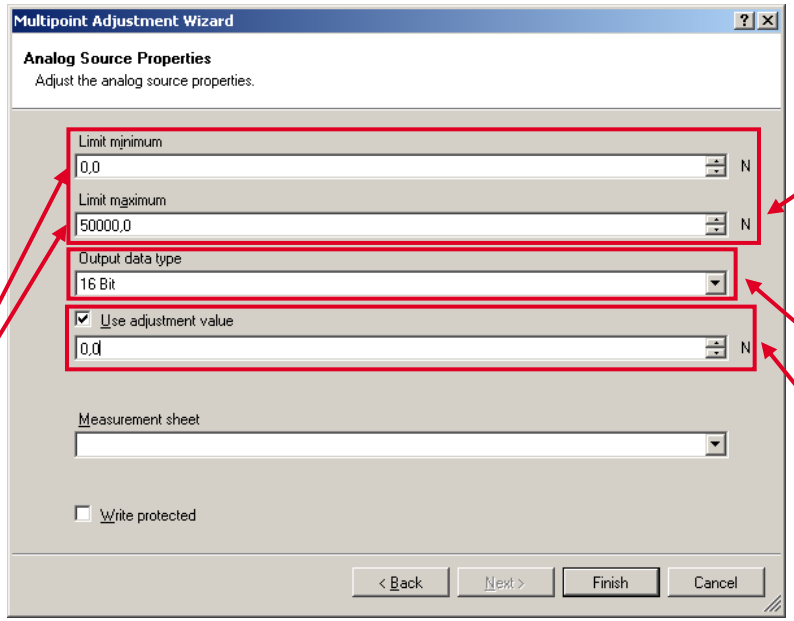
Enter physical adjustment values here (Can still be edited later)

Choose unit group and unit of physical unit here

- Click ‘Next’ when done

Configuring Inputs – Multipoint Adjustment

- The second part of the ‘Multipoint Adjustment Wizard’ opens



Physical limits of channel

Enter physical limits of the sensor here

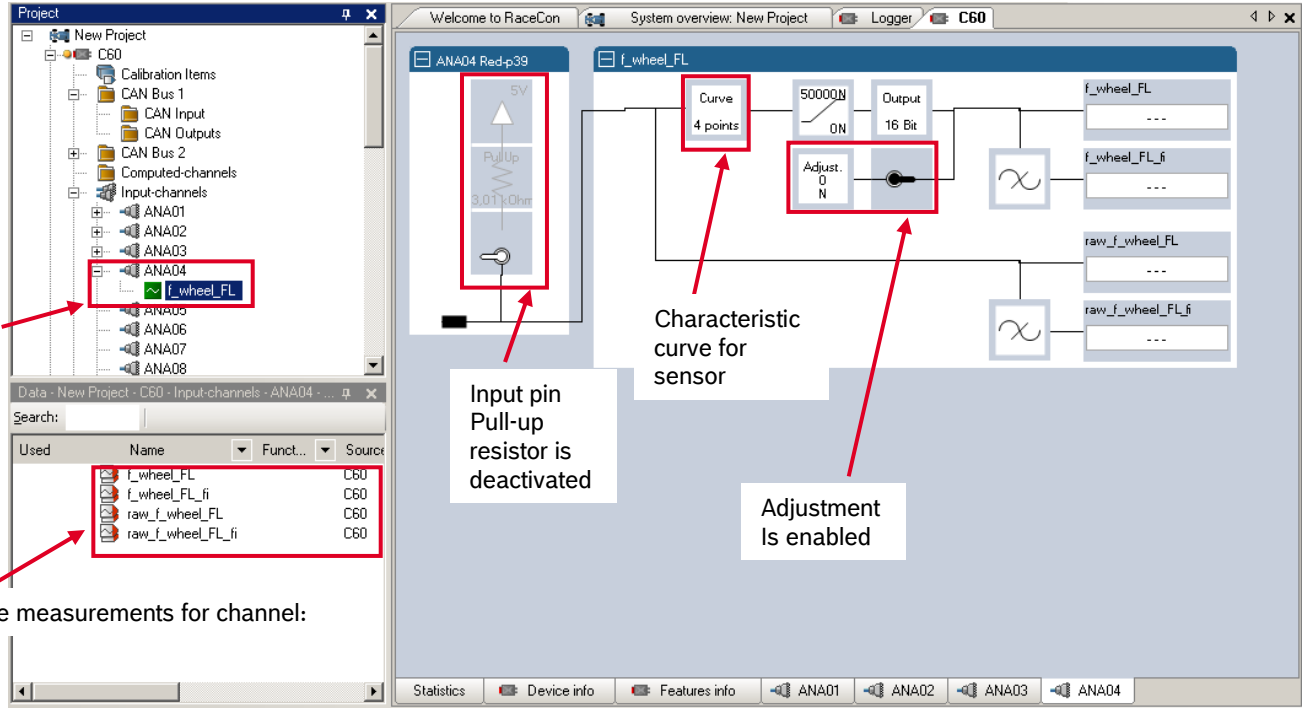
Choose data type of the measurement variable here

Enable additional online calibration

- Click ‘Finish’ when done
- Enter channel name and description
- Click ‘OK’ when done

Configuring Inputs – Multipoint Adjustment

- The channel is inserted into the C 60 project tree



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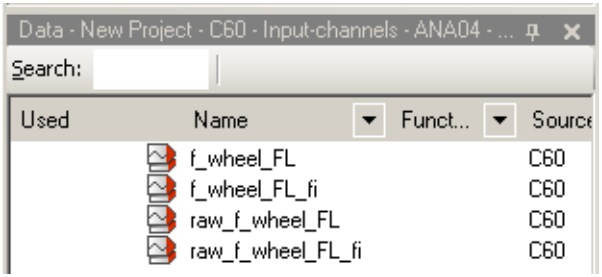
- **Online definition of the curve is covered in the section ‘Online Measurement’**

Analog Inputs – Measurement Channels

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



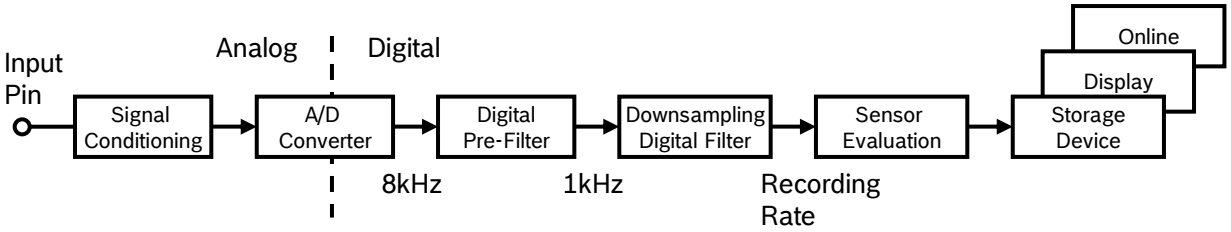
  - **raw**_name — mV value of sensor
  - **raw**_name**_fi** — filtered mV value of sensor
  - name — physical value of sensor
  - name**_fi** — filtered physical valuexxx

- Filtered channels are routed through digital low pass filters
  - C 60 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

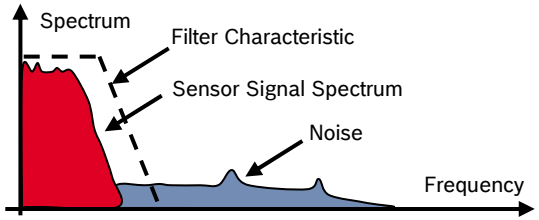
:

Analog Inputs – Digital Filter Details

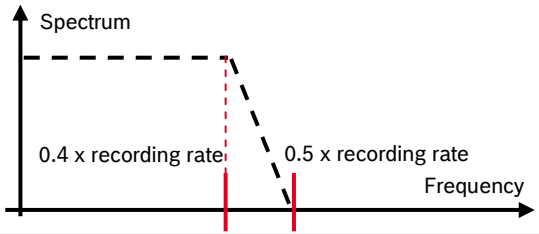
- C 60 uses A/D converter oversampling and digital filtering to recording rate



- Digital filters eliminate 'out-of-band' noise



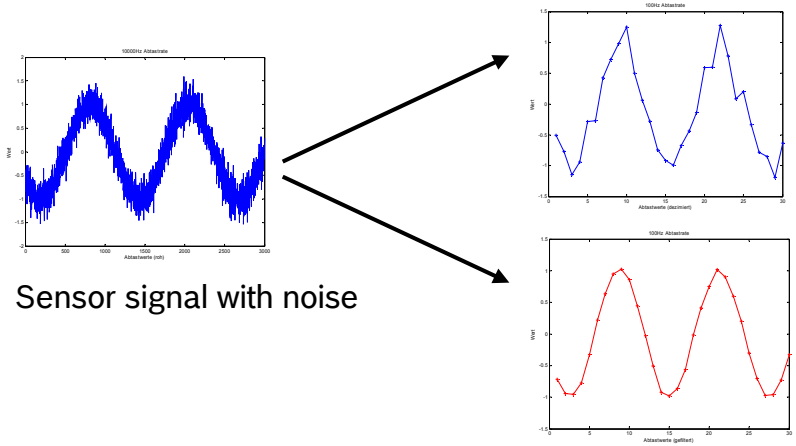
- Cut-off frequency automatically adjusted to recording rate



Example:
- 100Hz recording rate (10ms)
- <40Hz passband (>99%)
- >50Hz stopband (<1%)

Analog Inputs – Digital Filter Details

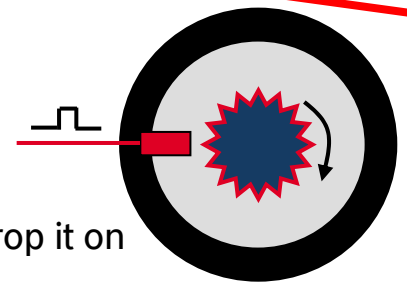
- Linear phase – no signal distortion



- 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
  - C 60 filters have constant, frequency independent delay
  - Delay (e.g. 22 samples @ 10ms) 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 realtime

Configuring Inputs – Frequency Inputs

Software Upgrade 1 required

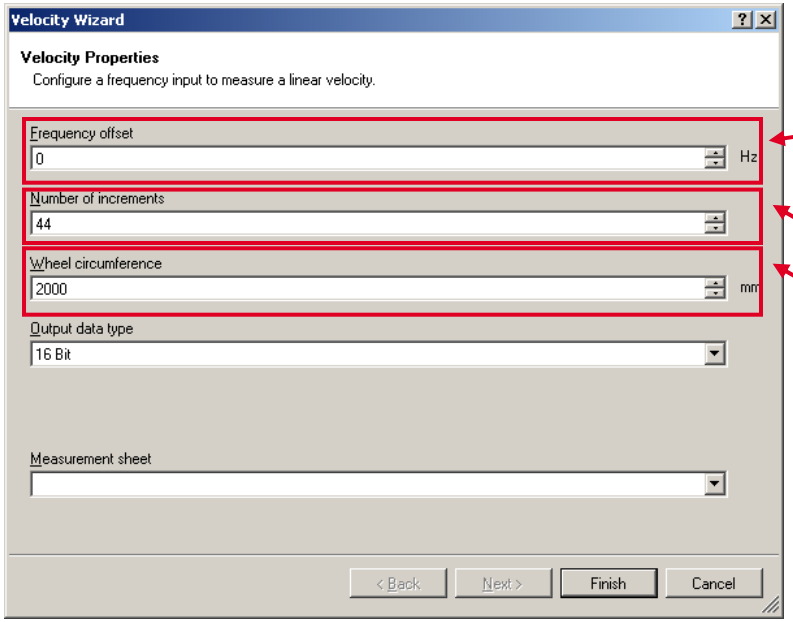


- Configuring a frequency input
  - Example: measurement of wheel speed
    - Pulse wheel attached to wheel
    - Each passing tooth of pulse wheel triggers hall sensor
    - Calculation of wheel speed with wheel circumference
  - Drag the ‘Velocity’ digital signal source from the Toolbox and drop it on the desired ‘Rev’ input channel in the C 60 project tree
  - A ‘Velocity Wizard’ opens

Configuring Inputs – Frequency Inputs

Software Upgrade 1 required

- A ‘Velocity Wizard’ opens



Special functionality for sensors with frequency offset (e.g. Correvit) Set to ‘0’ for wheelspeed measurement

Number of teeth on the pulse wheel

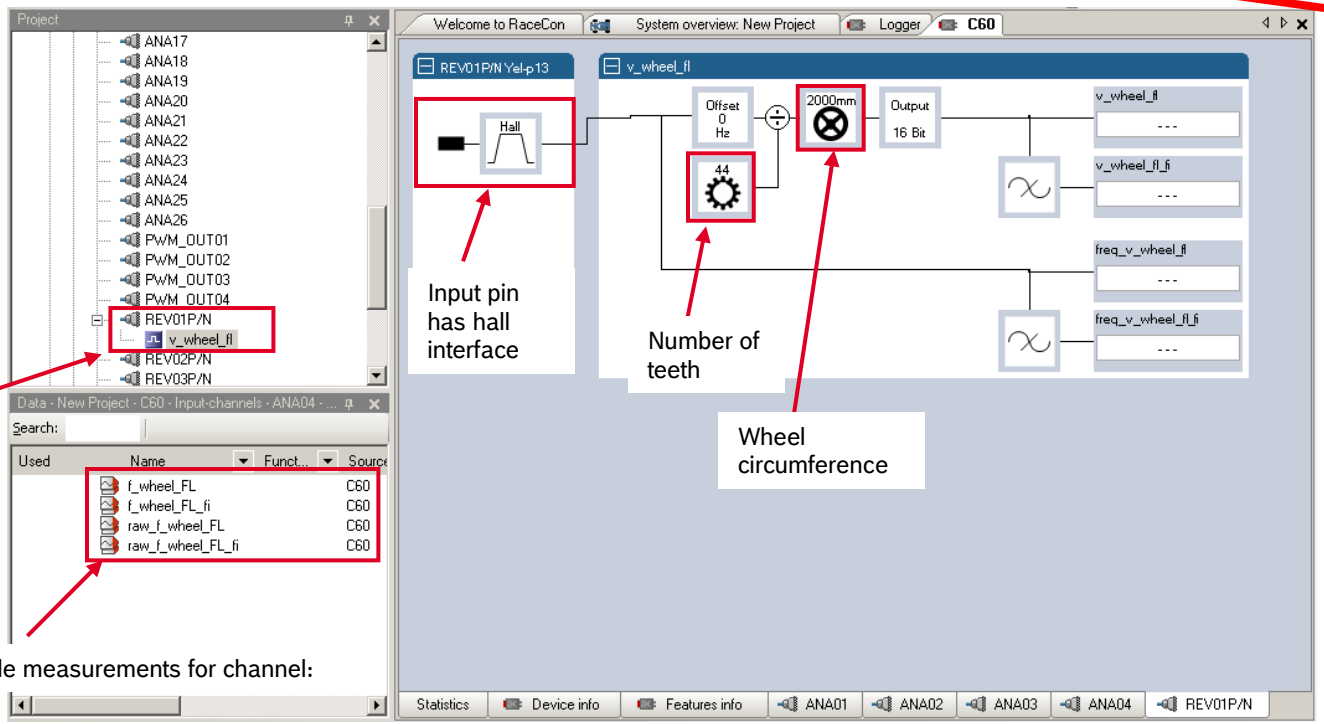
Circumference of wheel for speed calculation

- Click ‘Finish’ when done
- Enter channel name and description
- Click ‘OK’ when done

Configuring Inputs – Frequency Input

Software Upgrade 1 required

- The channel is inserted into the C 60 project tree



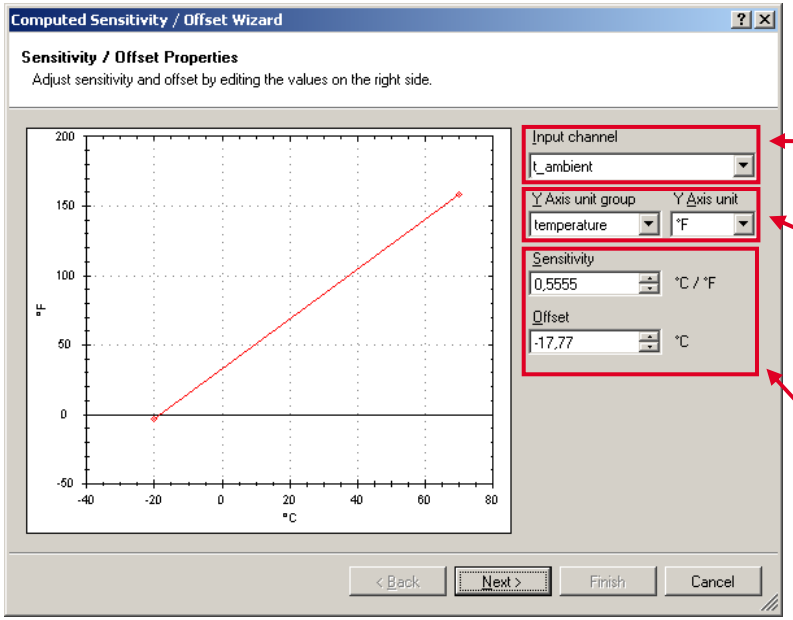
- Measurement of ‘Revolution’ is similar

Computed Sources

- 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
    - PWM output control (covered in a special section)
    - Lap trigger (covered in a special section)

Computed Sources

- **Example: Sensitivity / Offset calculation on input channel**
  - Drag the ‘Characteristic Curve’ computed source from the Toolbox and drop it on ‘Computed Channels’ in the C 60 project tree
  - A ‘Computed Sensitivity / Offset Wizard’ opens



Choose input channel here

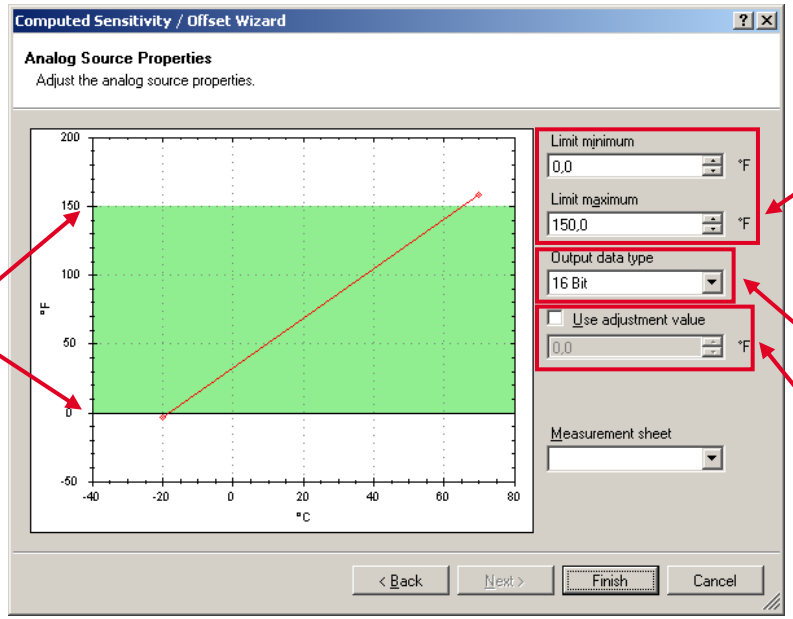
Choose unit group and unit of output here

Enter sensitivity and offset of conversion formula here

  - Click ‘Next’ when done

Computed Sources

- The second part of the ‘Computed Sensitivity / Offset Wizard’ opens



Physical limits of channel

Enter physical limits of the channel here

Choose data type of the measurement variable here

This sensor does not need offset calibration

- Click ‘Finish’ when done
- Enter channel name and description
- Click ‘OK’ when done

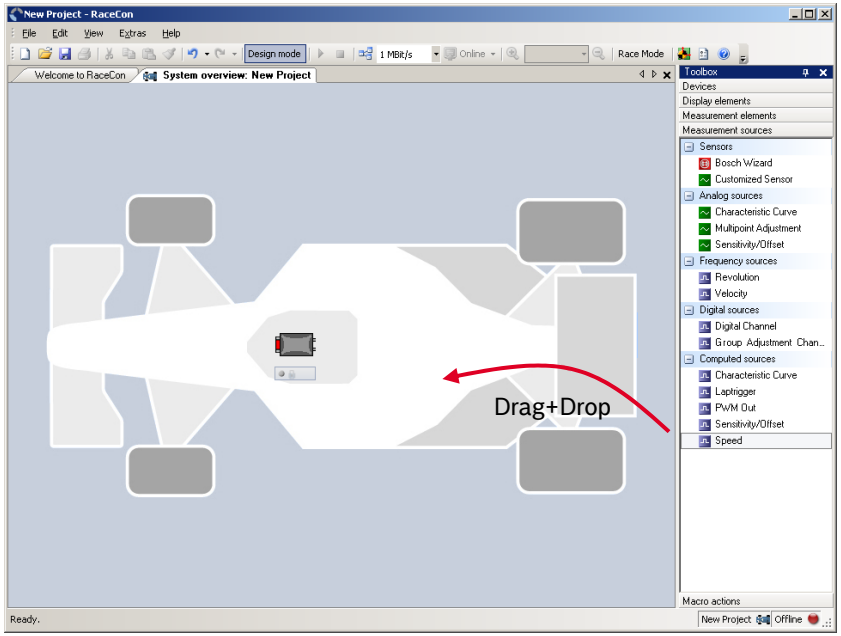
Special Functionality: Vehicle Speed

- High performance vehicles
  - Wheel spin under acceleration
  - Wheel slip/lock under braking
- Vehicle ‘speed over ground’ must be calculated

- Vehicle speed calculation function
  - Two wheel drive
    - Wheel speeds of non-driven axle as input
    - Calculated speed is
      - If speed difference between wheels < limit: average of both speeds
      - If speed difference between wheels > limit: maximum of both speeds
  - Four wheel drive
    - Wheel speeds of all wheels as input
    - Calculated Speed is
      - Speed of 2nd fastest wheel

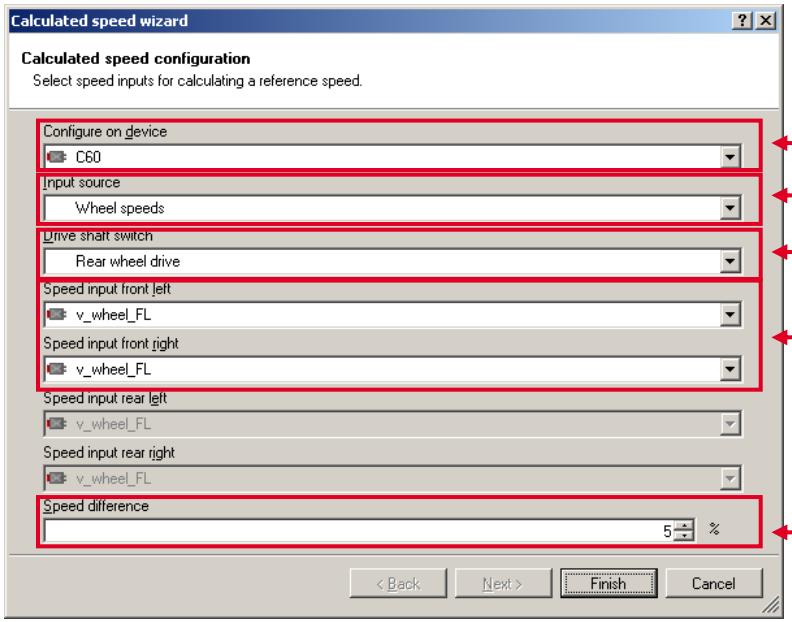
Special Functionality: Vehicle Speed

- Setting up calculated speed for C 60
  - Select ‘Measurement Sources’ in Toolbox
  - Select ‘Computed Sources’
  - Select and drag ‘Speed’ into ‘System Overview’
  - Drop ‘Calculated Speed’ on vehicle
    (Not on C 60!)
  - A pop-up window opens



