BOSCH

Modular Sensor Interface MSI 60

Manual

1 11/12/2019

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1 Getting started

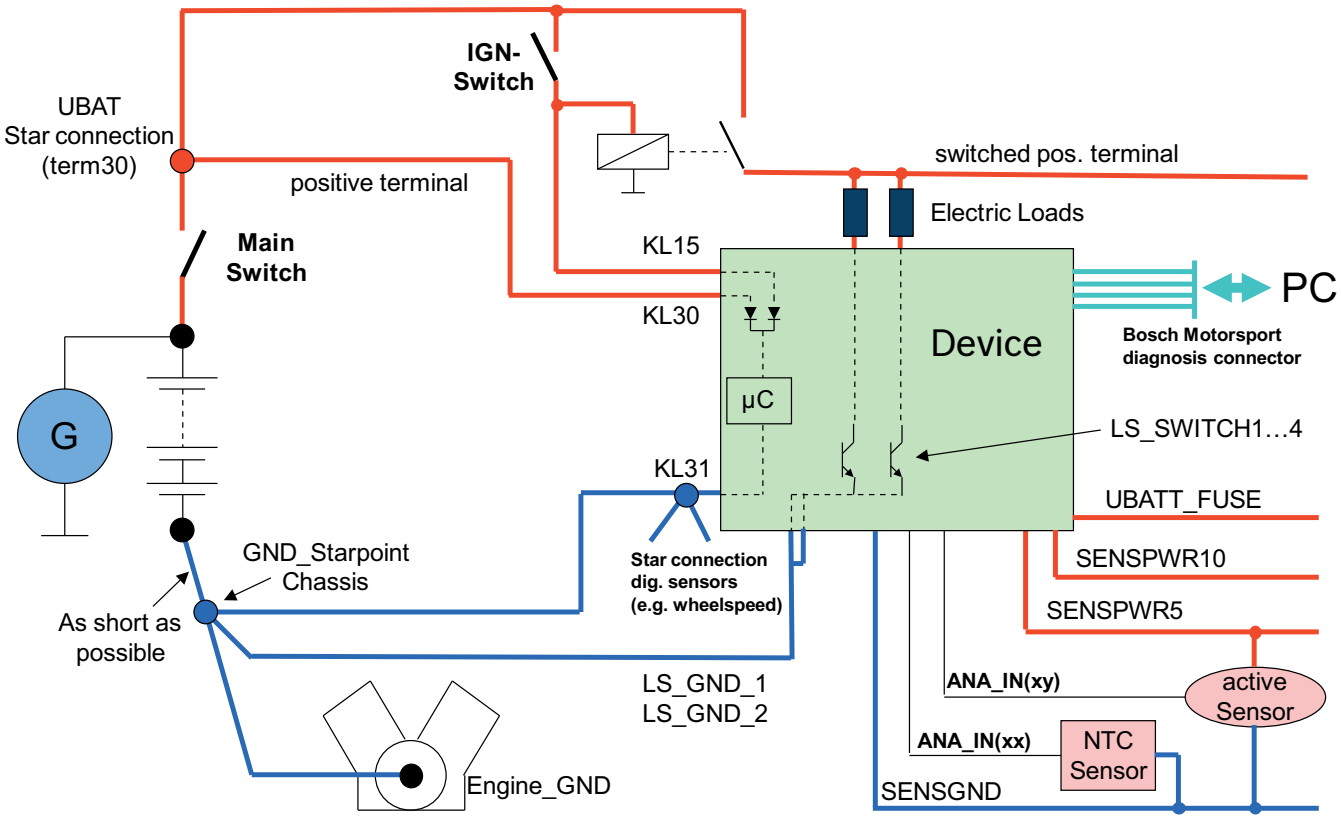
Use the MSI 60 only as intended in this manual. Any maintenance or repair must be performed by authorized and qualified personnel approved by Bosch Motorsport.

Operation of the MSI 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. 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 back page of this document.

Disclaimer

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

2 Onboard Network Concept



3 Installation

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:

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

NOTICE

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

4 Technical Data

The MSI 60 is a high quality signal conditioning and data acquisition unit for analogue, digital, frequency and linear variable differential (LVDT) sensors.

MSI 60 offers a large number of freely configurable inputs (32 x differential analogue, 8 x single ended analogue, 8 x LVDT, 2 x frequency, 1 x RS 232 for GPS). Possible applications of the differential inputs include e.g. 31 TC-J type or TC-K type temperature sensors arranged in a sensor array (one diff. input used for compensation), PT100, PT1000 (specific pull up values available), NTC, strain gauges etc. Each differential input features 200 times oversampling.

The cut-off frequency of the digital filters in all inputs is automatically adjusted to match the acquisition rate. MSI 60 also corrects the latency of the digital filters during recording, yielding zero filter delay in the recorded data. Quantization of each MSI measurement channel is individually configurable. Data can be sent via Ethernet interface to any Bosch Motorsport logging device.

Application

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
3-port network switch

Mechanical Data

Size	153 x 119 x 38 mm
Weight	645 g
Aluminum housing	
High density type motorsport connectors	
Vibration damped printed circuit boards	
Operating temperature	-20 to 85°C
Max. vibration	15 g sinus at 1,200 Hz for t < 5 h

Electrical Data

Supply voltage	7 to 18 V
Max. power consumption (w/o sensor power supply)	15 W

Inputs

Analog inputs, 0 to 5 V, 12 bit Switchable pull-up value, 3.01 kOhm	8
Differential analog inputs -5 to +5 V, 18 bit, 3 pull-ups	32
LVDT inputs	8
Rotational inputs	4

Outputs

PWM outputs (low side switch 1 A each)	4
Sensor supply 5 V (400 mA each), precision: 0.1 % (up to 300), 0.2 % (max. 300 mA)	2
Sensor supply 5 V/10 V (200 mA each)	2
Sensor supply 12 V (800 mA, non regulated)	1

Environment

Software Upgrade 1	
CCP-Master (ASAP 2 file from ECU manufacturer required)	F 02U V01 012-01

Connectors and Wires

Motorsports connectors double density	2 x 64 pin and 1 x 34 pin
Mating connector I AS212-35PN (red)	F02U 000 443-01
Mating connector II ASDD214-64PA (yellow)	F02U 003 098-01
Mating connector III ASDD214-64PN (red)	F02U 000 854-01

Communication

Configuration via RaceCon over Ethernet or MSA-Box II
2 CAN interfaces
3 Ethernet 100BaseT
RS232 for GPS

The required software for this device is available on www.bosch-motorsport.com.

5 Inputs and Outputs

The following chapter introduces the Input and Output Channels.

5.1 Input Channels

The MSI 60 provides diverse analog inputs which allows the direct connection of a multiplicity number of sensors.

5.1.1 Basic Analog Inputs

The MSI 60 basic 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 Differential Analog Inputs

The MSI 60 differential analog inputs offers a wide configurability. The inputs can be switched between single ended or differential mode. In single ended mode input signals of 0 to 5 V are accepted. In differential mode input signals are accepted in the range of -5 V to +5 V.

Three pull-up resistors can be activated by software. A 3.01 kOhm resistor can be used for evaluation both ntc sensors and switches or push-buttons.

The resistors of 4.99 kOhm and 49.9 kOhm provide the direct connection of PT100 and PT1000 sensors.

A selectable amplification of small input signals allows the direct connection of resistive strain gauges.

For further wiring details please refer to the given figures.

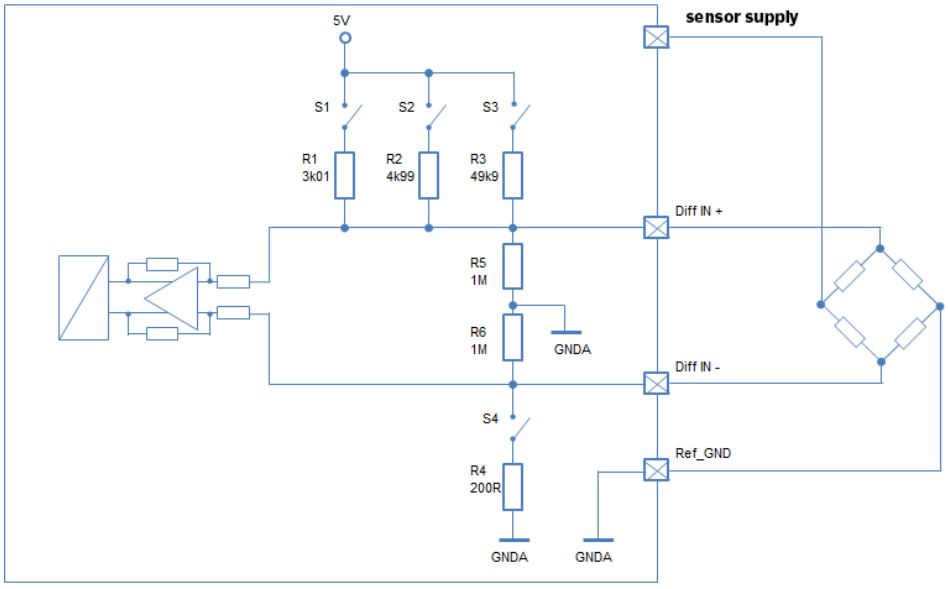


Illustration 1: Differential sensor

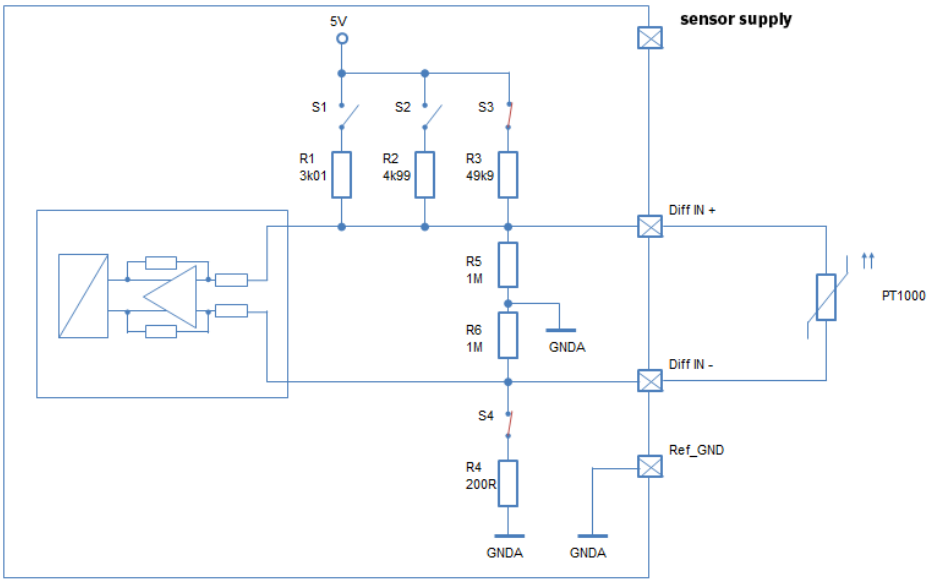


Illustration 2: Differential_PT1000 sensor

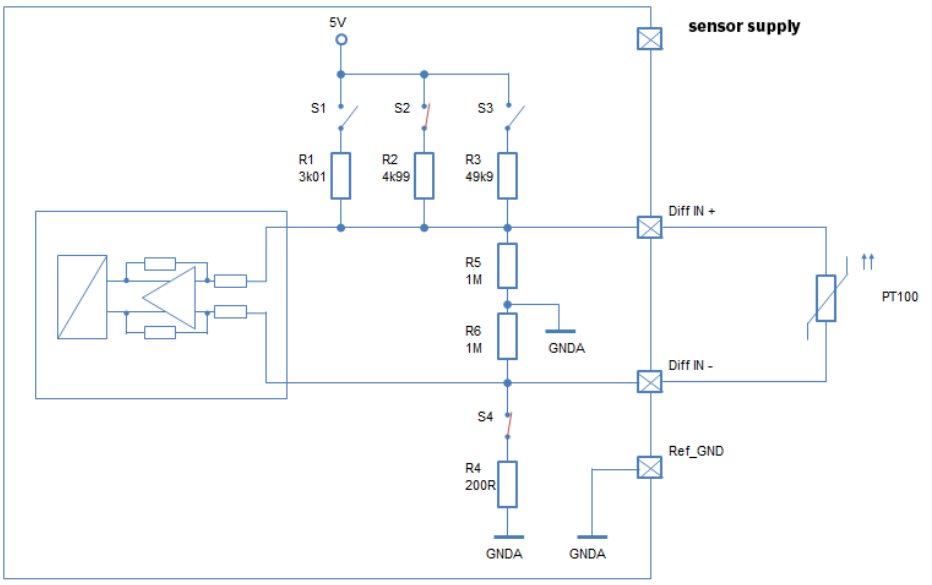


Illustration 3: Differential_PT100 sensor

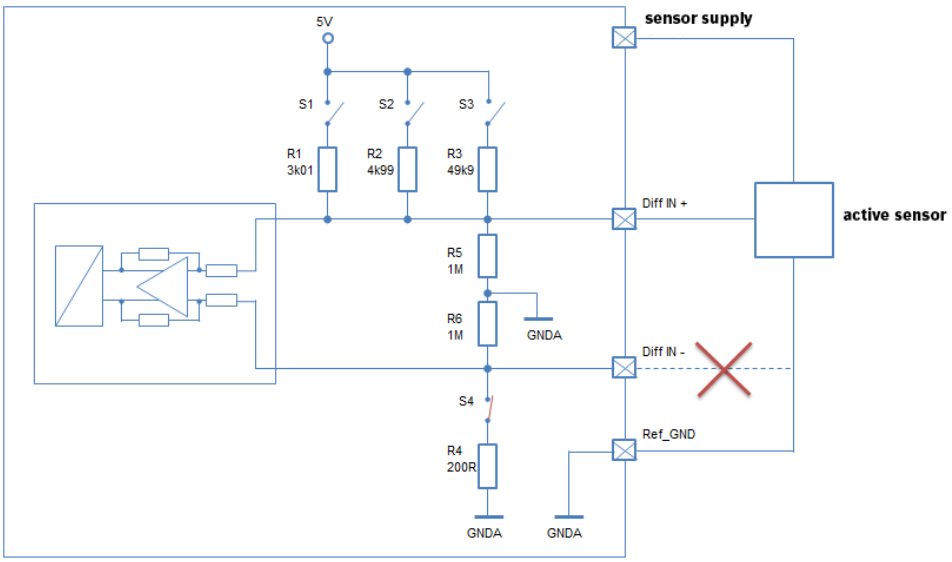


Illustration 4: Single ended sensor

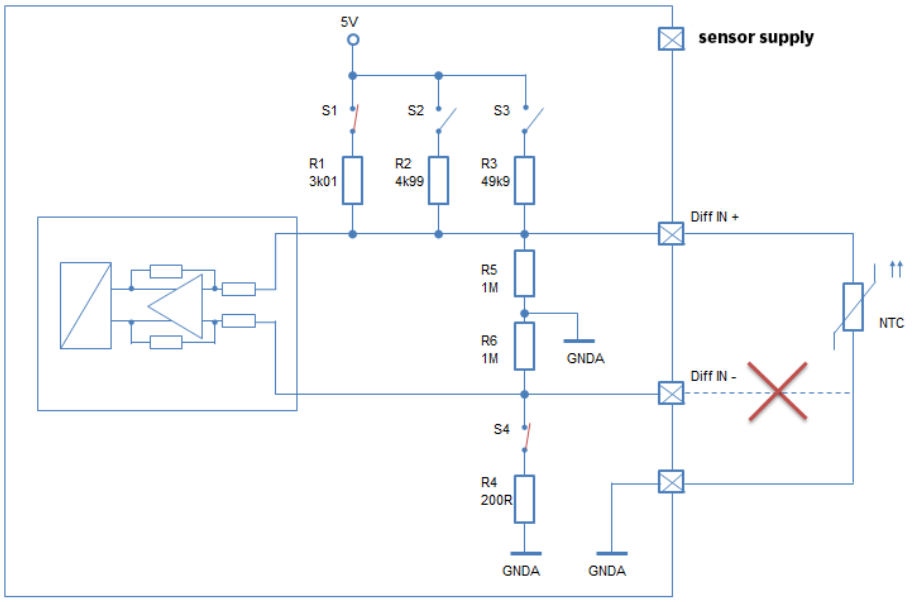


Illustration 5: NTC sensor

5.1.3 LVDT Inputs

The MSI 60 LVDT inputs allows the connection of various LVDT sensors. Switchable exciting voltage and frequency are used for the correct adaption of the applied sensor. For further wiring details please refer to the following figure:

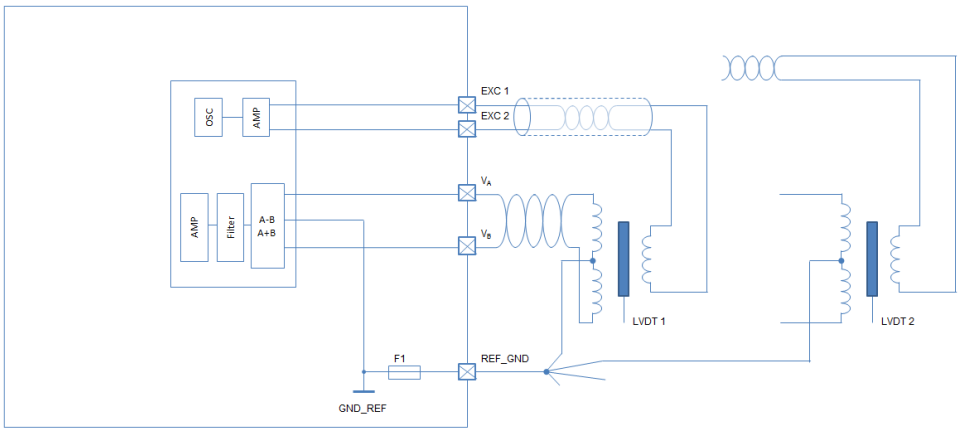


Illustration 6: LVDT

For further details see on chapter Configuring an LVDT Sensor [▶ 67].

See also

- *Online Calibration of Measurement Channels [▶ 90]*

5.1.4 Digital Inputs

The digital inputs of the MSI 60 can be switched for the direct connection of Hall-effect, inductive and DF11 sensors.

- For Hall-effect sensors an input signal from 0 V to 5 V is accepted.
- For inductive sensors a zero-crossing signal is necessary.

Connect the sensor between I_F_REVx and digital ground G_R_DIGx.

5.2 Output Channels

This chapter describes the PWM Output and Sensor Power Supply of the MSI 60.

5.2.1 PWM Outputs

The MSI 60 has 4 low side switch outputs controlled by pulse width modulation (PWM). Each switch is rated 1 A maximum current. Maximum PWM switch frequency is 1 kHz with a 0 % ... 100 % duty cycle. Each output is short circuit protected to GND and battery voltage. 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 MSI 60 has three types of sensor power supply:

- One 12 V unregulated battery voltage
- Two fixed outputs with 5 V regulated
- Two switchable 5 V/10 V outputs with regulated voltage

5.3 Communication Channels

This chapter describes the Communication Channels of the MSI 60.

5.3.1 CAN Bus

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

5.3.2 Ethernet Channels

The MSI 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 Port

The MSI 60 has one RS232 serial port. The baudrate is programmable which can be used for reception of data from a serial GPS sensor, see on GPS Sensor [▷ 110].

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: AS012-35SN.

PIN	Name	Description	Used for MSI 60
1	Terminal 30	Permanent positive	+
2	Terminal 15	Switched positive	+
3	Terminal 31	GND	+
4	CAN High	Diagnostic CAN bus	

PIN	Name	Description	Used for MSI 60
16	CAN Low	Diagnostic CAN bus	
10	K-Line	ECU diagnosis	
8	Ethernet RxD +	Ethernet interface	+
9	Ethernet RxD -	Ethernet interface	+
11	Ethernet TxD +	Ethernet interface	+
12	Ethernet TxD -	Ethernet interface	+
22	Screen	Cable screen	+

5.4 Pin Layout Connectors

5.4.1 Pin Layout Life Connector AS212-35PN (red)

PIN	Name	Description	Direction	Remark
1	V_V_BAT+_A	UBATT ECU	Input	ECU SUPPLY
2	V_V_BAT+_A	UBATT ECU	Input	ECU SUPPLY
3	I_S_T15	KL15 input signal ignition	Input	
4	G_G_BAT	GND		not sc safe to UBATT
5	G_G_BAT	GND		not sc safe to UBATT
6	B_D_ETH0_RX-	Ethernet Channel1 Rx minus		
7	B_D_ETH0_TX-	Ethernet Channel1 Tx minus		
8	B_D_ETH1_TX-	Ethernet Channel2 Tx minus		
9	B_D_ETH1_RX-	Ethernet Channel2 Rx minus		
10	B_D_ETH1_RX+	Ethernet Channel2 Rx plus		
11	B_D_ETH2_RX-	Ethernet Channel3 Rx minus		
12	B_D_ETH2_TX-	Ethernet Channel3 Tx minus		
13	B_D_ETH2_TX+	Ethernet Channel3 Tx plus		
14	B_D_CAN_L_A	CAN A Low		CAN A Low
15	B_D_CAN_H_A	CAN A High		CAN A High
16	O_V_UBAT	Output switched UBATT	Output	
17	B_D_ETH0_RX+	Ethernet Channel1 Rx plus		
18	B_D_ETH0_TX+	Ethernet Channel1 Tx plus		
19	B_D_ETH1_TX+	Ethernet Channel2 Tx plus		
20	B_D_ETH2_RX+	Ethernet Channel3 Rx plus		
21	G_R_SCREEN	Screen		Screen
22	I_F_TIMESYNC	SYNCH_CLKIN		

5.4.2 Pin Layout Sensor Connector ASDD214-64PA (yellow)

PIN	Name	Description	Direction	Remark
1	G_R_LVDT	LVDT REF GND		LVDT GND & SCREEN
2	LS_SWITCH_2	Output LowSide 2	Output	1.1 A
3	LS_SWITCH_1	Output LowSide 1	Output	1.1 A
4	EXC1_4	LVDT exciting voltage +	Output	LVDT 4
5	VA_4	LVDT input A	Input	LVDT 4
6	EXC1_3	LVDT exciting voltage +	Output	LVDT 3
7	EXC2_2	LVDT exciting voltage +	Output	LVDT 2
8	VB_2	LVDT B	Input	LVDT 2

PIN	Name	Description	Direction	Remark
9	VA_1	LVDT A	Input	LVDT 1
10	SE_ANA_1	Analog input 0 to 5 V, switchable pull-up	Input	R_{PU}: 3k01
11	SE_ANA_3	Analog input 0 to 5 V, switchable pull-up	Input	R_{PU}: 3k01
12	UNI_ANA_16_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
13	UNI_ANA_15_N		Input	
14	UNI_ANA_13_N		Input	
15	UNI_ANA_12_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
16	UNI_ANA_10_N		Input	
17	UNI_ANA_08_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
18	UNI_ANA_07_N		Input	
19	UNI_ANA_04_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
20	UNI_ANA_06_N		Input	
21	UNI_ANA_05_N		Input	
22	UNI_ANA_02_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
23	UNI_ANA_01_N		Input	
24		Reserved. Do not connect.		
25	B_D_CAN B Low	CAN B Low		CAN B LOW
26	G_R_DIG1	Ground Reference DIG1		REV IN
27	EXC2_4	LVDT exciting voltage -		LVDT 4
28	VB_4	LVDT input B	Input	LVDT 4
29	EXC2_3	LVDT exciting voltage -	Input	LVDT 3
30	EXC1_2	LVDT exciting voltage +	Input	LVDT 2
31	VA_2	LVDT input A	Input	LVDT 2
32	VB_1	LVDT input B	Input	LVDT 1
33	SE_ANA_2	Analog input 0 to 5 V, switchable pull-up	Input	R_{PU}: 3k01
34	UNI_ANA_16_N		Input	
35	UNI_ANA_15_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
36	UNI_ANA_13_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
37	UNI_ANA_11_N		Input	
38	UNI_ANA_08_N		Input	
39	UNI_ANA_07_P		Input	R_{PU}: 3k01 or 4k99 or 49k9

PIN	Name	Description	Direction	Remark
40	UNI_ANA_06_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
41	UNI_ANA_03_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
42	UNI_ANA_02_N		Input	
43	UNI_ANA_01_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
44	B_D_CAN B High	CAN B High		CAN B High
45	VA_3	LVDT input A	Input	LVDT 3
46	VB_3	LVDT input B	Input	LVDT 3
47	EXC1_1	LVDT exciting voltage +	Input	LVDT 1
48	EXC2_1	LVDT exciting voltage -	Input	LVDT 1
49	G_R_AGND1	Reference GND1 for analog inputs	Input	not sc save to UBATT
50	SE_ANA_4	Analog input 0 to 5 V, switchable pull-up	Input	R_{PU}: 3k01
51	UNI_ANA_14_P			R_{PU}: 3k01 or 4k99 or 49k9
52	UNI_ANA_12_N			
53	UNI_ANA_10_P			R_{PU}: 3k01 or 4k99 or 49k9
54	UNI_ANA_04_N			
55	UNI_ANA_03_N			
56	UNI_ANA_05_P			R_{PU}: 3k01 or 4k99 or 49k9
57	I_F_REV1	Revolution/Frequeny input		I-encoder wheel / Hall / DF11
58	SENSPWR_5V	Sensor supply 5 V, 400 mA max.		
59	SENSPWR_5V_10V	Sensor supply 5 V, 10 V, 200 mA max.		not sc safe to UBATT
60	G_R_AGND2	Reference GND2 for analog inputs	Input	not sc safe to UBATT
61	UNI_ANA_14_N		Input	
62	UNI_ANA_11_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
63	UNI_ANA_09_P		Input	R_{PU}: 3k01 or 4k99 or 49k9
64	UNI_ANA_09_N		Input	