Special Functionality: Vehicle Speed

- A ‘Calculated Speed Wizard’ opens



Choose device here

Choose input source (internal / external) here

Choose driven axle here

Choose individual wheel speed channels here

Set limit for speed difference for calculation

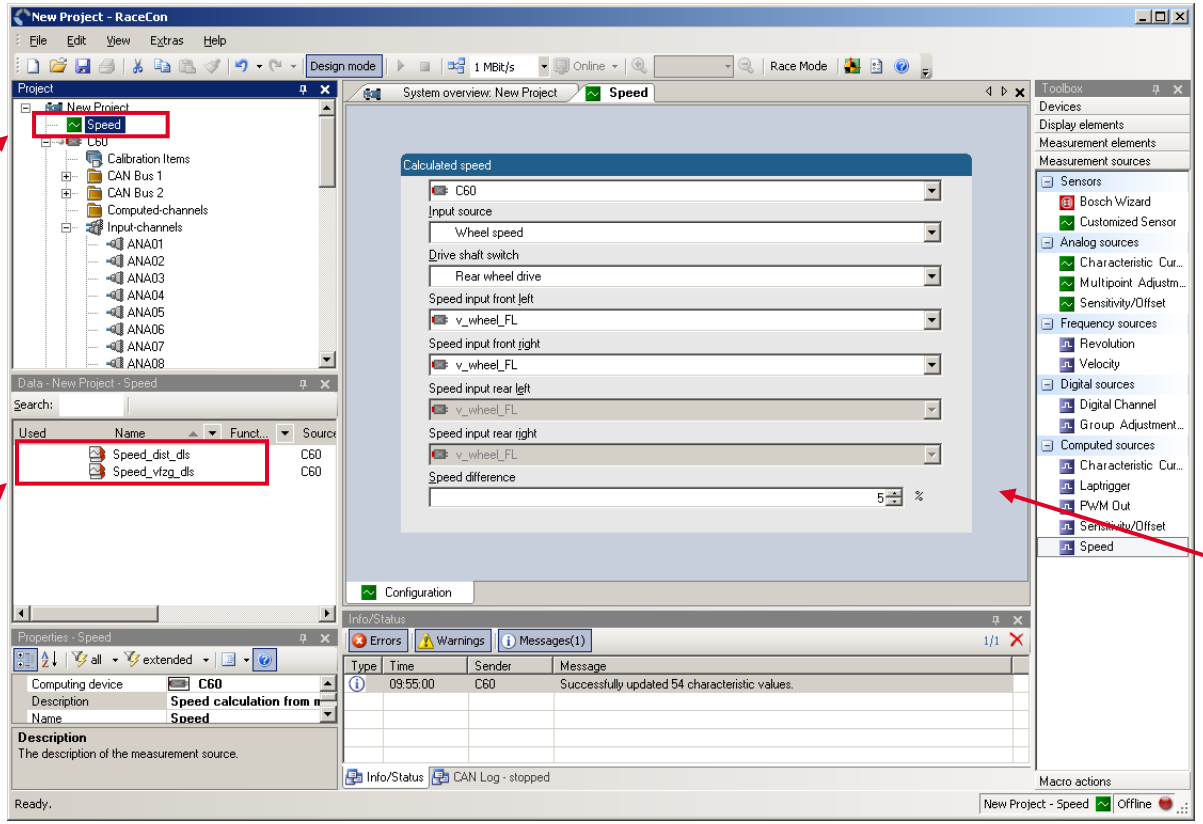
- Click ‘Finish’ when done

Special Functionality: Vehicle Speed

- The speed calculation is inserted into the project tree

Speed calculation in project tree

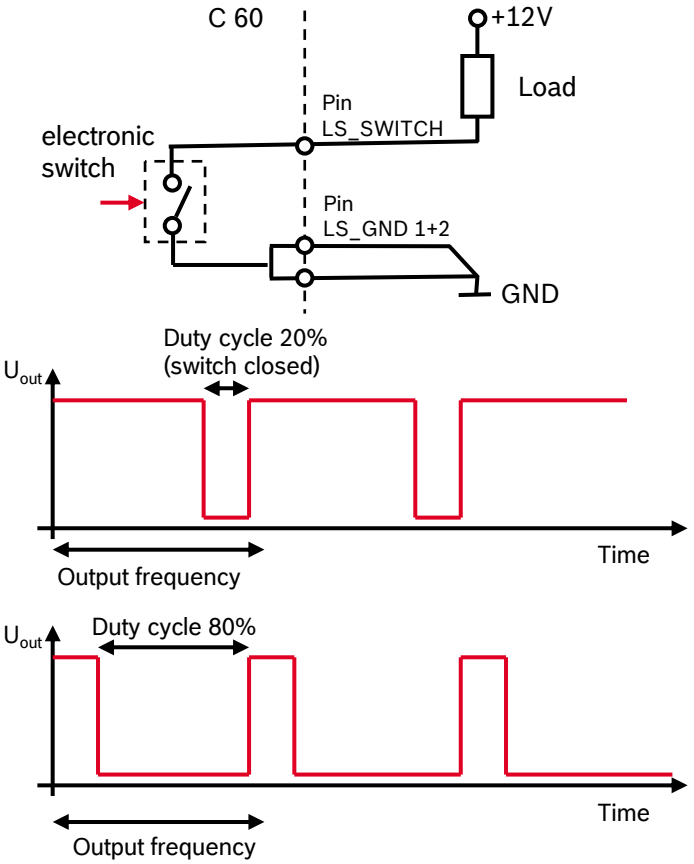
Measurement channels calculated speed and calculated distance



Configuration window

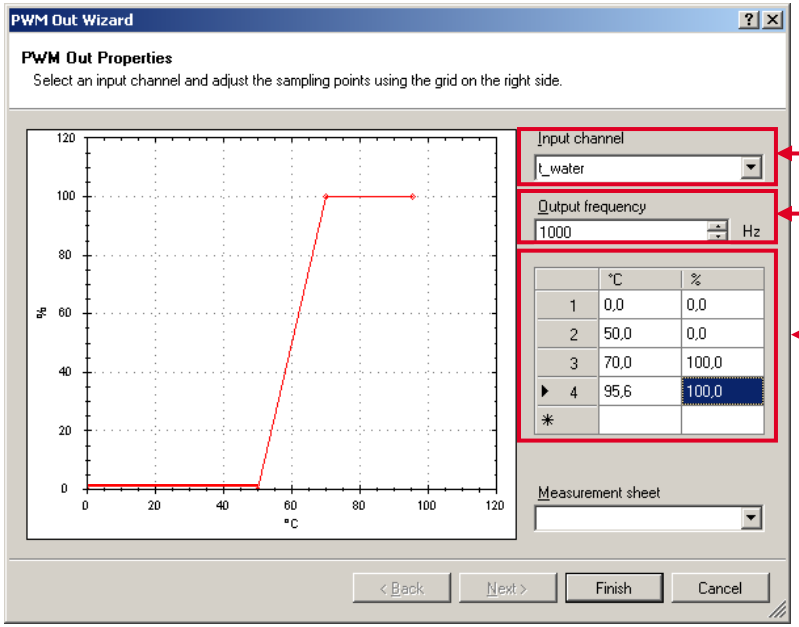
Configuring PWM Outputs

- PWM
  - **P**ulse **W**idth **M**odulation
  - Output frequency is constant
  - ‘On time’ (duty cycle) controlled by input channel
- C 60 has 4 PWM outputs
  - Low-side switch
  - Up to 2A each
  - Selectable output frequency
  - Duty cycle controlled by characteristic curve
- Configuring a PWM Output
  - Drag the ‘PWM Out’ computed source from the Toolbox and drop it on the desired ‘PWM Out’ channel in the C 60 project tree
  - A ‘PWM Out Wizard’ opens



Configuring PWM Outputs

- A ‘PWM Out Wizard’ opens



Choose input channel here

Choose output frequency here

Define characteristic curve here

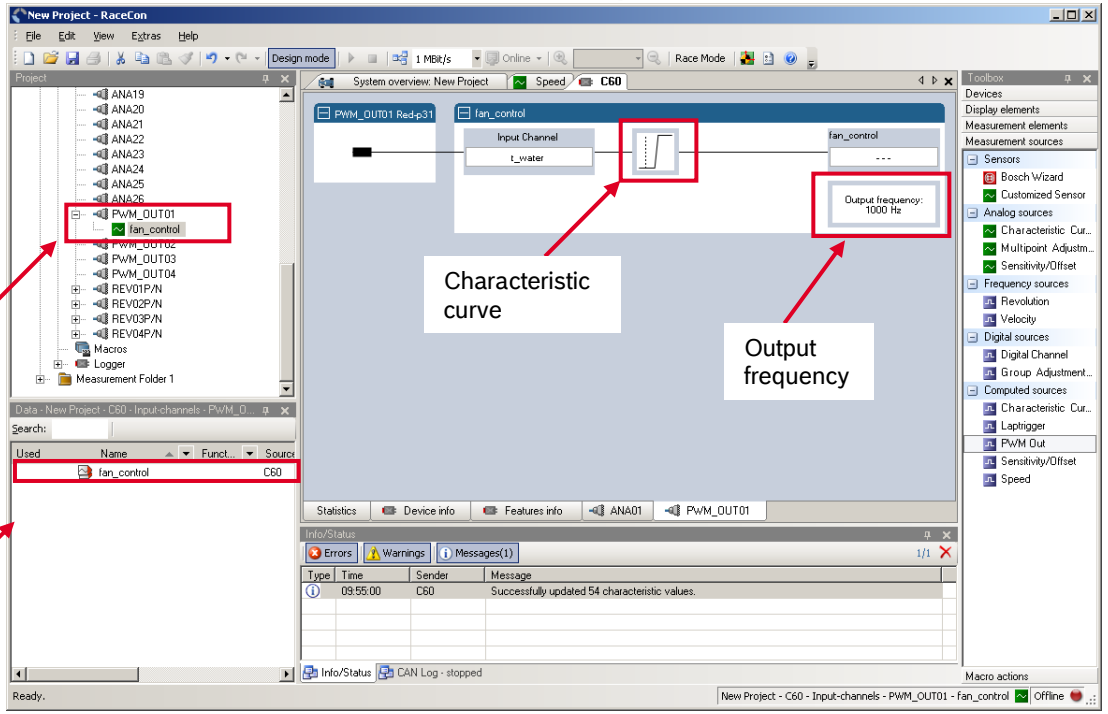
Note:
Choosing a filtered channel as an input for PWM out will cause delayed reaction due to the delay introduced by the digital filter. Use unfiltered values for this purpose.

Note:
The ‘power-on’ state of the PWM output is ‘switch open’ (0% duty cycle)

- Click ‘Finish’ when done
- Enter channel name and description
- Click ‘OK’ when done

Configuring PWM Outputs

- The channel is inserted into the C 60 project tree



Diagnostic channels:

pwm_err_ls_out_01_OL	PWM output 1 error open load
pwm_err_ls_out_01_OT	PWM output 1 error over temperature
pwm_err_ls_out_01_SCB	PWM output 1 error short circuit to battery
pwm_err_ls_out_01_SCG	PWM output 1 error short circuit to GND

Similar:
PWM output 2..4 diagnosis

Online Measurement

Online Measurement and Calibration

C 60 Online Measurement + Calibration

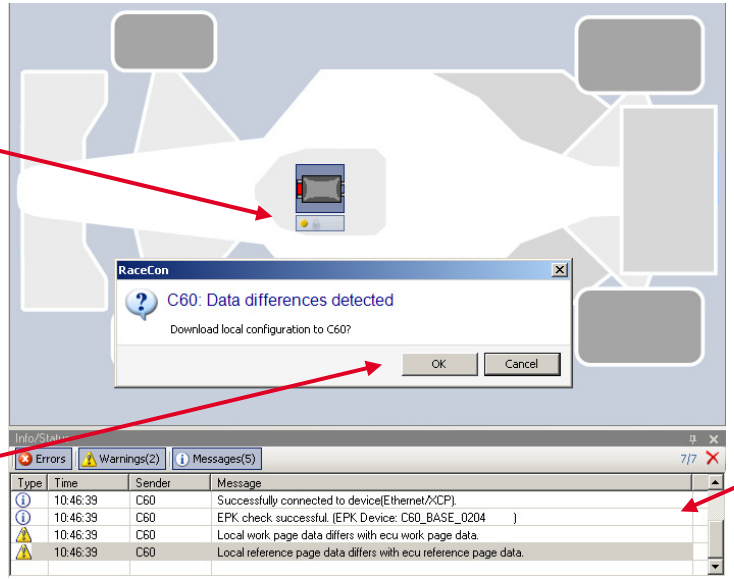
- C 60 Configuration
  - System configuration (channel + display configuration, CAN I/O, PWM Out, etc.) is stored in the C 60
  - Use RaceCon to create and download configuration from the PC to C 60
  - Communication interface: Ethernet
  - Communication protocol: XCP

- 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

C 60 Online Measurement + Calibration

- Achieving an On-line Connection
  - Set up the PC for access to the C 60
    - IP Configuration for the Ethernet interface to ‘automatic configuration’ (DHCP)
    - Switch off local firewall on the PC
    - Start RaceCon
    - Establish the electrical Ethernet connection to the vehicle
    - Power on the vehicle

Yellow dot indicates live connection to the device, but local RaceCon configuration does not match the C 60’s configuration

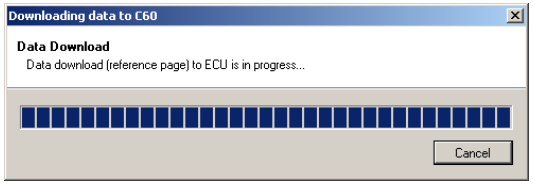


Click ‘OK’ to download RaceCon configuration to device

Status message window

C 60 Online Measurement + Calibration

- Going Online…
  - Click ‘OK to download RaceCon configuration to device
  - The download starts



  - A green dot at the device in the project view and the project tree indicates a successful download and system consistency

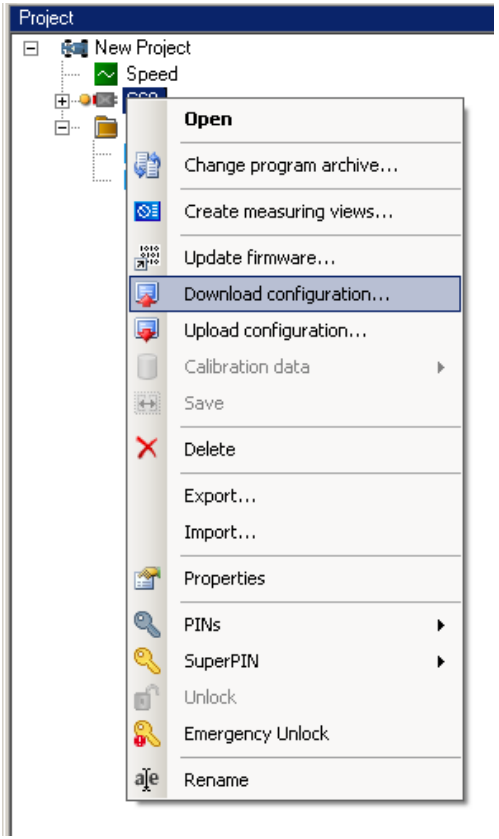
Type	Time	Sender	Message
ⓘ	11:08:20	C60	Successfully downloaded configuration.
ⓘ	11:08:20	C60	Successfully connected to device(Ethernet/XCP).
ⓘ	11:08:20	C60	EPK check successful. (EPK Device: C60_BASE_0204)
ⓘ	11:08:20	C60	The ECU data matches the current project data.

  - If the system’s configuration in RaceCon has been changed, the dot becomes yellow and a configuration download is necessary

C 60 Online Measurement + Calibration

➔ Configuration download

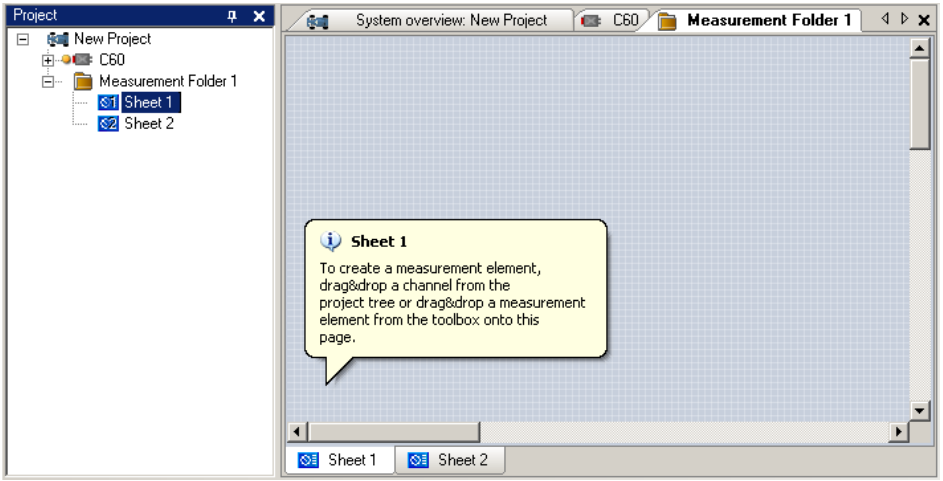
- Right click on C 60 in project tree
- Select ‘Download configuration’
- The configuration download starts
- Green dots indicate a successful download



C 60 Online Measurement + Calibration

➔ Setting up an online measurement

- C 60 supports online measurement of sensor values and diagnostic variables
- Expand ‘Measurement Folder 1’ in the project tree and double click on ‘Sheet1’

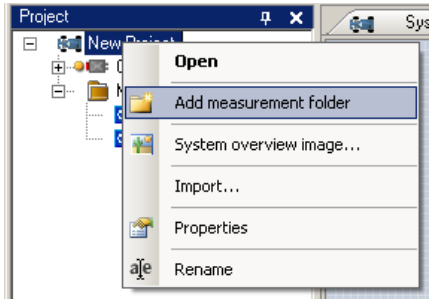


- ‘Sheet 1’ is opened in the main area

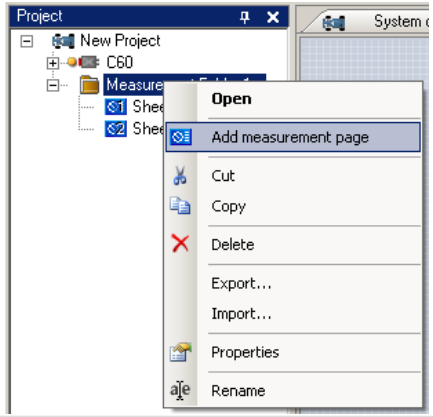
C 60 Online Measurement + Calibration

➔ Setting up an online measurement

- From the context menu of the project, new measurement folders can be created:



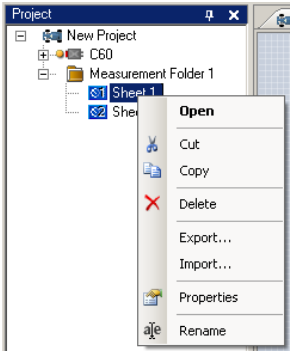
- From context menu of a measurement folder, the folder can be renamed and deleted. It also allows the creation of measurement pages



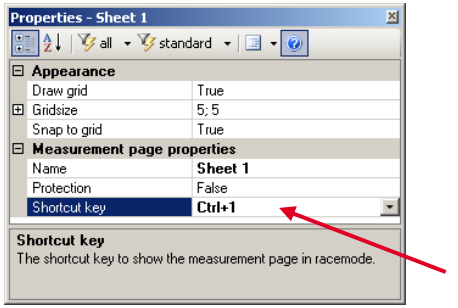
C 60 Online Measurement + Calibration

➔ Setting up an online measurement

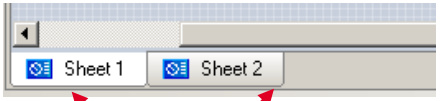
- From context menu of a measurement page, the page can be renamed and deleted



- To change between different pages, use the shortcut specified in the properties menu or click on the tabs on the bottom of the main project area



Shortcut key

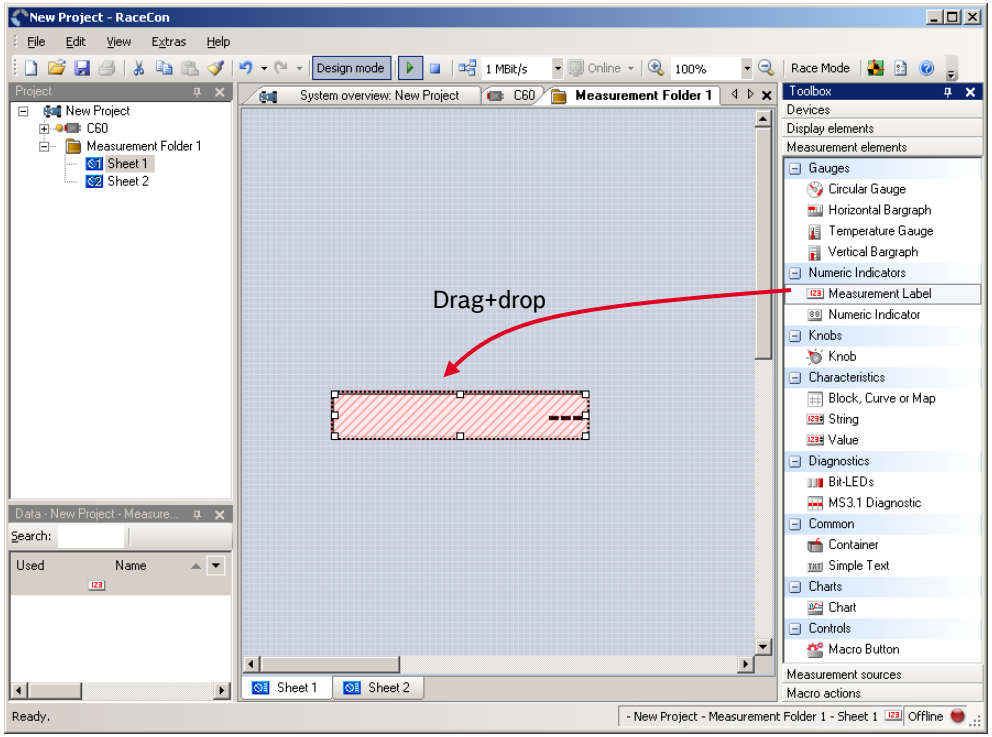


Tabs to change between sheets

C 60 Online Measurement + Calibration

➔ Setting up an online measurement

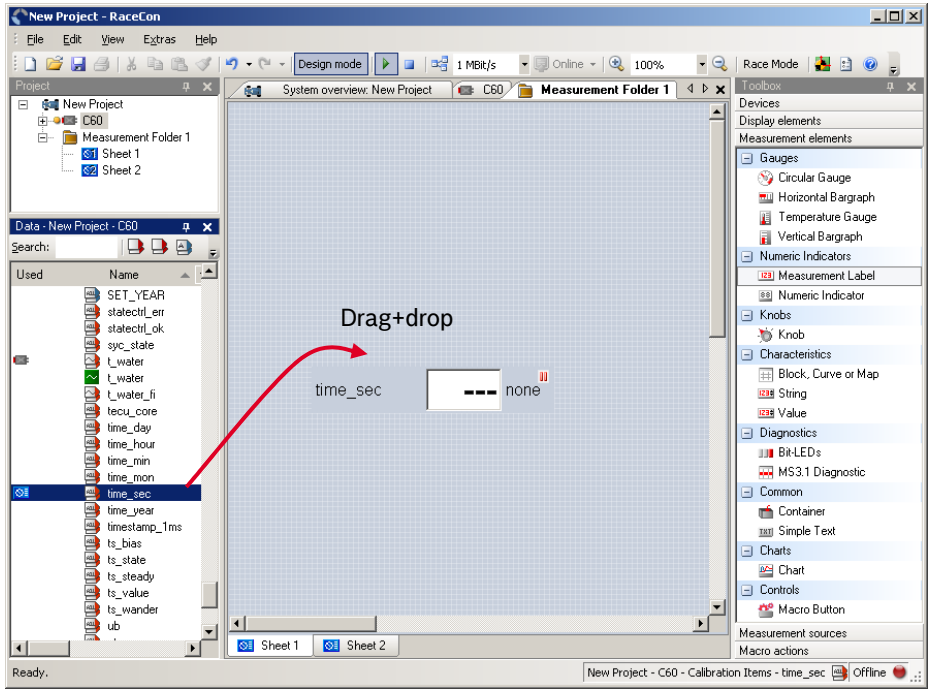
- To add an element to a measurement sheet, drag a measurement element from the toolbox and drop on the measurement sheet



C 60 Online Measurement + Calibration

➔ Setting up an online measurement

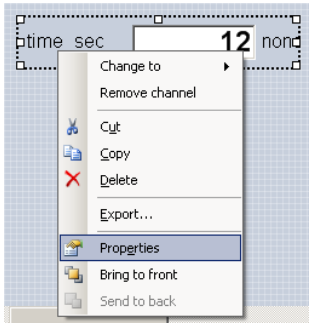
- To link a measurement channel to the measurement element, click on ‘C 60’ in the project tree to display all labels, select the desired measurement channel and drop it on the measurement element. If the C 60 is online, the value is displayed.

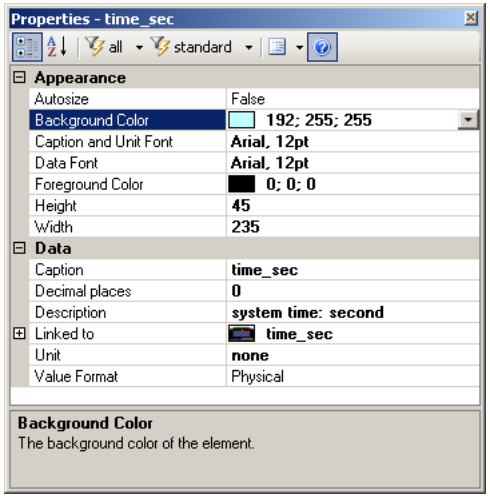


C 60 Online Measurement + Calibration

➔ Setting up an online measurement

- Utilizing the properties menu of the measurement element, its appearance can be changed.