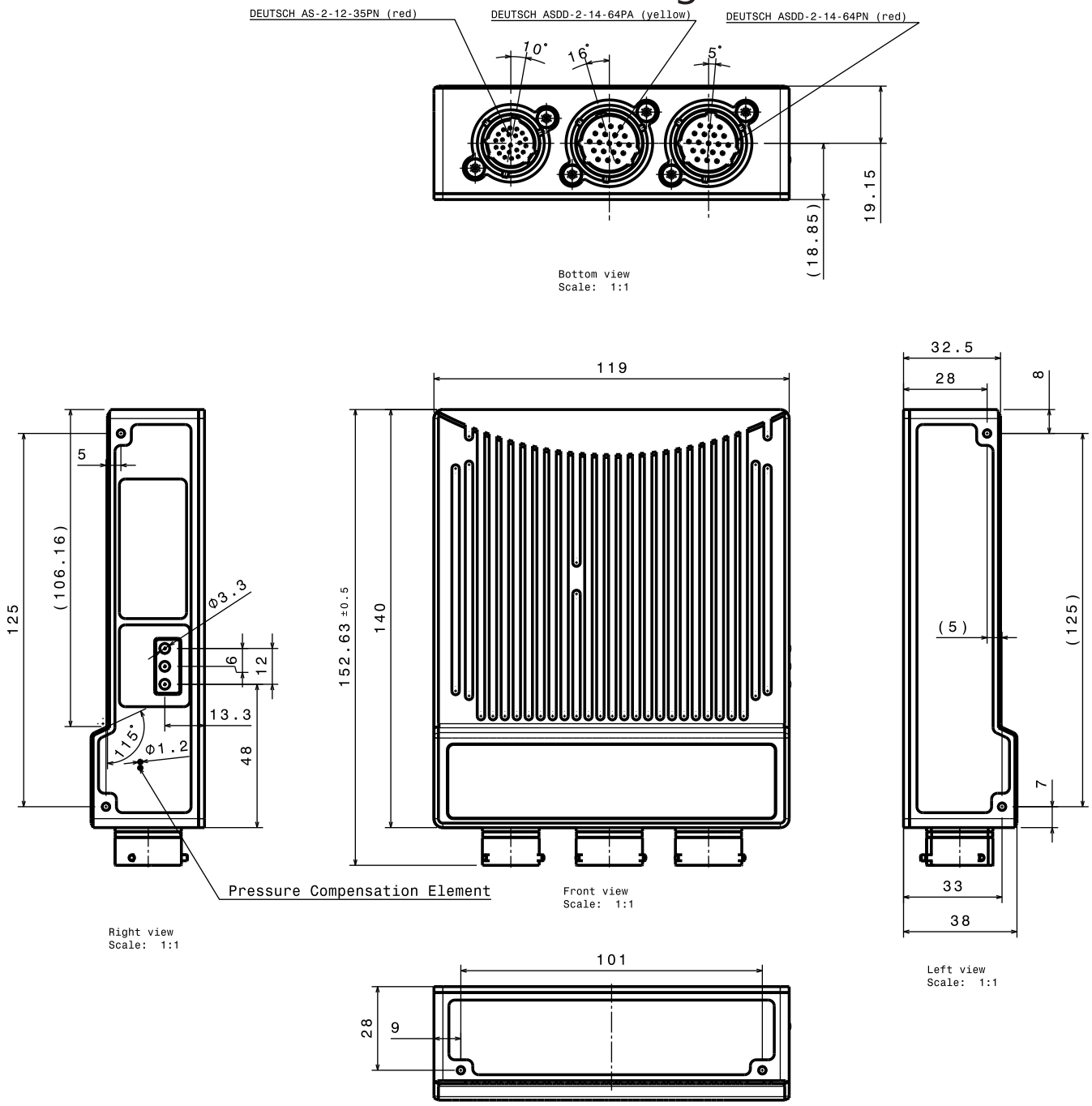
5.4.3 Pin Layout Sensor Connector ASDD214-64PN (red)

PIN	Name	Description	Direction	Remark
1	DGND2	LVDT REF GND		LVDT GND & SCREEN
2	LS_SWITCH_4	Output LowSide 4		1.1 A
3	LS_SWITCH_3	Output LowSide 3		1.1 A
4	EXC1_8	LVDT exciting voltage +		LVDT 8
5	VA_8	LVDT input A		LVDT 8
6	EXC1_7	LVDT exciting voltage +		LVDT 7
7	EXC2_6	LVDT exciting voltage -		LVDT 6
8	VB_6	LVDT input B		LVDT 6
9	VA_5	LVDT input A		LVDT 5
10	SE_ANA_5	Analog input 0 to 5 V, switchable pull-up		R_{PU}: 3k01
11	SE_ANA_7	Analog input 0 to 5 V, switchable pull-up		R_{PU}: 3k01
12	UNI_ANA_32_P			R_{PU}: 3k01 or 4k99 or 49k9
13	UNI_ANA_31_N			
14	UNI_ANA_29_N			
15	UNI_ANA_28_P			R_{PU}: 3k01 or 4k99 or 49k9
16	UNI_ANA_26_N			
17	UNI_ANA_24_P			R_{PU}: 3k01 or 4k99 or 49k9
18	UNI_ANA_23_N			
19	UNI_ANA_20_P			R_{PU}: 3k01 or 4k99 or 49k9
20	UNI_ANA_22_N			
21	UNI_ANA_21_N			
22	UNI_ANA_18_P			R_{PU}: 3k01 or 4k99 or 49k9
23	UNI_ANA_17_N			
24	B_D_PSI5_2	Reserved. Do not connect.		
25	RS232A TX	RS232 transmit		
26	G_R_DIG2	Ground reference DIG2		REV IN
27	EXC2_8	LVDT exciting voltage -		LVDT 8
28	VB_8	LVDT input B		LVDT 8
29	EXC2_7	LVDT exciting voltage -		LVDT 7
30	EXC1_6	LVDT exciting voltage +		LVDT 6
31	VA_6	LVDT input A		LVDT 6
32	VB_5	LVDT input B		

PIN	Name	Description	Direction	Remark
33	SE_ANA_6	Analog input 0 to 5 V, switchable pull-up		R_{PU}: 3k01
34	UNI_ANA_32_N			
35	UNI_ANA_31_P			R_{PU}: 3k01 or 4k99 or 49k9
36	UNI_ANA_29_P			R_{PU}: 3k01 or 4k99 or 49k9
37	UNI_ANA_27_N			
38	UNI_ANA_24_N			
39	UNI_ANA_23_P			R_{PU}: 3k01 or 4k99 or 49k9
40	UNI_ANA_22_P			R_{PU}: 3k01 or 4k99 or 49k9
41	UNI_ANA_19_P			R_{PU}: 3k01 or 4k99 or 49k9
42	UNI_ANA_18_N			
43	UNI_ANA_17_P			R_{PU}: 3k01 or 4k99 or 49k9
44	RS232A RX	RS232 receive		
45	VA_7	LVDT input A		LVDT 7
46	VB_7	LVDT input B		LVDT 7
47	EXC1_5	LVDT exciting voltage +		LVDT 5
48	EXC2_5	LVDT exciting voltage -		LVDT 5
49	G_R_AGND3	Reference GND3 for analog inputs		not sc safe to UBATT
50	SE_ANA_8	Analog input 0 to 5 V, switchable pull-up		R_{PU}: 3k01
51	UNI_ANA_30_P			R_{PU}: 3k01 or 4k99 or 49k9
52	UNI_ANA_28_N			
53	UNI_ANA_26_P			R_{PU}: 3k01 or 4k99 or 49k9
54	UNI_ANA_20_N			
55	UNI_ANA_19_N			
56	UNI_ANA_21_P			R_{PU}: 3k01 or 4k99 or 49k9
57	I_F_REV2	Revolution/frequency input.		I-encoder wheel / Hall / DF11
58	SENSPWR_5V	Sensor supply 5 V, 400 mA max.		
59	SENSPWR_5V_10V	Sensor supply 5 V, 10 V, 200 mA max.		
60	G_R_AGND4	Reference GND4 for analog inputs		not sc safe to UBATT

PIN	Name	Description	Direction	Remark
61	UNI_ANA_30_N			
62	UNI_ANA_27_P			R_{PU}: 3k01 or 4k99 or 49k9
63	UNI_ANA_25_P			R_{PU}: 3k01 or 4k99 or 49k9
64	UNI_ANA_25_N			

6 Mechanical Drawing



7 Starting up

The following chapter explains what you have to do before starting the MSI 60 and how to connect it to RaceCon.

7.1 Before Starting

Install the software required for MSI 60 operation. It is developed for Windows 2000/XP/ Vista/7. Following software versions are used in this manual:

- MSI 60 setup, configuration and calibration: RaceCon V2.5 and following
- Measurement data analysis: WinDarab V7

Set up the 100 Mbit Ethernet connection to the MSI 60.

- All three Ethernet ports of MSI 60 are internally connected by a network switch.
- All Ethernet ports have 'cable auto crossover' functionality.

Minimum wiring loom of the Life connector (red):

PIN	Description
1+2+3	12 V Supply Voltage
4+5	GND Supply Voltage
18	Ethernet Tx+
7	Ethernet Tx-
17	Ethernet Rx+
6	Ethernet Rx-
21	Ethernet Screen

7.1.1 Starting the MSI 60

The MSI 60 powers up by turning on the ignition of the car.

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

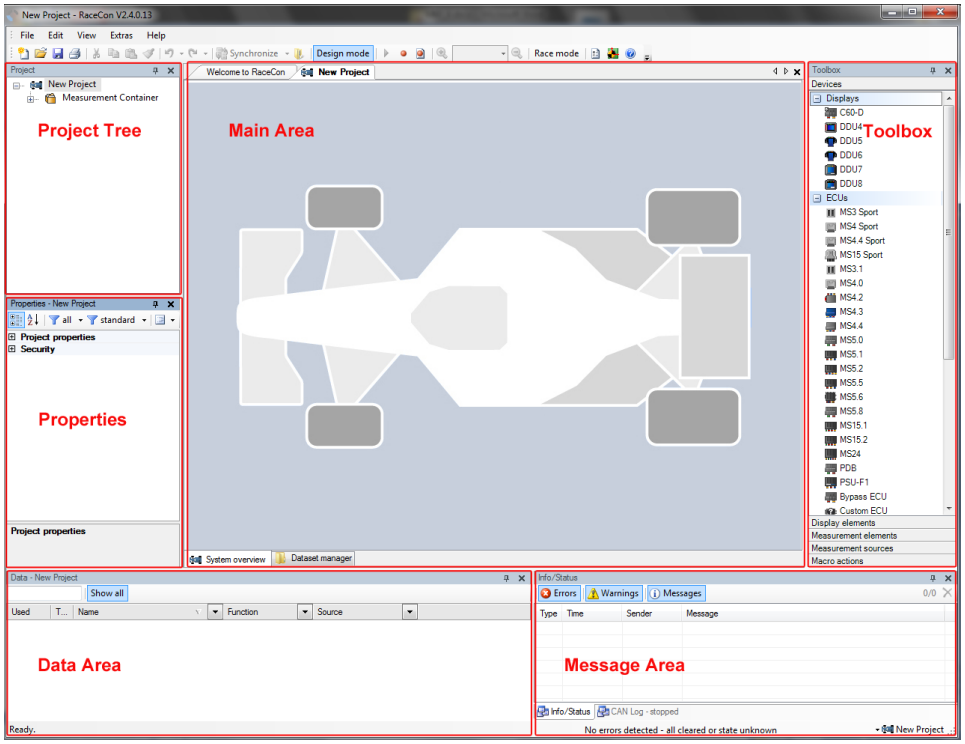
7.1.2 About RaceCon

RaceCon is an all integrated software tool for configuration and calibration of Bosch Motorsport hardware products. It is used to set up, configure and calibrate the MSI 60.

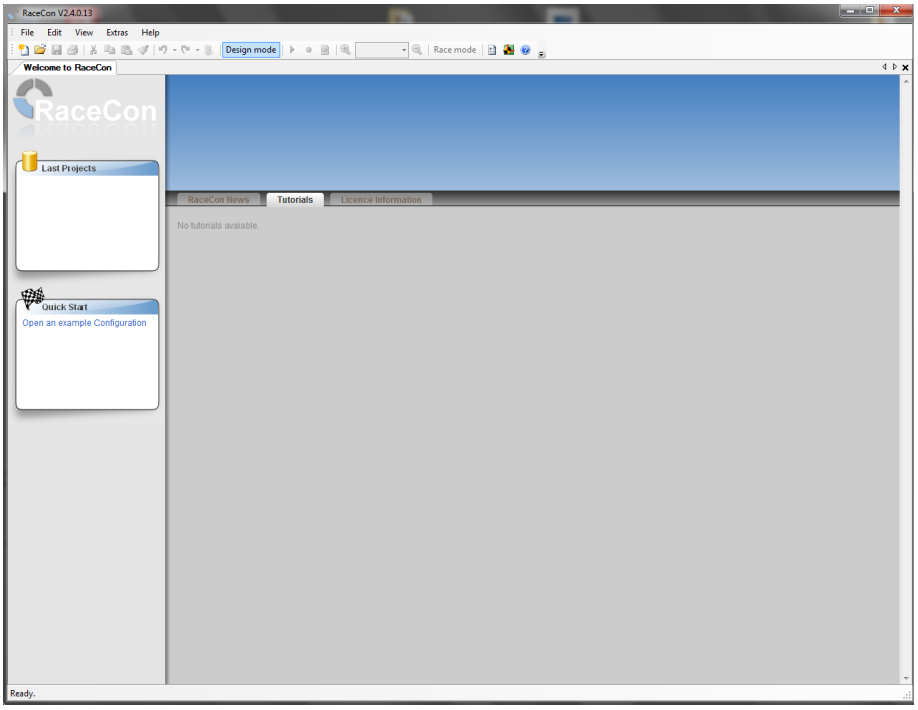
For better understanding, Bosch Motorsport offers a video tutorial that explains many functions of RaceCon. The video tutorial is available in the 'Software Download' section on www.bosch-motorsport.com.

7.1.3 Connecting the MSI 60 to RaceCon

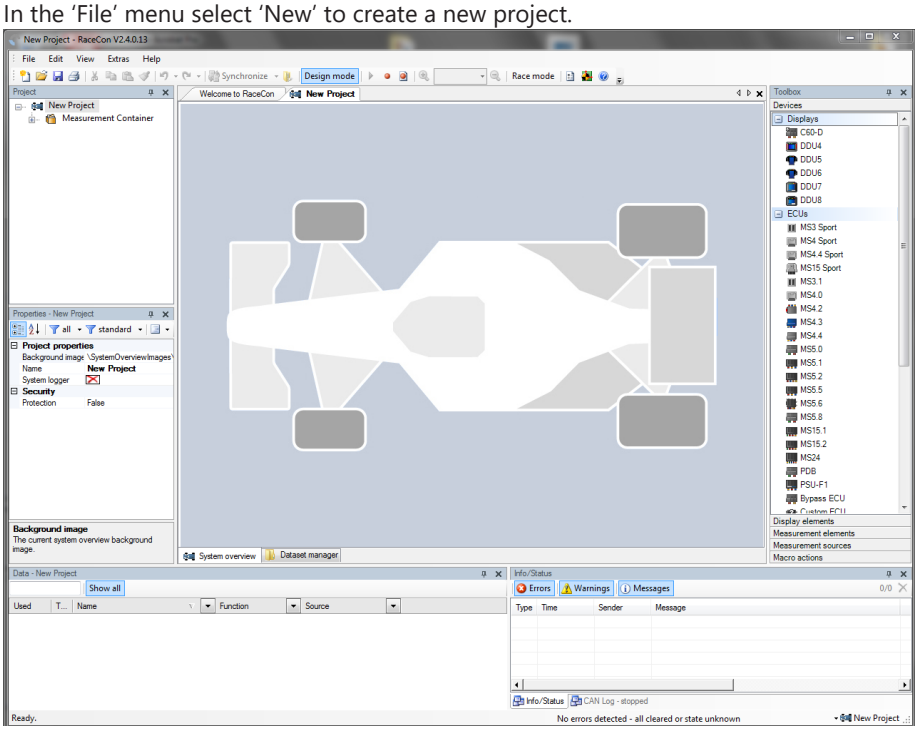
The following screenshot shows an overview of the RaceCon main screen with its areas. All (sub-) windows are resizable and dockable.



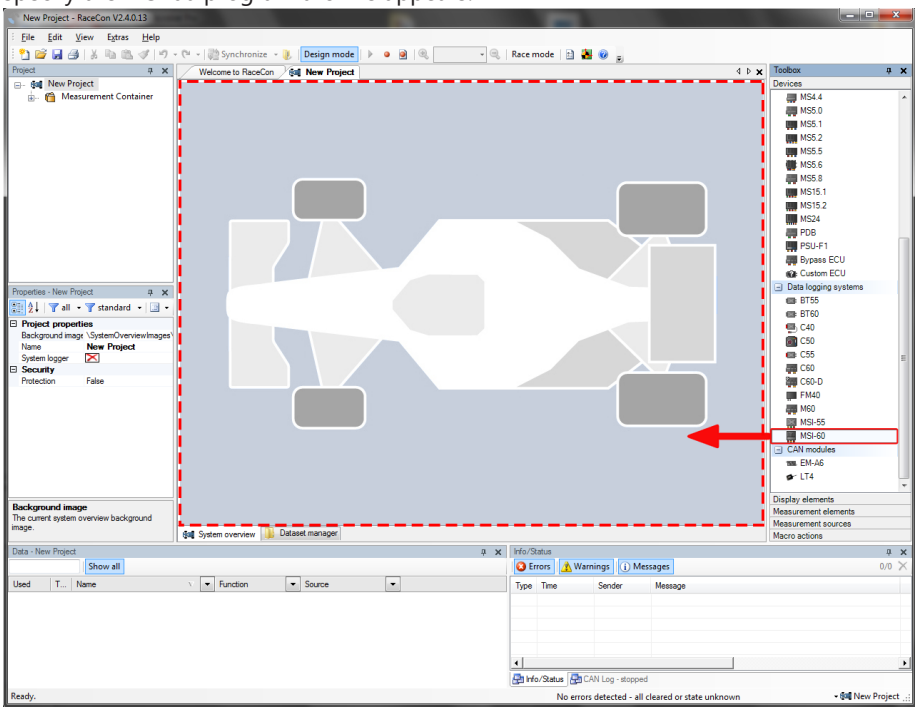
1. Start the RaceCon software.



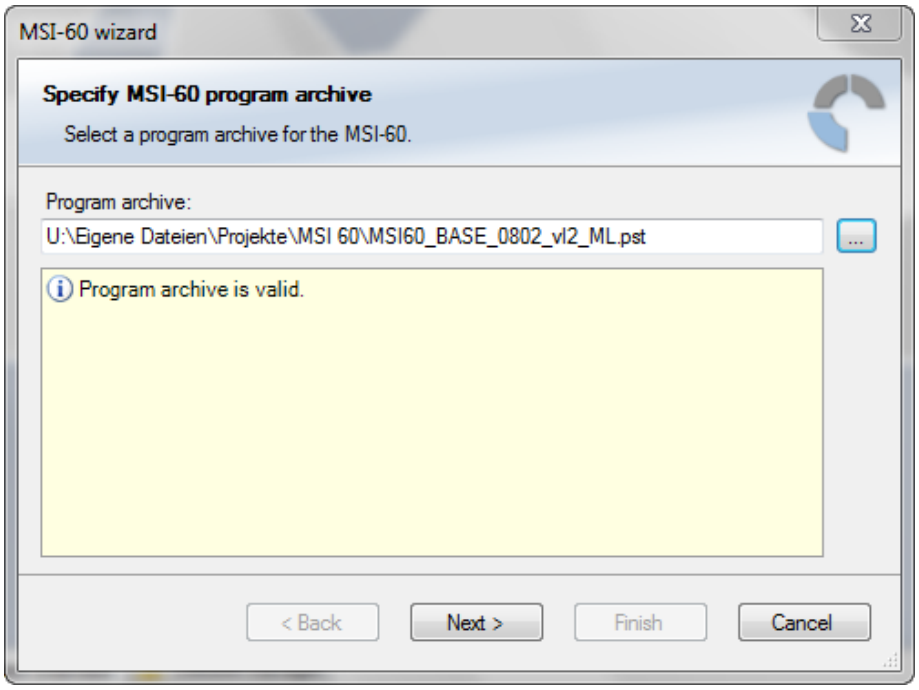
2. In the ‘File’ menu select ‘New’ to create a new project.



3. In the Toolbox select the MSI 60 and drag it into the Main Area. A pop-up window to specify the MSI 60 program archive appears.

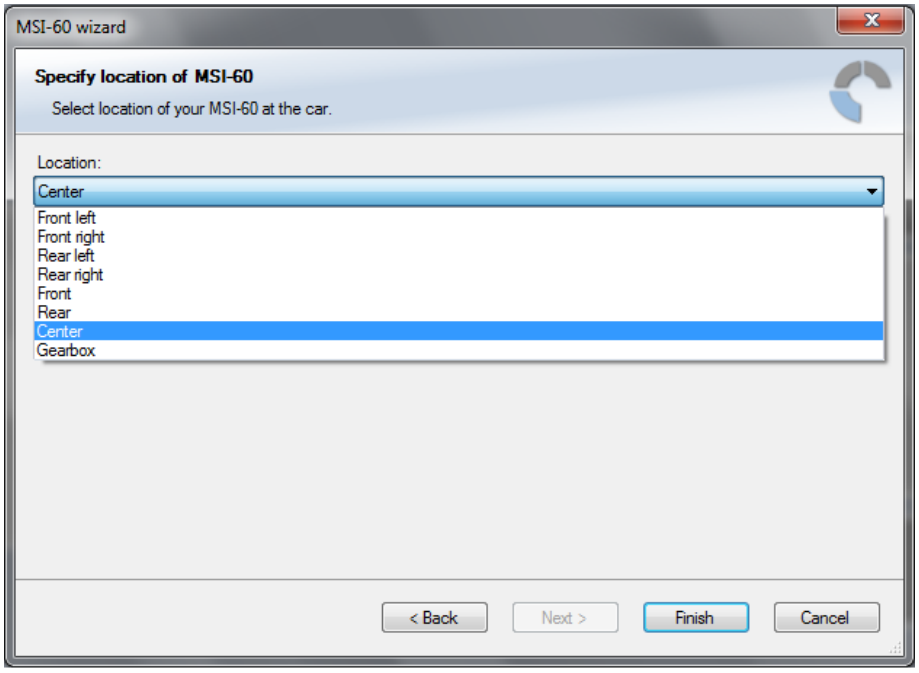


4. Select the program archive delivered with the MSI 60 (.PST file). An information shows that the archive is valid or not.

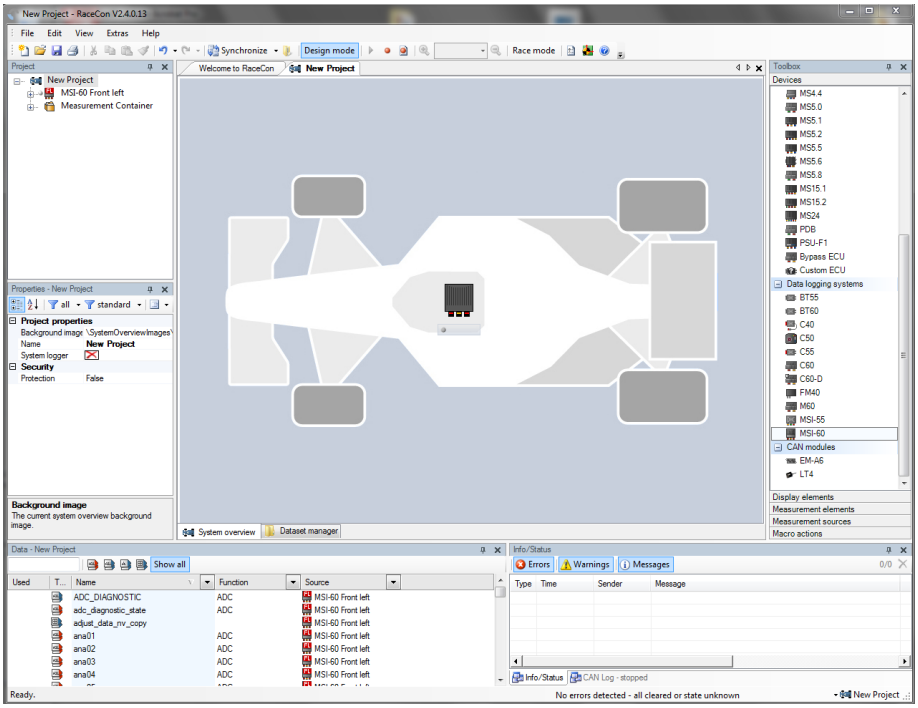


5. Click 'Next'.

6. Select location of MSI 60.



7. Click 'Finish'. The MSI 60 is inserted into the project and RaceCon tries to connect to the device. Repeat the bespoken procedure for every additional MSI 60 . If you are starting with a new delivered MSI 60 you once-only need to assign the mountain location(s). Please refer to Assign the Mounting Location [▷ 25].



RaceCon detects configuration differences between the MSI 60 and the RaceCon project and asks for permission for data download.

8. Click ‘OK’ to proceed.

The download starts and the MSI 60 carries out a reset. After the reset RaceCon reconnects to the MSI 60 . Local configuration on both the PC and MSI 60 match (indicated by green background and dot). The MSI 60 is now connected to RaceCon.

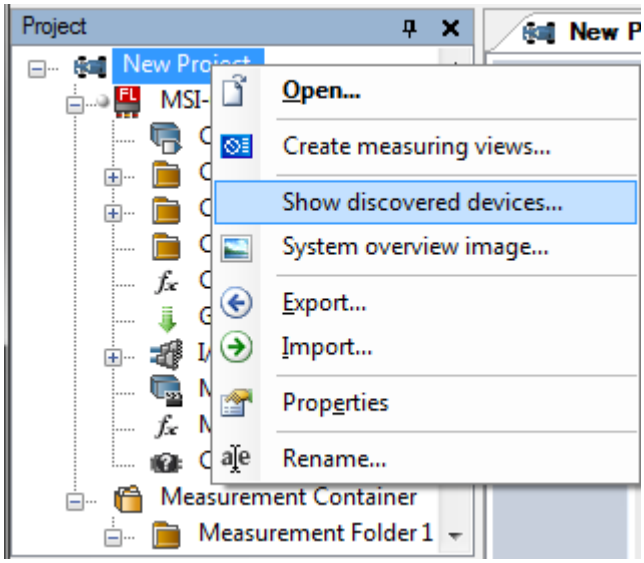
7.2 Assign the Mounting Location

Because up to eight MSI 60 can be used in one network for I/O expansion, the mounting location is used for determination between the different MSI 60.

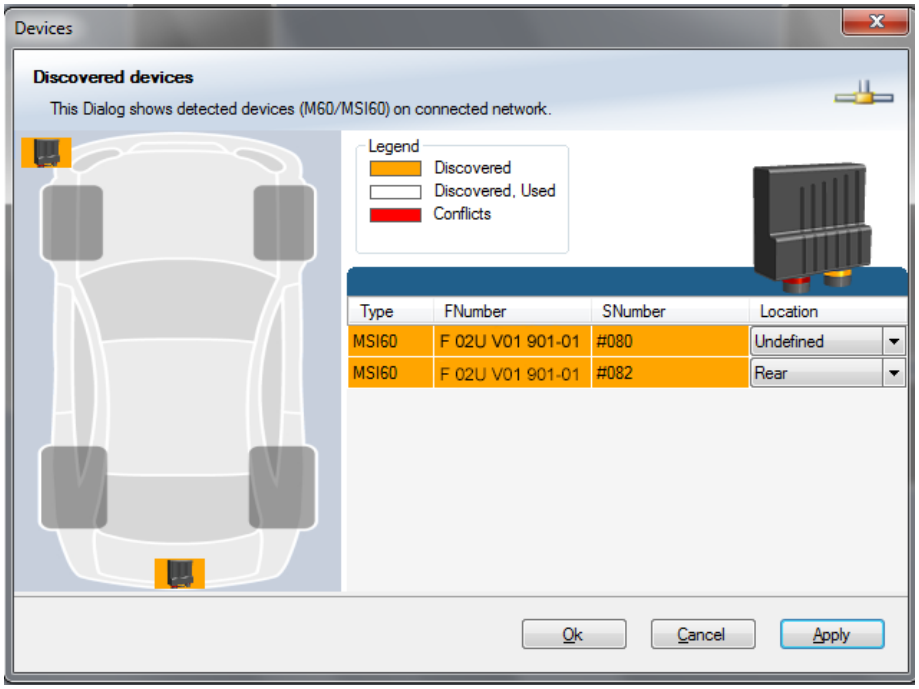
At delivery no mounting location is set. This is signaled by an orange ‘RUN’ LED on the device. Therefore one must first assign a mounting location to the MSI 60 before it can be used in the project. The mounting location is permanently saved in the MSI 60. If necessary you can at any time reassign a different mounting location following the same procedure.

A mounting location must not be used several times in one network, this would disturb the functionality of the respective MSI 60.

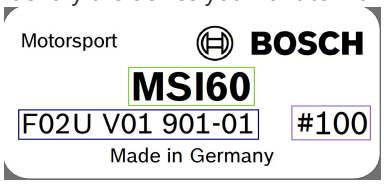
1. In the Project Tree, right click on the project name e.g. 'New Project' and then select 'Show discovered devices...'.



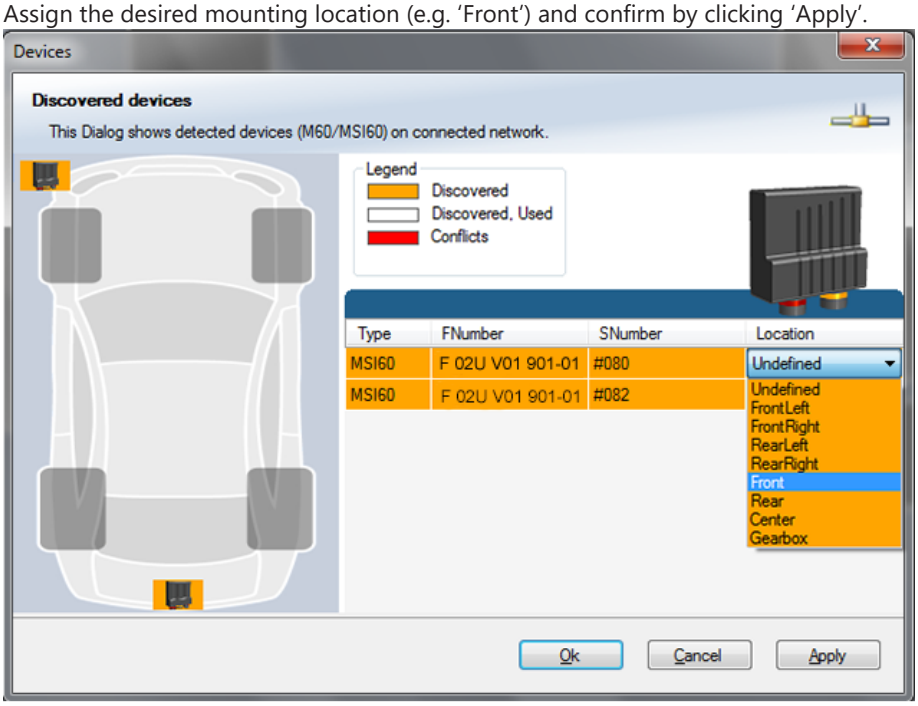
All connected MSI 60 are listed.



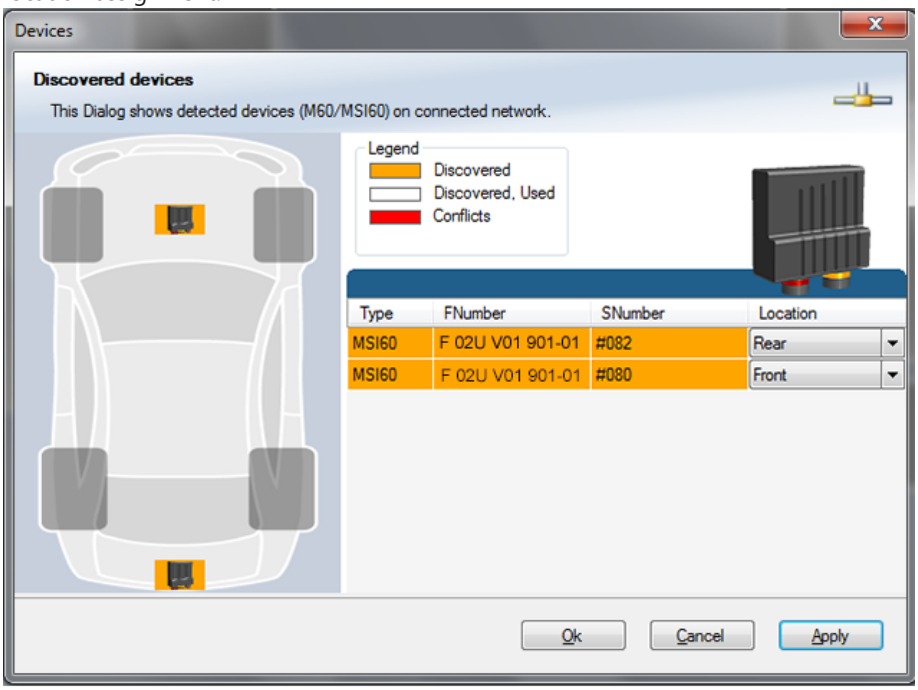
2. Compare the listed device Type, FNumber and SNumber to the identification plate to identify the device you want to make changes to:



3. Assign the desired mounting location (e.g. ‘Front’) and confirm by clicking ‘Apply’.



The mounting location is now stored in the device. The device will do a reset and the ‘RUN’ LED on the device will change to green. The list will show the new mounting location assignment.

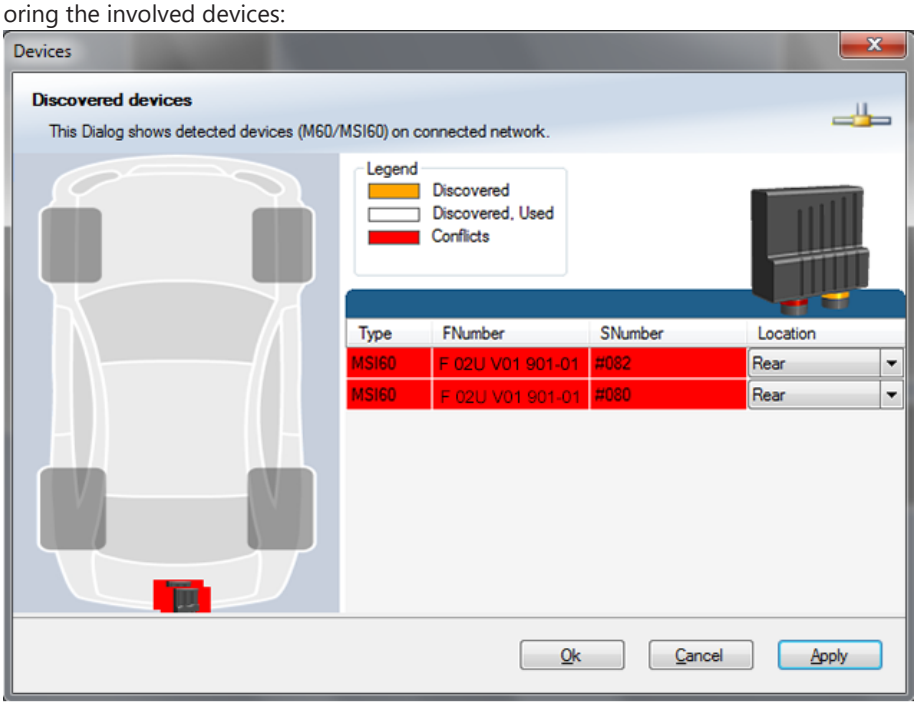


It is good practice to physically label the MSI 60 with its mounting location.

Now the device is ready to be used.

A different coloring of the MSI 60 is used to indicate that the device is already configured in the currently loaded RaceCon project or not (white/orange).

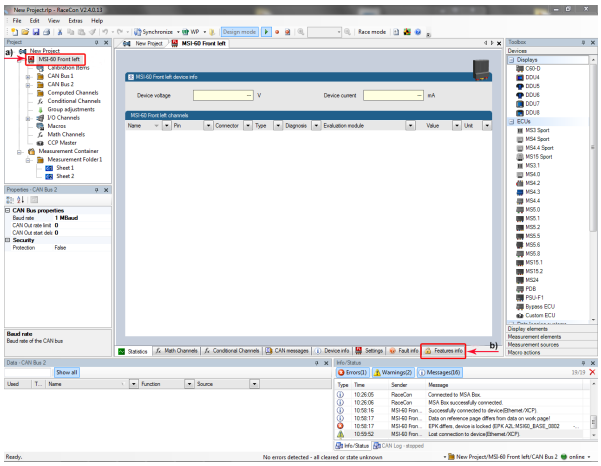
A conflict of several connected MSI 60 using the same location is indicated by red coloring the involved devices:



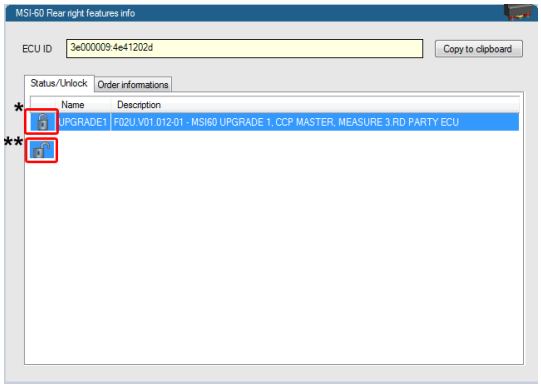
7.3 Feature Activation

- 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 MSI 60 does not work on any other MSI 60.
- If you have not purchased an option package, the next steps can be skipped.

1. To activate a feature, double-click on 'MSI 60' in the Project Tree and click on the 'Features info' tab in the Main Area.



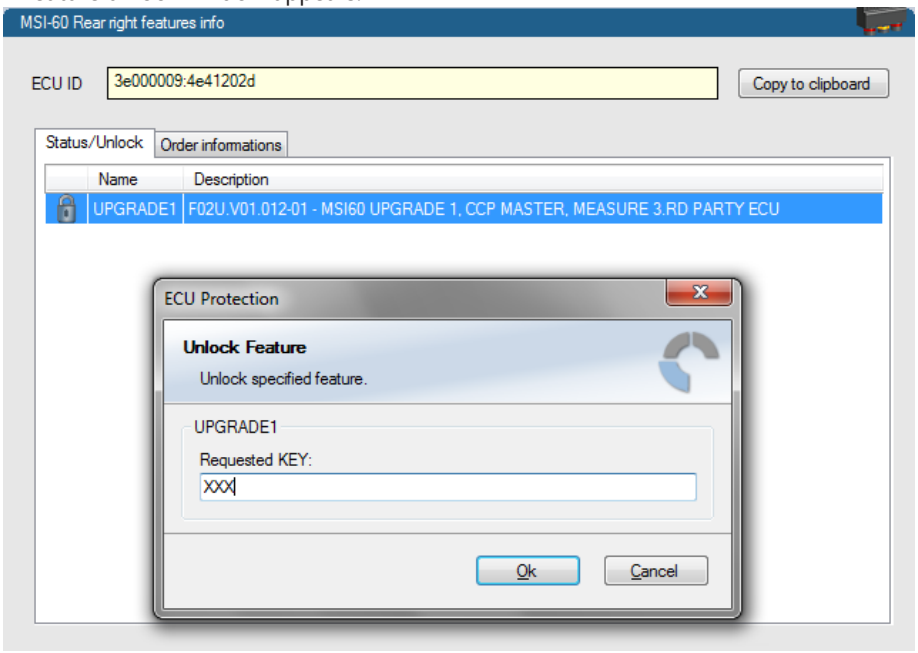
a) Double-click on 'MSI 60'.
b) Click on 'Features Info'. The MSI 60 'features info' window appears.



Feature status Locked (disabled)
***Unlocked (activated)*

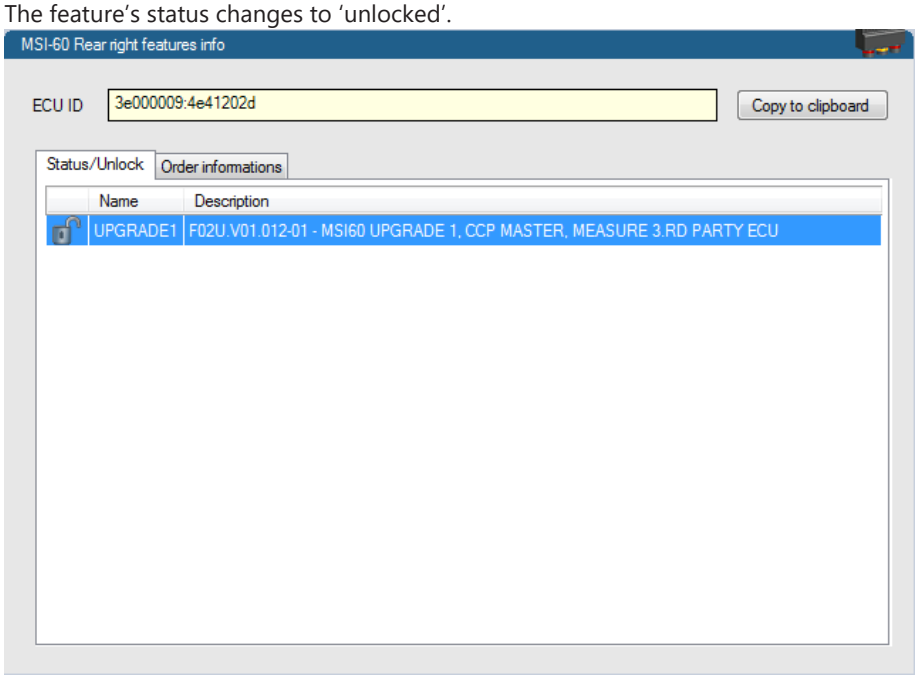
2. Double-click on the feature you want to activate.

   A feature unlock window appears.



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

The feature's status changes to 'unlocked'.



4. Perform these steps to activate other features you purchased.

Switch the car's ignition off and on again to cycle the power of the MSI 60.

8 Math and Condition Channels

This chapter describes how to create a Math or Condition Channel.

8.1 Math Channels

Math channel

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

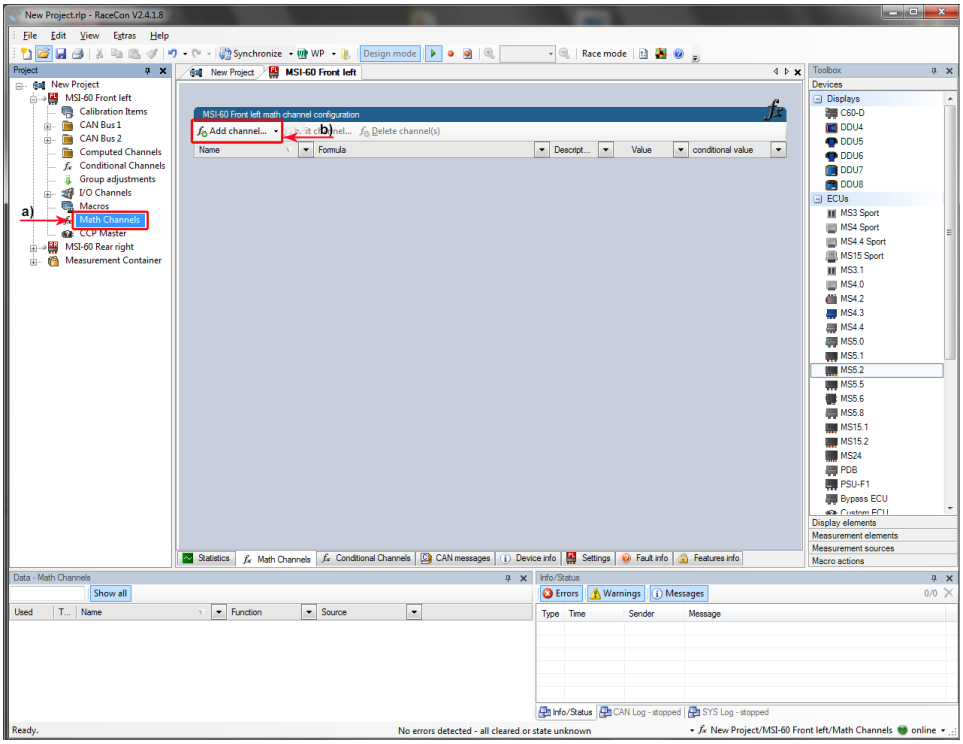
Conditional function

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

All math channels can be used globally in the whole MSI 60 project.

8.1.1 Creating a new Math Channel

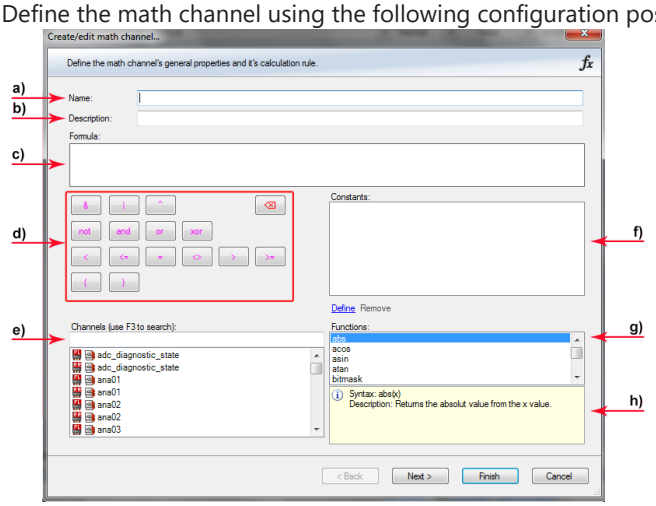
Follow the steps shown in the screenshots.



a) Double-click on 'Math Channels' in Project Tree.
b) Click on 'Add channel'.

The 'create/edit math channel' window appears.

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



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

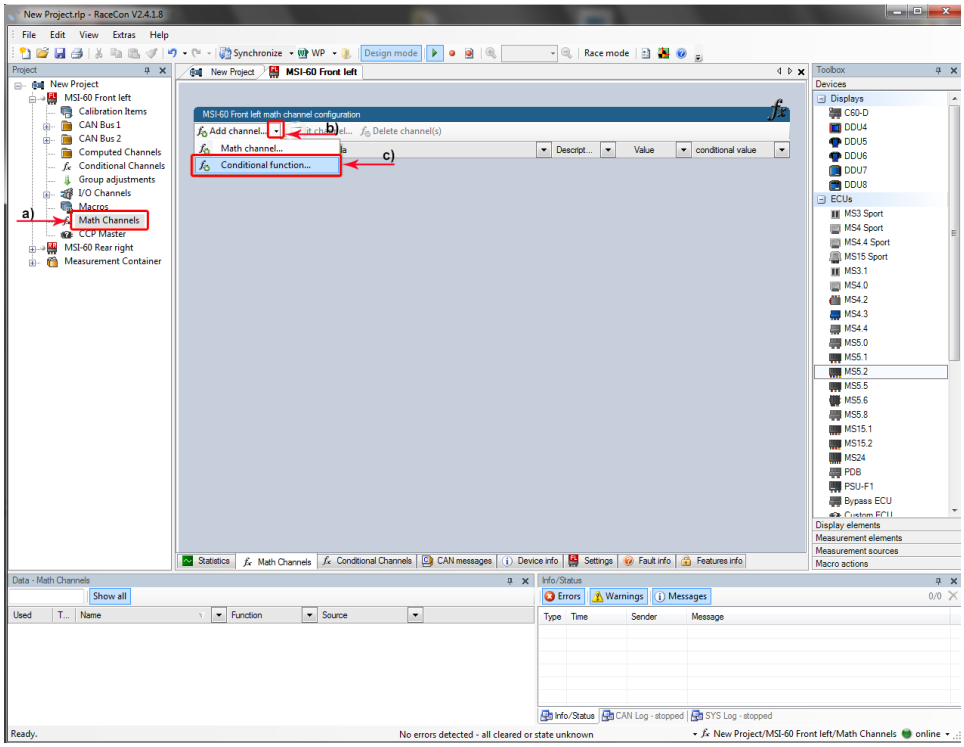
NOTICE

To select an input channel from a specific device, put the device name enclosed by ´#´ in front of it, e.g. #MSI 60 Left#time_sec

2. Click 'Finish' when done.
   The math channel is displayed in the MSI 60 math channel window.

8.1.2 Creating a new Conditional Function

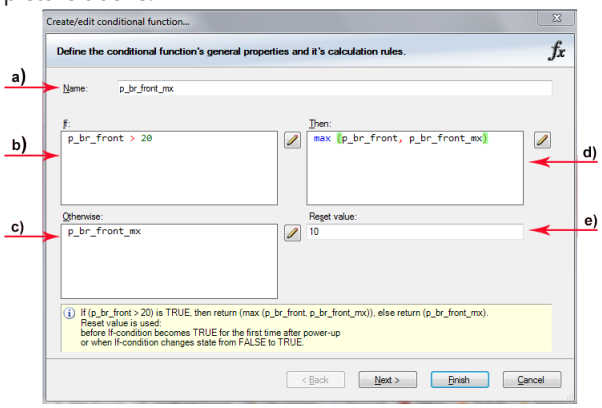
Follow the steps shown in the screenshots.



a) Double-click on 'Math Channels' in Project Tree.
b) Click on the dropdown arrow beside 'Add channel'.
c) Choose 'Conditional Function'.

The 'create/edit conditional function' window appears.

1. Define the conditional function using the following configuration possibilities in the picture above.



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

2. Click 'Finish' when done.

The conditional function is displayed in the MSI 60 math channel window.

NOTICE

To select an input channel from a specific device put the device name enclosed by ´#´ in front of it. E.g. #MSI 60 Front Left#time_sec

The conditional function works in the following way:

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

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

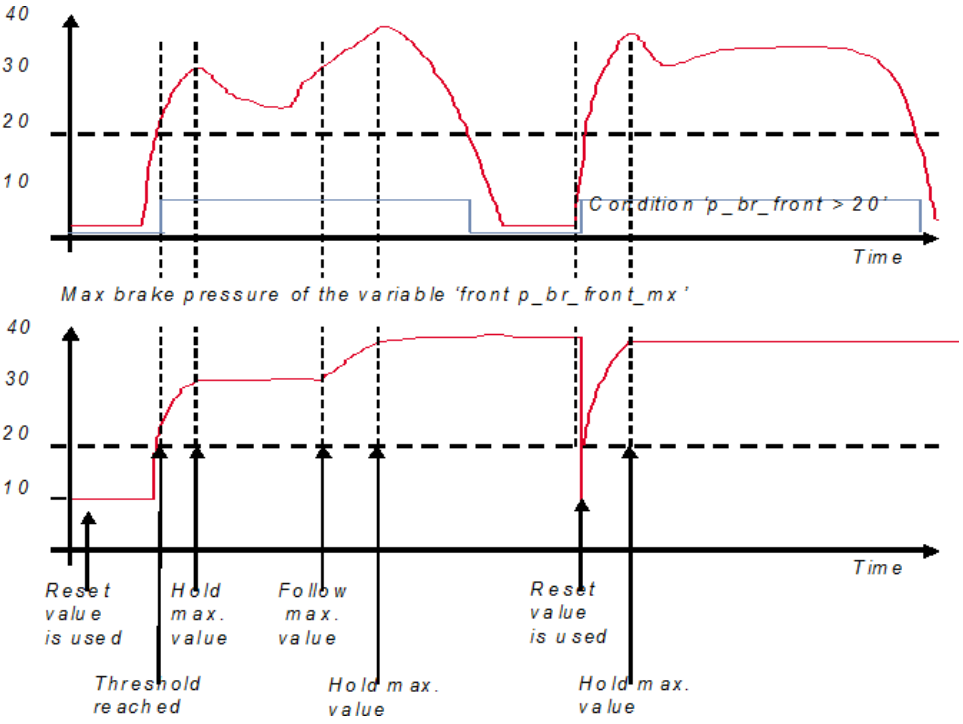
If the condition entered in the IF window is FALSE, the program calculates the condition entered in the OTHERWISE window. The returned value is the content of the new variable (entered in 'Name').

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

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

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

Example: Setting up a condition for maximum front brake pressure. "**Brake pressure front 'p_br_front'"**



- At power-up, the reset value (10) is used for 'p_br_front_mx'.
- 'p_br_front' rises to 30. As 'p_br_front' is > 20 (condition is TRUE), the condition 'max (p_br_front, p_br_front_mx)' in the THEN window is triggered. The condition sets the bigger value as new value for 'p_br_front_mx'. As 'p_br_front' (30) is bigger than 'p_br_front_mx' (10), the new value for 'p_br_front_mx' is set to 30.

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

8.2 Condition Channels

Condition channel

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

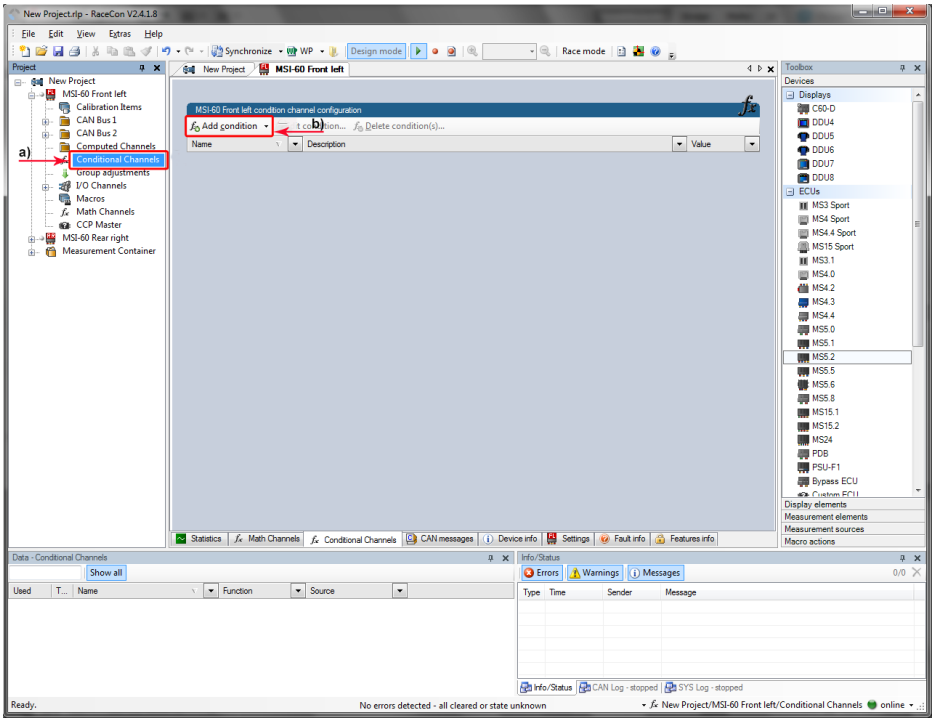
Condition combination

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

All condition channels can be used globally in the whole MSI 60 project.

8.2.1 Creating a new Condition Channel

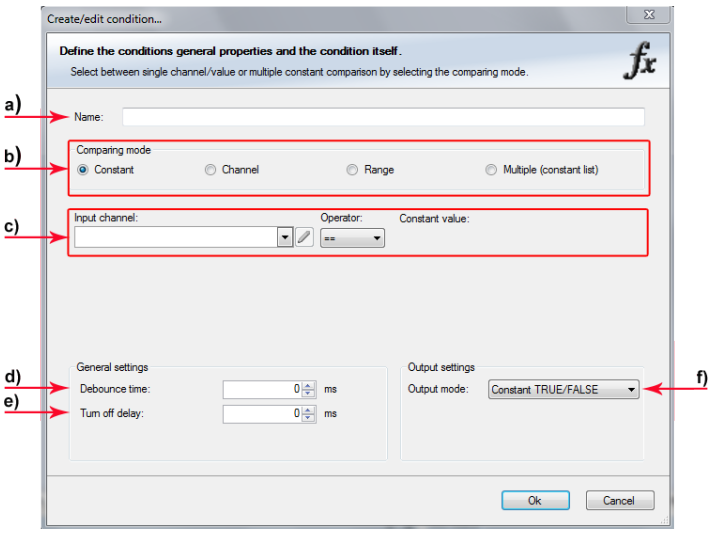
Follow the steps shown in the screenshot.



a) Double-click on 'Conditional Channels' in Project Tree.
b) Click on 'Add condition'.