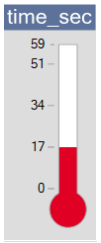


C 60 Online Measurement + Calibration

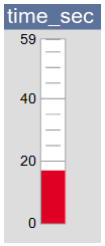
➔ Setting up an online measurement

- RaceCon offers different types on measurement elements

Circular gauge

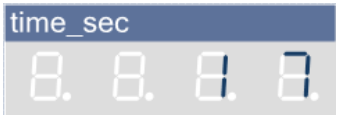


Temperature gauge

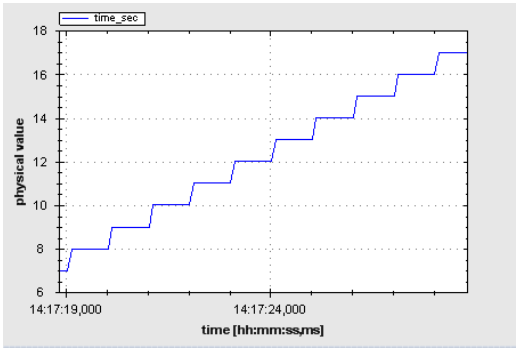


Vertical Bar graph style

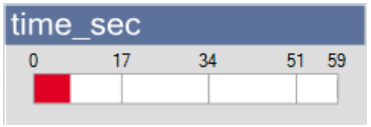
Measurement label



Numeric indicator



Chart

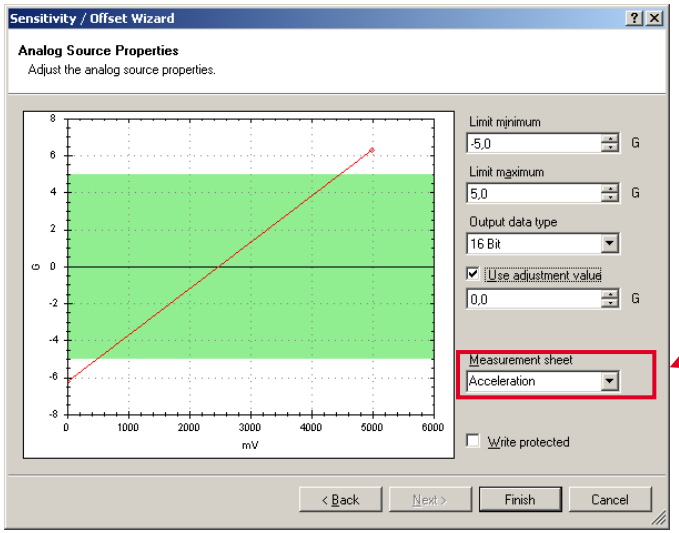


Horizontal Bar graph style

C 60 Online Measurement + Calibration

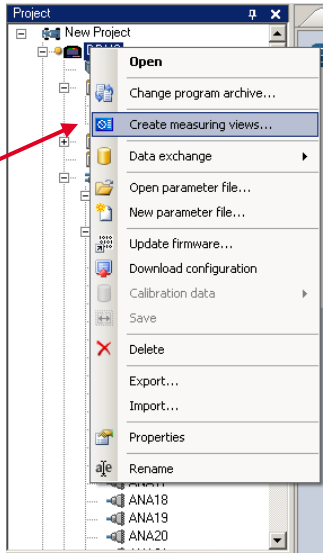
➔ Automatic creation of measurement sheets

- RaceCon can create measurement sheets automatically
  - During the configuration of a measurement channel, select a measurement sheet from the list box or enter a name for a new measurement sheet
  - To create the sheets, click ‘Create measurement views…’ from the C 60 context menu



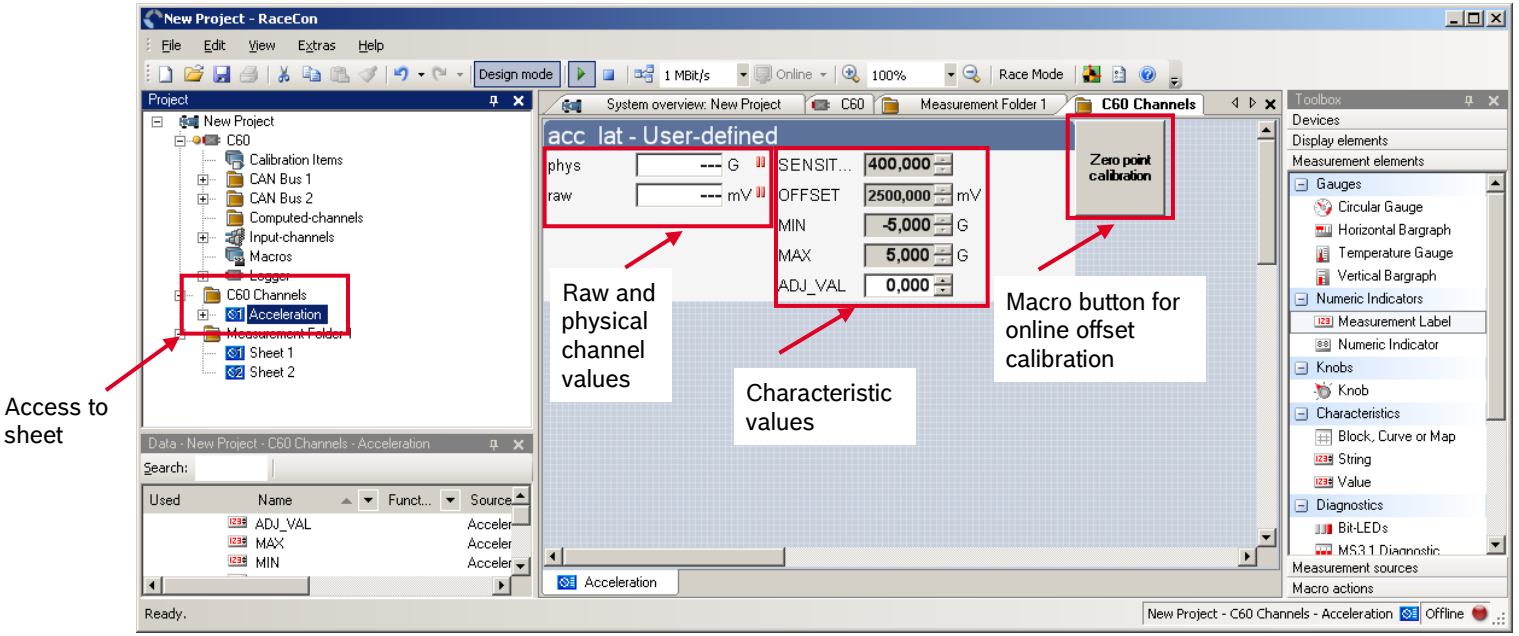
Select existing sheet from list or enter name of new sheet

Click to create measurement sheets



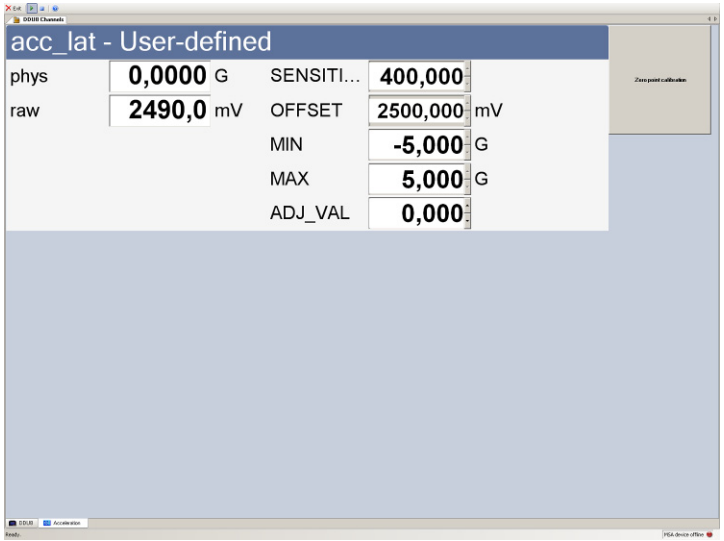
C 60 Online Measurement + Calibration

- Automatic creation of measurement sheets
  - The automatically created sheet is inserted in the tree under ‘C 60 Channels’



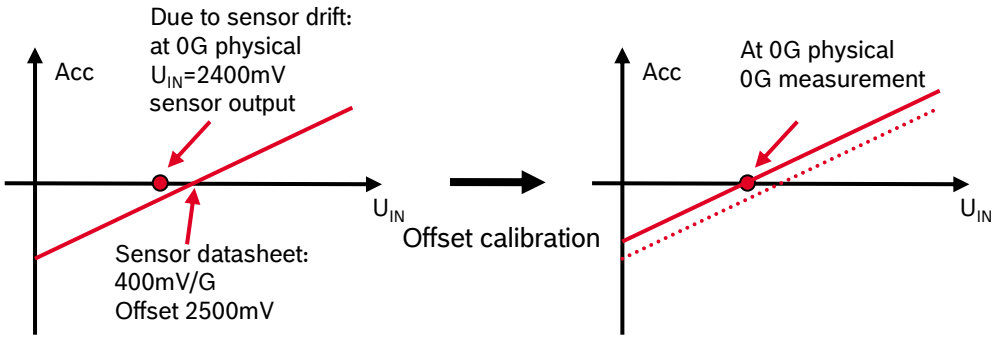
C 60 Online Measurement + Calibration

- Automatic creation of measurement sheets
  - Using the measurement sheets
    - 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 macro button for offset calibration is active
    - Switch between different sheets using the tabs at the bottom of the page or the keyboard shortcuts associated with the sheets
    - Return to ‘Design Mode’ by pressing the ‘Esc’ key



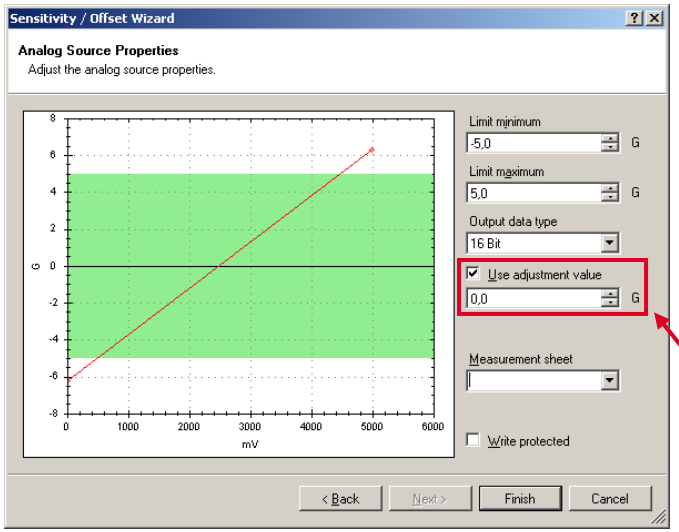
C 60 Online Measurement + Calibration

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

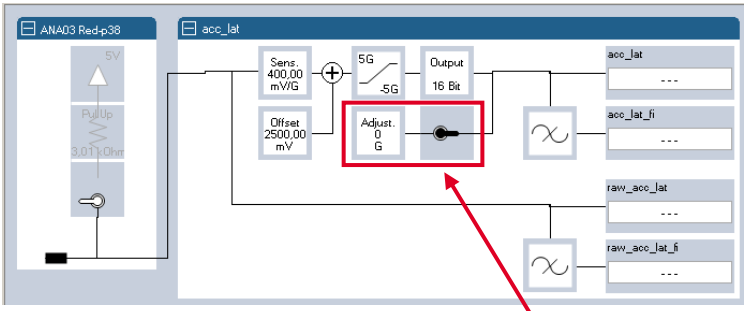


C 60 Online Measurement + Calibration

- Online calibration of adjustment channels
  - Enable offset calibration for measurement channel



During creation of the measurement channel



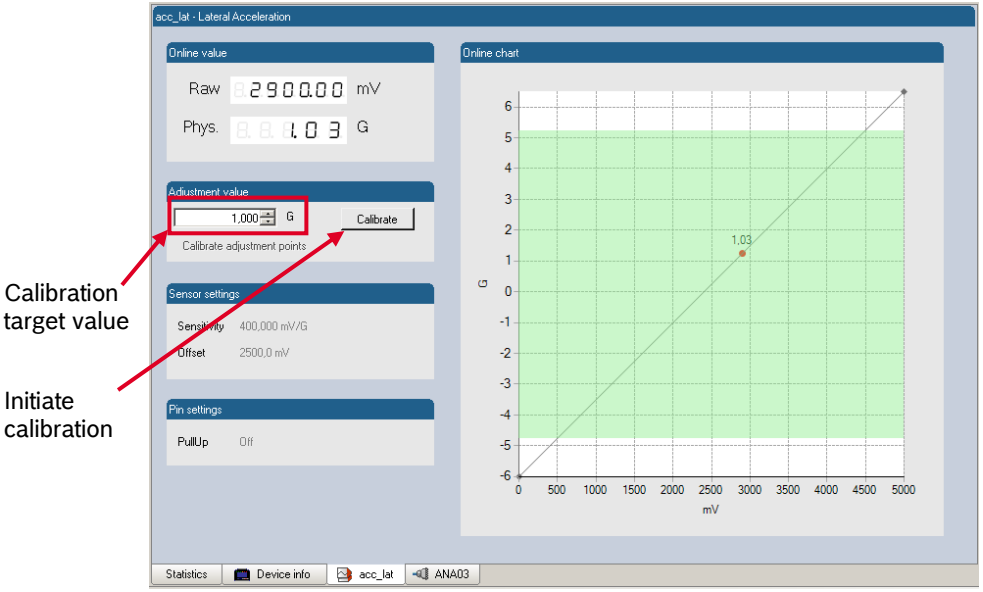
In the channel view

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

Activate switch to enable online calibration

C 60 Online Measurement + Calibration

- Online calibration of measurement channels
  - Performing the offset calibration:
    - Apply the desired physical condition to the sensor (e.g. 1G to an acceleration sensor)
    - Open the channel's online page by double clicking on the channel name
    - Enter the physical target value (e.g. 1G) and press the 'Calibrate' button



C 60 Online Measurement + Calibration

➔ Group adjustment

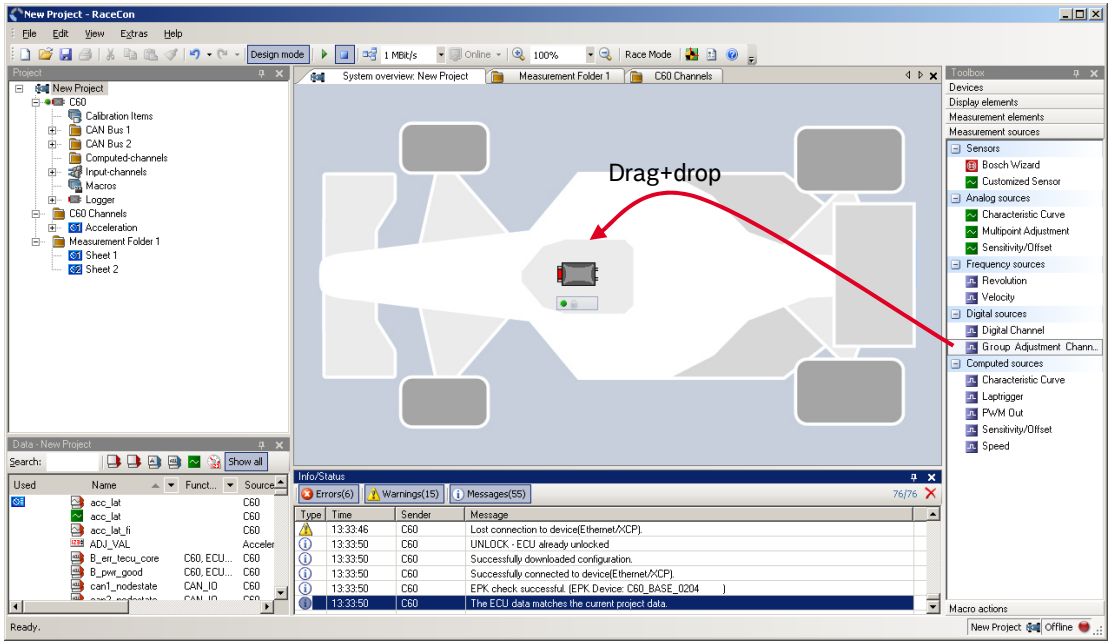
- What is group adjustment?
  - Simultaneous online calibration of several channels
  - This is useful e.g. to set all wheel forces and damper positions to ‘0’ when the vehicle is positioned on a flat patch

- 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

C 60 Online Measurement + Calibration

➔ Group adjustment

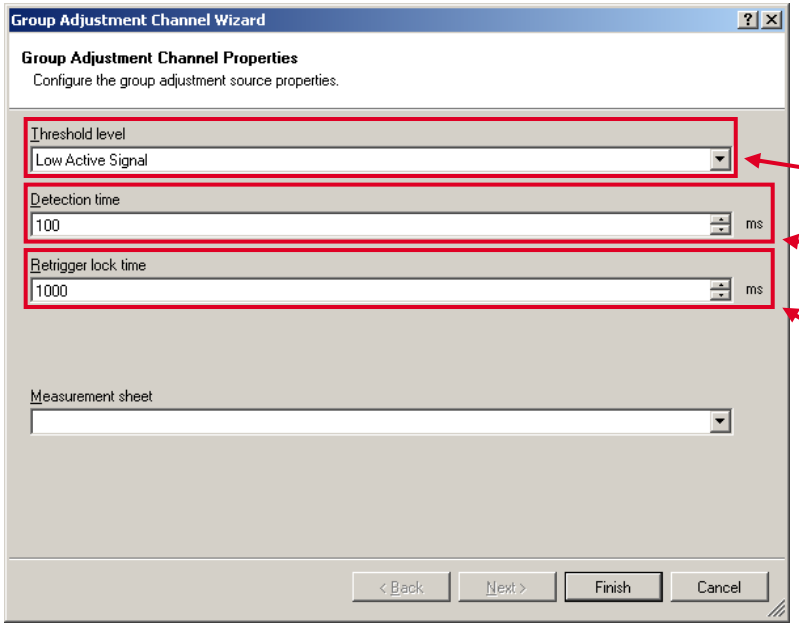
- Setting up the group adjustment trigger channel
  - To add a ‘Group Adjustment Channel’ to the project, drag the ‘Group Adjustment Channel’ element from the toolbox and drop on the C 60



C 60 Online Measurement + Calibration

➔ Group adjustment

- Setting up the group adjustment trigger channel
  - To add a ‘Group Adjustment Channel’ to the project, drag the ‘Group Adjustement Channel’ element from the toolbox and drop on the C 60
  - A ‘Group Adjustment Channel Wizard’ opens

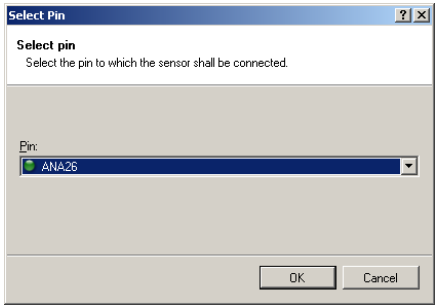


  - Click ‘Finish’ when done

C 60 Online Measurement + Calibration

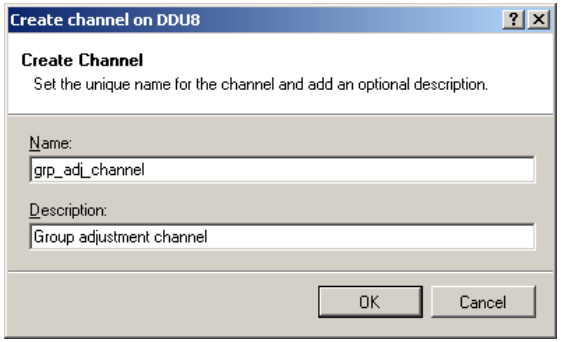
➔ Group adjustment

- Next, select an input pin for the trigger channel



Note: 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

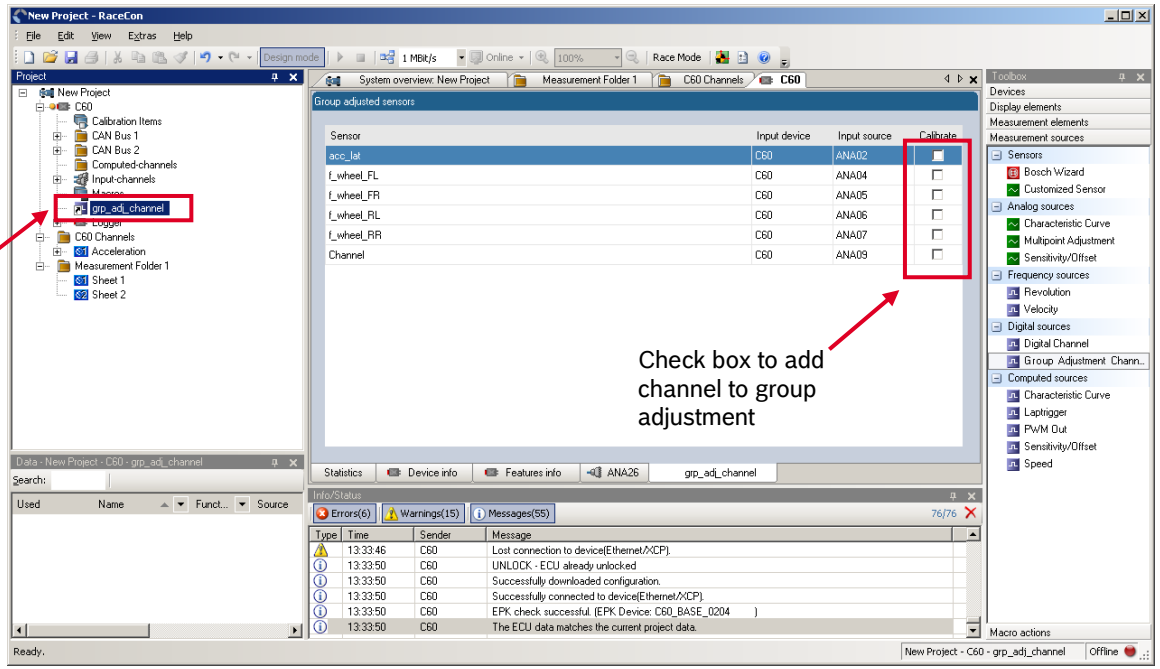
- And create a channel name for the trigger channel



C 60 Online Measurement + Calibration

➔ Group adjustment

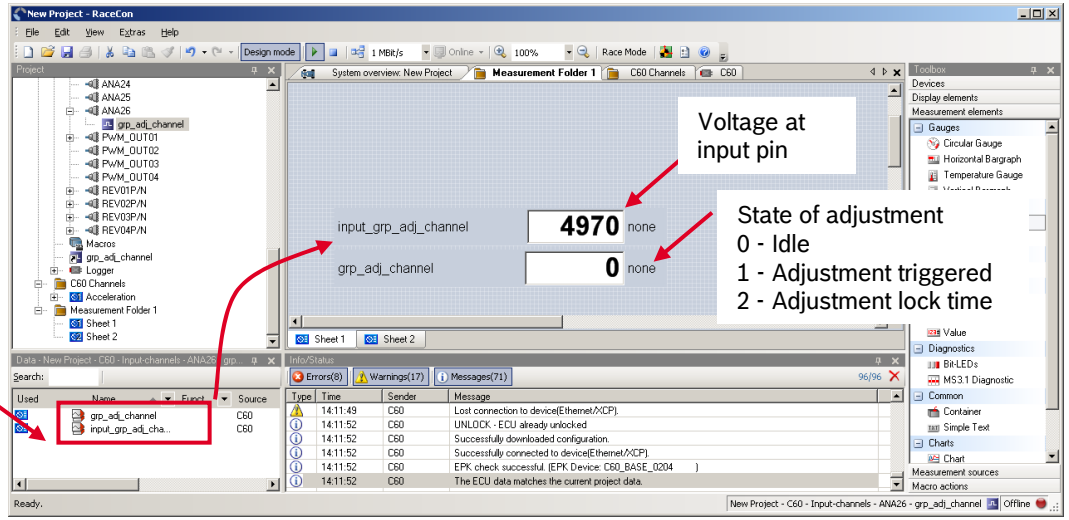
- Assigning channels to the group adjustment event
  - Double click on ‘group_adjust_input’ in the project tree. In the main area, an overview of the available adjustment channels opens. To add measurement channel(s) to the group adjustement event, tick the ‘Calibrate’ box of the desired channel(s).