The 'create/edit condition' window appears.

Define the condition channel using the following configuration possibilities:

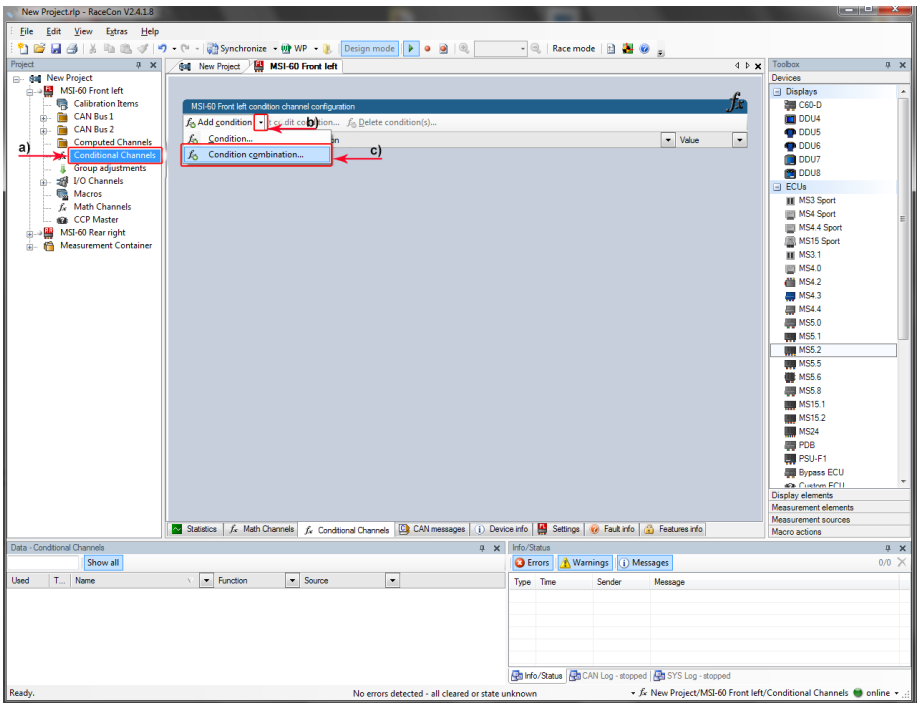


a) Enter the name of the condition channel.
b) Select the comparing mode:
• Constant: Compare a measurement channel with a constant value.
• Channel: Compare a measurement channel with a measurement channel.
• Range: Compare a measurement channel with a defined value range.
• Multiple: Compare a measurement channel with up to 5 constant values.
c) Depending on the chosen comparing mode, you can enter the following values:
• Constant: Choose the measurement channel or condition, the operator and enter the value of the constant.
• Channel: Choose the measurement channel or condition, the operator and the measurement channel or condition to becompared.
• Range: Choose the measurement channel or condition, the operator and define the minimum and maximum value.
• Multiple: Choose the measurement channel or condition, the operator and enter the value of up to 5 constants.
d) Enter the minimal time to detect the signal of the measurement channel to avoid high-frequent switchovers.
e) Enter the time the signal of the measurement channel is delayed after its ending.
f) Choose the output setting of the result.
• Constant TRUE/FALSE: Result is as a constant with the value TRUE or FALSE.
• Blinking: Result is a blinking if the condition is fulfilled.
• Pulse: Result is a short one-time pulse if the condition is fulfilled.
• Toggling output: Result is a pulse that lasts until the next condition is fulfilled.

The conditional channel is displayed in the MSI 60 condition channel window.

8.2.2 Creating a new Condition Combination

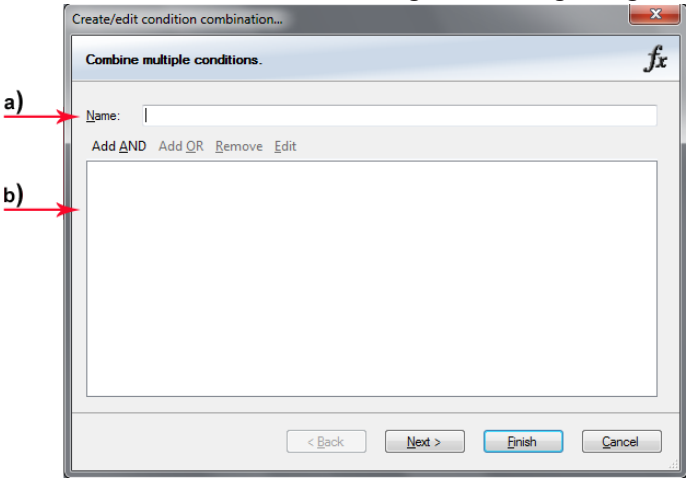
Follow the steps shown in the screenshot.



a) Double-click on 'Conditional Channels' in Project Tree.
b) Click on the dropdown arrow beside 'Add condition'.
c) Choose 'Conditional combination'.

The 'create/edit condition combination' window appears.

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



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

2. Click ‘Next’ to go to the next page. Choose the output setting of the result:
   - Constant TRUE/FALSE: Result is as a constant with the value TRUE or FALSE.
   - Blinking: Result is a blinking if the condition is fulfilled.
   - Pulse: Result is a short one-time pulse if the condition is fulfilled.
   - Toggling output: Result is a pulse that lasts until the next condition is fulfilled.
3. Click ‘Finish’ when done.

The conditional combination is displayed in the MSI 60 condition channel window.

9 CAN Bus

MSI 60 has 2 CAN buses. Both buses are fully configurable.

- Baudrate (125 kbit to 1 Mbit)
- 11 bit or 29 bit identifiers
- Input configuration: Read messages from CAN bus and convert to MSI 60 measurement/display variables. CAN bus supports row counter configuration.
- Output configuration: Write MSI 60 measurement variables to CAN messages, output frequency and row counter are configurable, CAN gateway functionality (transfer from one bus to the other).

9.1 CAN Bus Trivia

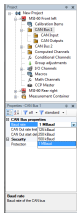
CAN message

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

CAN bus

- Needs termination resistors (120 Ohm) in wiring harness
- All devices connected to the bus must use identical data rate

Configuration of MSI 60 bus data rate in ‘Properties’ menu.



Row counter concept

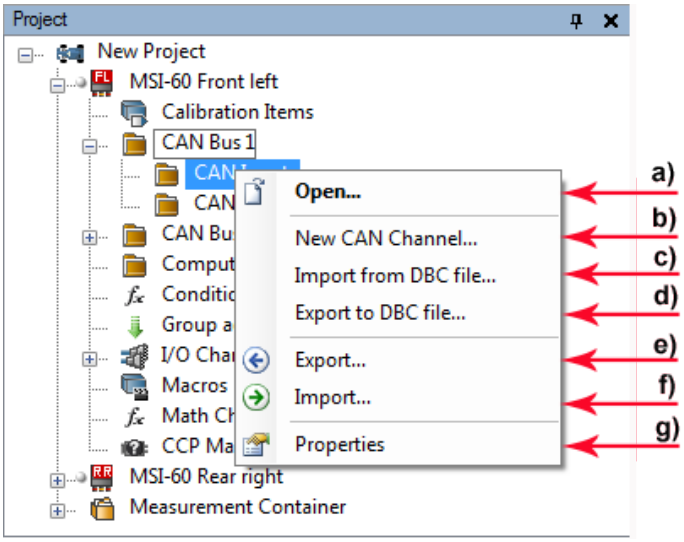
- Re-use (multiplex) of message identifiers
- One byte of message contains row counter
- 7 bytes payload remaining
- Position of row counter is configurable

	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

9.2 CAN Input

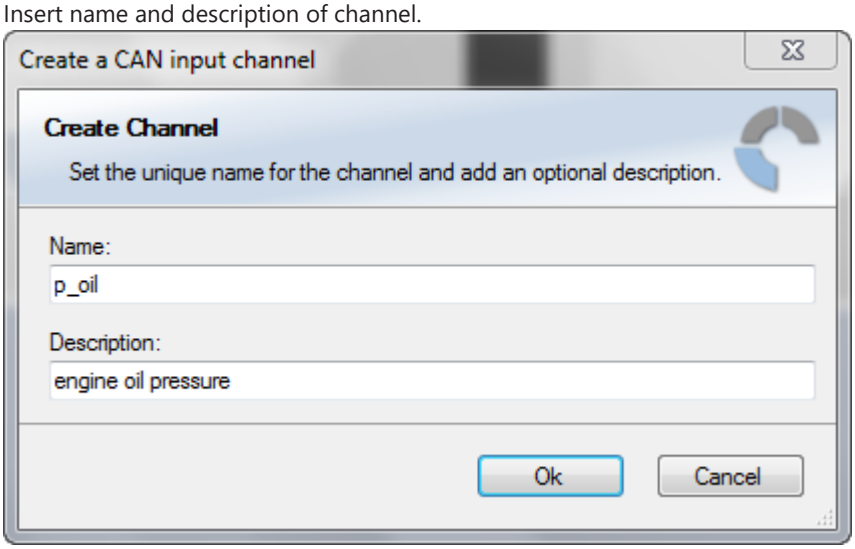
9.2.1 Input Configuration



a) Open CAN messages overview window.
b) Create new channel to read from CAN bus.
c) Import Vector CAN database (DBC) channel configuration.
d) Export channel configuration to vector CAN database (DBC).
e) Export RaceCon CAN input configuration to file.
f) Import RaceCon CAN input configuration from file.
g) Display CAN bus properties (baudrate).

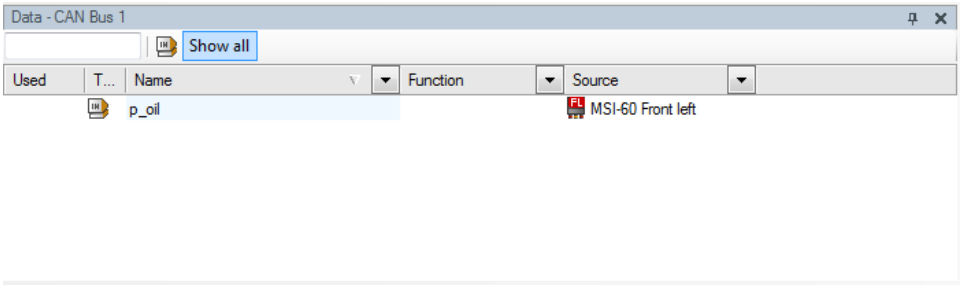
9.2.2 Create new CAN Channel

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

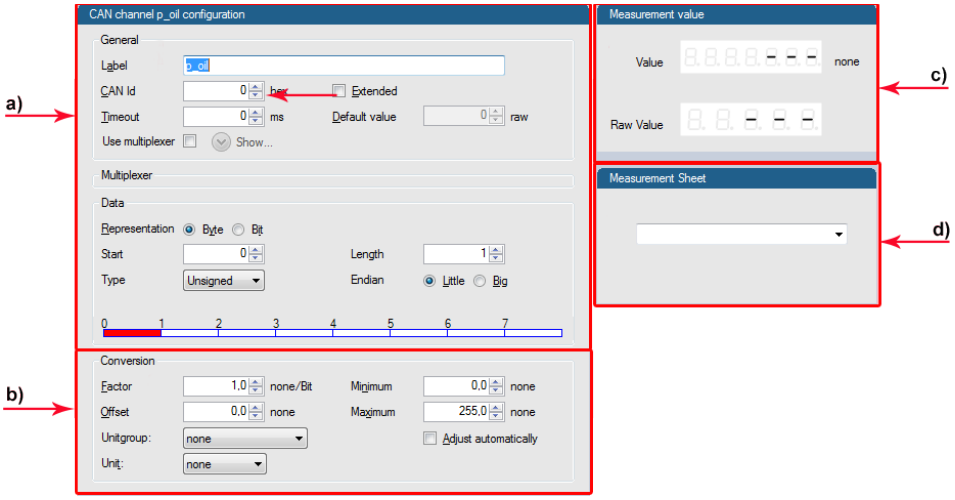


4. Click 'OK' when done.

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



9.2.3 CAN Channel Configuration

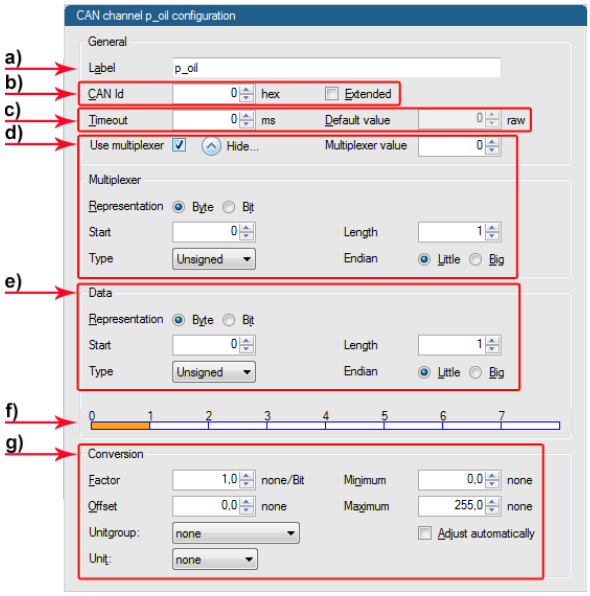


a) Extraction of data from CAN bus.
b) Conversion to physical values.
c) Mini CAN analyzer functionalit.
d) Automatic assignment to measurement view.

9.2.4 Extracting Data from CAN Bus

Representation: Byte

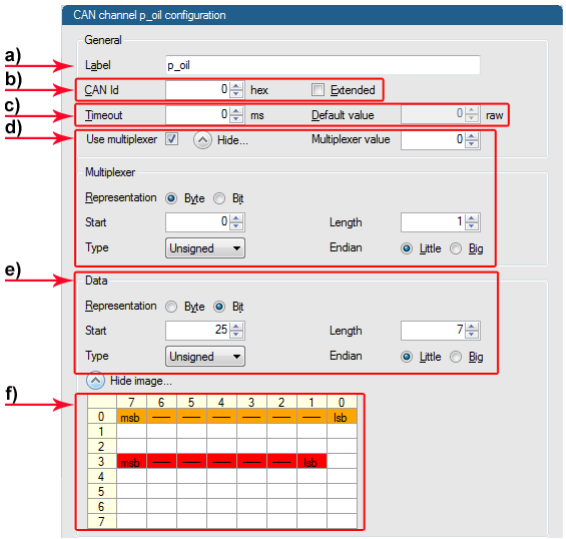
Some CAN devices need to be addressed by a byte represented CAN channel. The address can be assigned in this window and is illustrated by a bargraph.



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

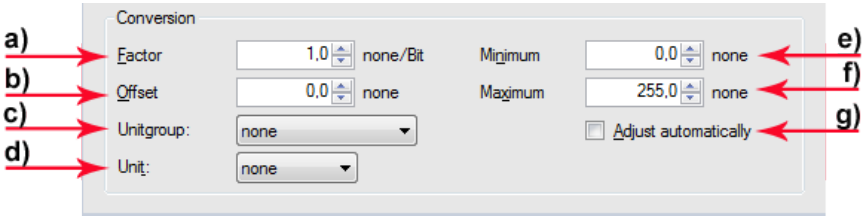
Representation: Bit

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



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

9.2.5 Conversion to Physical Values



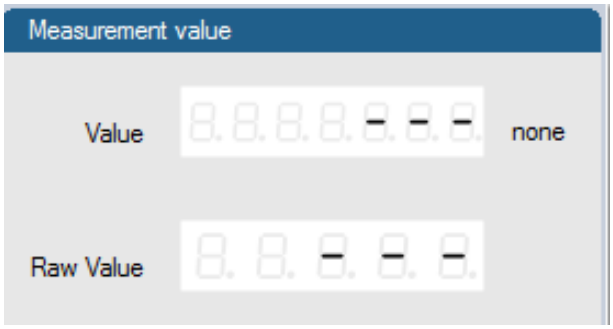
a) Enter factor (gain) for conversion to physical value.
b) Enter offset for conversion to physical value.
c) Select type of physical value.
d) Select unit of physical value.
e) Enter minimum physical limit of the channel (for manual setup).
f) Enter maximum physical limit of the channel (for manual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

9.2.6 Special Features

CAN analyzer functionality

This functionality is only available, if a MSA-Box (I & II) is used to connect the MSI 60 to the PC.

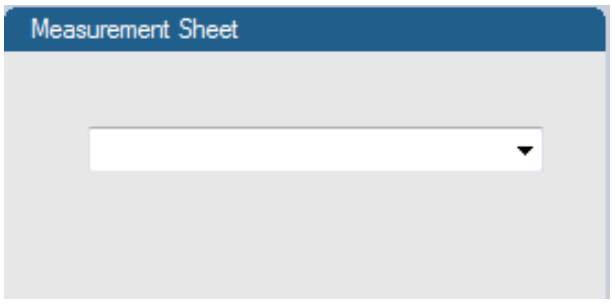
Choose the CAN bus that is connected to the MSA-Box to display the raw value and the converted physical value here.



Automatic creation of online measurement sheets

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

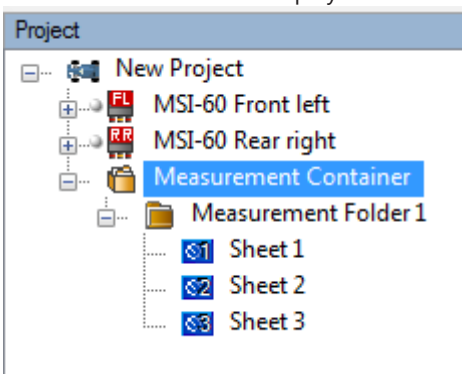
For an online view of the value measured by the MSI 60, insert the channel in an online measurement sheet which is described in the next chapter.



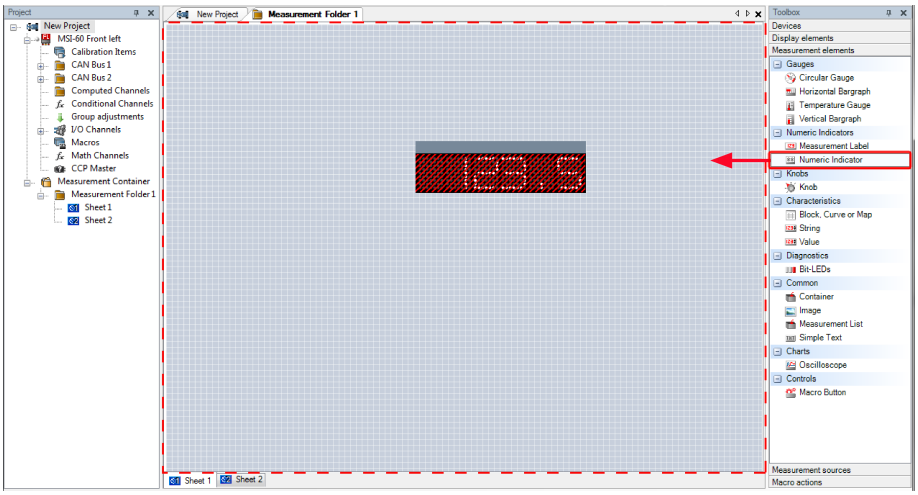
9.2.7 Online View of CAN Channels in Vehicle

1. Double-click on ‘Sheet 1’ in Project Tree.

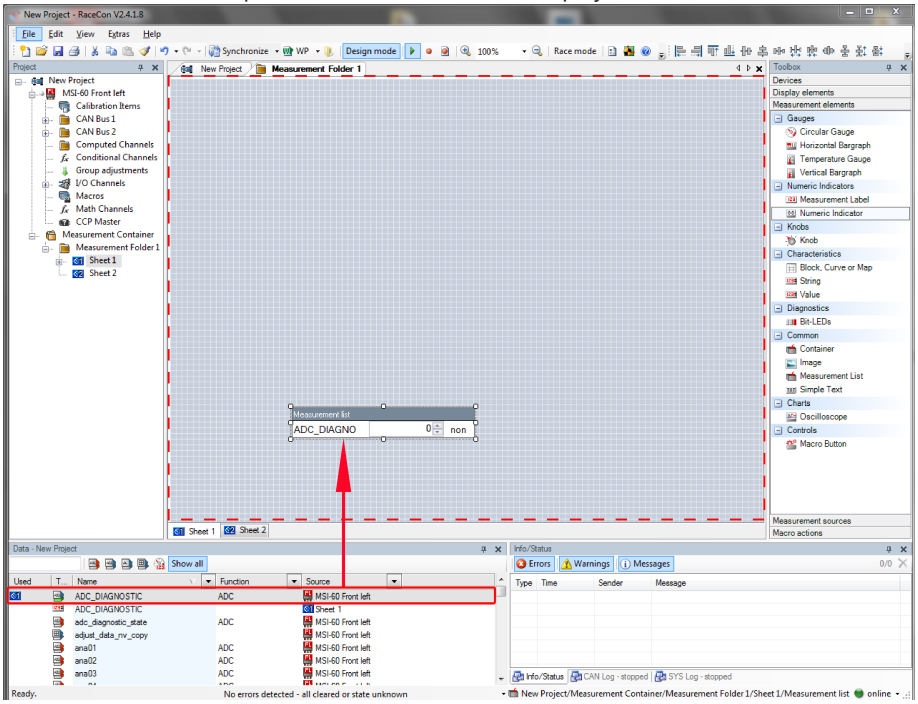
Measurement Sheet 1 is displayed in Main Area.



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



4. Click on folder ‘CAN Input’ of desired CAN bus to display available channels.



5. Drag desired measurement channel and drop it on the measurement element.

   The measurement element displays the values of the assigned channel.

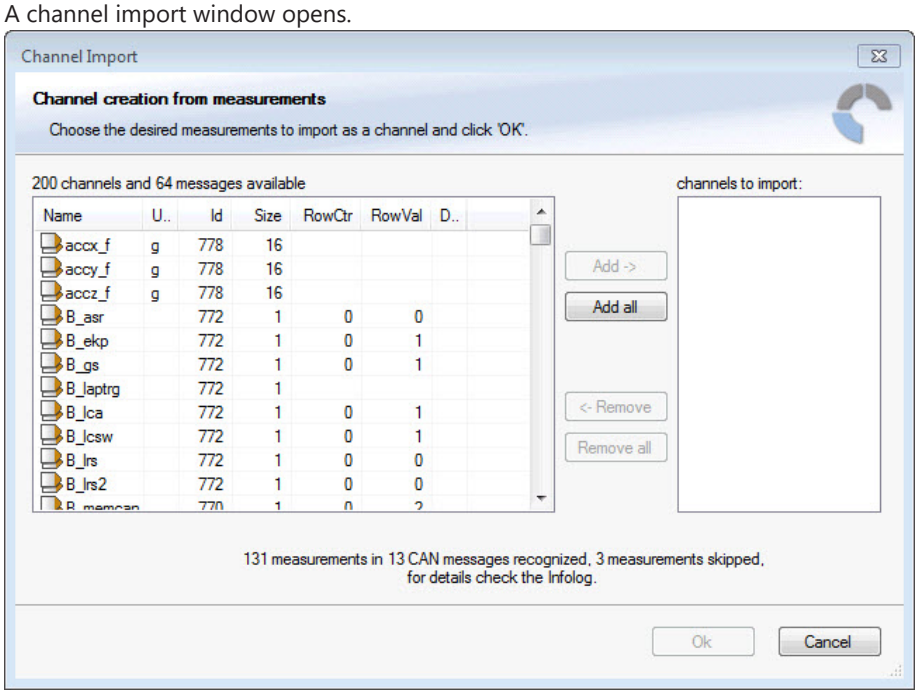
6. Connect PC to the vehicle and switch to ‘Race Mode’ by clicking ‘F11’ on the keyboard to display online data.

9.2.8 Import a CAN Database (DBC) File

1. Right-click on CAN Input of desired bus (CAN1 or CAN2).
2. Select ‘Import DBC file’ from menu.

   A file browser opens.
3. Select DBC file to import and click ‘OK’ when done.

   A channel import window opens.



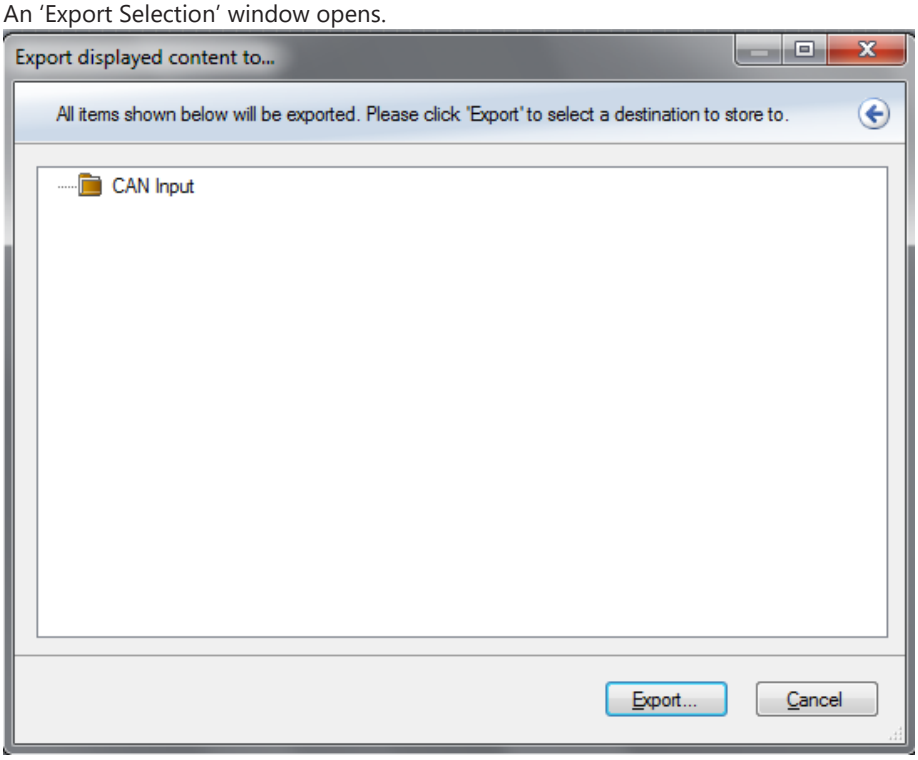
4. Select desired channels on the left and use the ‘Add’ button to add them to import list.
5. Click ‘OK’ when complete.

The channels are inserted in the Data window.

9.2.9 Export RaceCon CAN Configuration

1. Right-click on CAN Input of desired bus (CAN1 or CAN2).
2. Select ‘Export …’ from menu.

An ‘Export Selection’ window opens.



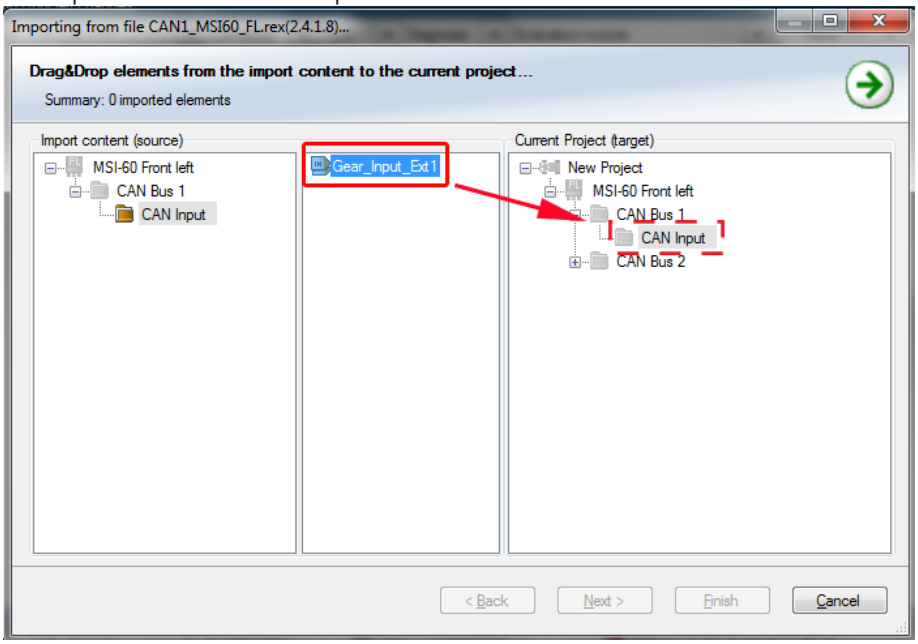
3. Specify the filename.
4. Click ‘OK’ when done.

9.2.10 Import RaceCon CAN Configuration

1. Right-click on CAN Input of desired bus (CAN1 or CAN2).
2. Select ‘Import ...’ from menu.

   A file browser opens.
3. Select the input file and click ‘OK’.

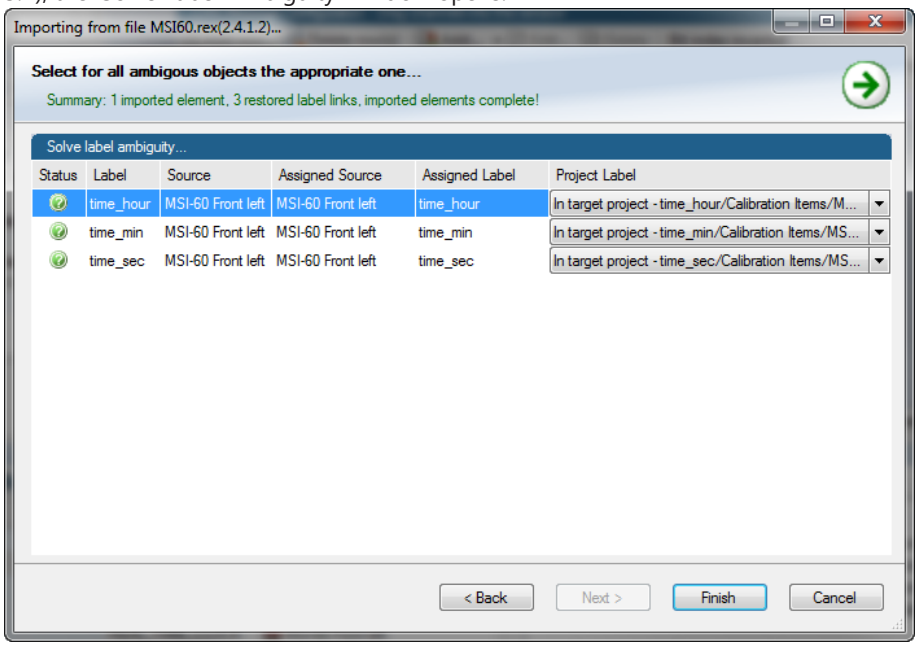
   An ‘Import Selection’ window opens.



4. Select channels to import.

5. Drag and drop the channel to 'CAN Input' of desired CAN bus on right hand side.
6. Click 'Next'.

   If a measurement channel belongs to more than one source (e.g. MSI 60 and ECU MS 5.1), the 'Solve Label Ambiguity' window opens.

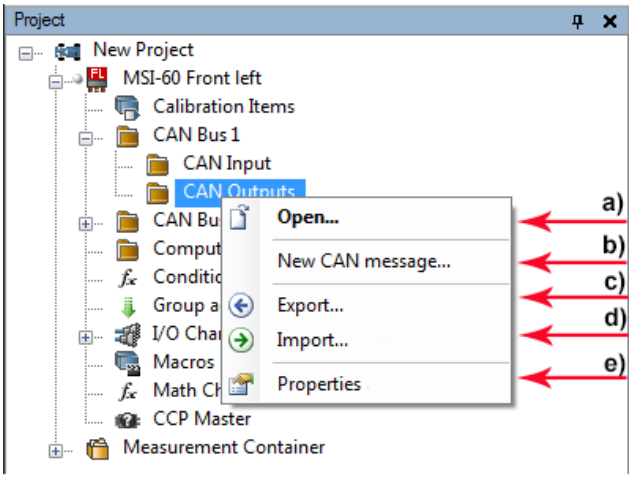


7. Assign the ambiguous channels to the desired source.
8. Click 'Finish'.

9.3 CAN Output

This chapter describes the CAN Output Channel of the MSI 60.

9.3.1 Output Configuration

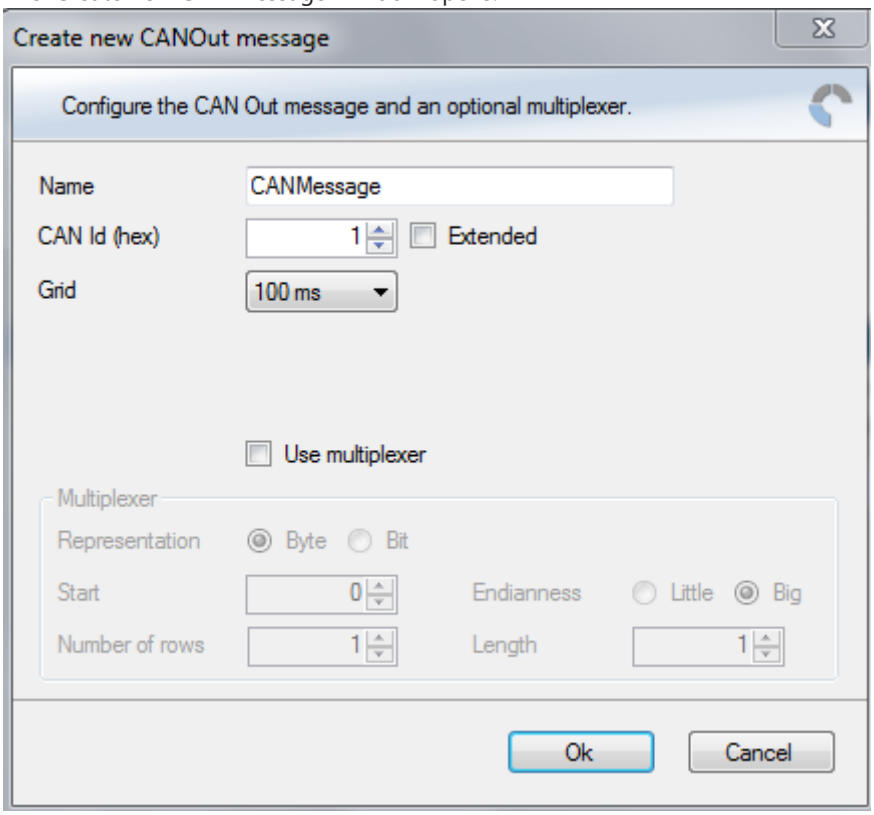


a) Open CAN output message.
b) Create new CAN output message.
c) Export RaceCon CAN output configuration to file.
d) Import RaceCon CAN output configuration from file.
e) Display CAN bus properties (baudrate).

9.3.2 Create new CAN Output Message Channel

1. Right-click on CAN Output of desired bus (CAN1 or CAN2).
2. Select 'New CAN Message' from menu.

   The 'Create new CAN message' window opens.



3. Enter name of message, CAN-Id and Grid (output interval).
4. Optionally, specify a row counter (multiplexer).
5. Click 'OK' when done.

   A CAN message configuration window opens in the Main Area.
6. Click on 'MSI 60' in the MSI 60 Project Tree to display all labels.
7. Select the desired measurement channel and drop it on message's bytes.

The measurement channel is assigned to the CAN message.

9.3.3 Set up of Word Length, Byte Order and Quantization

Word length and quantization of channel can be adapted if necessary.

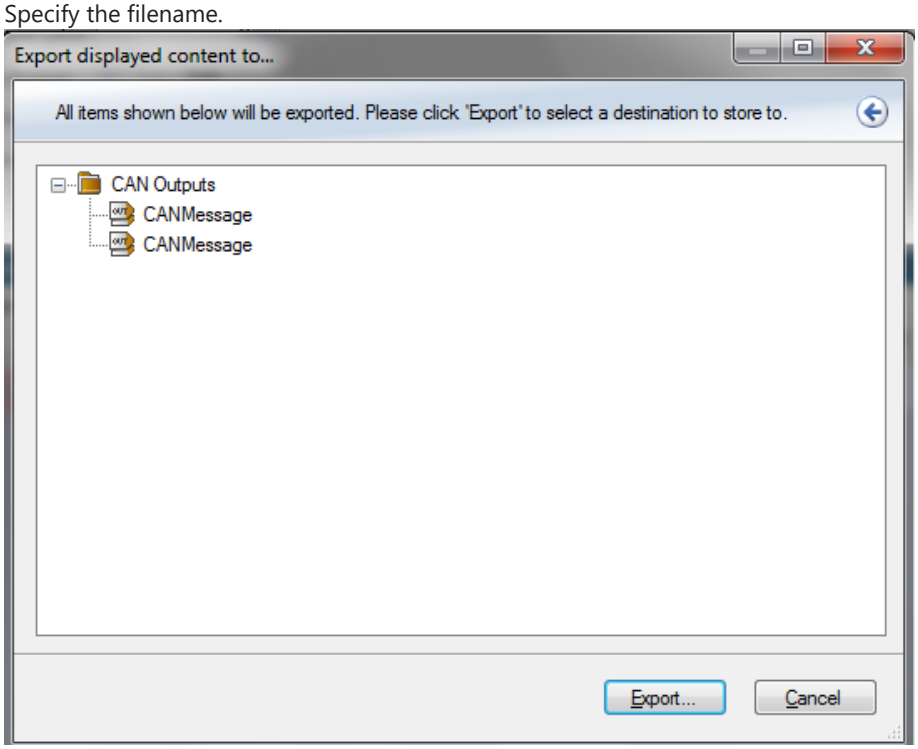
Byte Order can only be changed if a channel allocates more than one byte.

9.3.4 Export RaceCon CAN Configuration

1. Right-click on CAN Output of desired bus (CAN1 or CAN2).
2. Select 'Export ...' from menu.

   The 'Export Selection' window opens.

3. Specify the filename.



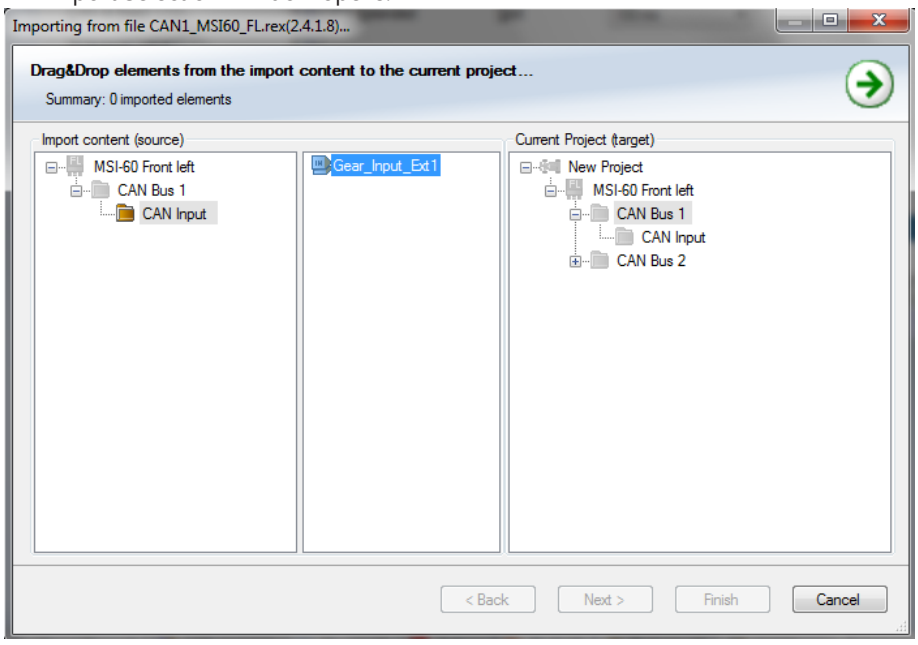
4. Click 'OK' when done.

9.3.5 Import RaceCon CAN Configuration

1. Right-click on 'CAN Output' of desired bus (CAN1 or CAN2).
2. Select 'Import ...' from menu.

   A file browser opens.
3. Select the input file and click 'OK'.

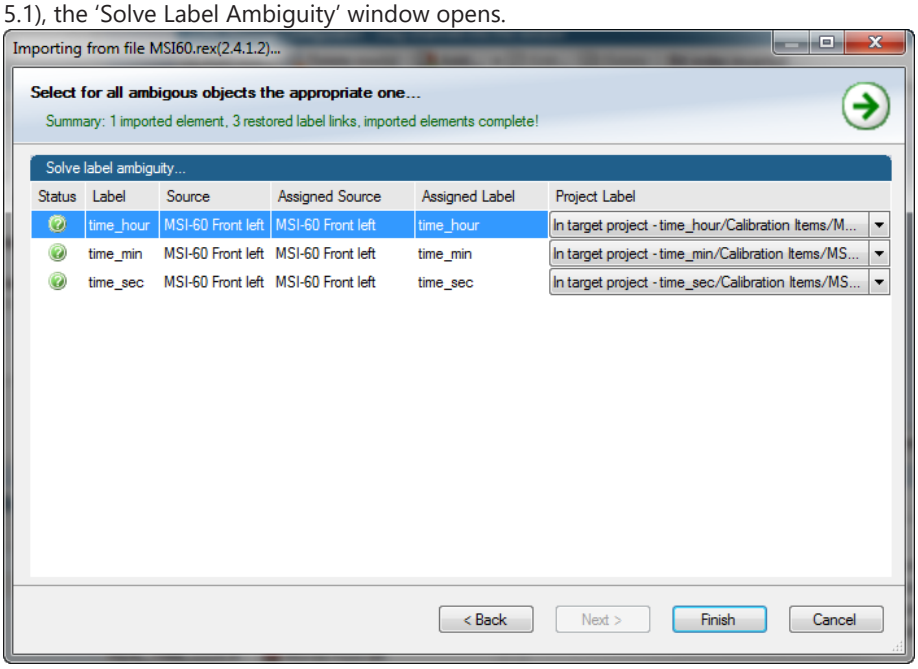
   An 'Import Selection' window opens.



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

6. Click ‘Next’.

   If a measurement channel belongs to more than one source (e.g. M 60 and ECU MS 5.1), the ‘Solve Label Ambiguity’ window opens.



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

10 Analog and Frequency Inputs

This chapter describes the analog and frequency inputs.

10.1 Features

8 standard analog inputs

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

32 universal analog inputs

- Differential
- - 5 V to 5 V
- Single ended 0 to 5 V
- 18 bit A/D converter
- Switchable pull-up resistors for switches, NTC, PT100 or PT1000 sensors
- 200 kHz acquisition rate, up to 1 kHz recording rate
- Linear phase digital filter

8 Lvdt inputs

- Switchable 2.5/5/10 kHz
- 3/5/10 VRMS

2 frequency inputs

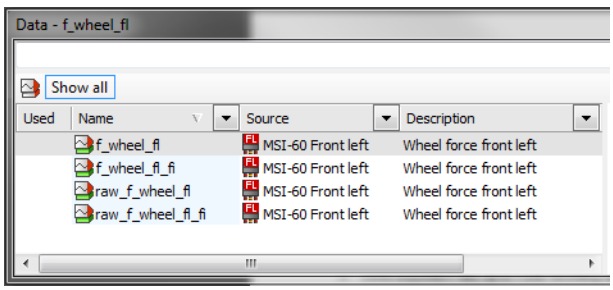
- Switchable Hall/inductive/DF11
- 20 kHz max. frequency
- 10 ms measurement window

4 PWM outputs

- Low-side switch
- Up to 1 A each
- Output frequency selectable

10.2 Measurement Channels

For each analog channel, several subchannels are available.



- Measurement labels with the characters ‘raw’ show the exact values in mV.

- Measurement labels with the characters '_fi' show filtered values.
- The word 'name' in the table is a placeholder for the channel's name.

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

Filtered channels are routed through digital low pass filters:

- MSI 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.

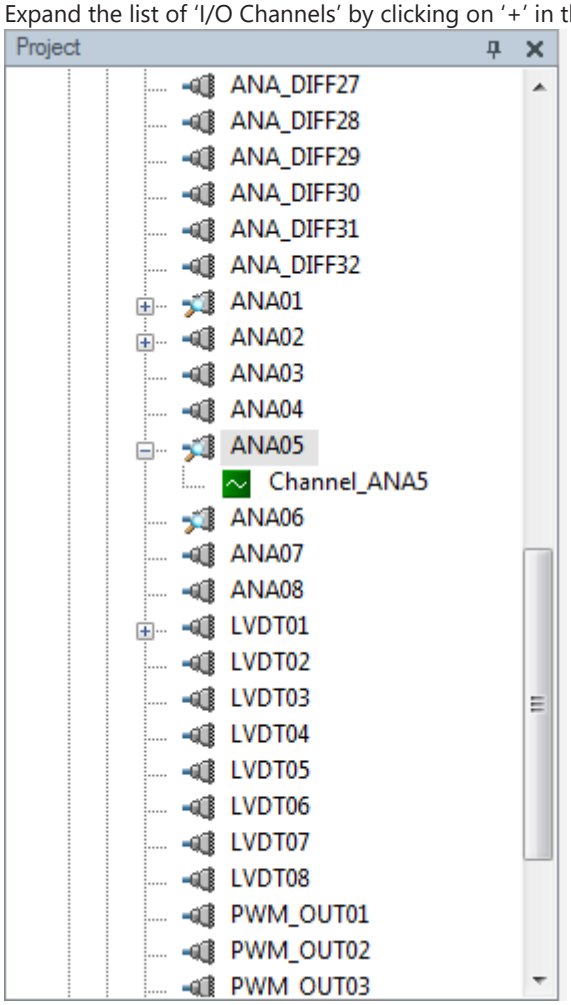
10.3 Configuring Inputs

This chapter describes how to configure the Input Sensors.

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

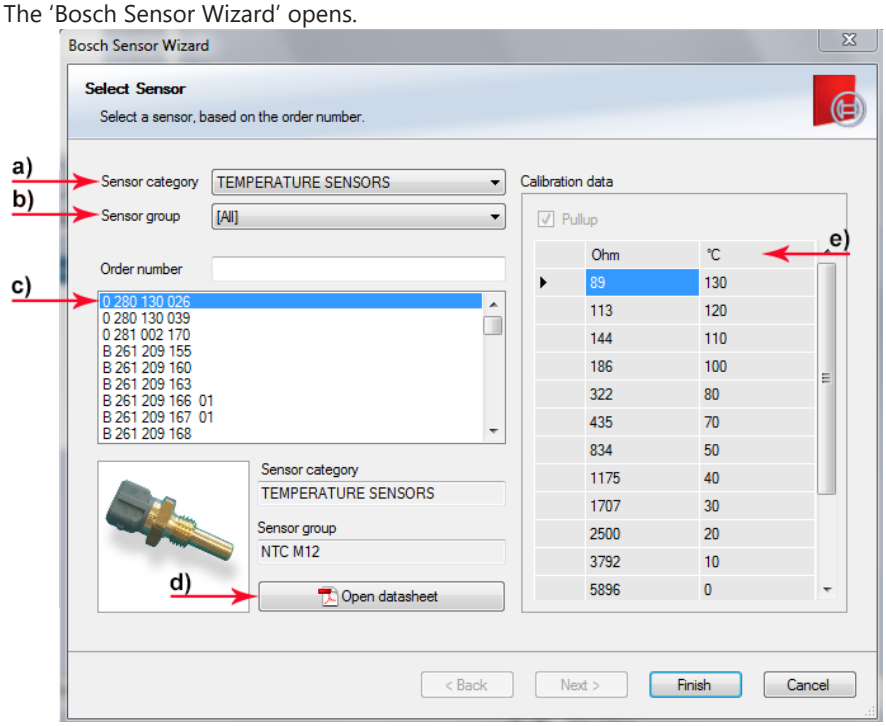
1. Click on 'Measurement Sources' in the Toolbox.

2. Expand the list of 'I/O Channels' by clicking on '+' in the MSI 60 Project Tree.



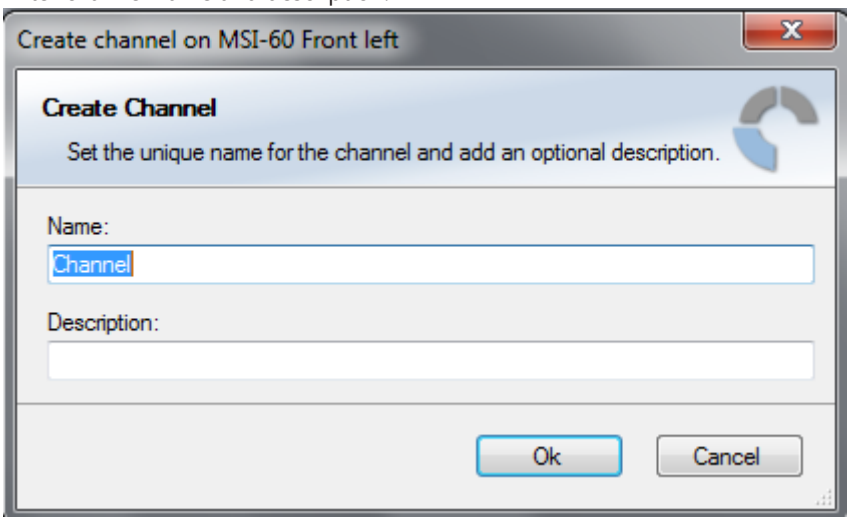
3. Drag the 'Bosch Wizard' from the Toolbox and drop it on the desired analog input channel in the MSI 60 Project Tree.

The ‘Bosch Sensor Wizard’ opens.



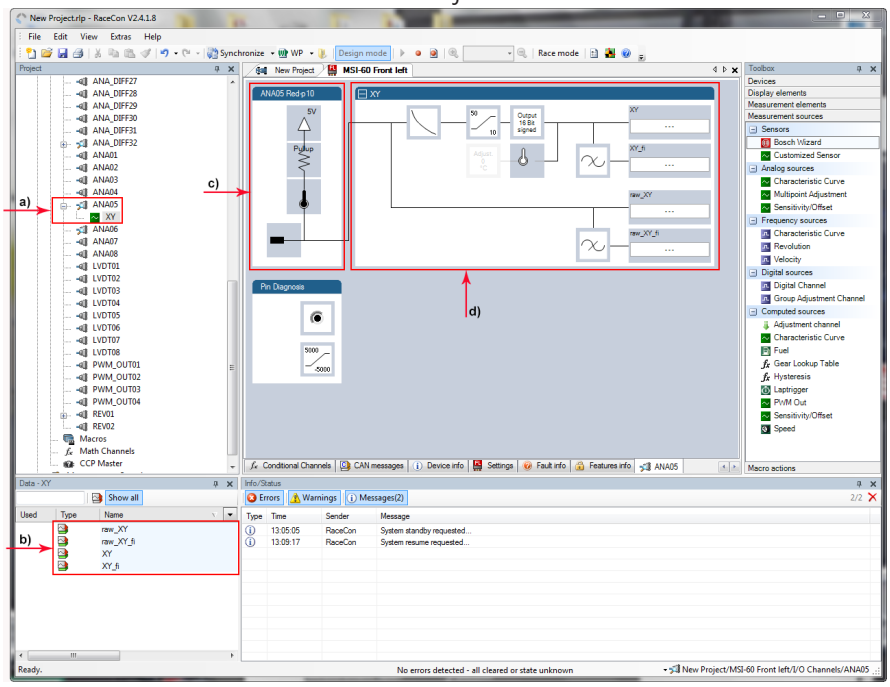
a) Choose the sensor’s category.
b) Narrow your choice by choosing a type.
c) Select the exact type.
d) Opens sensor’s datasheet.
e) These calibration values will be used.

4. Click ‘Finish’ when done.
5. The ‘Create channel on MSI 60’ window opens.
6. Enter channel name and description.



7. Click ‘Ok’ when done.

8. The channel is inserted into the MSI 60 Project Tree.



a) Channel is linked to ANA05.
b) Available measurements for channel.
c) Input pin pull-up resistor is activated.
d) Calculation of physical value with characteristic curve.

Available measurements for channel

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

10.3.2 Configuring a generic linear Sensor

Example: Acceleration sensor 5 g

– From sensor data sheet – operating characteristics:

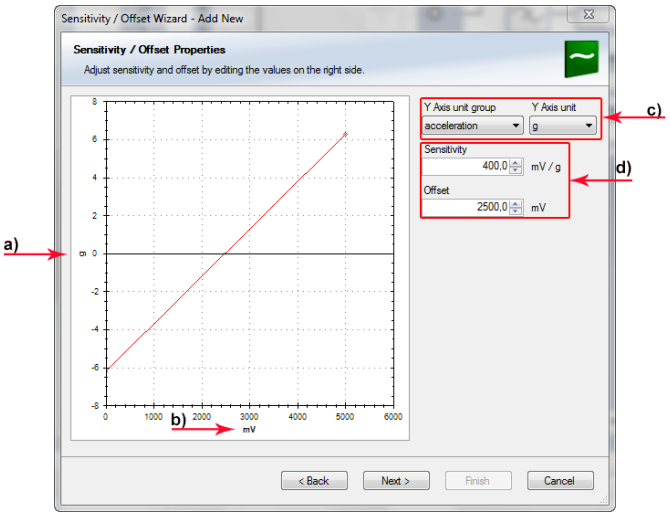
Output Signal					
Zero g (T_A = 25°C, V_{DD} = 5.0 V)(4)	V_{OFF}	2.25	2.5	2.75	V
Zero g (V_{DD} = 5.0 V)	V_{OFF}	2.0	2.5	3.0	V
Sensitivity (T_A = 25°C, V_{DD} = 5.0 V)(5)	S	380	400	420	mV/g
Sensitivity (V_{DD} = 5.0 V)	S	370	400	430.1	mV/g
Bandwidth Response	f_{-3dB}	42.5	50	57.5	Hz
Nonlinearity	NL_{OUT}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

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

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

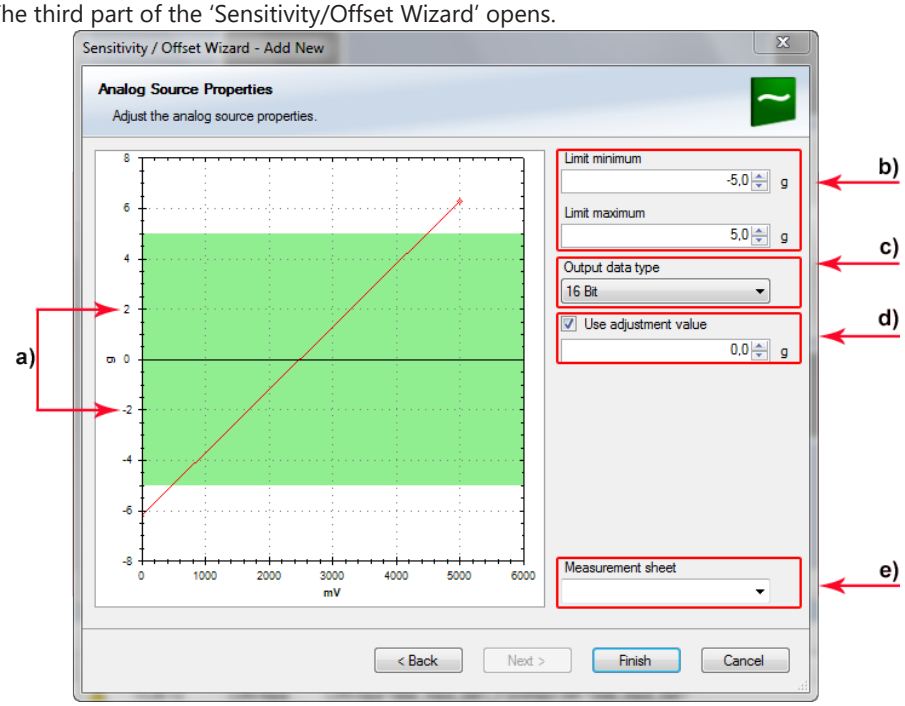
1. Click on ‘Measurement Sources’ in the Toolbox.
2. Expand the list of ‘I/O Channels’ by clicking on ‘+’ in the MSI 60 Project Tree.
3. Drag the ‘Sensitivity/Offset’ analog signal source from the Toolbox and drop it on the desired analog input channel in the MSI 60 Project Tree.
   A ‘Sensitivity/Offset Wizard’ opens.