C 60 Online Measurement + Calibration

➔ Group adjustment

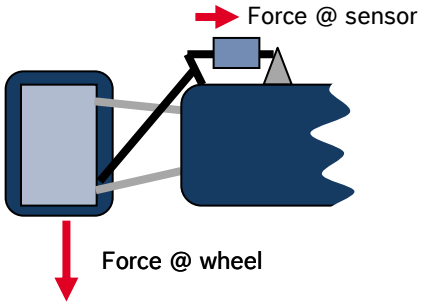
- Triggering the group adjustment
  - Double click on the input channel of the group adjustment.
  - Make sure the pull-up resistor is enabled, if you selected ‘active low’ trigger polarity
  - Connect the input pin to GND using a push-button
  - Download the configuration on the C 60
  - Drag the ‘grp_adj_channel’ and the ‘input_grp_adj_channel’ to an online measurement sheet
  - Press and release the push-button
  - The measurement labels indicate the state of the input pin and the state of the adjustment
  - Hint: A display alarm can be linked to the trigger channel indicate that the trigger has been detected



C 60 Online Measurement + Calibration

➔ Online calibration of multi-point adjustment channels

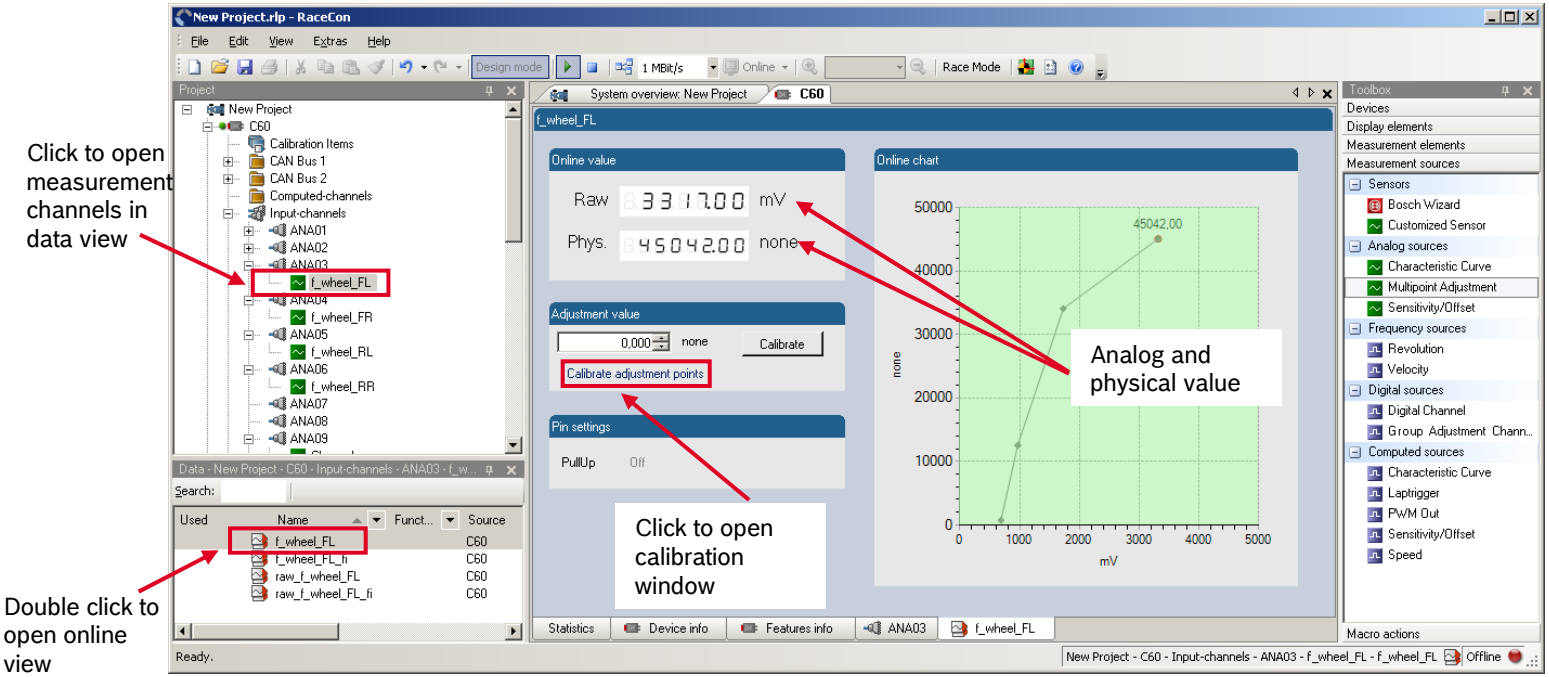
- Example: measurement of wheel force
  - Physical property ‘wheel force’ not directly measureable
  - Load transfer through suspension kinematics
  - Physical value at sensor position defined by vehicle
  - Curve definition by online adjustment at vehicle



C 60 Online Measurement + Calibration

➔ Online calibration of multi-point adjustment channels

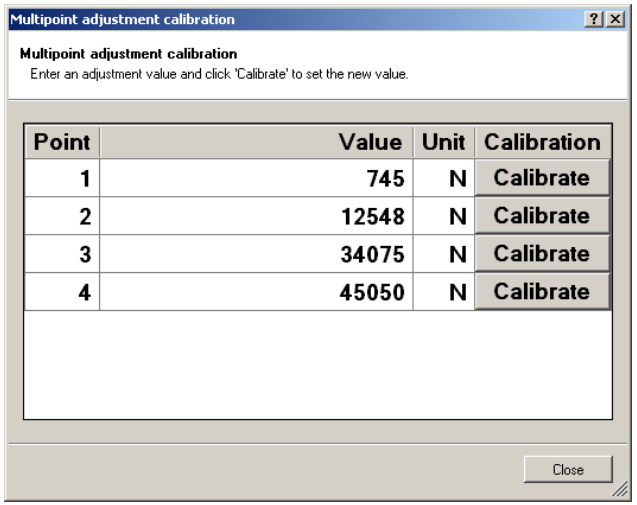
- Create a multi-point adjustment measurement channel and download configuration
- Click on the channel in the project tree
- Double click a measurement channel in the data window to open the online view



C 60 Online Measurement + Calibration

➔ Online calibration of multi-point adjustment channels

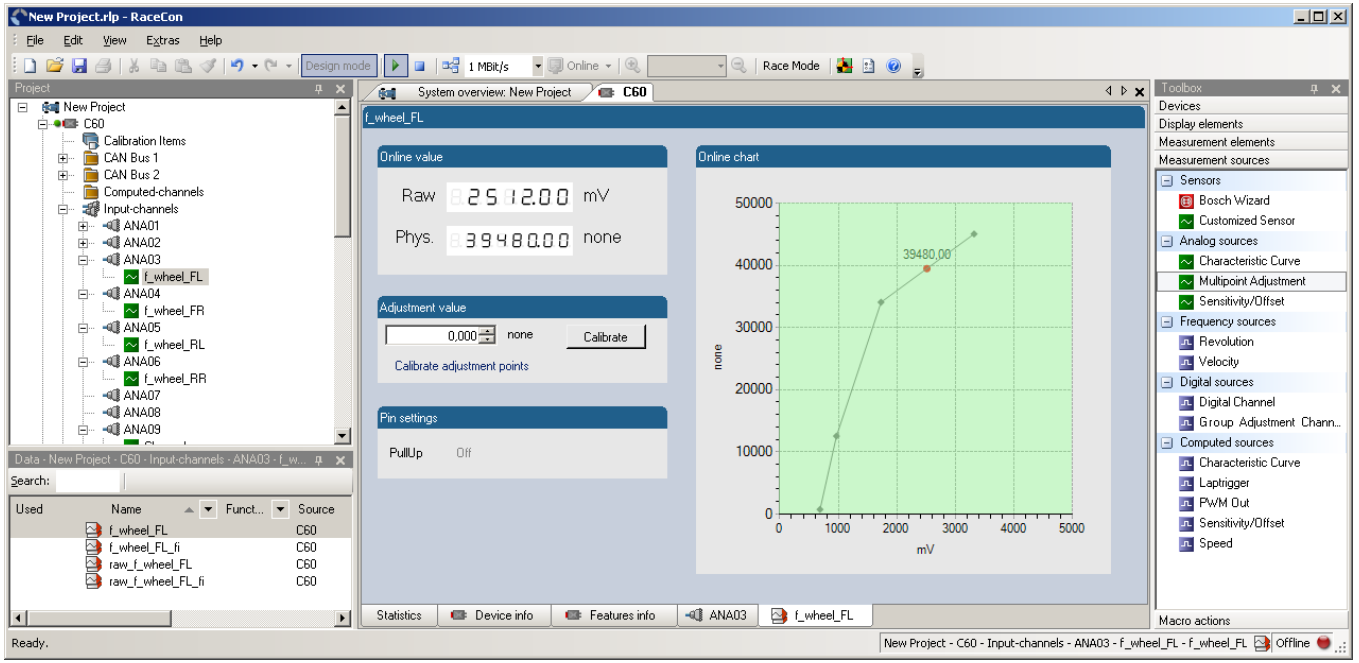
- Click on ‘Calibrate adjustment points’ to open calibration window
- Apply the desired physical condition to the sensor (e.g. by applying a force on the wheel)
- Enter the physical value in the value column of the desired calibration point (e.g. 745N)
- Press the ‘Calibrate’ button of the desired calibration point
- Repeat for all curve points
- Click ‘Close’ when done



C 60 Online Measurement + Calibration

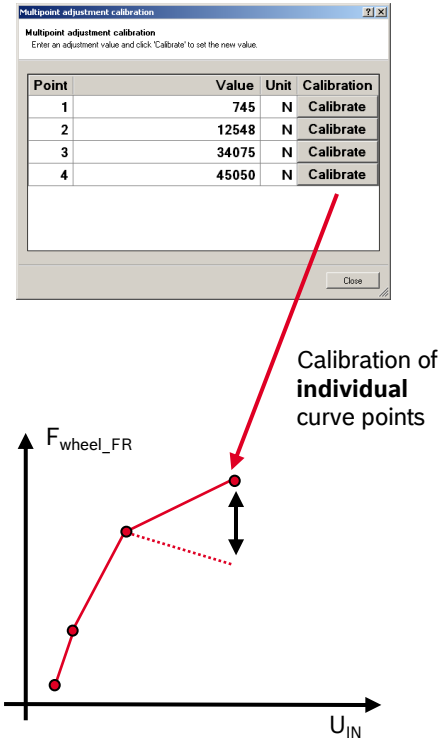
➔ Online calibration of multi-point adjustment channels

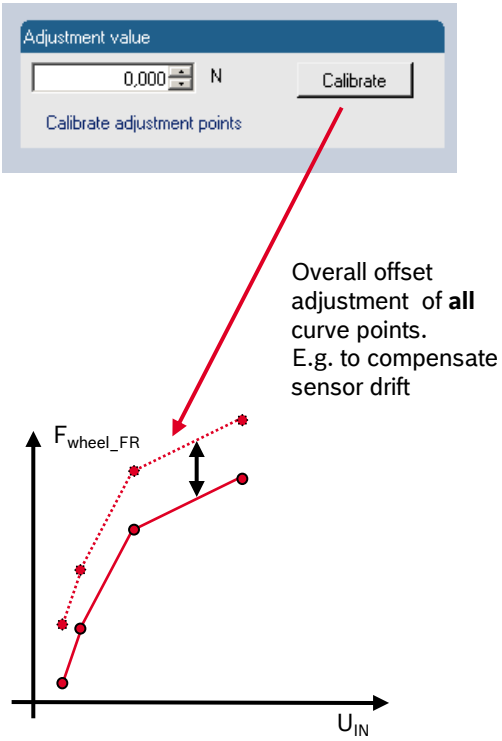
- The calibration curve is displayed in the online view



C 60 Online Measurement + Calibration

- Online calibration of multi-point adjustment channels
  - Adjustment points vs. offset adjustment





Recording and Telemetry

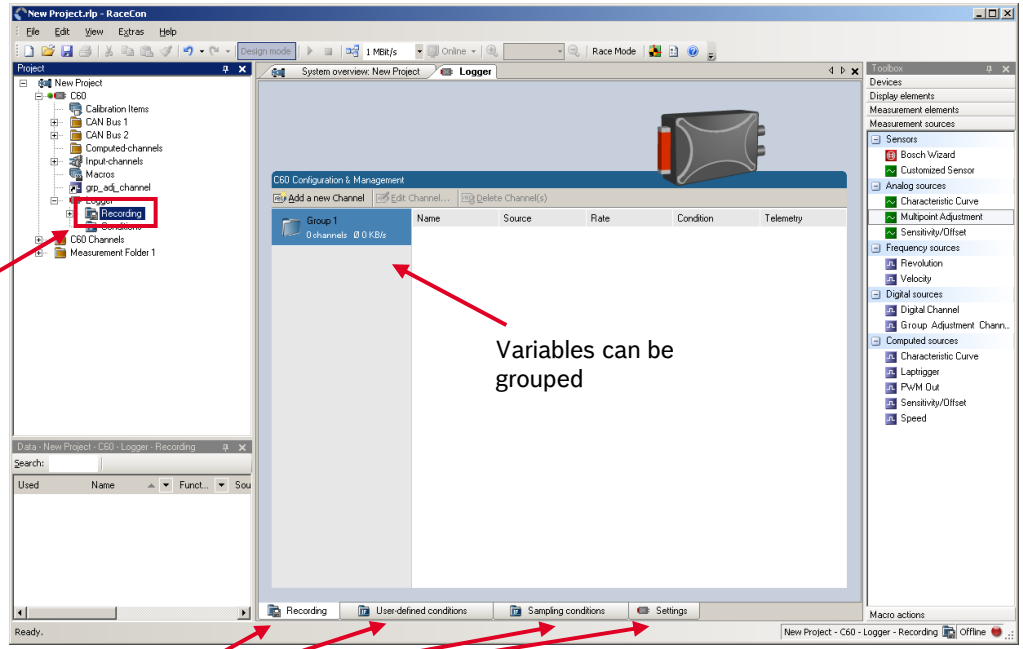
Configuration of Recordings
Configuration of Online Telemetry
Configuration of Burst Telemetry
Recording on USB Memory

C 60 Recording and Telemetry

- C 60 features
  - Recording
    - Synchronized recording of
      - C 60 analog and digital input channels
      - C 60 internal measurement channels
      - ECU data
      - Data from external sensor interfaces
    - Up to two independent recordings
    - Measurement rate 1ms…1s
    - Two global start conditions (thresholds)
    - Up to 16 measurement conditions (fast-slow-switches)
  - 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 C 60

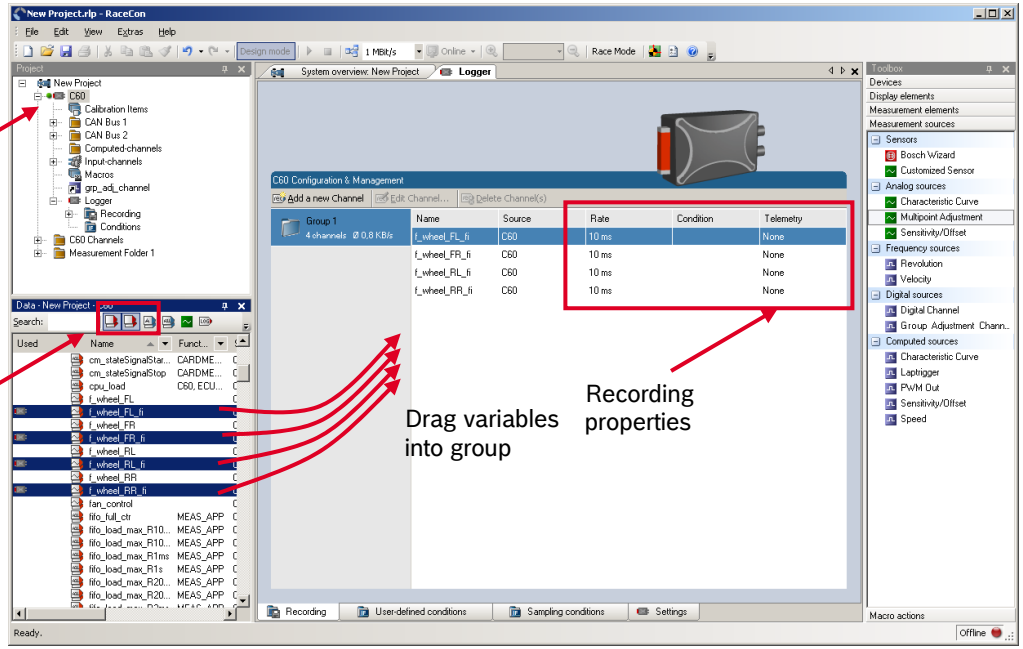
Configuration of Recordings

- Double click on ‘Recording’ in C 60 project tree
- The recording configuration is displayed in the main area



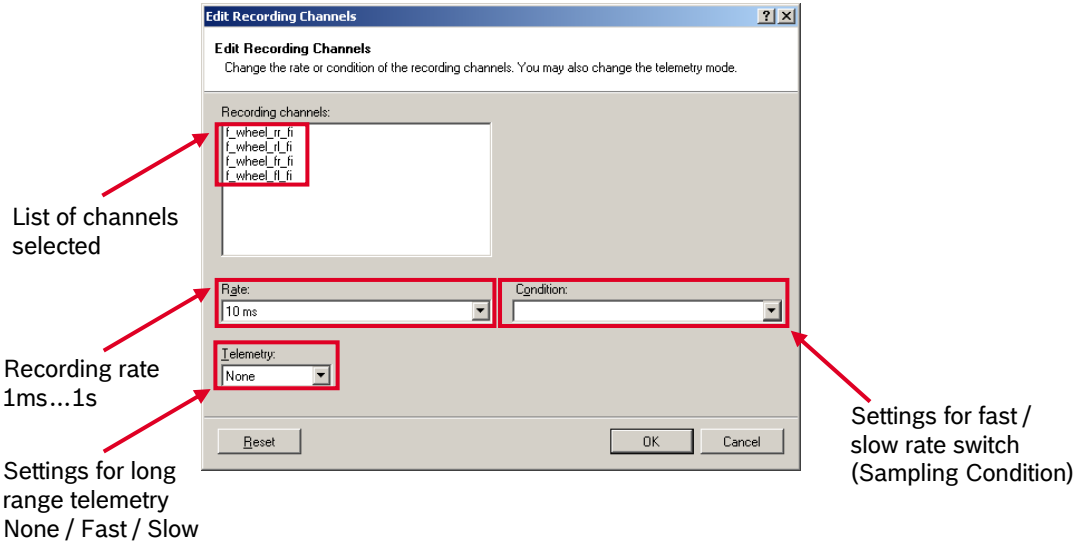
Configuration of Recordings

- To add channels to a recording, click on ‘C 60’ in the project tree
- In the data area, the channels are displayed
- Drag + drop channels into recording group



Configuration of Recordings

- To change recording rate, mark the channel(s) and double click
- A configuration window opens

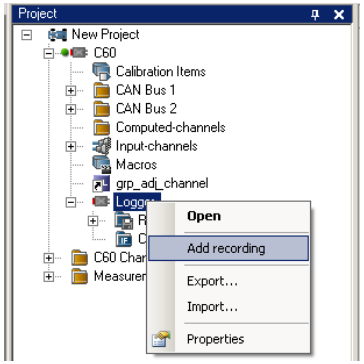


- Click ‘OK’ when done

Configuration of Recordings

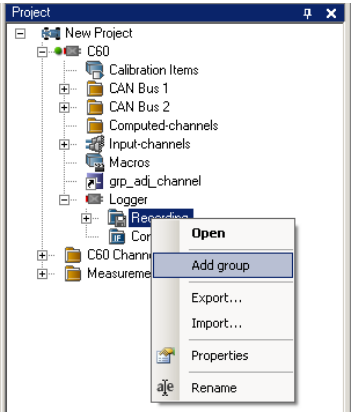
Adding a recording

- C 60 supports up to two independent recordings
- To add a recording, select ‘Add Recording’ from the context menu of the logger in the project tree.
- Hint: The name of the recording is stored in the ‘Cardinfo’ field of the recorded file



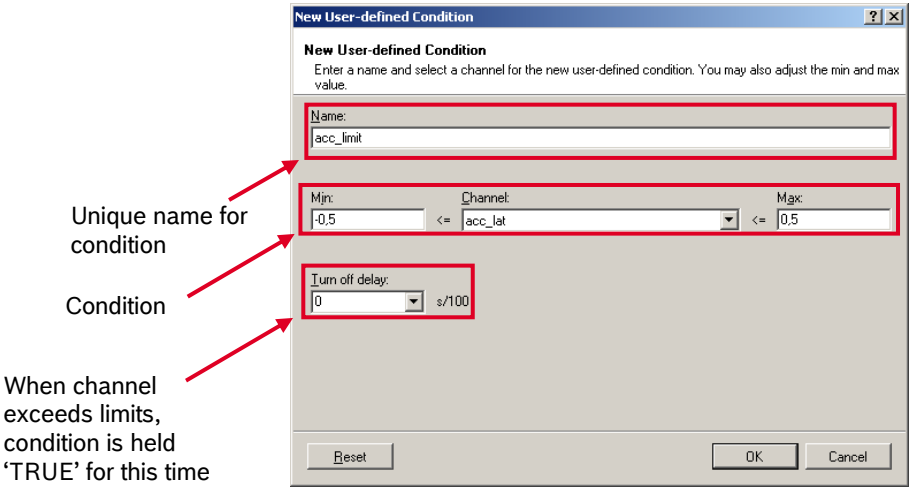
Adding a recording group

- Recording channels can be grouped
- To add a new group, select ‘Add group’ in the context menu of the recording
- Hint: The groups can be renamed to ‘Gearbox’, ‘Aero’, ‘Engine’, etc.



Configuration of Recordings

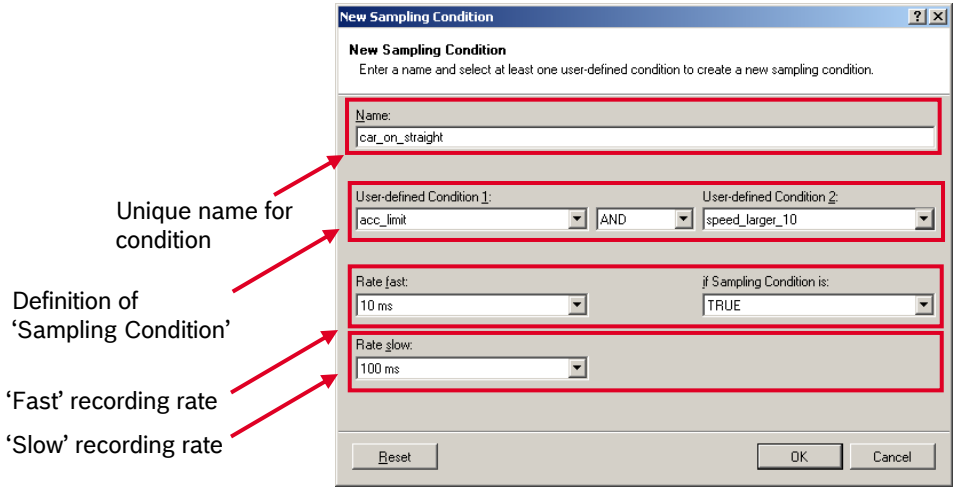
- User Defined Condition
  - Used for a global recording start condition and ‘Sampling Conditions’
  - Evaluation of one channel’s limits with optional turn-off-delay
  - To add a ‘User Defined Condition’ select the tab ‘User Defined Condition’ and click on ‘Add a new condition’
  - A configuration window opens



  - Click ‘OK’ when done

Configuration of Recordings

- Sampling Conditions
  - Switch between ‘fast’ recording rate and ‘slow’ recording rate based on thresholds
    - Uses one or two ‘User Defined Conditions’
    - Definition of ‘Fast Rate’ and ‘Slow Rate’
  - To add a ‘Sampling Condition’ select the tab ‘Sampling Condition’ and click on ‘Add a new condition’



  - Click ‘OK’ when done

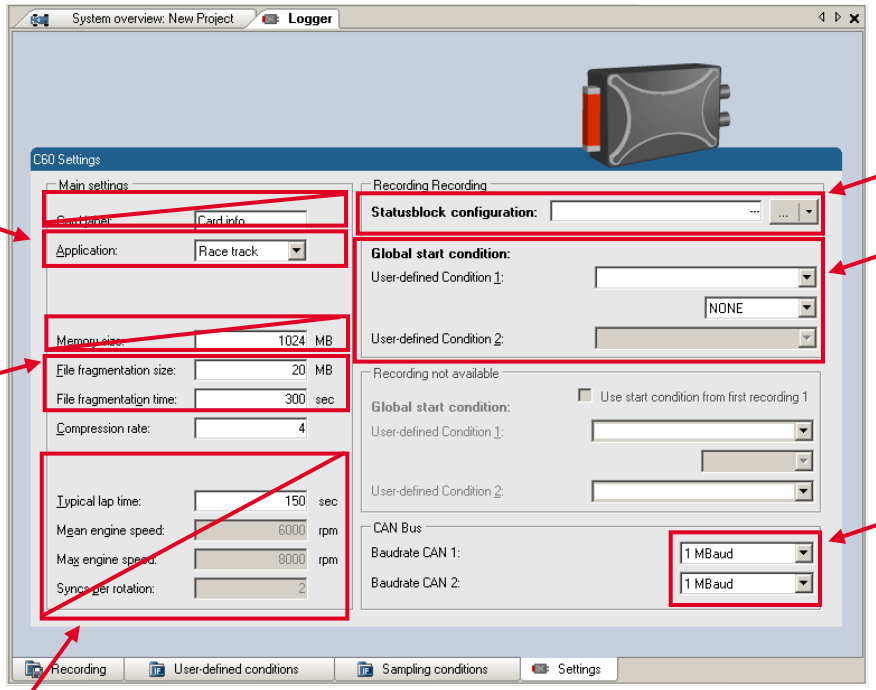
Configuration of Recordings

➔ Global C 60 Settings

- To display the global C 60 setting, select the ‘Settings’ Tab

Setting for outing counter mode
•For dyno (without lap trigger) select ‘Dyno’
•For racetrack (with lap trigger) select ‘Racetrack’

Setting for automatic fragmentation
(Please do not change)



Select (optional) ‘Statusblock’ here

Enable global recording start condition here

Baud rate of CAN bus

Settings have no effect on C 60, please ignore

Configuration of Recordings

➔ Recording Diagnosis

- The channel ‘stateclrl_ok’ of the C 60 can be used for online monitoring of recording status