4. To activate the internal MSI 60 pull-up resistor, check the box.
   The internal MSI 60 pull-up resistor is used to get a 5 V signal at the analog channel of the MSI 60.
   Select the 3,010 Ohm pull-up resistor.
5. Click ‘Next‘ when done.
   The second part of the ‘Sensitivity/Offset Wizard‘ opens.



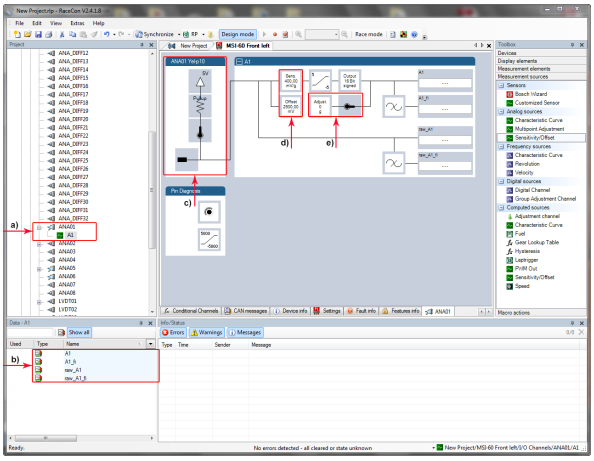
a) Physical (channel) value.
b) Electrical (pin) value.
c) Choose unit group and unit of physical value.
d) Enter values from sensor datasheet.

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



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

9. Click ‘OK’ when done.



a) Channel is linked to ANA01.
b) Available measurements for channel.
c) Input pin pull-up resistor is activated.
d) Value for sensor.
e) Adjustment is enabled.

The channel is inserted into the MSI 60 Project Tree.

Available measurements for channel

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

Working with automatically created measurement sheets is explained in chapter ‘Setting up an online Measurement’ [▶ 85].

10.3.3 Configuring a generic nonlinear Sensor

Example: Thermistor 5 kOhm

– From sensor data sheet: resistance values over temperature

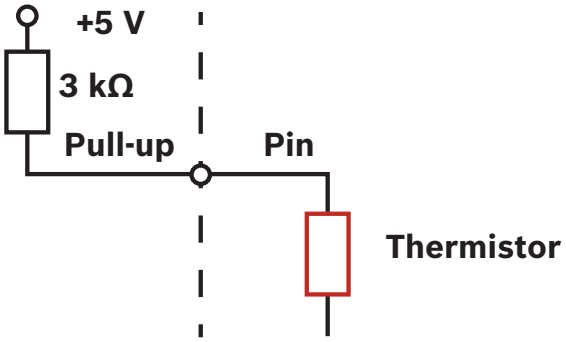
PART NR.: 2381 640 502
HTCLE100E3502

Toper [°C]	RT [Ω]	Toper [°C]	RT [Ω]	Toper [°C]	RT [Ω]	Toper [°C]	RT [Ω]
-40	166 047	0	16 277	40	2 685	80	628
-35	119 950	5	12 669	45	2 166	85	535
-30	87 600	10	9 936	50	1 903	90	457
-25	64 643	15	7 849	55	1 494	95	399
-20	48 179	20	8 244	60	1 245	100	338
-15	36 250	25	5 000	65	1 024	105	292
-10	27 523	30	4 030	70	876	110	251
-5	21 078	35	3 267	75	740	115	221

– The sensor has a nonlinear behavior.

– Use characteristic curve for linearization.

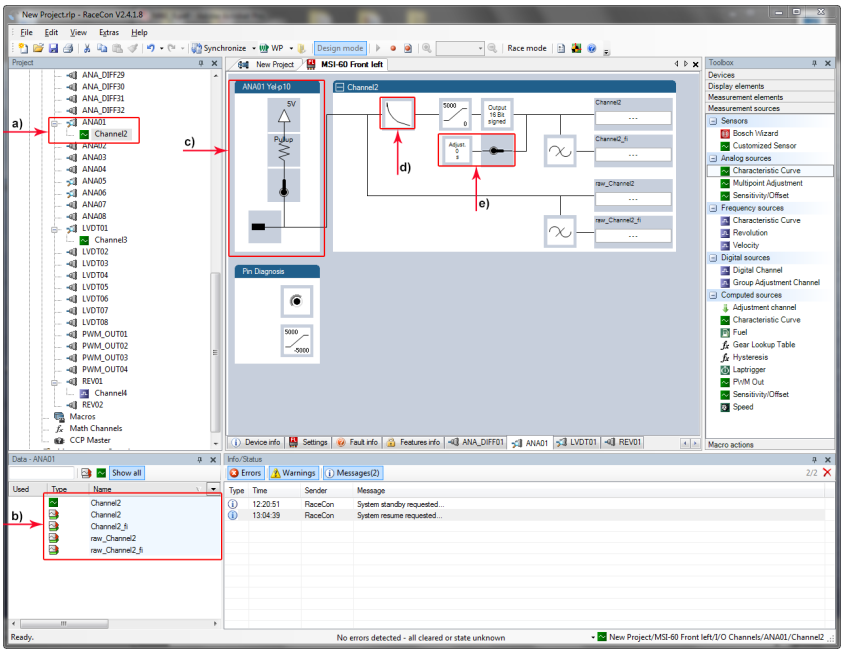
– Input voltage is the ratio between pull-up resistor and thermistor.



1. Click on ‘Measurement Sources’ in the Toolbox.
2. Expand the list of ‘I/O Channels’ by clicking on ‘+’ in the MSI 60 Project Tree.
3. Drag the ‘Characteristic Curve’ analog signal source from the Toolbox and drop it on the desired analog input channel in the MSI 60 Project Tree.
   A ‘Characteristic Curve Wizard’ opens.
4. To activate the internal MSI 60 pull-up resistor, check the box.

   The internal MSI 60 pull-up resistor is used to get a 5 V signal at the analog channel of the MSI 60.

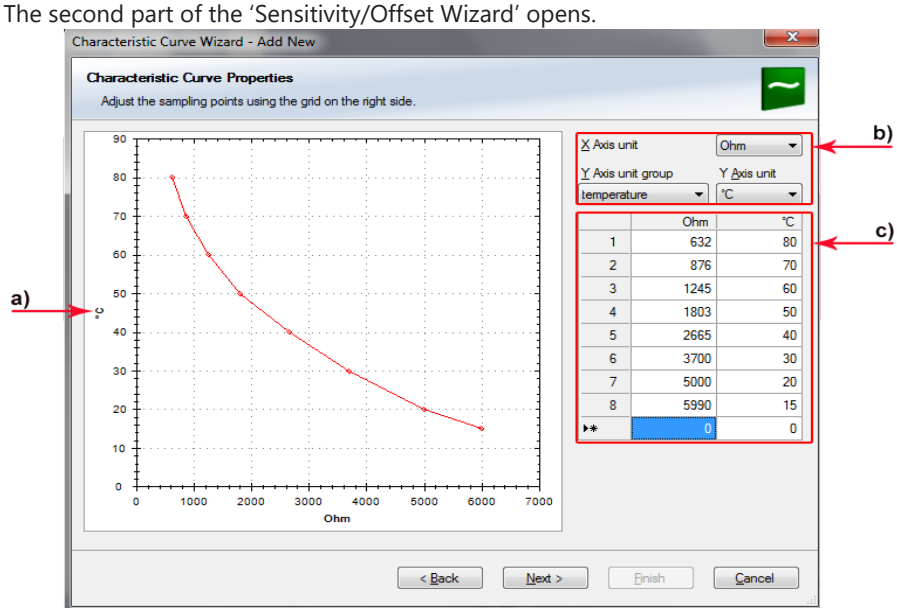
   Select the 3,010 Ohm pull-up resistor.



a) Channel is linked to ANA1.
b) Available measurements for channel.
c) Input pin pull-up resistor is activated.
d) Characterestic curve Properties.
e) Adjustment is enabled.

5. Click ‘Next’ when done.

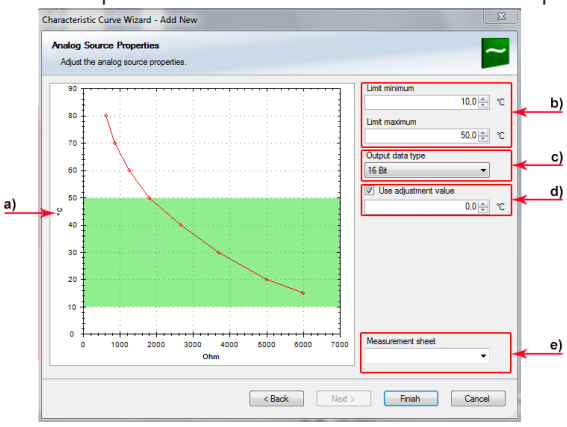
The second part of the ‘Sensitivity/Offset Wizard’ opens.



a) Physical (channel) value.
b) Choose ‘Ohm’ to enter datasheet values directly and select physical unit.
c) Enter resistance/temperature pairs from sensor datasheet here (the 3.01 kOhm pull-up resistor is automatically taken into account).

6. Click ‘Next’ when done.

   The third part of the ‘Characteristic Curve Wizard’ opens.

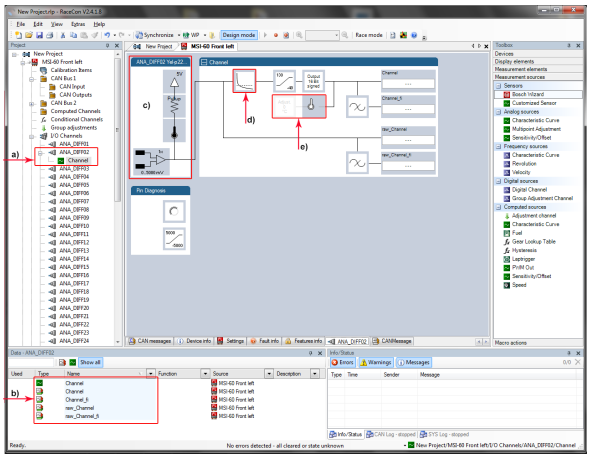


a) Physical limits of channel.
b) Enter physical limits of the channel.
c) Choose data type of the measurement.
d) This sensor does not need offset calibration.
e) Enter name to automatically create a new measurement sheet.

7. Click ‘Finish’ when done.

8. Enter channel name and description.

9. Click ‘OK’ when done.
   The channel is inserted into the MSI 60 Project Tree.



a) Channel is linked to ANA_DIFF02.
b) Available measurements for channel.
c) Input pin pull-up resistor is activated.
d) Characteristic curve for sensor.
e) Adjustment is disabled.

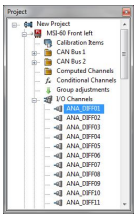
Available measurements for channel

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

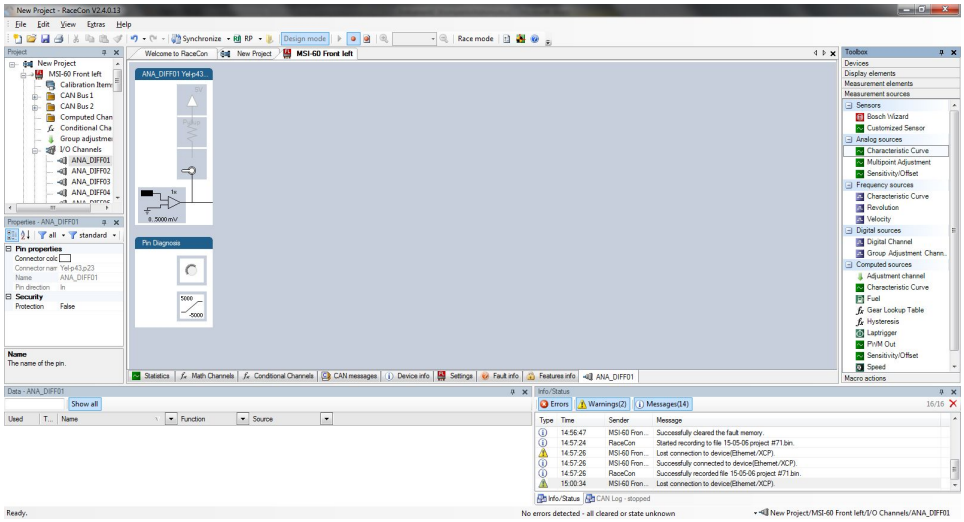
Working with automatically created measurement sheets is explained in chapter ‘Setting up an online Measurement [▶ 85]’.

10.3.4 Configuring a PT 100 or PT 1000 Sensor

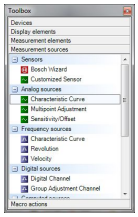
Select one of the ANA_DIFF channels.



Double click the selected channel.



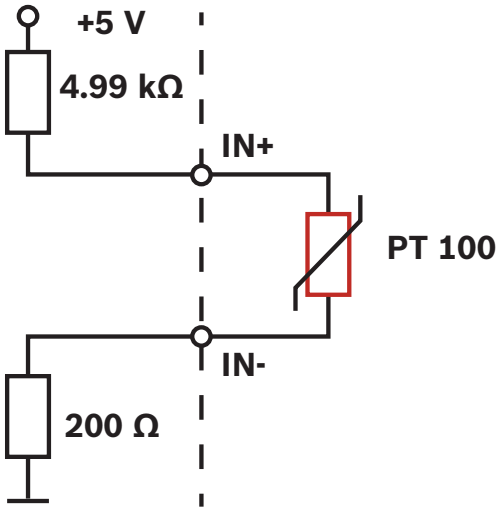
Select Characteristic Curve and drop it into the Main area.



Select all items as bellow.

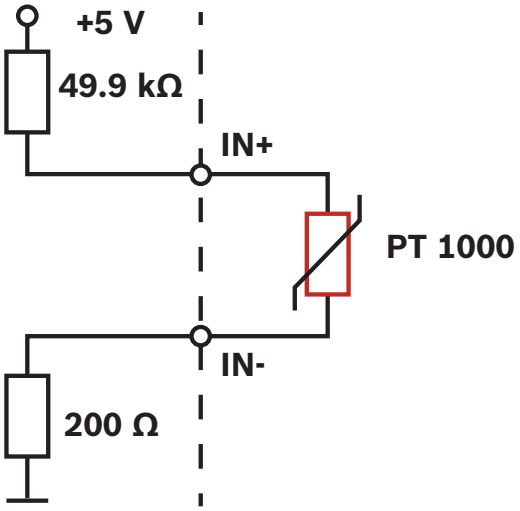
PT100

Signal type	Single Ended
Pull-up value	4.99 kOhm
Input range	0 ... 5,000mV
Gain	16x

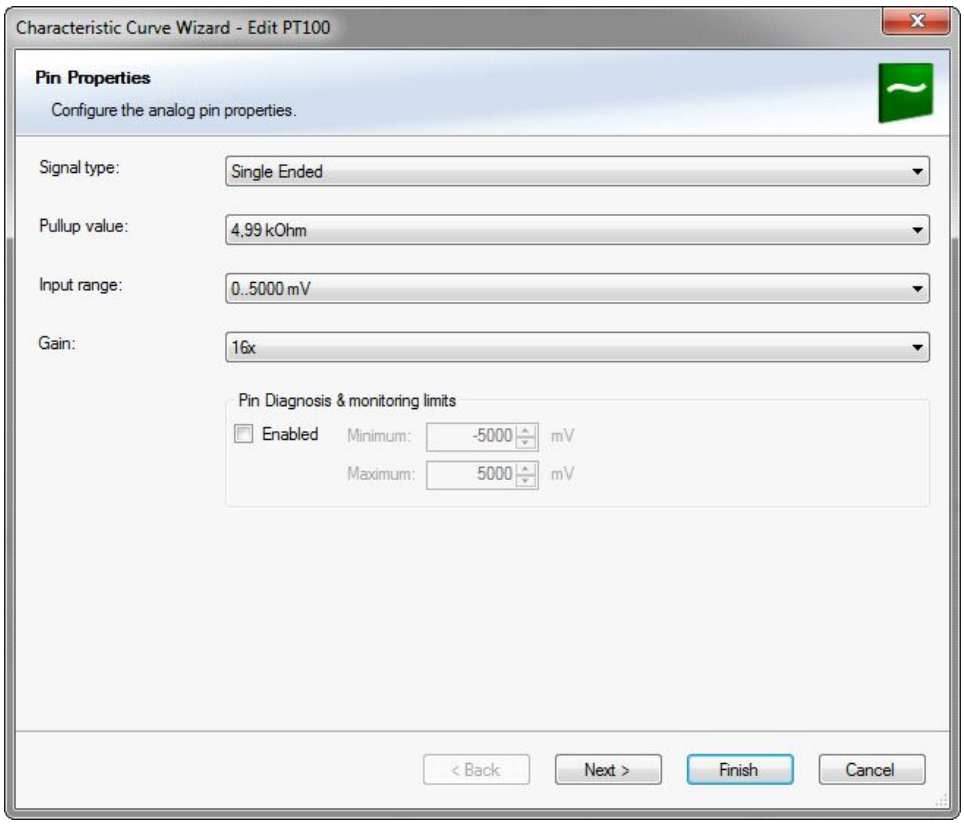


PT1000

Signal type	Single Ended
Pull-up value	49.9 kOhm
Input range	0 ... 5,000mV
Gain	16x



And go next.



Select all items bellow.

X Axis unit	mV
Y Axis group	temperature
Y Axis unit	℃

Relation between mV and temperature

PT 100

mV	1278	1337	1396	1454	1512	1570	1628	1685	1742	1799	1856	1912	1968	2024
℃	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90

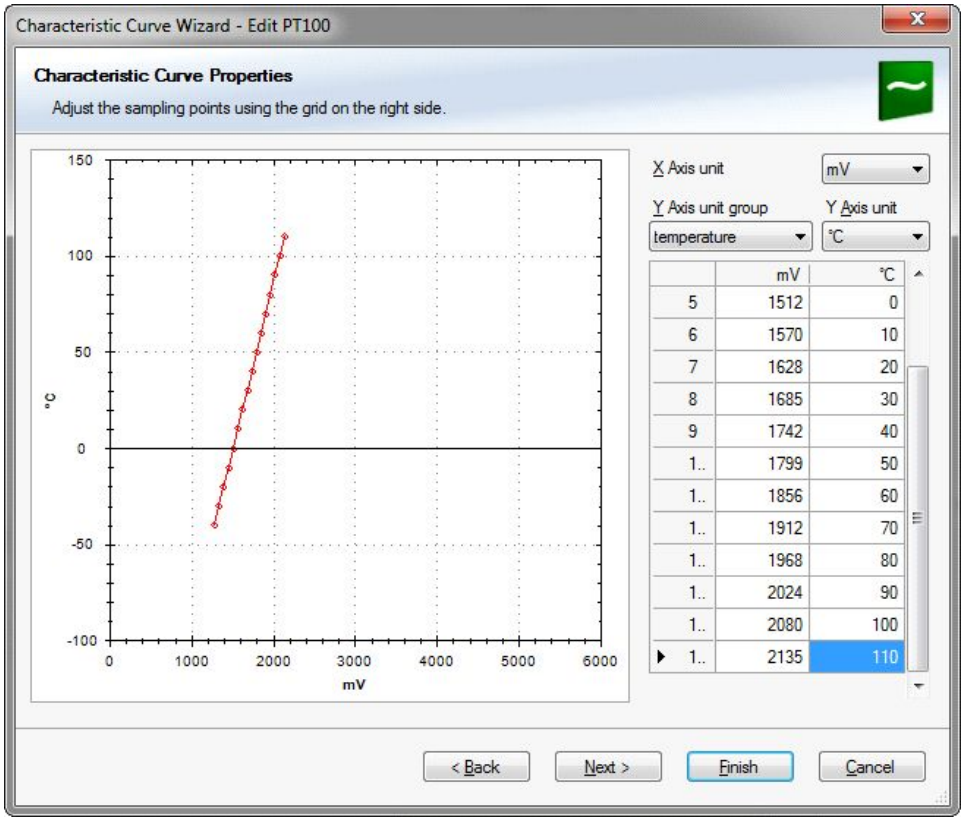
mV	2080	2135	2190	2245	2299	2354	2408	2462	2515	2569	2622	2675	2727	2780
℃	100	110	120	130	140	150	160	170	180	190	200	210	220	230
mV	2832	2884	2936	2987	3038	3089	3140	3191	3241	3291	3341	3391	3440	3489
℃	240	250	260	270	280	290	300	310	320	330	340	350	360	370
mV	3538	3587	3636	3684	3732	3780	3827	3875	3922	3969	4016	4062	4109	4155
℃	380	390	400	410	420	430	440	450	460	470	480	490	500	510
mV	4201	4246	4292	4337										
℃	520	530	540	550										

PT 1000

mV	1323	1384	1445	1505	1565	1625	1684	1744	1803	1862	1920	1979	2037	2094
℃	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90
mV	2152	2209	2266	2323	2379	2435	2491	2547	2602	2657	2712	2767	2822	2876
℃	100	110	120	130	140	150	160	170	180	190	200	210	220	230
mV	2930	2983	3037	3090	3143	3196	3248	3300	3352	3404	3456	3507	3558	3609
℃	240	250	260	270	280	290	300	310	320	330	340	350	360	370
mV	3659	3710	3760	3810	3859	3909	3958	4007	4055	4104	4152	4200	4248	4295
℃	380	390	400	410	420	430	440	450	460	470	480	490	500	510
mV	4343	4390	4437	4484										
℃	520	530	540	550										

- X axis has 16 grids; please choose the range that will be measured.

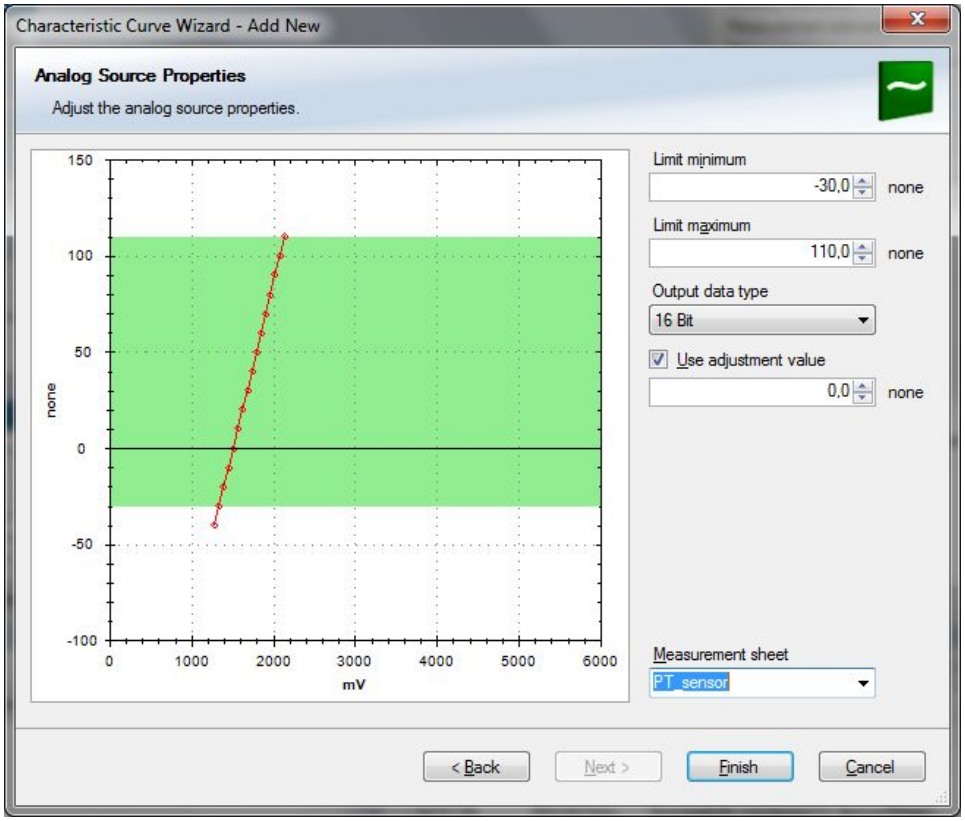
Go Next.



Select all items bellow.

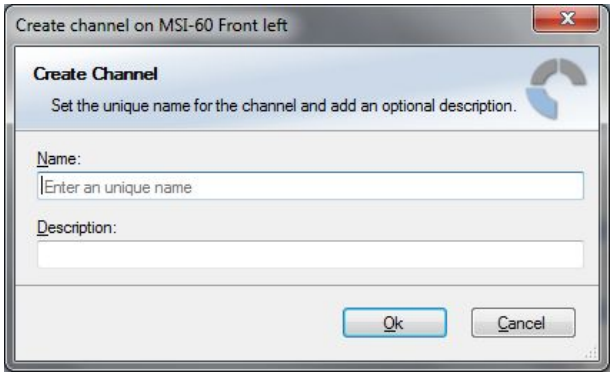
Limit minimum	Expected minimum temperature
Limit maximum	Expected maximum temperature
Output data type	8, 12 or 16 Bit
Adjustment value	Check it if adjustment value will be used, and input adjustment value
Measurement sheet	Input the name of Measurement sheet if needed

Go Finish.



Put in the channel name and its description (optional).

Go OK



After sensor setup, MSI 60 Front left goes orange (different between PC and MSI 60 Front left). Then right click and select Download configuration.

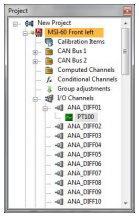


Illustration 7: Before sending configuration

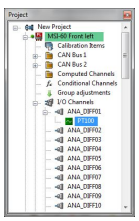
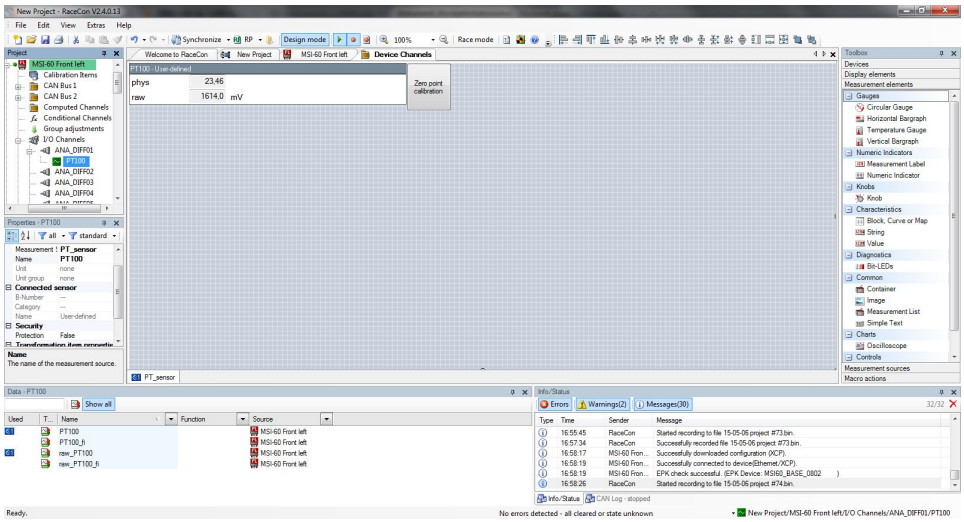


Illustration 8: After sending configuration

Right click MSI 60 Front left and create measuring views. It shows raw and physical value.



10.3.5 Configuring an LVDT Sensor

Example: LVDT sensor 50 mm

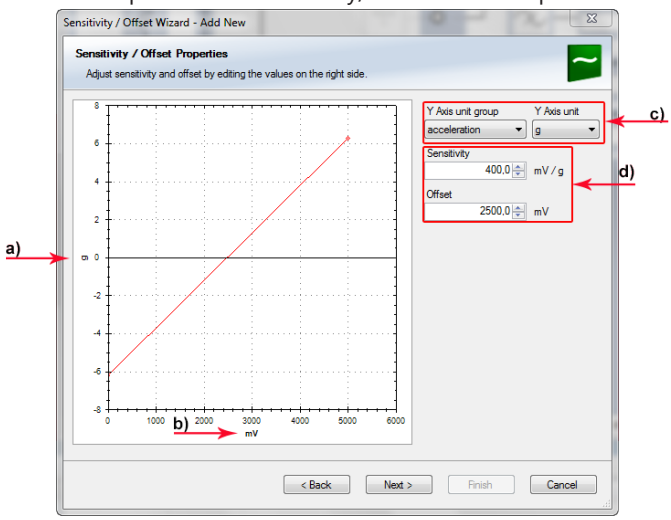
From sensor data sheet – operating characteristics:

Stroke range	± 1.00 inch ± 25.4 mm
Sensitivity	0.8 V/V/inch 31.5 mV/V/mm **(C)**
Output at stroke ends	800 mv/V
Non-linearity (% of FR), max.	± 0.25
Input voltage, sine wave	3 VRMS **(B)**
Input frequency range	400 Hz to 5 kHz
Test input frequency	2.5 kHz **(A)**

- Sensitivity 31.5 mV/V/mm
- The zero position of the sensor is internally represented as +2,500 mV, therefore the Offset must be set to 2,500 mV.
- The sensor has a linear output signal with sensitivity and offset.

1. Click on ‘Measurement Sources’ in the Toolbox.
2. Expand the list of ‘I/O Channels’ by clicking on ‘+’ in the MSI 60 Project Tree.
3. Drag the ‘Sensitivity/Offset’ analog signal source from the Toolbox and drop it on the desired LVDT input channel in the MSI 60 Project Tree.
   A ‘Sensitivity/Offset Wizard’ opens.
4. Set the according operation parameter from sensor data sheet for frequency **(A)** and input voltage **(B).**
5. Click ‘Next’ when done.

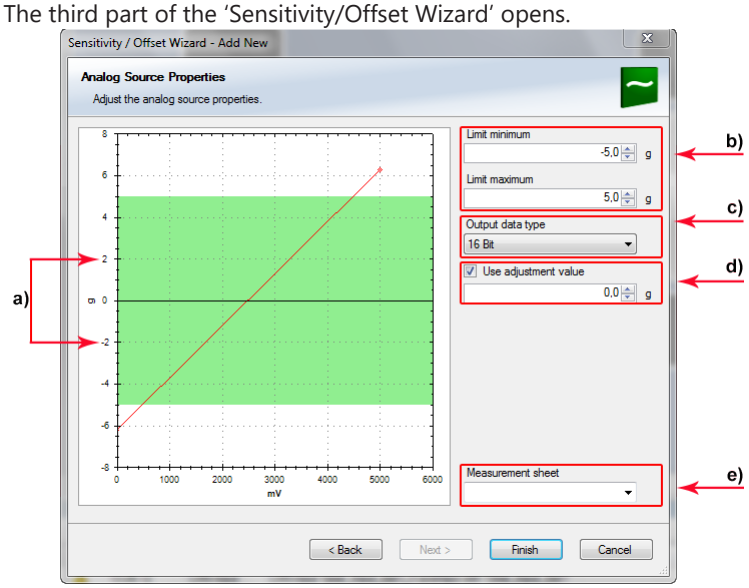
The second part of the 'Sensitivity/Offset Wizard' opens.



a) Physical (channel) value.
b) Electrical (pin) value.
c) Choose unit group and unit of physical value.
d) Enter values from sensor datasheet.

6. Click 'Next' when done.

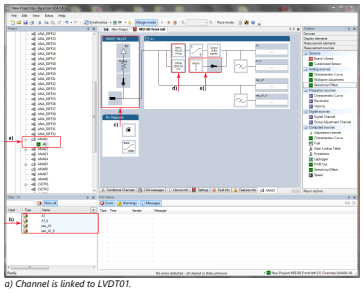
The third part of the 'Sensitivity/Offset Wizard' opens.



a) Physical limits of channel.
b) Enter physical limits of the sensor.
c) Choose datatype of the measurement variable.
d) Checkbox to enable online calibration of offset and enter desired physical offset value.
e) Enter name to automatically create a new measurement sheet.

7. Click 'Finish' when done.
8. Enter channel name and description.

9. Click ‘OK’ when done.
   The channel is inserted into the MSI 60 Project Tree.



a) Channel is linked to LVDT01.
b) Available measurements for channel.
c) Operating parameters for sensor.
d) Sensitivity and offset properties.
e) Adjustment is enabled.

Available measurements for channel

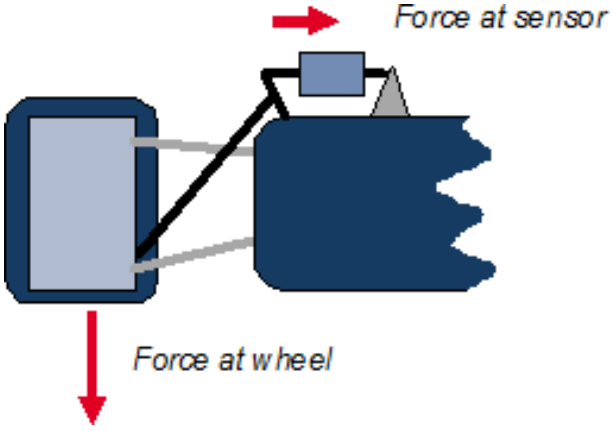
Measurement label	Function
raw_name	mV value of sensor
raw_name_fi	filtered mV value of sensor
name	physical value of sensor
name_fi	filtered physical value

Working with automatically created measurement sheets is explained in chapter ‘Setting up an online Measurement [▶ 85]’.

10.3.6 Configuring a Multipoint Adjustment

Example: Measurement of wheel force

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

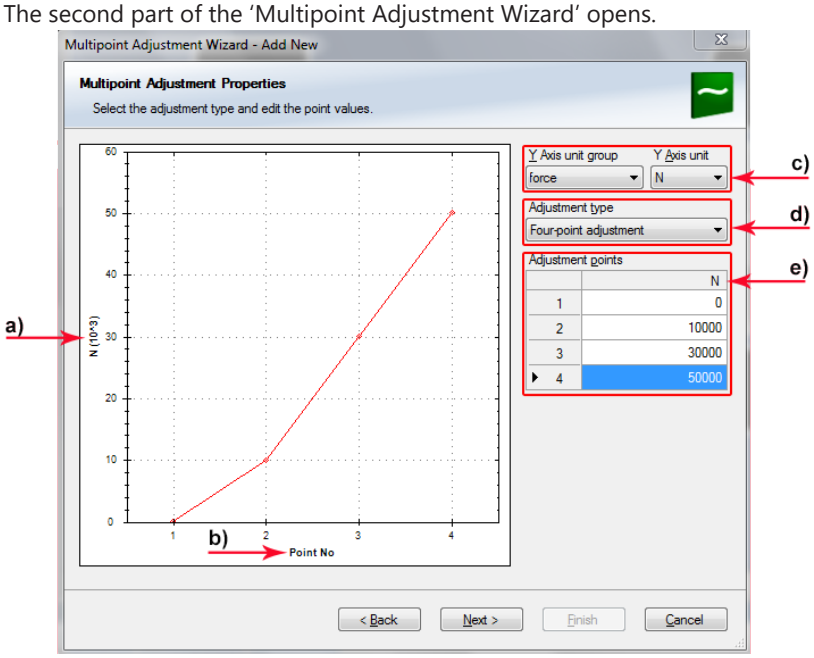


1. Click on ‘Measurement Sources’ in the Toolbox.
2. Expand the list of ‘I/O Channels’ by clicking on ‘+’ in the MSI 60 Project Tree.
3. Drag the ‘Multipoint Adjustment’ analog signal source from the Toolbox and drop it on the desired analog input channel in the MSI 60 Project Tree.
   A ‘Multipoint Adjustment Wizard’ opens.

4. To activate the internal MSI 60 pull-up resistor, check the box.
   The internal MSI 60 pull-up resistor is used to get a 5 V signal at the analog channel of the MSI 60.
   The fixed value of the internal MSI 60 pull-up resistor is 3,010 Ohm.

1. Click ‘Next’ when done.

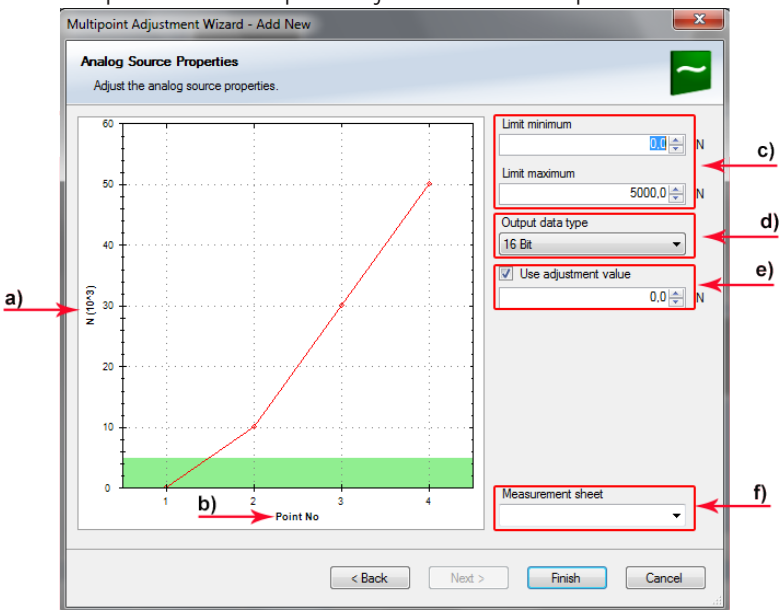
   The second part of the ‘Multipoint Adjustment Wizard’ opens.



a) Physical (channel) value.
b) Electrical (pin) value.
c) Choose unit group and unit of physical value.
d) Select type of curve.
e) Enter physical adjustment values here (can still be edited later).

2. Click ‘Next’ when done.

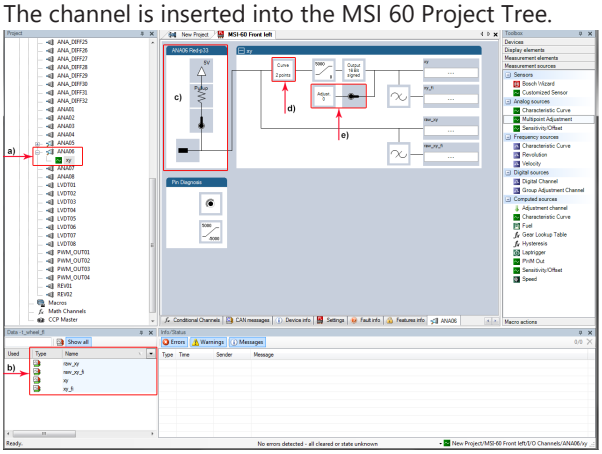
The third part of the 'Multipoint Adjustment Wizard' opens.



a) Physical (channel) value.
b) Electrical (pin) value.
c) Enter physical limits of the sensor.
d) Choose data type of the measurement variable.
e) Enable additonal online calibration.
f) Enter name to automatically create a new measurement sheet.

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

The channel is inserted into the MSI 60 Project Tree.



a) Channel is linked to ANA06.
b) Available measurements for channel
c) Input pin pull-up resistor is activated.
d) Multipoint characteristic curve for sensor
e) Adjustment is enabled.

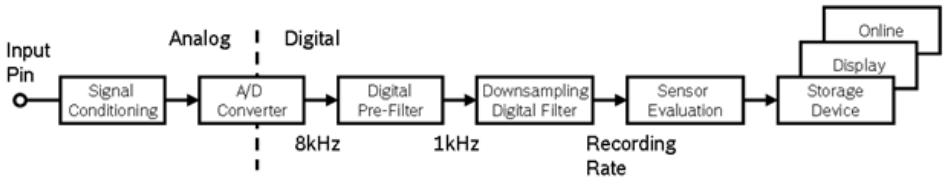
Available measurements for channel

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

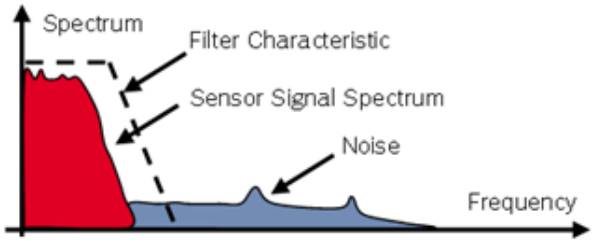
Online definition of the curve is covered in the chapter 'Online Calibration of Measurement Channels [▶ 90]'.
Working with automatically created measurement sheets is explained in chapter 'Setting up an online Measurement [▶ 85]'.

10.3.7 Digital Filter Details

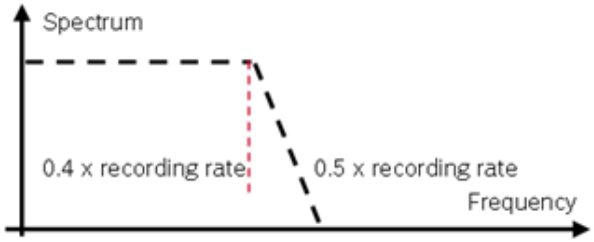
MSI 60 uses A/D converter oversampling and digital filtering to recording rate.



Digital filters eliminate 'out-of-band' noise



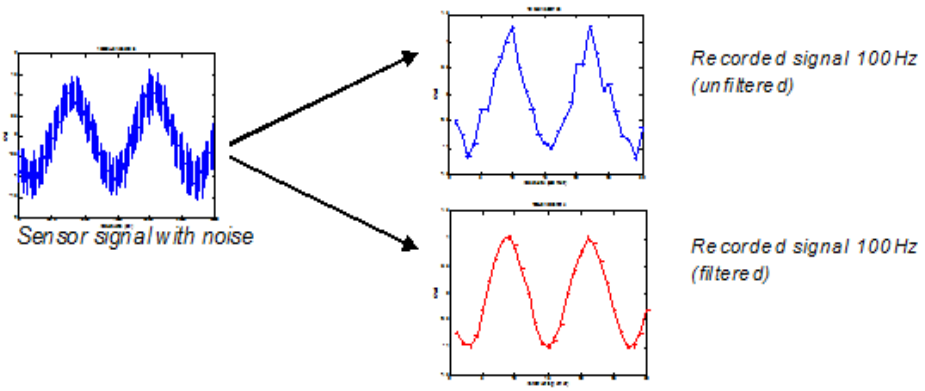
Cut-off frequency automatically adjusted to recording rate



Linear phase – no signal distortion

Example:

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



Latency compensation – no filter delay in recorded data

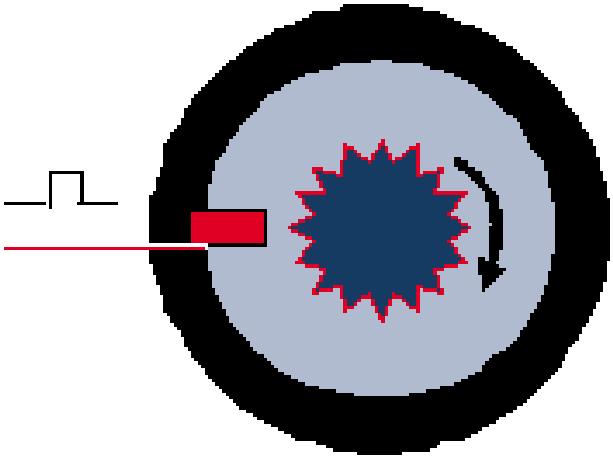
- Filtering is (smart) averaging over several samples.

- Filtered signal is delayed with respect to real time signal.
- MSI 60 filters have constant, frequency independent delay.
- Delay (e.g. 22 samples at 10 ms) is corrected during recording.
- No delay filtered vs. unfiltered in recorded data.
- Correction is (of course) not possible for real time data (display, online, PWM out).
- Use filtered data for recording, use unfiltered data for realtime.

10.3.8 Configuring a Frequency Input

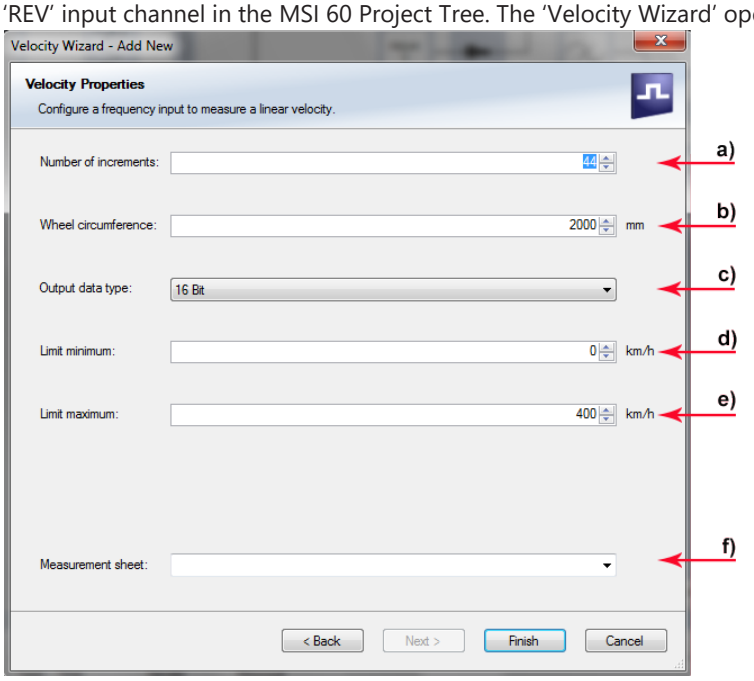
Example: Measurement of wheel speed

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



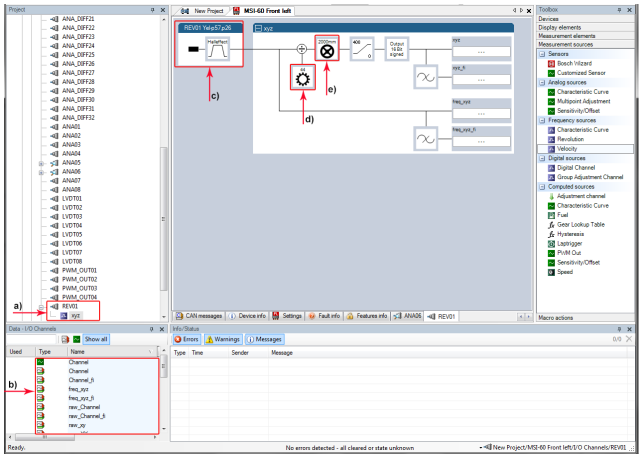
1. Click on ‘Measurement Sources’ in the Toolbox.
2. Expand the list of ‘I/O Channels’ by clicking on ‘+’ in the MSI 60 Project Tree.

3. Drag the 'Velocity' digital signal source from the Toolbox and drop it on the desired 'REV' input channel in the MSI 60 Project Tree. The 'Velocity Wizard' opens.



a) Number of teeth on the pulse wheel.
b) Circumference of wheel for speed calculation.
c) Choose data type of the measurement variable.
d) Choose Limit minimum speed.
e) Choose Limit minimum speed.
f) Enter name to automatically create a new measurement sheet.

4. Click 'Finish' when done.
5. Enter channel name and description.
6. Click 'OK' when done. The channel is inserted into the MSI 60 Project Tree.



a) Channel is linked to REV01.
b) Available measurements for channel.
c) Input pin has Hall interface.
d) Number of teeth.
e) Wheel circumference.

Available measurements for channel

Measurement label	Function
raw_name	mV value of sensor

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

NOTICE

Measurement of ‘Revolution’ is similar.

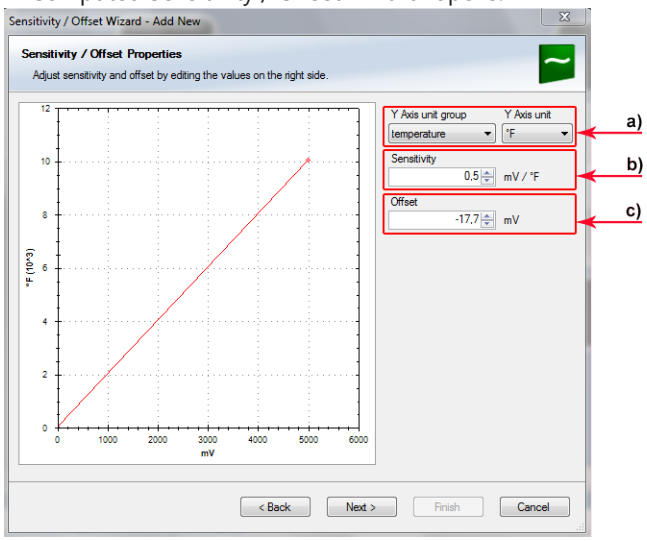
10.4 Configuring computed Sources

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

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

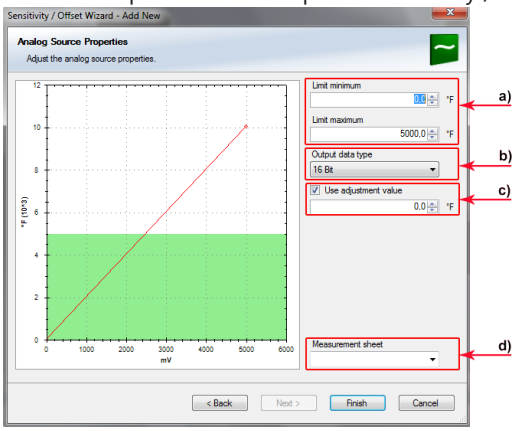
Example: Sensitivity/Offset calculation on input channel

1. Click ‘Measurement Sources’ in the Toolbox.
2. Drag the ‘Sensitivity/Offset’ computed source from the Toolbox and drop it on ‘Computed Channels’ in the MSI 60 Project Tree.
   A ‘Computed Sensitivity / Offset Wizard’ opens.



a) Choose input channel.
b) Choose unit group and unit of output.
c) Enter sensitivity and offset of conversion formula.

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



a) Enter physical limits of the channel.
b) Choose data type of the measurement variable.
c) Check the box to force the channel’s quantization if the quantization should be a fixed value in the whole CAN system.
d) Enter name to automatically create a new measurement sheet.*

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

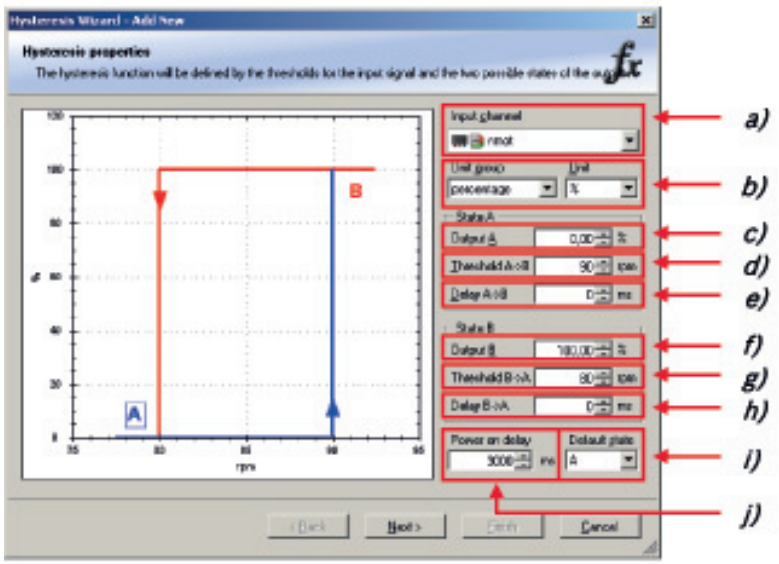
The channel is inserted into the MSI 60 Project Tree.

*Working with automatically created measurement sheets is explained in chapter ‘Setting up an online Measurement [▶ 85]’.

10.5 Hysteresis

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

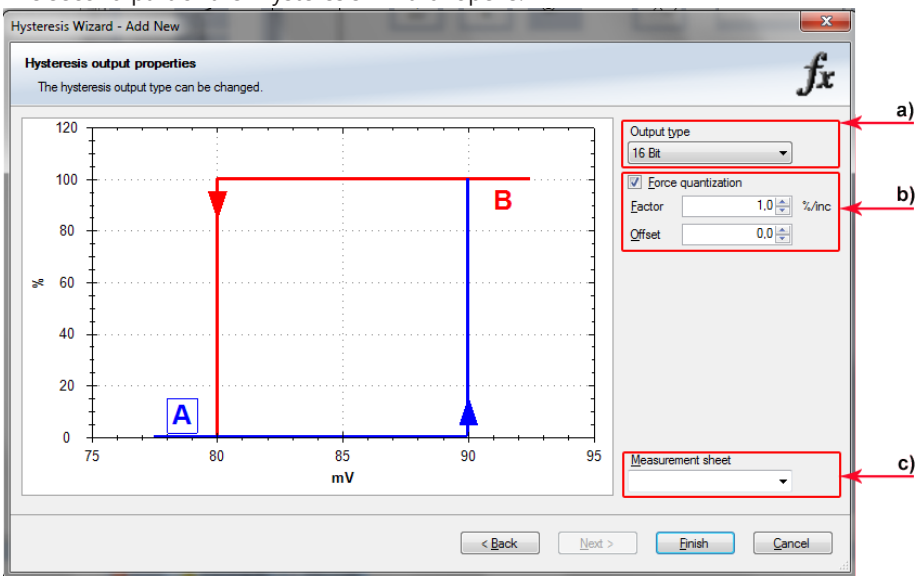
1. Click ‘Measurement Sources’ in the Toolbox.
2. Drag the ‘Hysteresis’ computed source from the Toolbox and drop it on ‘Computed Channels’ in the MSI 60 Project Tree.
   A ‘Hysteresis Wizard’ opens.