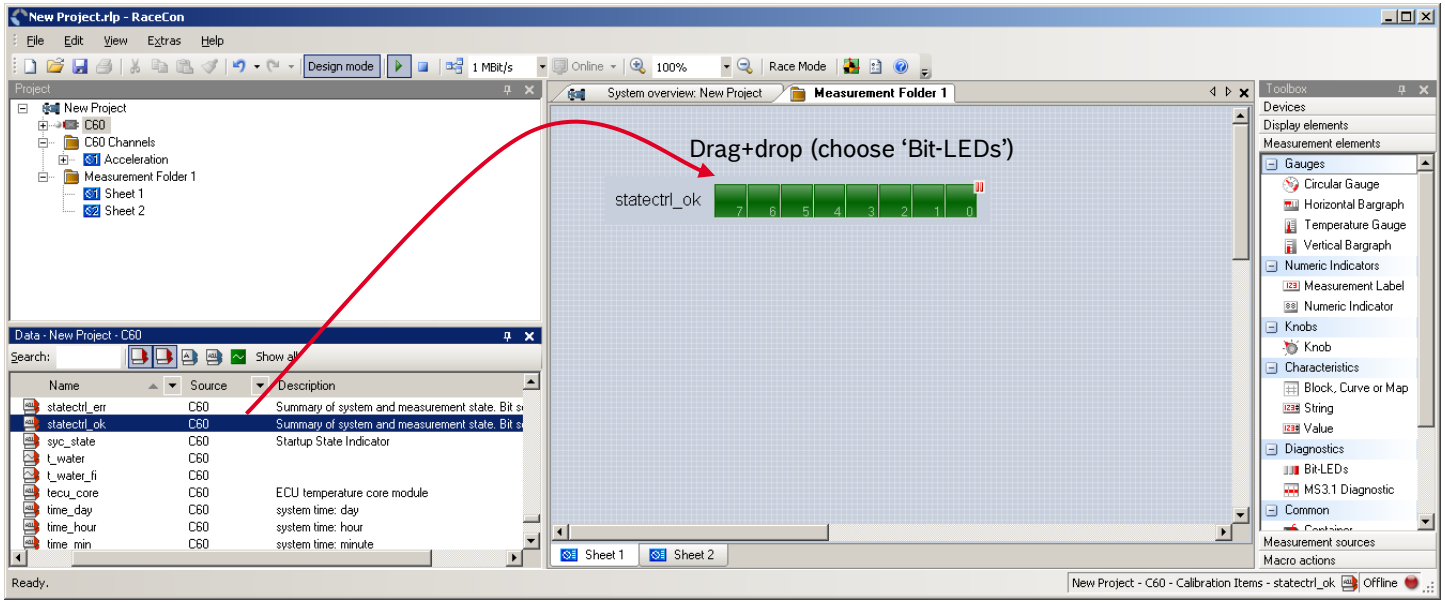
Bit	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1
Name	1	STARTED	1	1	1	BLKOK	DATAOK	RECORD

- Content of status bits

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

Configuration of Recordings

- Online display of ‘statectrl_ok’



- Measurement correctly initialized, but recording threshold(s) not reached: 254
- Measurement correctly initialized, C 60 is recording data: 255
- Values less than 254 indicates an error state

Setup for USB recording

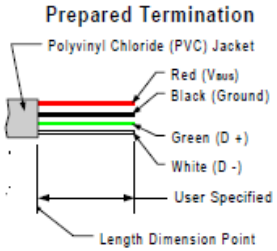
Software Upgrades 1+4 required

- Enable the software upgrade for USB recording
  - USB recording is enabled by the ‘Software Upgrade 4’
  - Note: for USB recording, Software Upgrade 1 also has to be enabled
  - To activate ‘Software Upgrade 4’, enter the license key as described in the chapter ‘Starting up the C 60’, section ‘Feature activation’ of this manual

- Wiring harness

C 60 ASDD-2-12-41PN (Red)	USB
Pin 23	Power (red)
Pin 24	D+ (green)
Pin 25	D – (white)
Pin 26	GND (black)

*colors matching a standard USB cable



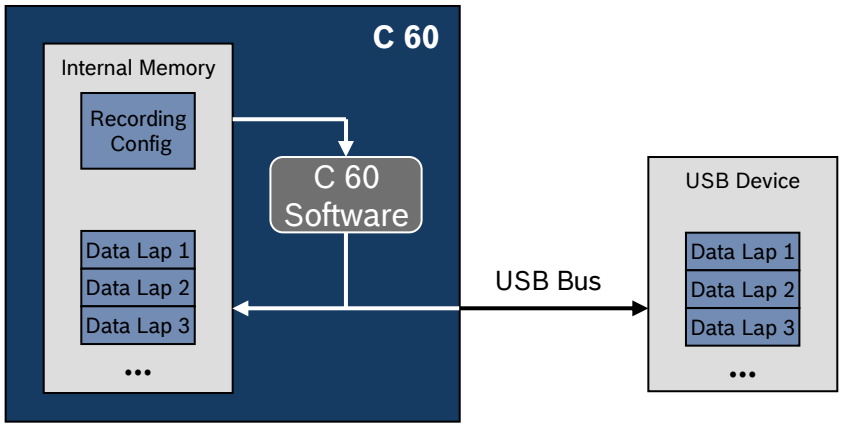
- Storage Device
  - To ensure reliable operation, use Bosch Motorsport USB devices only (Part Number F 02U V00 867-01 - 2GByte capacity)
  - The Bosch Motorsport USB devices are preformatted with the Bosch File System (BFS)
    - A device is recognized by Windows as a ‘storage medium’, but it can only be initialized with RaceCon and read with WinDARAB

Recording Data on USB device

Software Upgrades 1+4 required

- Plug a USB Device to C 60
- Prepare a recording configuration in RaceCon
- Power on the system and connect with RaceCon to the vehicle
- Download the configuration to the C 60

- Record measurement data. If a USB device is present, the C 60 stores the data in parallel on the internal memory and the USB device.

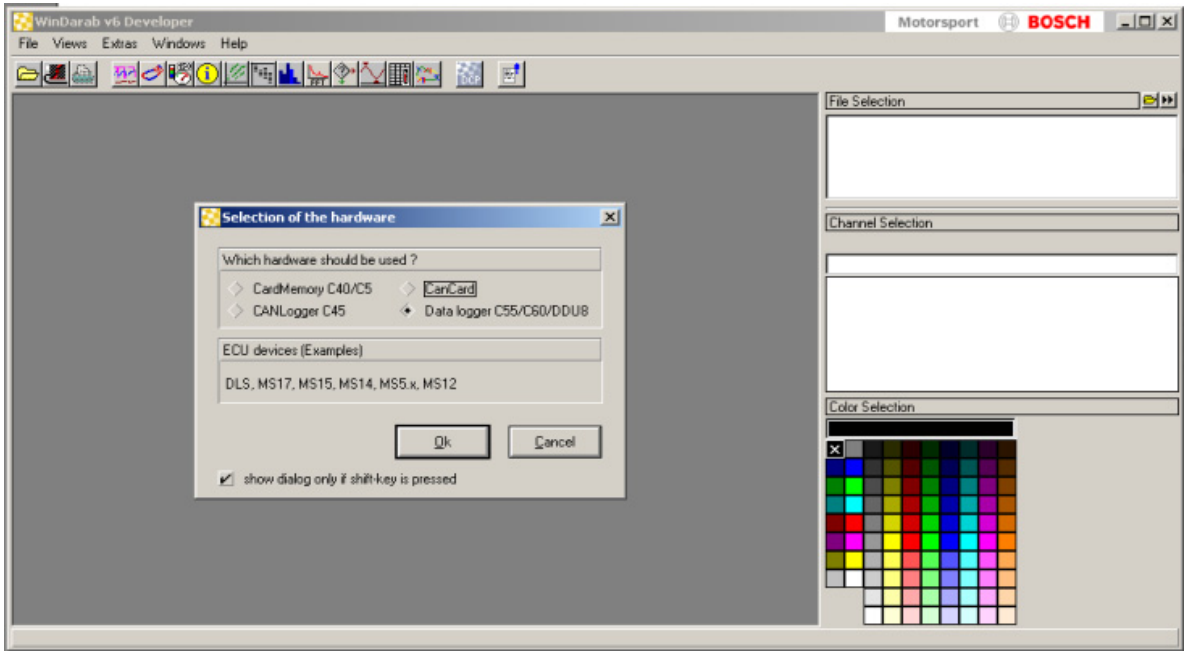


- Power off the system
- Remove USB device from the vehicle

Recording Data on USB device

Software Upgrades 1+4 required

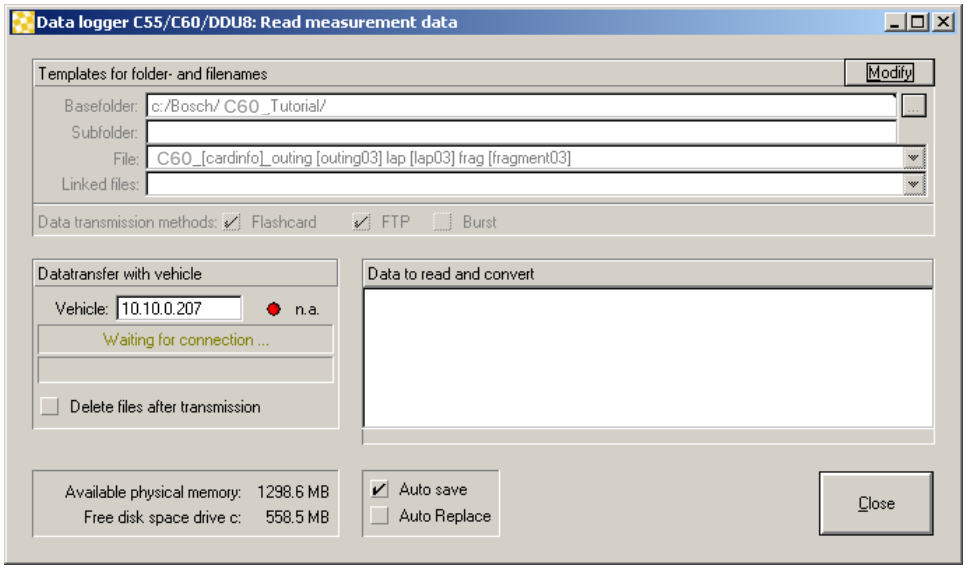
- Start WinDarab
- Hold the ‘Shift’-Key and click on the ‘Import Measurement Data’ Icon
- Select the ‘Data logger C55/C60/DDU8’ and click ‘Ok’ when done



Recording Data on USB device

Software Upgrades 1+4 required

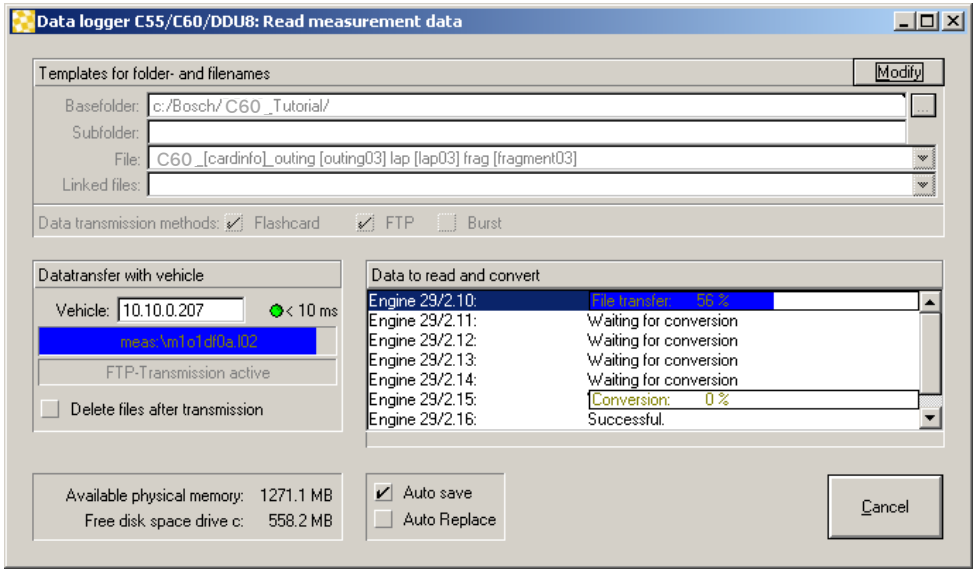
- The ‘Read Measurement Data’ dialog opens
- Click ‘Modify’ button and select the base folder
- Choose ‘Flashcard’ as data transmission method
- Activate ‘Auto save’
- Click ‘Save’ when done



Recording Data on USB device

Software Upgrades 1+4 required

- Insert the USB device into the PC
- Data transmission from device starts automatically
- Measurement files are stored automatically
- Click ‘Close’ when transmission has finished



USB Device Handling Hints

Software Upgrades 1+4 required

USB device

- Use Bosch Motorsport USB devices only
  (Part Number F 02U V00 867-01 - 2GByte capacity)
- The USB device must be preformatted to BFS format
  (Bosch Motorsport USB devices are delivered preformatted to BFS format)

Using the USB device

- Always plug USB device into vehicle before power up to ensure that all measurement data is stored on the USB device
  - If USB device is plugged in after recording has started, data is stored on the USB device beginning with the next lap or next file fragment.

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 while the C 60 is powered up, the C 60 restarts. In this case, the C 60 is not operational for 1.5s.

Troubleshooting

Software Upgrades 1+4 required

➔ **When no data on the USB device is recorded:**

- Configure the measurement label **usb_mediastate** on a RaceCon measurement view or on a C 60 display page

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

  - **0: Wait: Device not found**
    The USB device is not found
    No USB device inserted
    USB device is defect
    No electrical connection or wiring harness problem

  - **1: Wait: Device detected**
    A USB device is found, but not yet installed

  - **2: Ok: Media installed**
    The USB device is found and is operational.
    This does not imply that recording data is written!

  - **3: Stop: Device unplugged**
    The USB device has been removed. The C 60 perform a restart when a USB device is plugged in

  - **4: Ok: Media access**
    Data is currently written to the USB device

Troubleshooting cont.

Software Upgrades 1+4 required

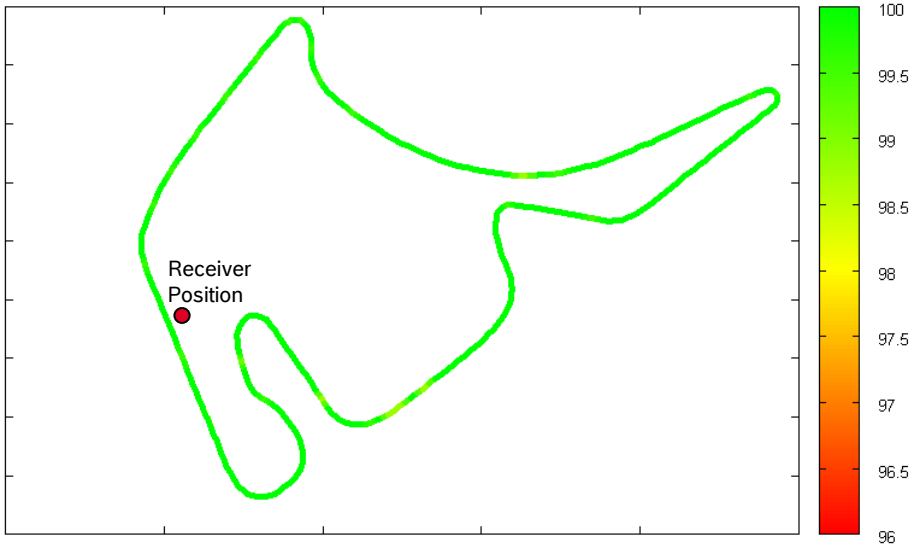
- The value of **usb_mediastate** reflects the operating condition of the USB bus
  - **5: Error: Media error**

    The USB device has been detected as defect/wrong.
    The USB device is defect.
    The USB device is not supported by C 60.
  - **6: Error: Media corrupt**

    The USB device is not in valid BFS format.
    Reformat the USB device in RaceCon.

Long Range Telemetry System FM40

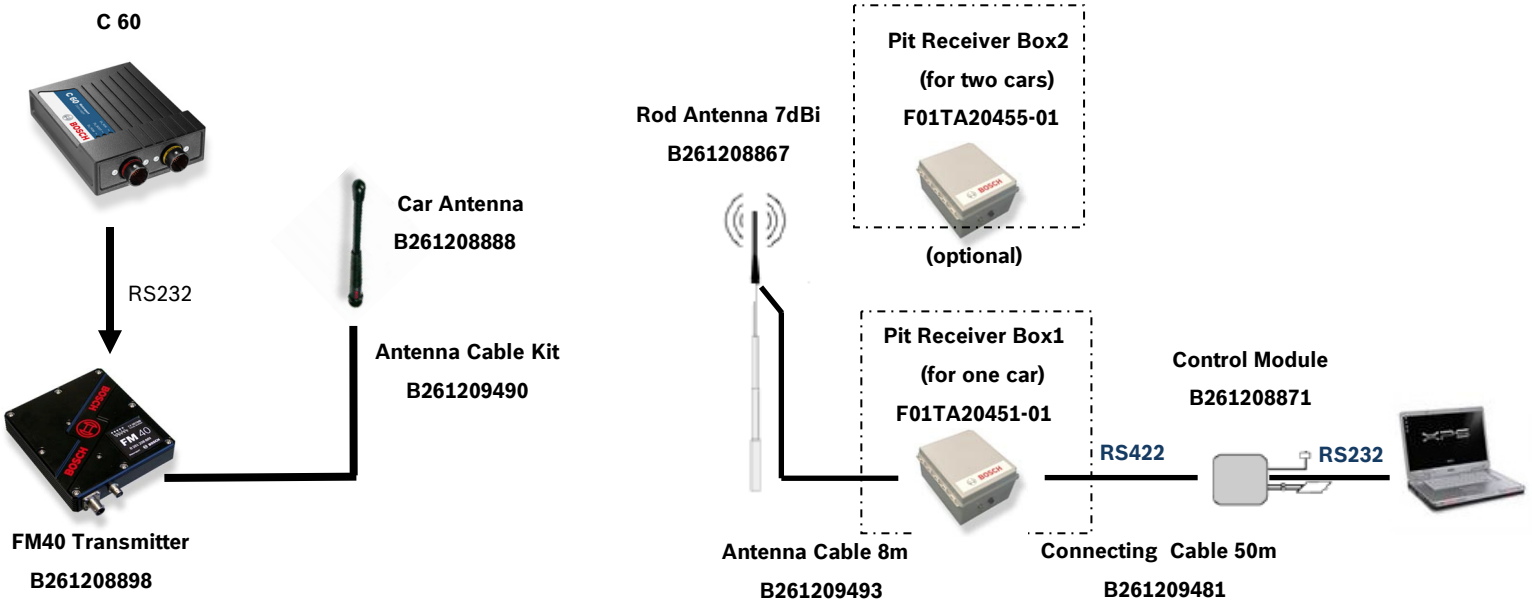
- 440MHz band
- 25KHz bandwidth
- 10W max. RF output
- 19.2 kBit/s data rate - unidirectional
- RS232 interface
- Full online track coverage on almost all tracks



Link Quality @ Hockenheim

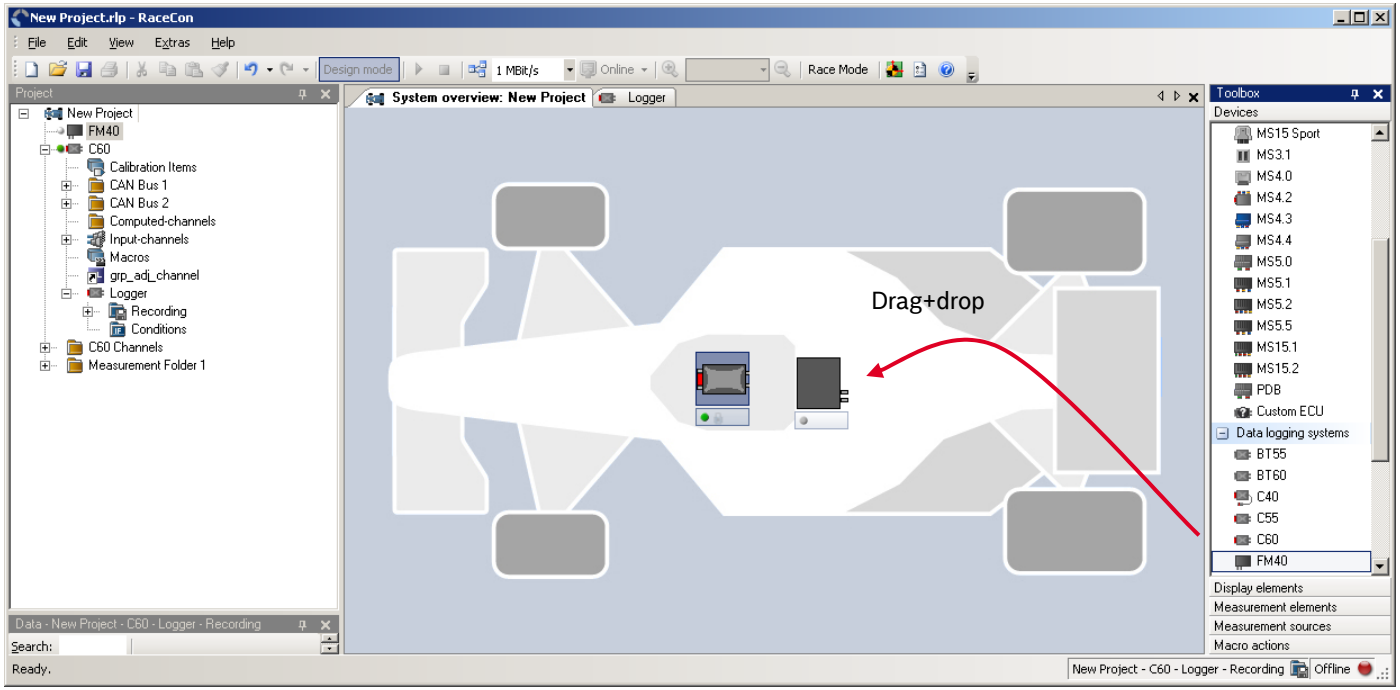
Configuration of Online Telemetry

- Hardware Setup



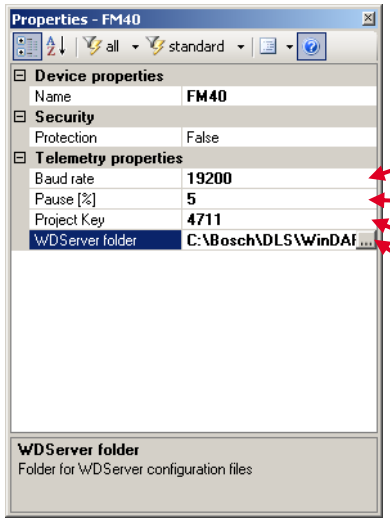
Configuration of Online Telemetry

- Software Setup
  - Drop FM40 from toolbox into system overview



Configuration of Online Telemetry

- Software Setup
  - Click on FM40 in project tree to display the properties menu



Baudrate of C 60
(must match baudrate of FM40)

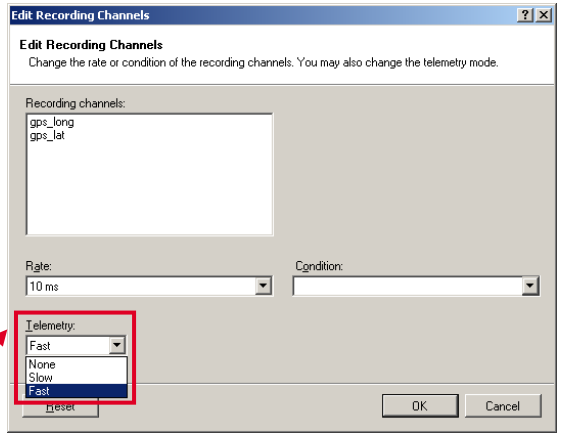
Transmission pause
(5% recommended for improved re-synchronisation)

Project Key (1111...9999)

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

Configuration of Online Telemetry

- Software Setup
  - Adding channels to telemetry
    - In the ‘Edit Recording Channels’ dialog: choose ‘Telemetry’



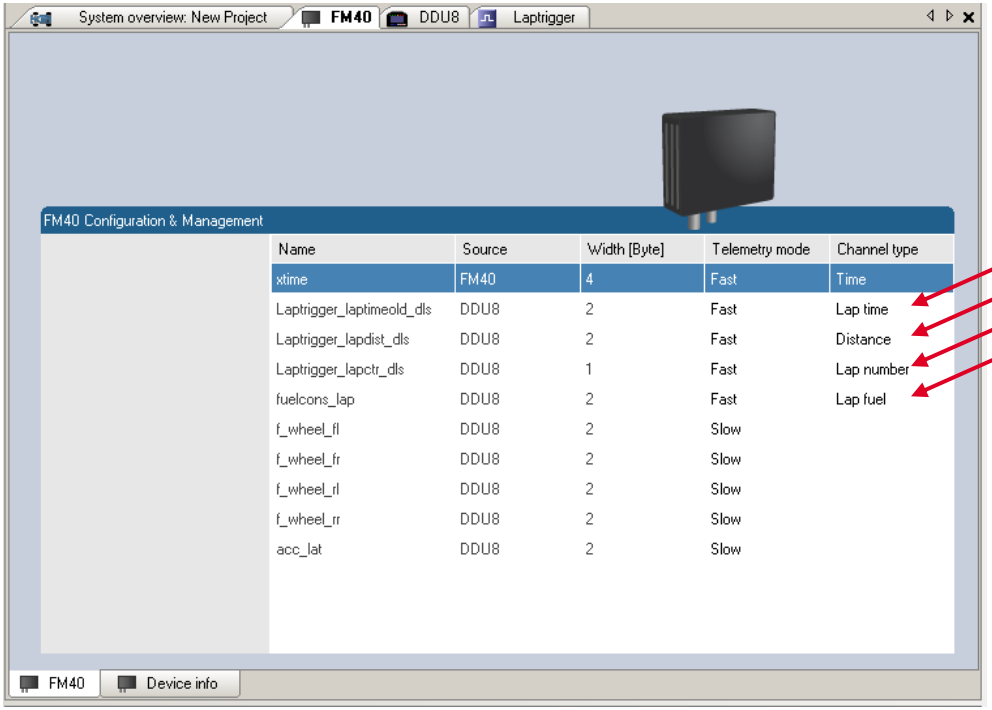
- None – channel(s) are not transferred
- Slow – channel(s) are transferred in the slow telemetry block
- Fast – channel(s) are transferred in the fast telemetry block

- Why fast block / slow block
  - C 60 telemetry uses available FM40 bandwidth (19200 baud -> approx. 1700 bytes/s)
  - Channels are grouped into blocks
    - Fast block (block 1): transferred every cycle
    - Slow blocks (block 2..n): transferred every n^{th} cycle

Transmission Scheme

Configuration of Online Telemetry

- Software Setup
  - Telemetry channels with special functionality
    - Double click on FM40 in project tree
    - Assign special functionality to channel(s) with the listbox in column ‘Channel type’



Exact lap time of last lap completed

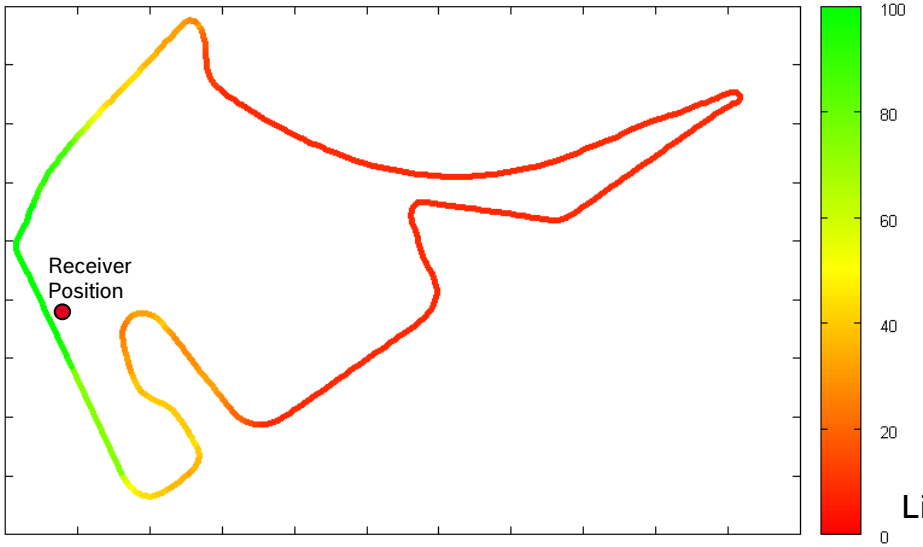
Running distance of current lap

Lap number of current lap

Fuel consumption of last lap completed

Burst telemetry system BT-60

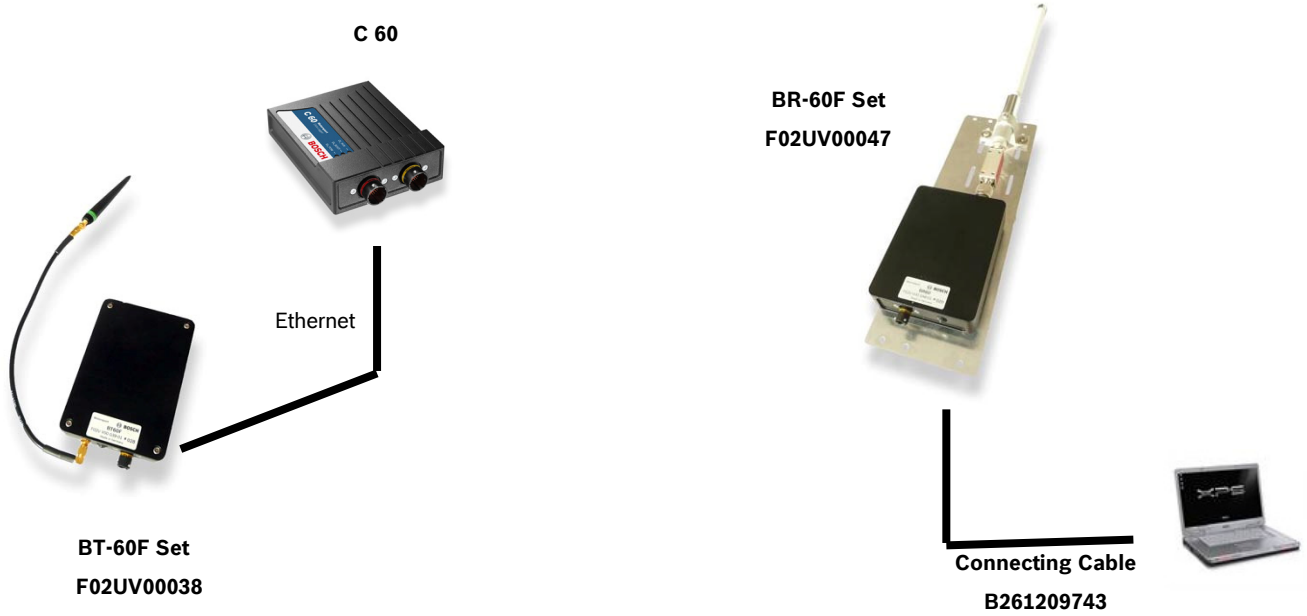
- 5GHz ISM band - 20MHz bandwidth
- 0.4W max. RF output
- 802.11a OFDM system; proprietary protocol
- max 12MBit/s data rate - bidirectional
- Ethernet interface to C 60 / C-60 / C-55
- Partial track coverage
- Approx. 300m reception range
- High speed burst transmission of recorded data



Link Quality @ Hockenheim

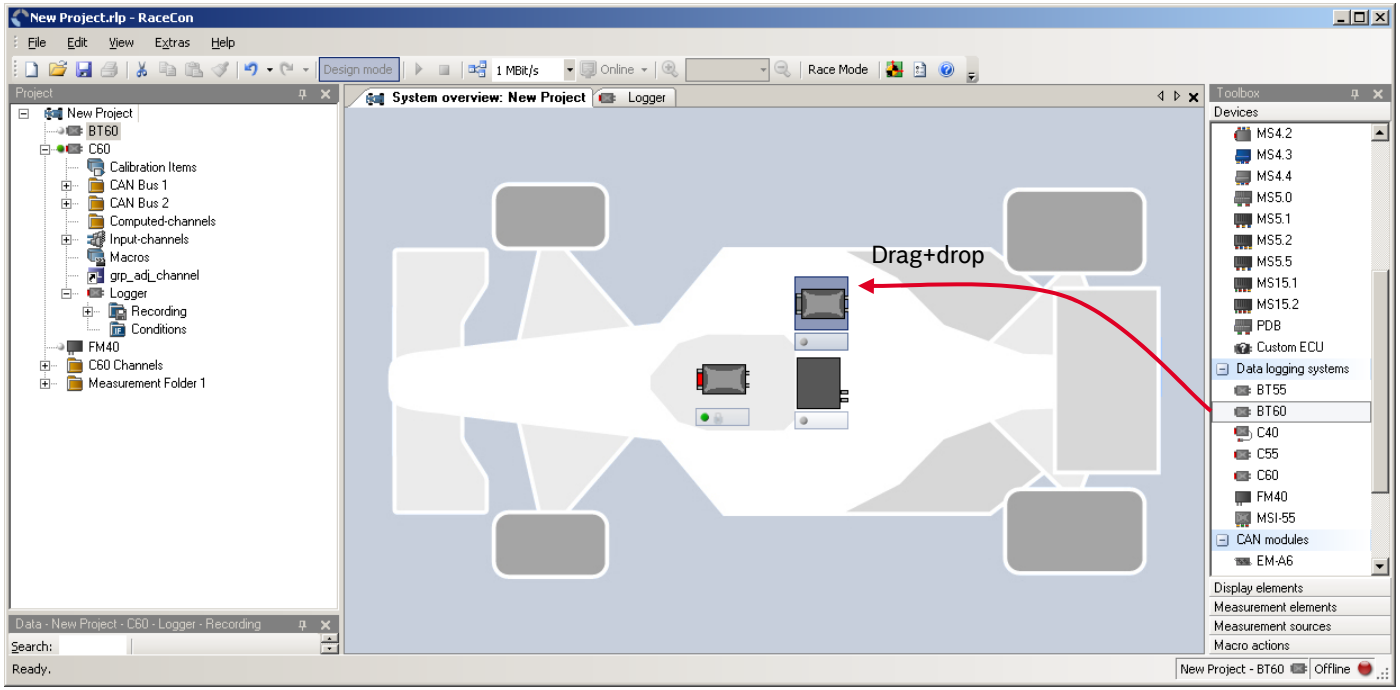
Configuration of Burst Telemetry

- Hardware Setup



Configuration of Burst Telemetry

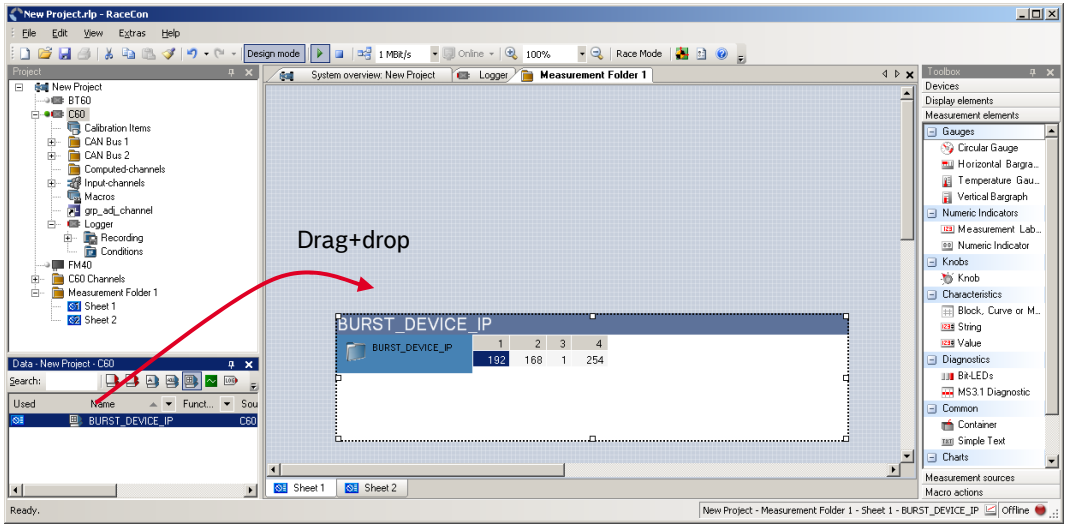
- Software Setup
  - Drop BT60 from toolbox into system overview



Configuration of Burst Telemetry

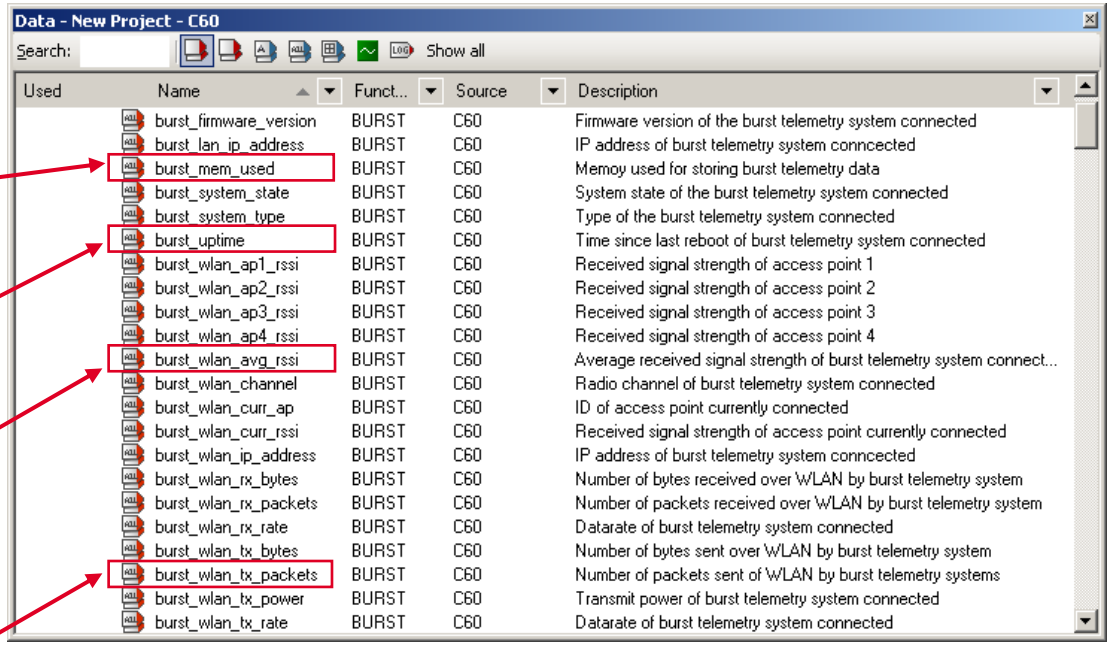
- Software Setup
  - Configure the burst IP address of the C 60

    (This address must be compatible with the address range of the pit PC, the BT-60 and the BR-60)
    - Open a measurement sheet
    - Drag the ‘BURST_DEVICE_IP’ to the measurement sheet
    - Switch to ‘Race Mode’
    - Configure the desired IP address



Configuration of Burst Telemetry

- Diagnostic channels
  - Diagnosis of BT-60 is possible through channels on C 60



Data ready for transmission

C 60 connected to BT-60

Signal quality of radio link
-55dBm: good
-70dBm: fair
-95dBm: no link

Byte counter for data transmission over radio link

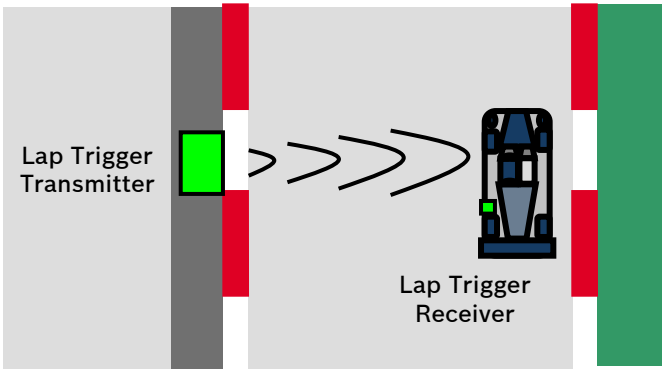
Lap trigger

Lap trigger (Timing Beacon)

Counting Outings / Laps / Fragments

Lap Trigger (Timing Beacon)

- Why do we need a lap trigger (timing beacon)?
  - Vehicle lap time measurement
  - Calculation of lap-dependent functions (lap fuel consumption, min/max values)
  - Calculation of lap distance dependent functions
  - Control of data logging system

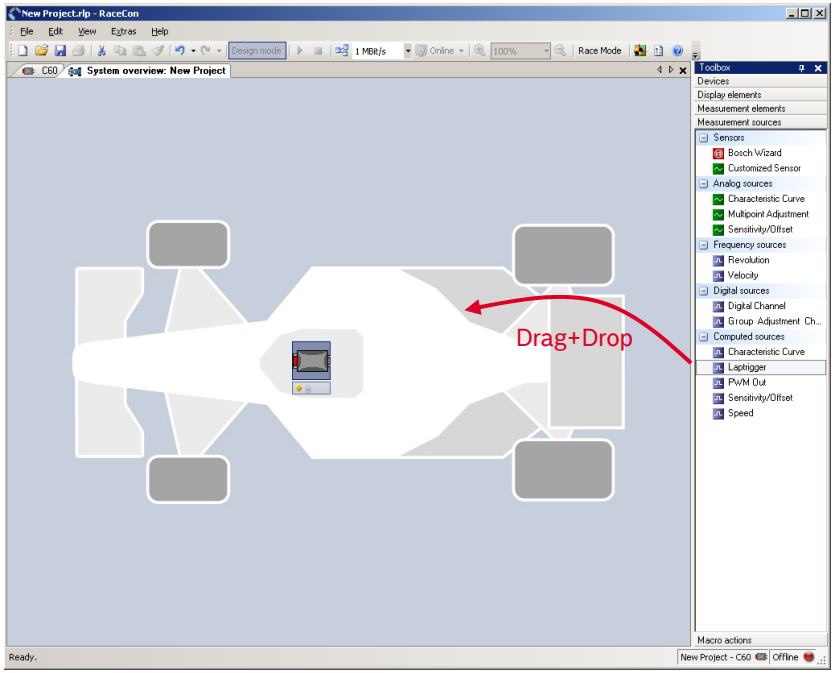


- System consists of
  - Transmitter (trackside unit)
  - Receiver (in-vehicle unit)

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

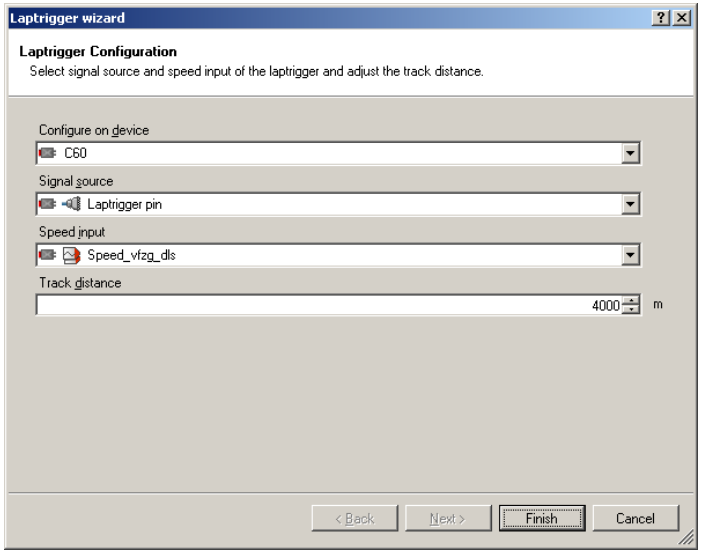
Lap Trigger (Timing Beacon)

- Setting up a lap trigger for C 60
  - Select ‘Measurement Sources’ in Toolbox
  - Select ‘Lap trigger’
  - Select and drag ‘Lap trigger’ into ‘System Overview’
  - Drop ‘Lap trigger’ on vehicle (Not on C 60!)
  - A pop-up window opens



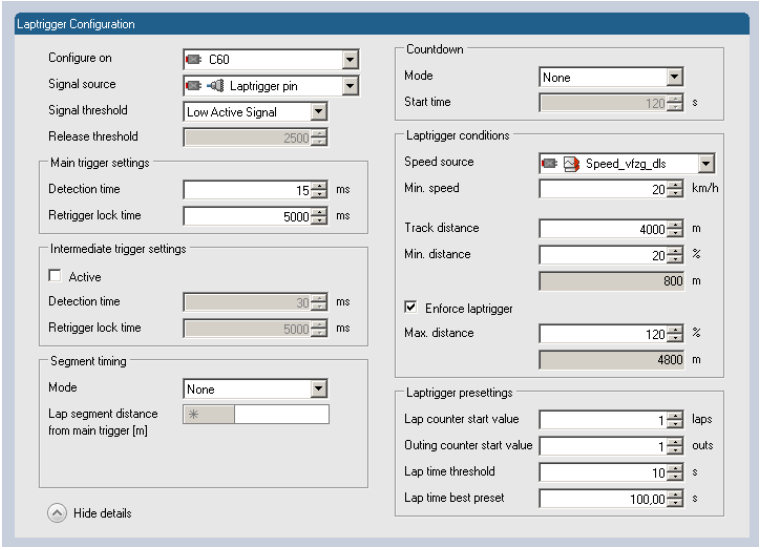
Lap Trigger (Timing Beacon)

- Setting up a lap trigger for C 60
  - Select the signal source for the trigger signal
    In this example, the Rx is connected to the dedicated lap trigger pin of C 60
  - Select the source for vehicle speed
    In this example, the vehicle speed_vfzg_dls' is calculated from 4 wheel speeds
  - Enter the track length of your racetrack
    In this example 4000m
    (Can be changed at any time later)
  - Press 'Finish' to complete the operation



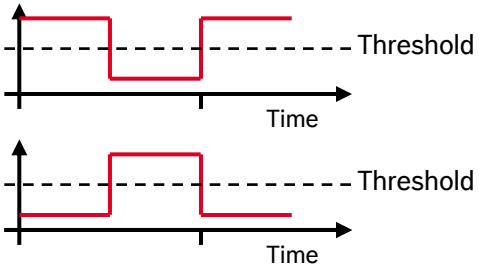
Lap Trigger (Timing Beacon)

- Setting up a lap trigger for C 60
  - A pre-configured lap trigger window opens
    - Low-active signal on lap trigger pin, min 15ms pulse length
    - Bosch recommendation for Bosch trigger:
      - 15ms pulse length for main trigger
      - 30ms pulse length for sub trigger
    - The trigger is protected against false triggers:
      - Min 20km/h for trigger release
      - Min 20% of track distance covered
      - Trigger is retrigger locked for 5s
    - Forced trigger mechanism is enabled at 120% of track distance



Lap Trigger (Timing Beacon)

- Electrical Trigger Signal
  - In C 60 all sources of measurement channels can be used as trigger signal
    - Analog input
    - Digital input
    - CAN input
  - Signal (measurement channel) properties:
    - Low active signal
    - High active signal



- Two types of trigger signal
  - Main trigger (end-of-lap @ start/finish line)
  - Sub-trigger (segment time, optional)
  - Bosch standard:
    - Main trigger >20ms, <40ms, low active
    - Sub trigger >40ms, low active

Lap Trigger (Timing Beacon)

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

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

- Forced triggers
  - Lap distance based insertion of ‘forced trigger’

Lap Timing

Variables for display:

Laptrigger_lapcurr_dls	Current lap number
Laptrigger_lapctr_dls	Number of completed laps
Laptrigger_laptime_dls	Running laptime
Laptrigger_laptime_best_dls	Laptime of best lap
Laptrigger_laptimeold_dls	Laptime of last lap completed
Laptrigger_laptimeseg_dls	Segment time of last segment

Segment timing

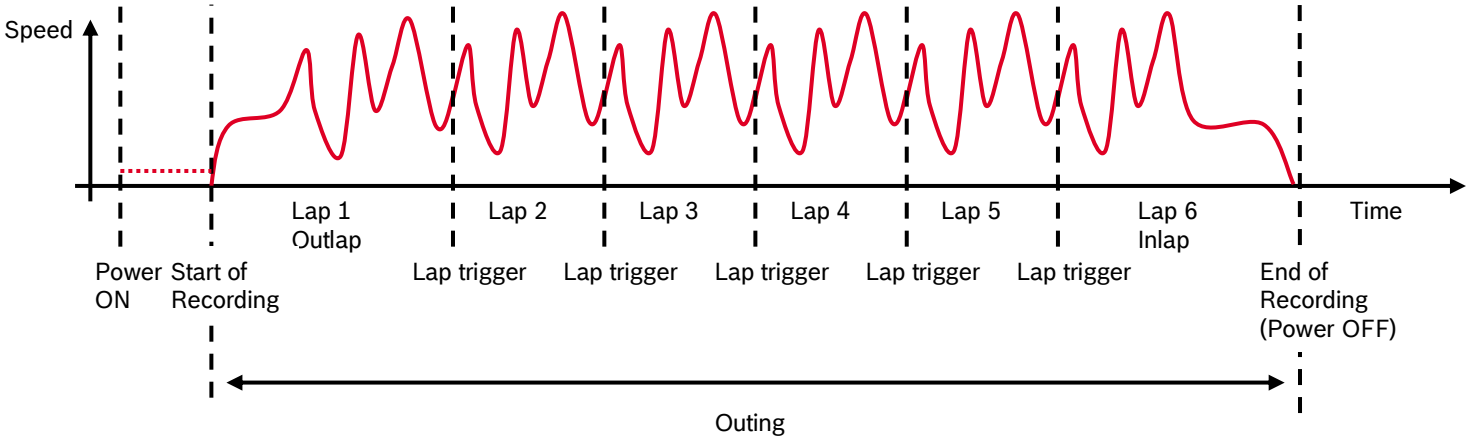
- Calculation of elapsed time for parts of laps (segments)
- Segments are defined:
  - Based on sub-trigger signals (additional transmitters)
  - Based on distance travelled

- Times for segments are compared to:
  - Last lap completed
  - Fastest lap

- Variables for display:

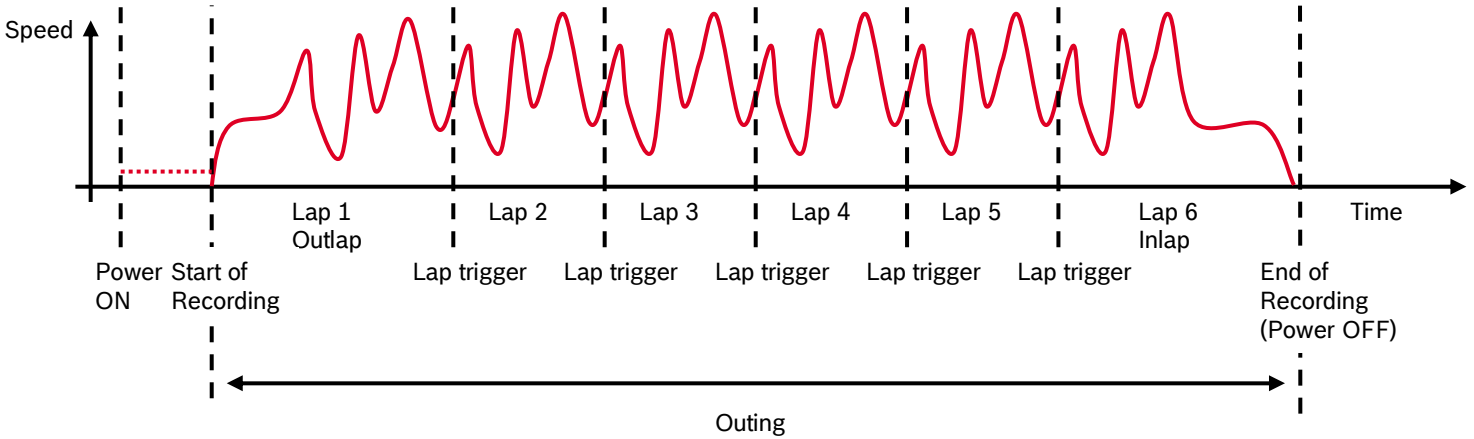
Laptrigger_lapdiff	Time difference between finished lap and last lap
Laptrigger_lapdiffb	Time difference between finished lap and best lap
Laptrigger_dlast	Difference of lap segment time compared to last lap
Laptrigger_dbest	Difference of lap segment time compared to best lap

Counting Outings / 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: recording of lap completed, system shutdown

Counting Outings / Laps / Fragments



- The system is counting:
  - Outing: one or several laps from leaving the garage to entering the garage
  - Lap (min. 20% of lap distance travelled)
    - Leaving the pits to lap trigger
    - Lap trigger to lap trigger
    - Lap trigger to entering the pits
  - Fragment (less than 20% of lap distance travelled)
    - Dyno operation
    - Engine warm-up
    - Power cycle on track (e.g. engine stalled)

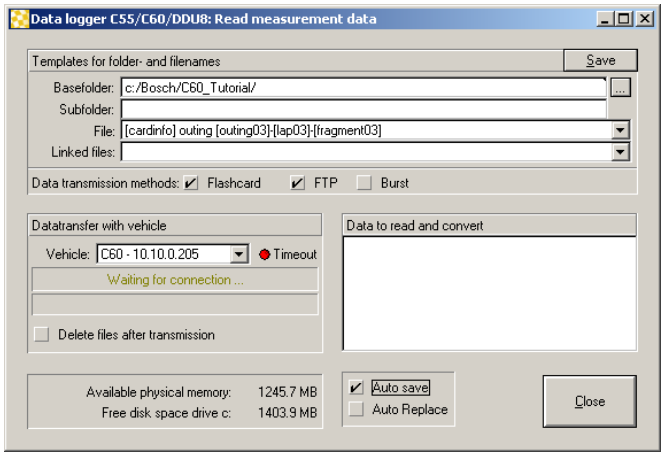
Counting Outings / Laps / Fragments

- Counters can be displayed:
  - Laptrigger_outcnt_dls — Outing counter
  - Laptrigger_lapctr_dls — Lap counter
  - Fractr — Fragment counter

- Counters can be reset:
  - Use diagnosis page in RaceCon

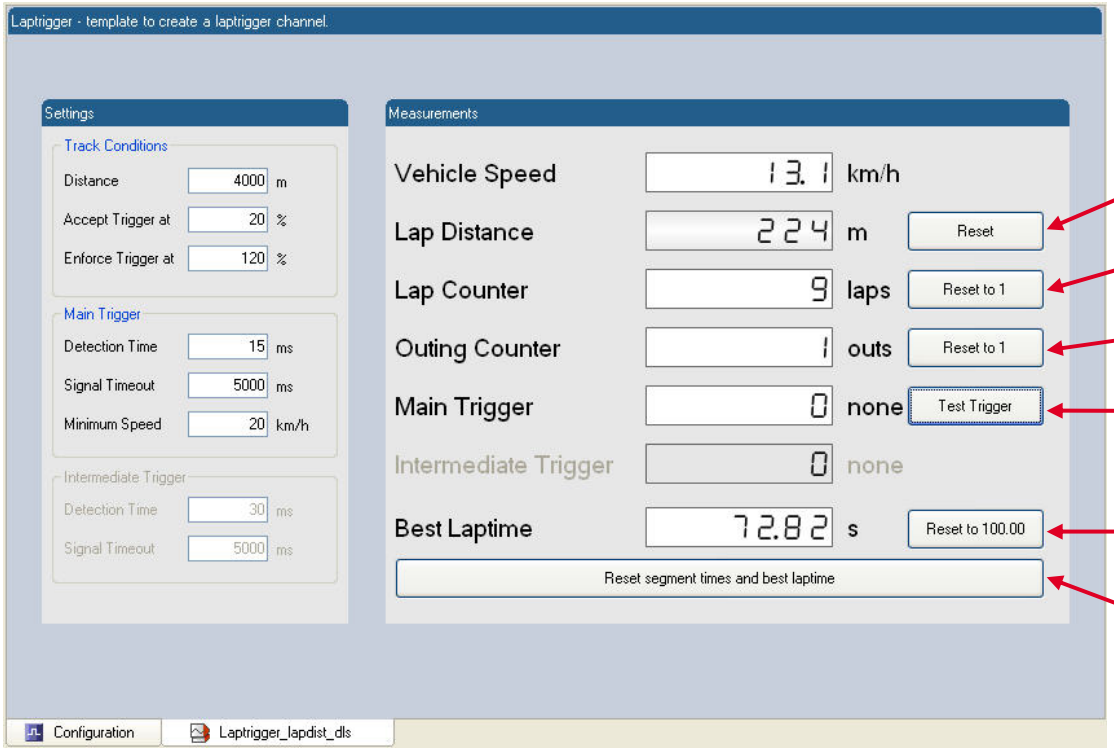
- Counters can be used to automatically name recorded files
  - Use filename templates in WinDARAB dialog
  - [outing] value of outing counter
  - [lap] value of lap counter
  - [fragment] value of fragment counter

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



Quick Diagnosis / Counter Reset

- Diagnosis Page:
  - Double click on any Laptrigger_xxx channel in channel list
  - A diagnosis window opens in main area



Button to reset lap distance to 0

Button to reset lap counter

Button to reset outing counter

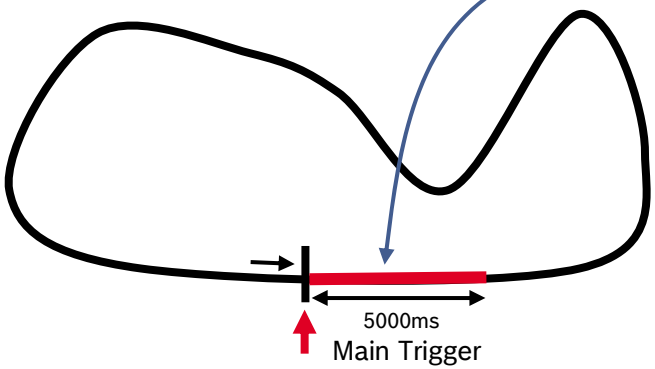
Button to generate trigger signal

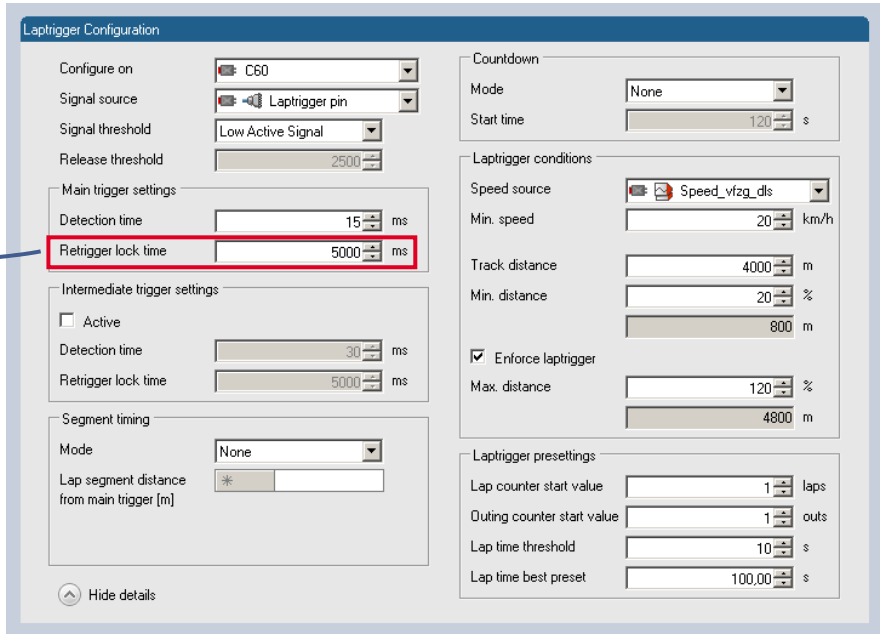
Button to reset best lap time

Button to reset best lap time and distance-based segmentation

Retrigger Protection

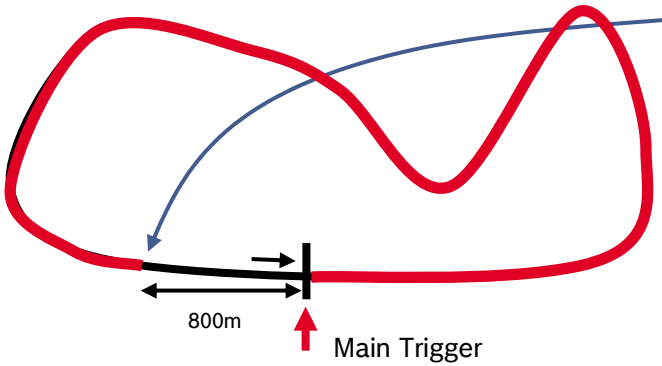
- Time based retrigger protection
  - Trigger is locked for 5s after main trigger was received
  - To deactivate: set ‘Retrigger lock time’ to 0ms

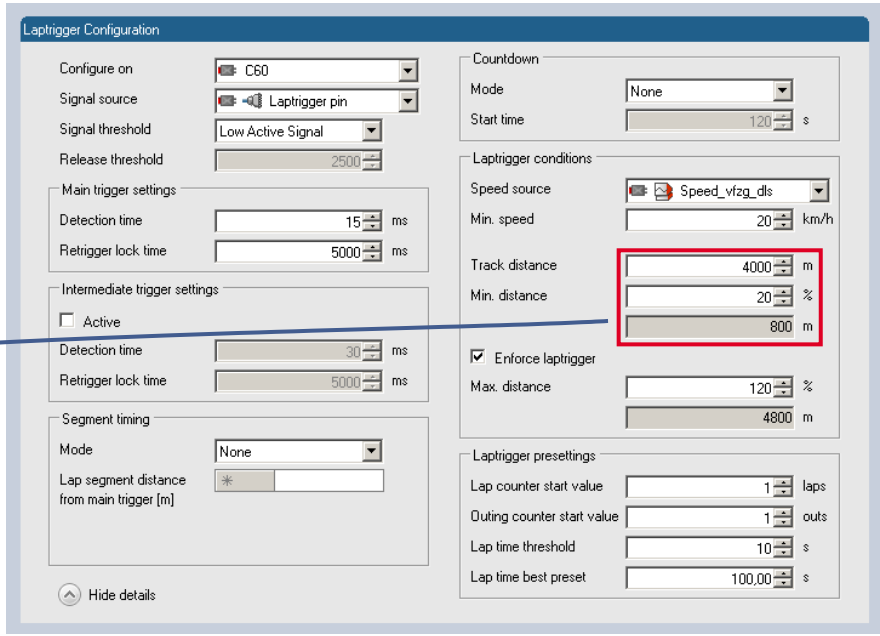




Retrigger Protection

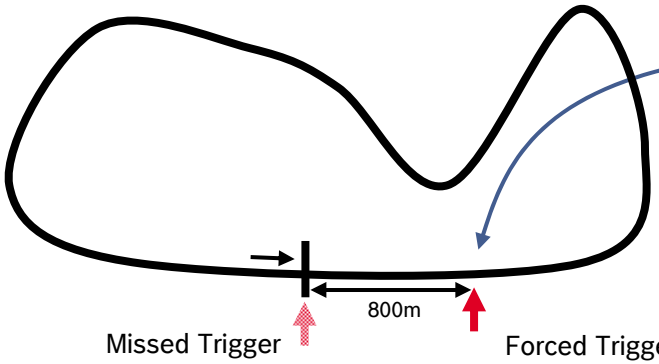
- Distance based re-trigger protection
  - Trigger is locked until 80% of track distance has been covered (3200m)
  - To deactivate: set min distance to 0%

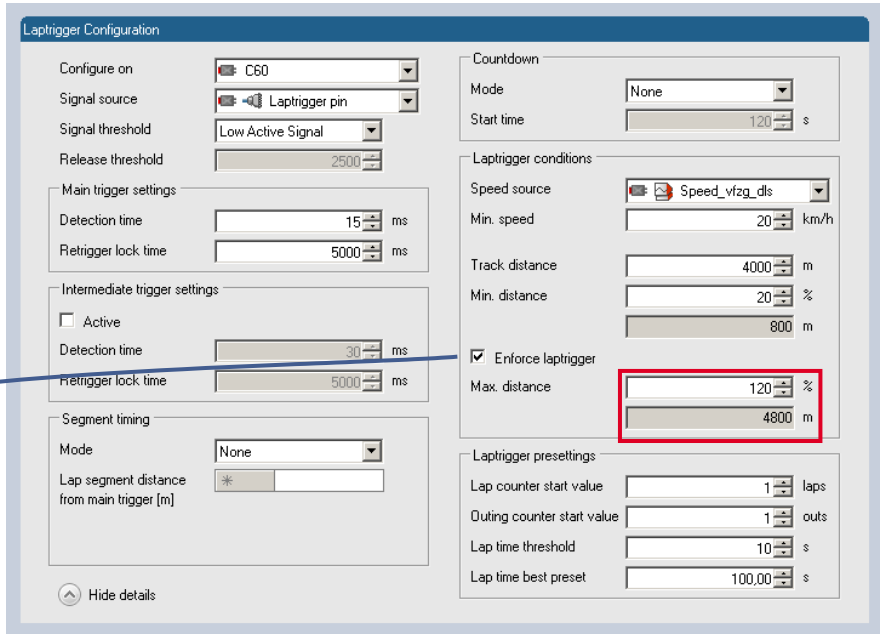




Forced Trigger

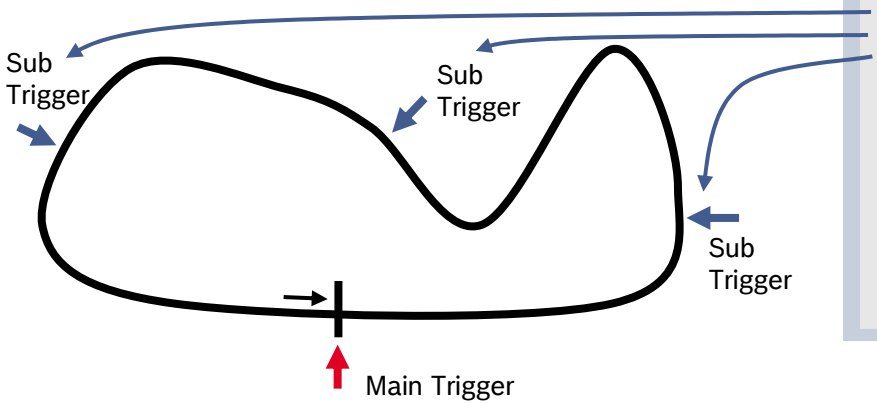
- Distance based forced trigger
  - After a missed main trigger, a forced trigger is inserted, if 120% of the track distance have been covered (4800m)
  - In this case, Laptrigger_distlap_dls starts at 800m
  - To deactivate: uncheck box

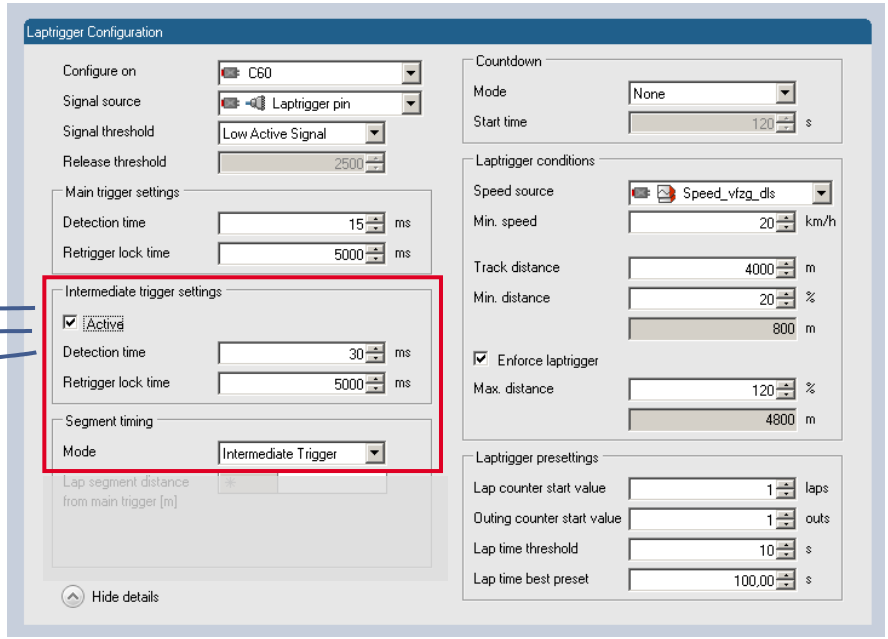




Segment Timing

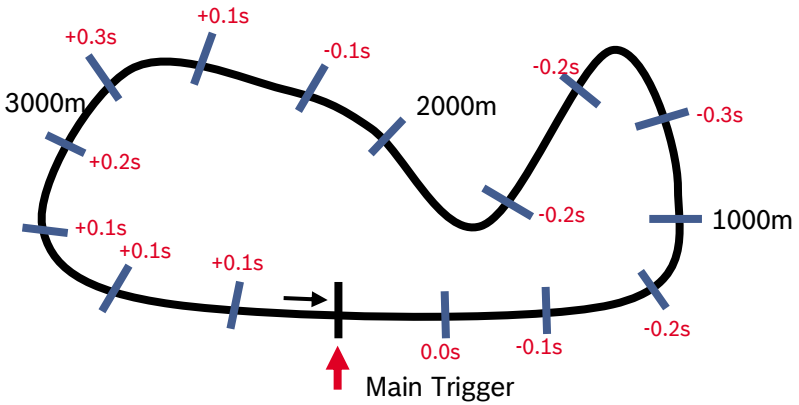
- Sub trigger mode
  - Using main trigger (20ms pulse) @ Start-Finish-Line
  - 3 sub triggers (40ms pulse) positioned @ 1000m, 2000m and 3000m
  - To deactivate: uncheck

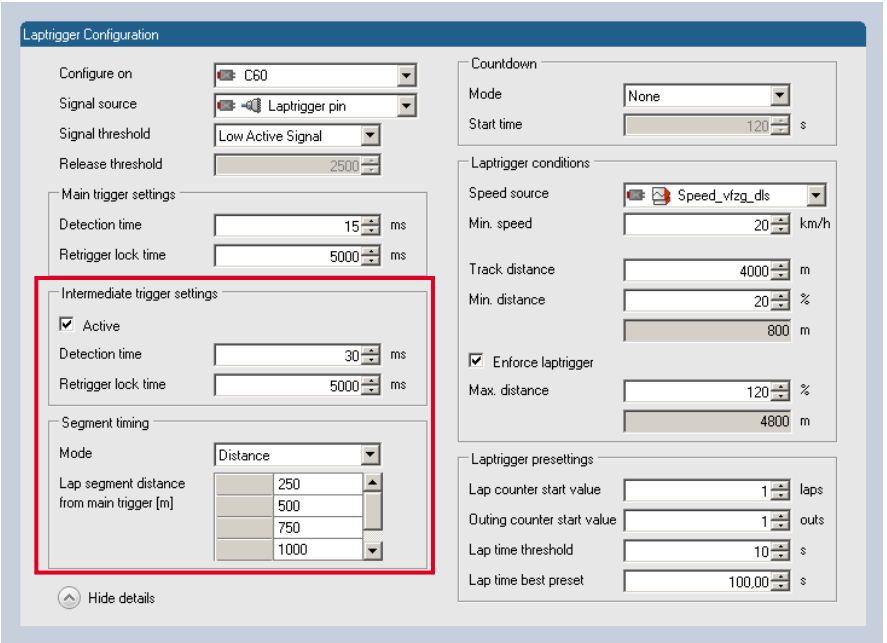




Segment Timing

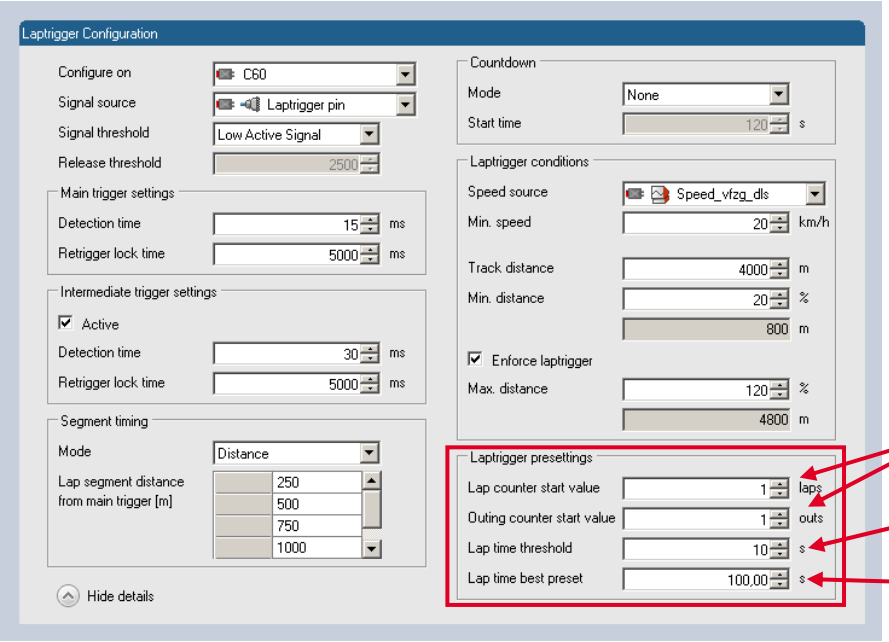
- Distance mode
  - Using main trigger (20ms pulse) @ Start-Finish-Line
  - Set ‘Mode’ to ‘Distance’ and enter desired segment distances
  - Segment time is automatically calculated @ each segment
  - Time difference to last lap and fastest lap is automatically calculated @ each segment
  - To deactivate: set ‘Mode’ to ‘None’





Laptrigger Presettings

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

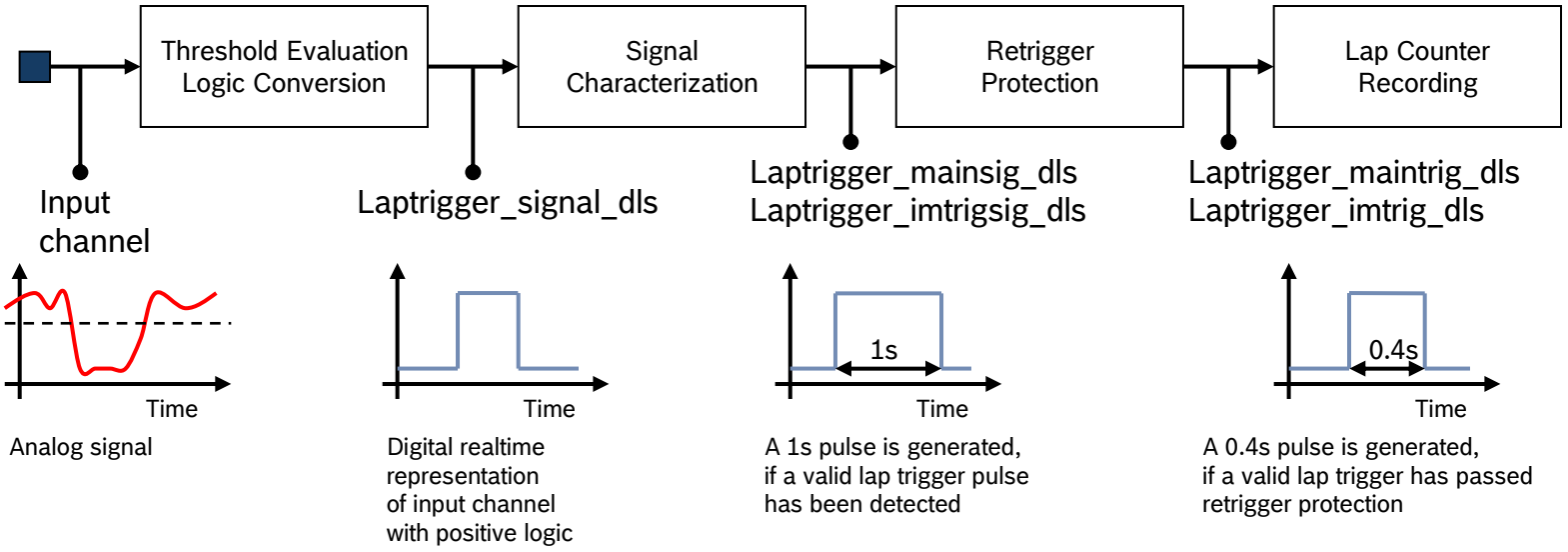


Preset values for lap counter and outing counter

Minimum laptime that a new ‘best laptime’ is accepted

Preset value for ‘best laptime’

Lap Trigger Diagnosis



Analog signal

Digital realtime representation of input channel with positive logic

A 1s pulse is generated, if a valid lap trigger pulse has been detected

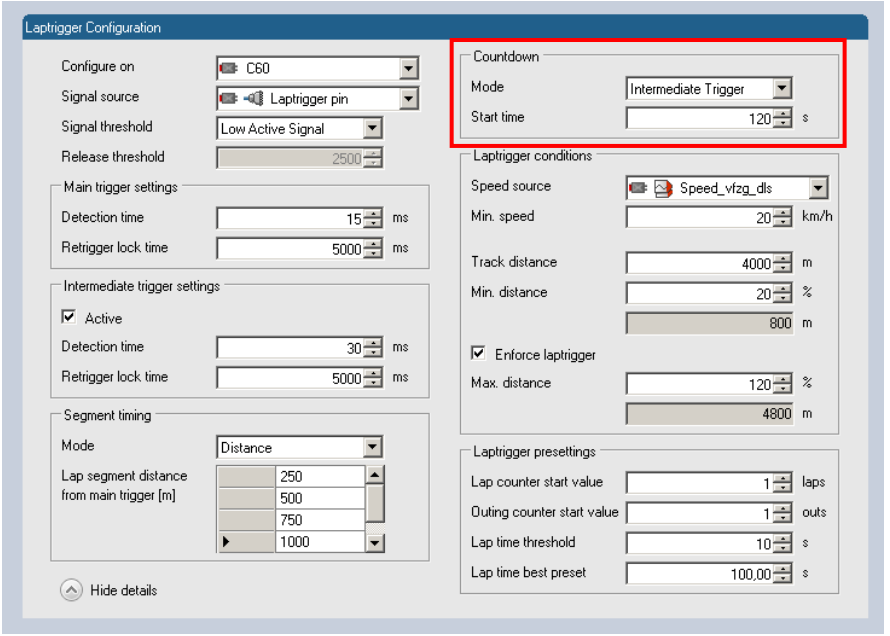
A 0.4s pulse is generated, if a valid lap trigger has passed retrigger protection

Please note: Laptrigger_xxx channels can be displayed with RaceCon and also recorded

Countdown Functionality

➔ 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 @ 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



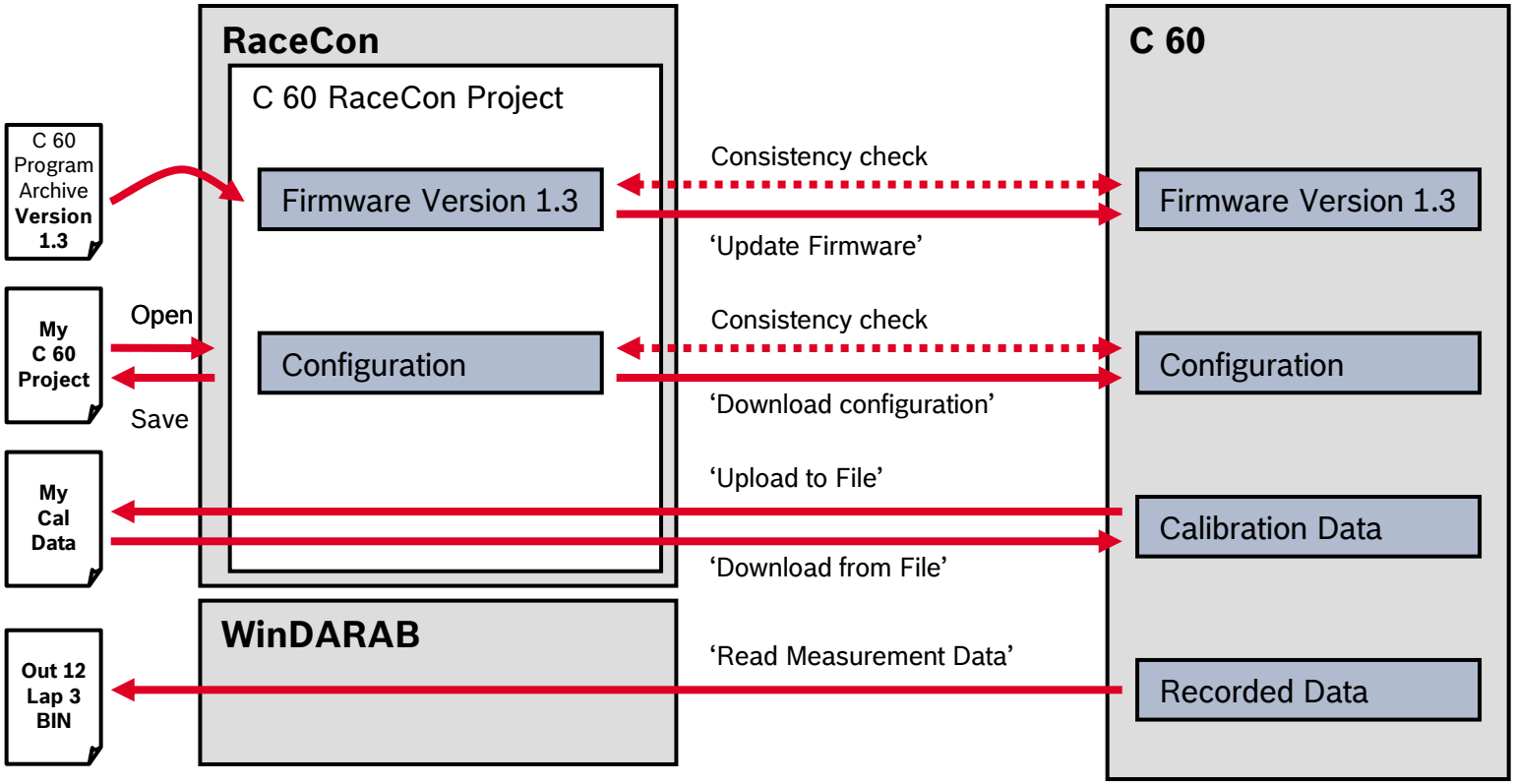
Firmware

Firmware and Configuration

C 60 Firmware and Configuration

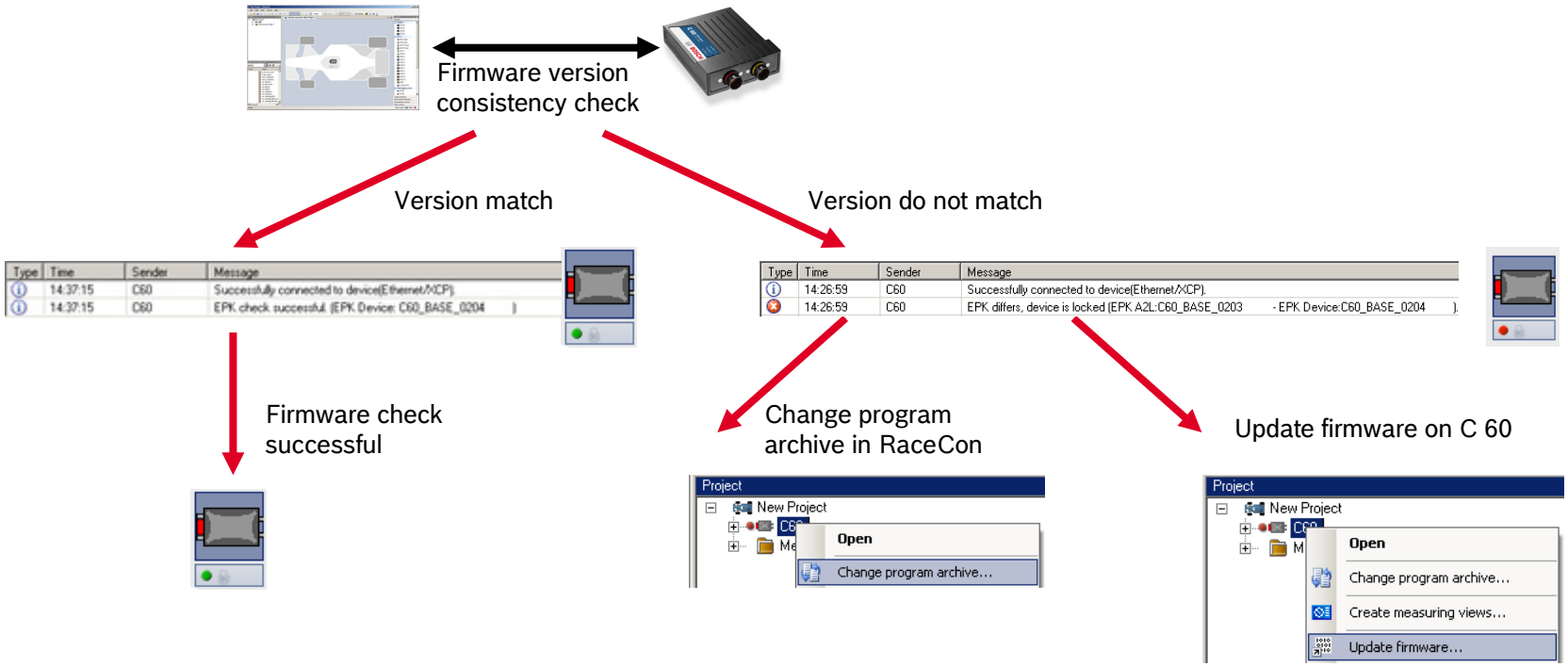
- C 60 holds 4 types of data
  - **Firmware** – the software (program) of the C 60
  - **Configuration** – the configuration of
    - Input channels, CAN I/O, PWM
    - Recording + telemetry configuration
    - Display configuration
  - **Calibration data**
    - Characteristic curves and offsets created by online calibration at the vehicle
  - **Recorded data**
    - Measurement data recorded during vehicle operation

C 60 Firmware and Configuration



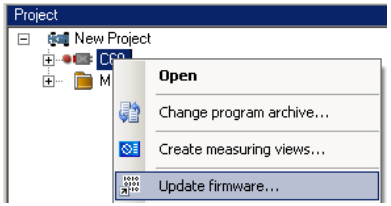
C 60 Firmware Update

- During each connect between C 60 and RaceCon

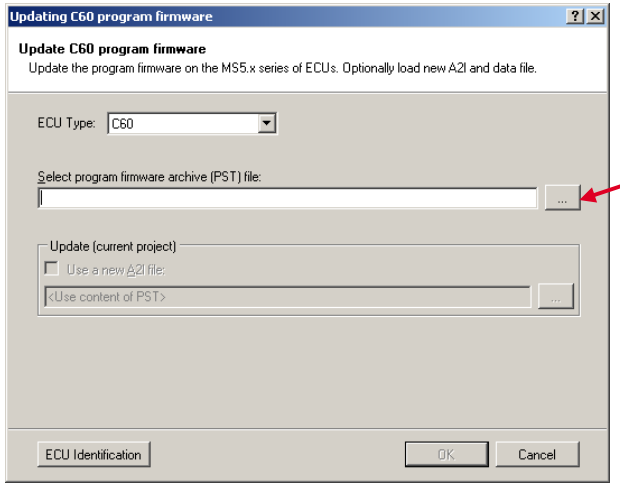


C 60 Firmware Update

- Performing the firmware update
  - In the project tree right-click on the ‘C 60’ and choose ‘Update firmware’



  - A pop-up menu opens

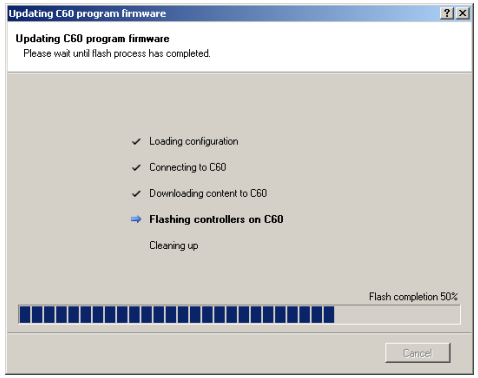


Select firmware archive here

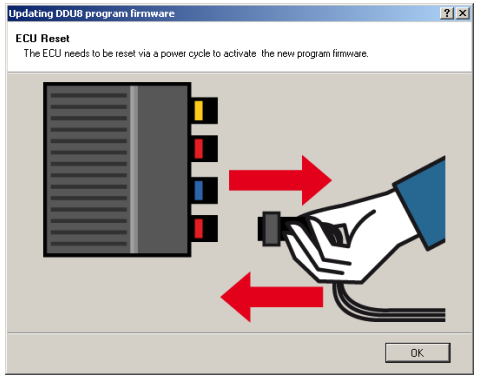
  - Click ‘OK’ when done

C 60 Firmware Update

- Performing the firmware update
  - The firmware update starts



  - When the firmware update is complete, cycle the power of the C 60



GPS

GPS Sensor

GPS Sensor

Software Upgrade 1 required

- GPS (**G**lobal **P**ositioning **S**ystem)
  - 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 C 60 (not covered here)
    - Serial output -> Read in messages via RS232 Interface of C 60 (serial interface 2)

  - Serial Interface is characterised by:
    - Voltage levels
      - RS232 is standard (+/-12V)
      - UART (0V/5V) needs level shifter
    - Baud rate
      - 9600 is standard for GPS, C 60 supports 1200...115200
      - GPS Rx interface baud rate must match DDU interface baud rate
      - C 60 Baud rate can be set with the GPS_BAUDRATE characteristic
    - Data format
      - C 60 expects 8 data bits, no parity bit, 1 stop bit (8N1)

GPS Sensor

Software Upgrade 1 required

- Protocol
  - C 60 expects NMEA Protocol (ASCII)
  - The following messages are decoded:
    - 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

- Sensor recommendation
  - The system has been tested with a **Navilock NL 403P serial GPS receiver**
  - This sensor is based on a UBlox5 chipset and is fully configurable with UCenter SW

GPS Sensor

Software Upgrade 1 required

- Measurement labels
  - The decoded NMEA messages are copied to these C 60 measurement labels
    - gps_PDOP — Position Dilution Of Precision
    - gps_HDOP — Horizontal Dilution Of Precision
    - gps_VDOP — Vertical Dilution Of Precision
    - gps_lat — Latitude in NDEG - +/-[degree][min].[sec/60]
    - gps_long — Longitude in NDEG - +/-[degree][min].[sec/60]
    - gps_elv — Antenna altitude above/below mean sea level (geoid) in meters
    - 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 — Mask specifying types of packages from which data has been obtained
    - 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)

GPS Sensor

Software Upgrade 1 required

- Measurement labels
  - 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])

• 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

GPS Sensor

Software Upgrade 1 required

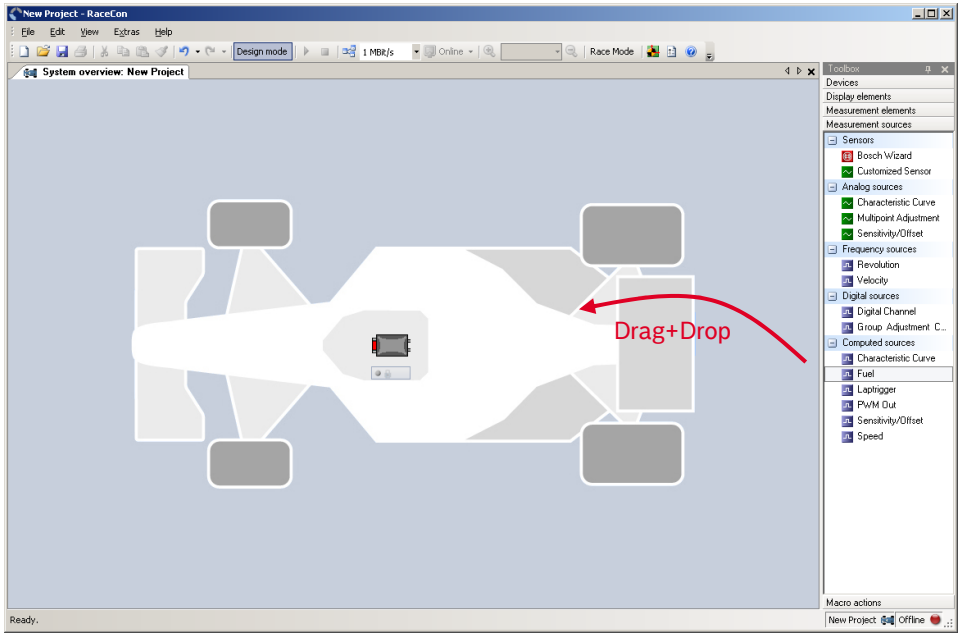
- Troubleshooting
  - Electrical
    - Is the transmitter signal of the GPS sensor connected to the receiver pin of serial interface 2 of the C 60?
    - Is the GPS sensor powered up?
    - Does the GPS sensor deliver RS232 signal levels?
  - Interface
    - Do the baudrates of the GPS sensor and the DDU 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?
    - With a correctly wired and powered GPS sensor the changing GPS time information (gps_sec) can be immediately observed
    - Is Software Upgrade 2 activated in the C 60?
  - 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 20min.
    - A correct reception is indicated when gps_fix is showing "3D Fix“

Fuel Consumption

Fuel Consumption

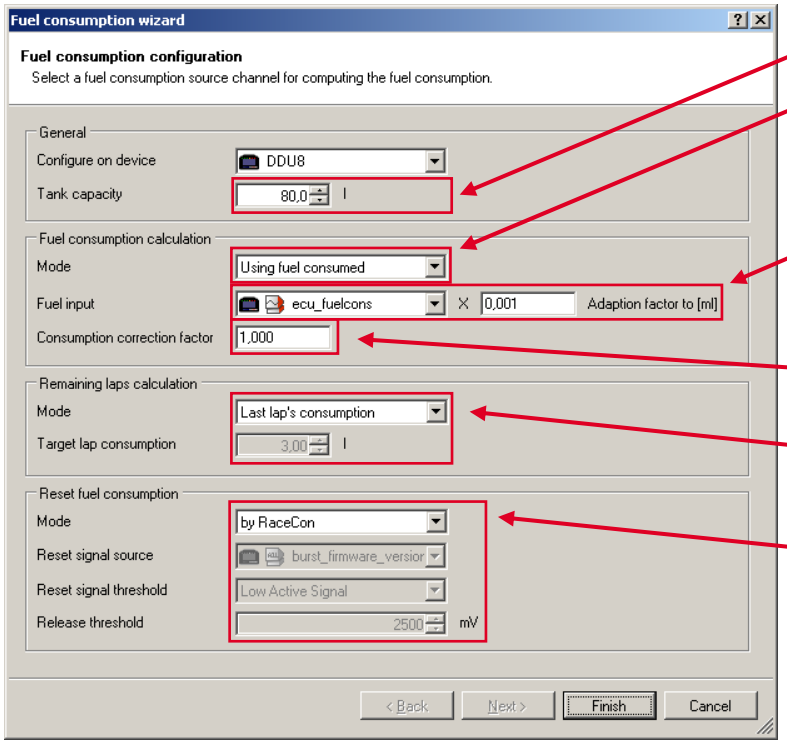
Fuel Consumption

- Setting up fuel consumption calculation and tank management for C 60
  - Select ‘Measurement Sources’ in Toolbox
  - Select ‘Fuel’
  - Select and drag ‘Fuel’ into ‘System Overview’
  - Drop ‘Fuel’ on vehicle (Not on C 60!)
  - A pop-up window opens



Fuel Consumption

- Setting up fuel consumption calculation and tank management for C 60
  - A fuel consumption wizard opens



Tank capacity of vehicle

Select calculation mode here
- Using fuel consumed (summed-up fuel consumption)
- Using flow rate (momentary fuel consumption)

Select input channel and adaption factor here
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

Factor to correct calculated consumption in C 60 vs. 'real' consumption of vehicle

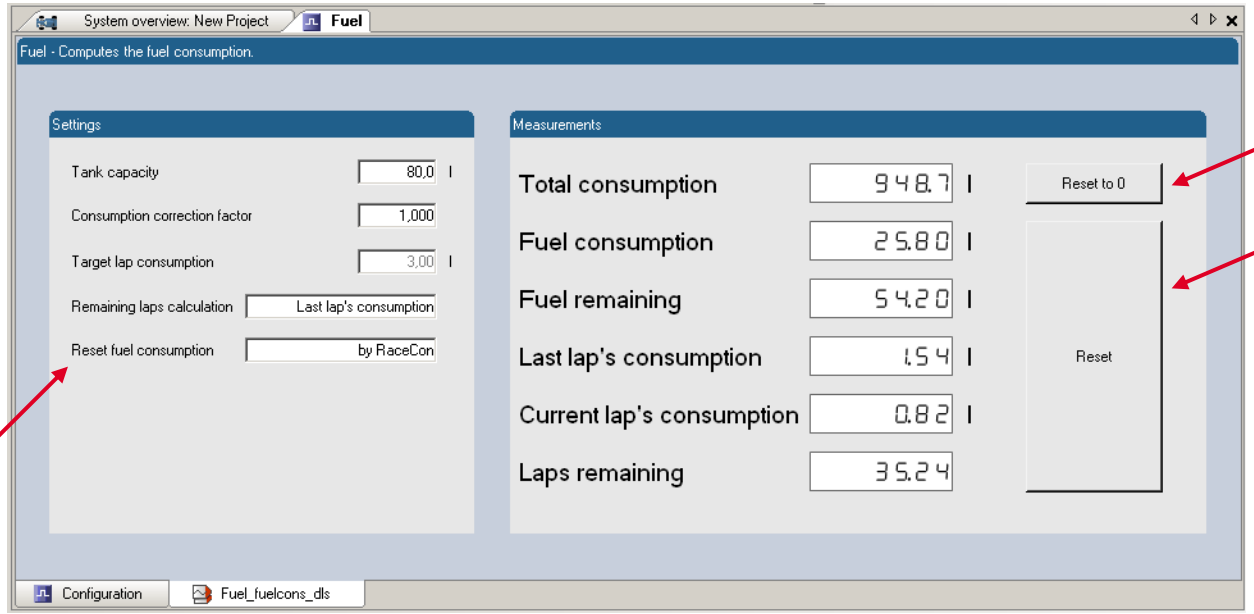
Remaining laps with fuel in tank can be calculated
- Using fuel consumption of last lap completed
- Using target lap consumption (entered here)

Reset of fuel consumption values can be initiated
- Manually using RaceCon
- Using an input channel (e.g. a switch connected to input pin)
- By 'power off' (assuming that the tank is filled each time the ignition is turned off)

  - Press 'Finish' to complete the operation

Quick Diagnosis / Counter Reset

- Diagnosis Page:
  - Double click on any Fuel_xxx channel in channel list
  - A diagnosis window opens in main area

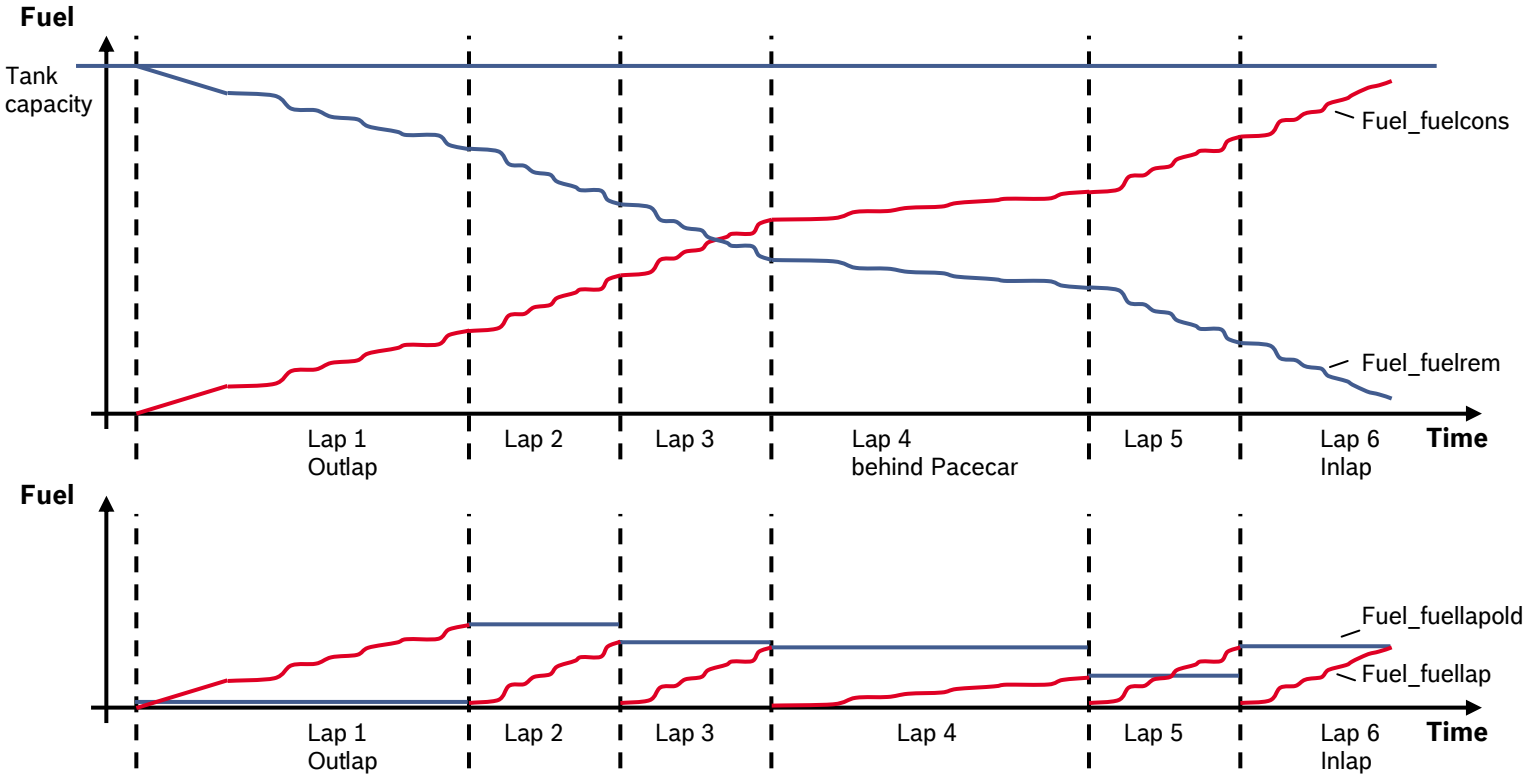


Settings overview

Button to reset total fuel consumption (Reset with RaceCon only)

Button to reset fuel consumption manually (Can also be triggered by channel or 'power down')

Example



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_fuellap_dls – Fuel consumption of last lap completed

Fuel_laprem_dls – Remaining laps with fuel in tank

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