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

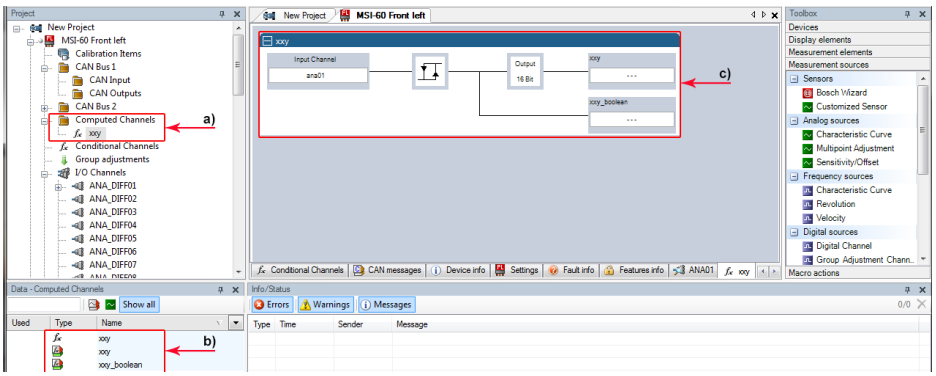
3. Click 'Next' when done.

   The second part of the 'Hysteresis Wizard' opens.



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

   The channel is inserted into the MSI 60 Project Tree.



a) Channels available in computed sources.
b) Available measurements for channel.
c) Calculation of hysteresis channel.

10.5.1 Special Functionality: Vehicle speed

This functionality allows:

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

Vehicle speed calculation function

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

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

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

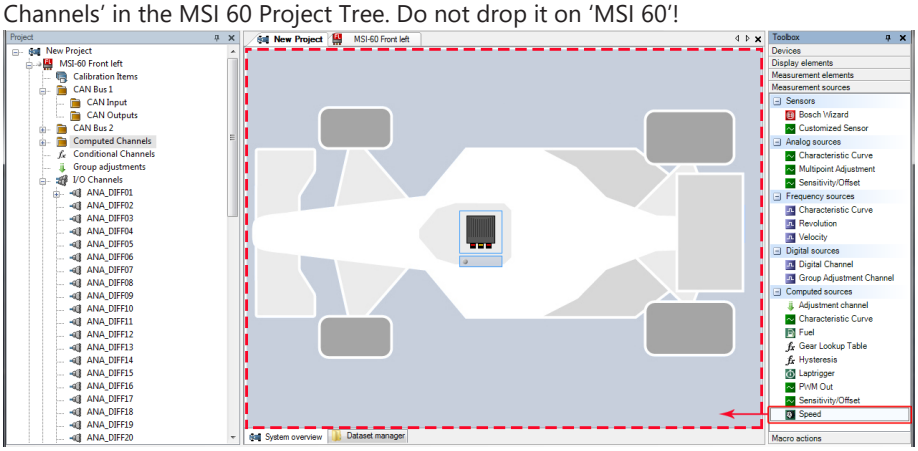
- Calculating vehicle speed of 4 wheel drive: (Wheel speeds of all wheels as input).

  Calculated speed is speed of 2nd fastest wheel.

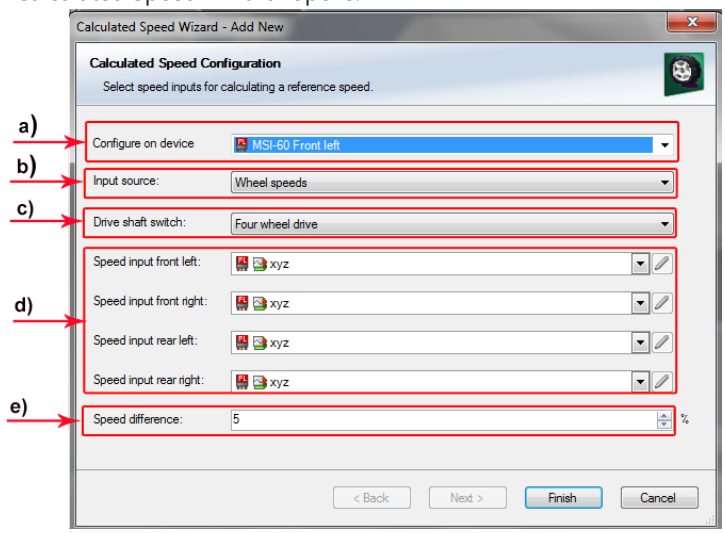
10.5.2 Setting up calculated Speed

1. Click on tab 'System Overview'.
2. Click on 'Measurement Sources' in the Toolbox.

3. Drag the 'Speed' computed source from the Toolbox and drop it on 'Computed Channels' in the MSI 60 Project Tree. Do not drop it on 'MSI 60'!

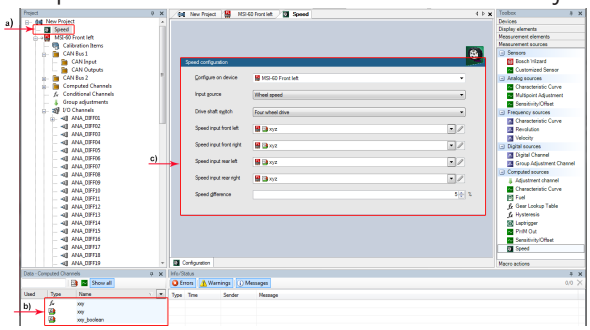


A 'Calculated Speed Wizard' opens.



a) Choose device.
b) Choose input source (internal / external).
c) Choose driven axle.
d) Choose individual wheel speed channels.
e) Set limit for speed difference for calculation.

4. Click 'Finish' when done.
The speed calculation is inserted into the MSI 60 Project Tree.

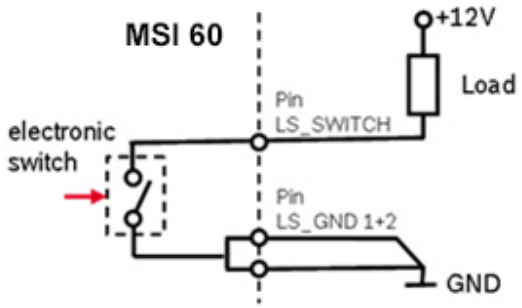


a) Speed calculation in MSI 60 Project Tree.
b) Measurement channels calculated speed and calculated distance.
c) Configuration window.

10.6 Configuring PWM Outputs

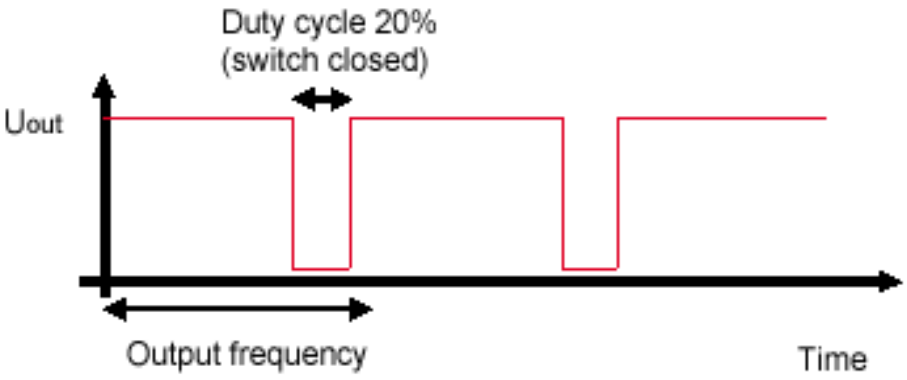
PWM

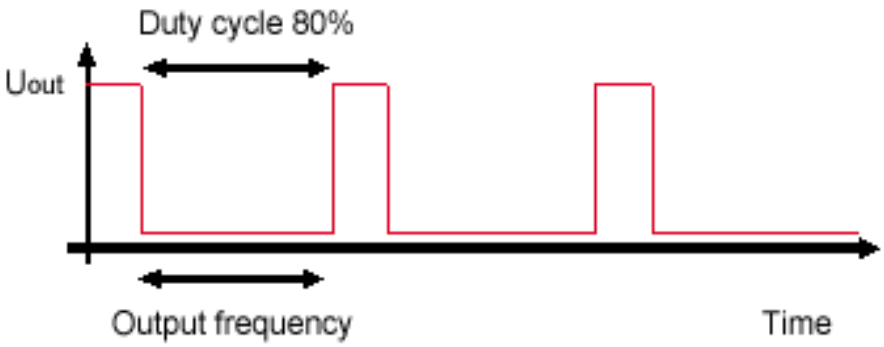
– Pulse Width Modulation
– Output frequency is constant.
– ‘On time’ (duty cycle) controlled by input channel.



MSI 60 has 4 PWM outputs:

– Low-side switch
– Up to 1 A each
– Selectable output frequency
– Duty cycle controlled by characteristic curve.





Configuring a PWM Output

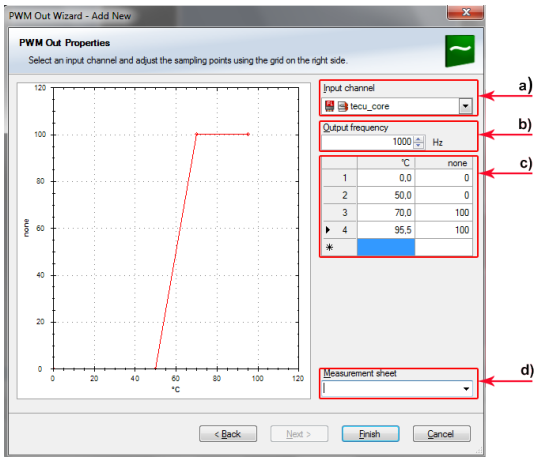
1. Click on ‘Measurement Sources’ in the Toolbox.
2. Drag the ‘PWM Out’ computed source from the Toolbox and drop it on the desired ‘PWM_OUT’ channel in the MSI 60 Project Tree.

   A ‘PWM Out Wizard’ opens.

Working with automatically created measurement sheets is explained in chapter 'Setting up an online Measurement' [▶ 85].

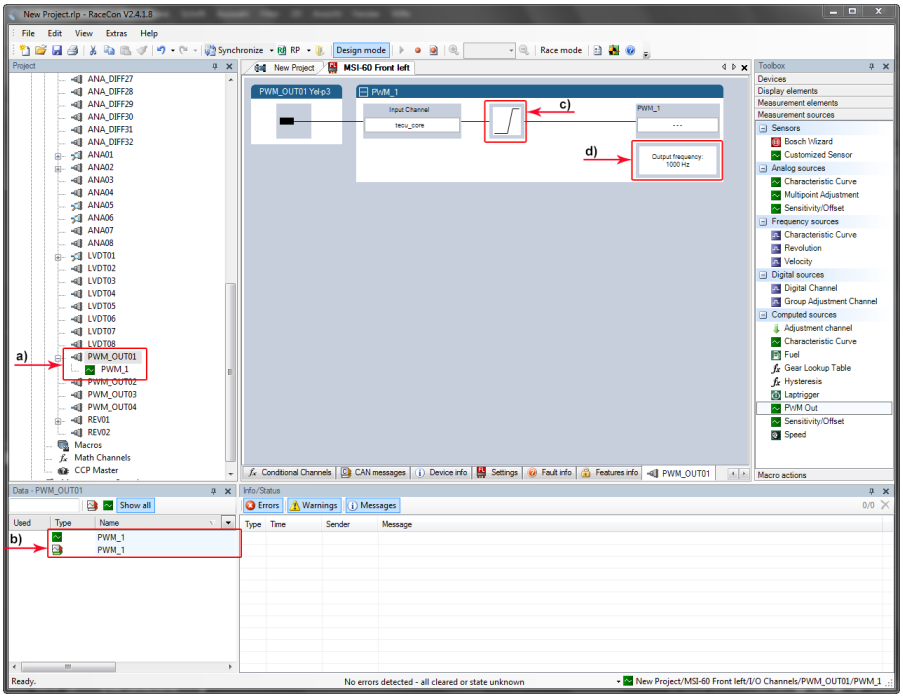
Choosing a filtered channel as an input for 'PWM_OUT' will cause delayed reaction due to the delay introduced by the digital filter. Use unfiltered values for this purpose.

The 'power-on' state of the PWM output is 'switch open' (0% duty cycle).



a) Choose input channel.
b) Choose output frequency.
c) Define characteristic curve.
d) Enter name to automatically create a new measurement sheet.

3. Click 'Finish' when done.
4. Enter channel name and description.
5. Click 'OK' when done.
   The channel is inserted into the MSI 60 Project Tree.



a) Channel is linked to 'PWM_OUT01'.
b) Measurement channels.
c) Characteristic curve.
d) Output frequency.

Diagnostic channels

Measurement label	Function
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

NOTICE

The diagnosis of PWM output 2 to 4 is similar.

11 Online Measurement

MSI 60 **configuration**

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

Online measurement and calibration

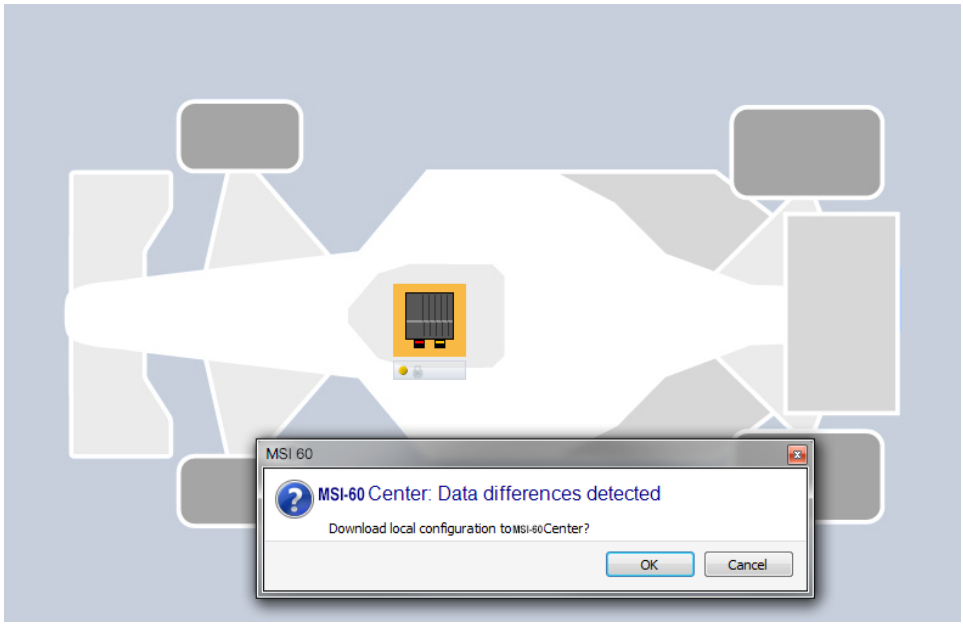
- System status and diagnosis
- Check and calibrate sensors in the vehicle.
- Live display of sensor values on the PC
- Use RaceCon for diagnosis, online measurement and calibration.
- Communication interface: Ethernet
- Communication protocol: XCP

11.1 Achieving an online Connection

This chapter describes how to set up the PC for access, going online and how to update the firmware.

11.1.1 Set up the PC for Access

1. Switch off local firewall on the PC.
2. Set IP Configuration for the Ethernet interface to ‘automatic configuration’ (DHCP).
3. Start RaceCon.
4. Establish the Ethernet connection to the vehicle.
5. Power on the vehicle.
6. Click ‘OK’ to download RaceCon configuration to device.



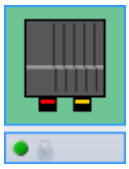
Yellow dot indicates live connection to the device, but local RaceCon configuration does not match the MSI 60's configuration.

11.1.2 Going online

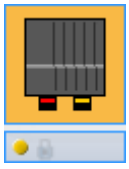
Click 'OK' to download RaceCon configuration to MSI 60.

The download starts.

A green dot and background on the device in the project view and the MSI 60 Project Tree indicate a successful download and system consistency.



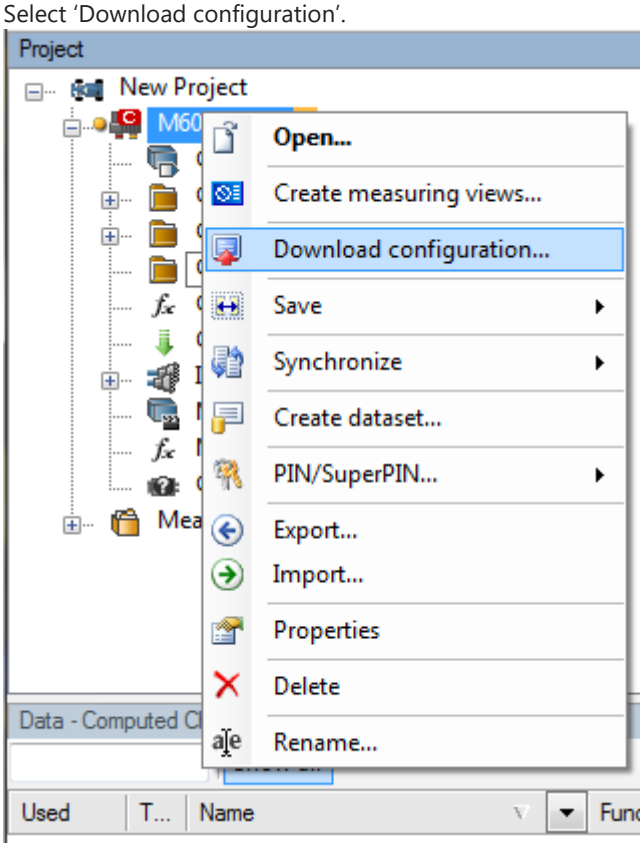
If the system's configuration in RaceCon has been changed, the dot and background becomes yellow and a configuration download is necessary.



11.1.3 Configuration Download

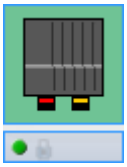
1. Right-click on MSI 60 in the MSI 60 Project Tree.

2. Select ‘Download configuration’.



The configuration download starts.

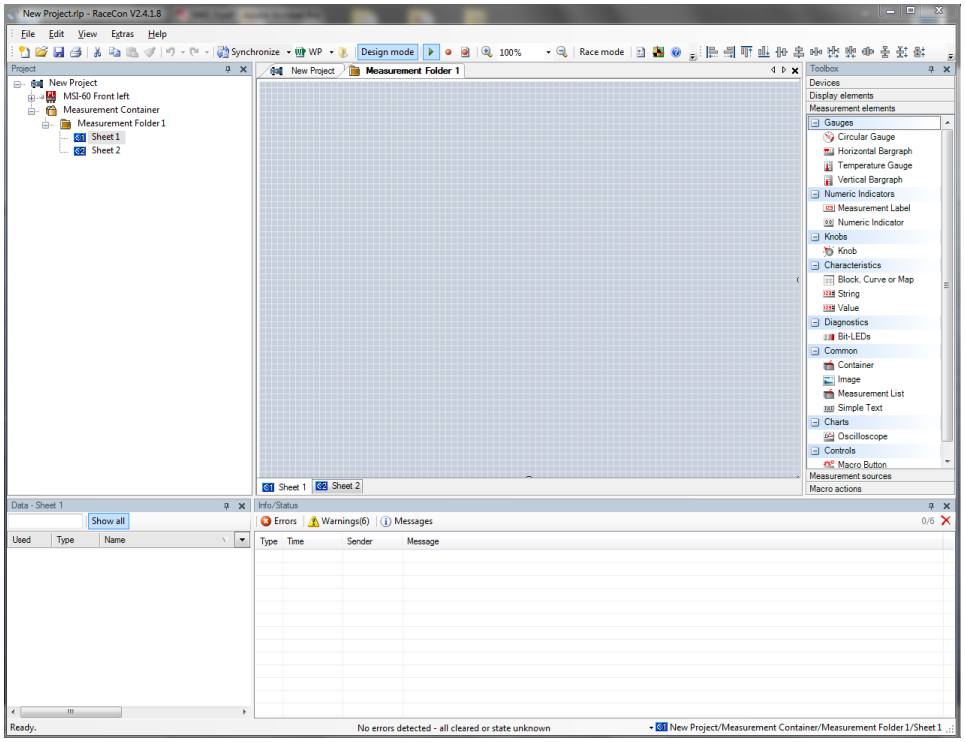
A green dot and background indicate a successful download.



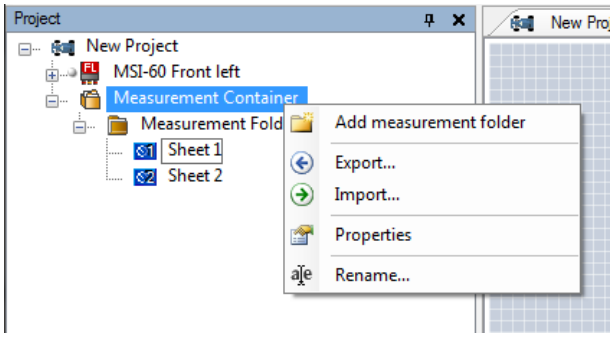
11.2 Setting up an online Measurement

MSI 60 supports online measurement of sensor values and diagnostic variables.

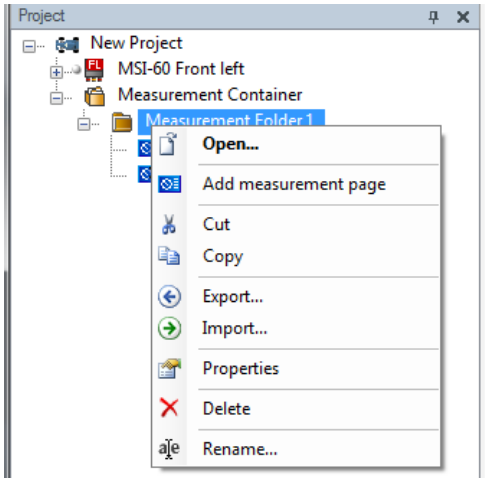
Expand ‘Measurement Container’ and ‘Measurement Folder 1’ in the Project Tree and double-click on ‘Sheet1‘. The ‘Sheet 1’ is opened in the Main Area.



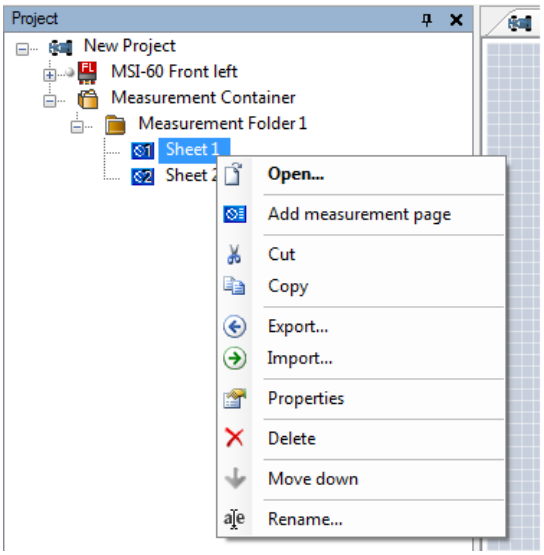
From the context menu of the project, new measurement folders can be created.



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



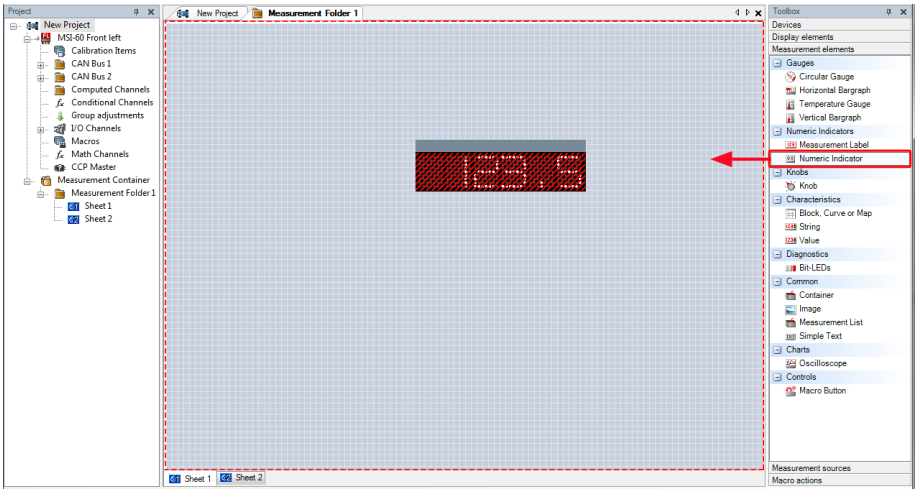
From the context menu of a measurement page, the page can be renamed and deleted.



To change between different pages, click on the tabs on the bottom of the Main Project Area.

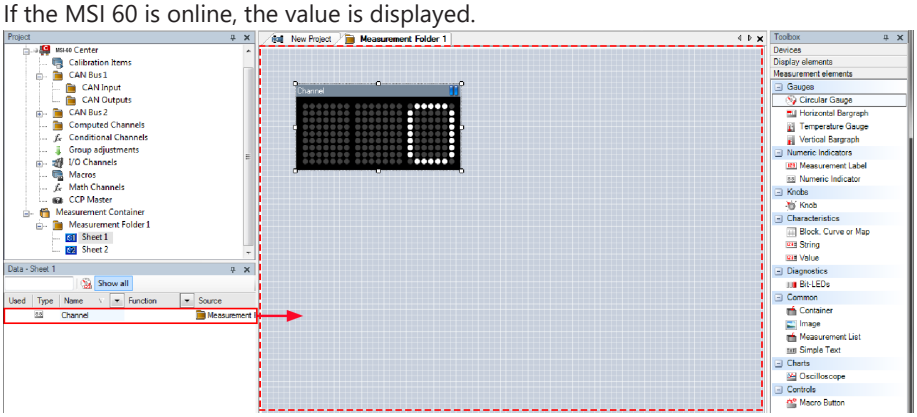
To add an element to a measurement sheet do following steps:

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

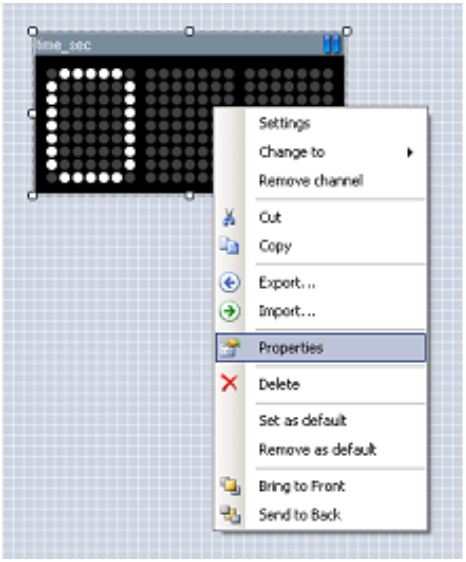


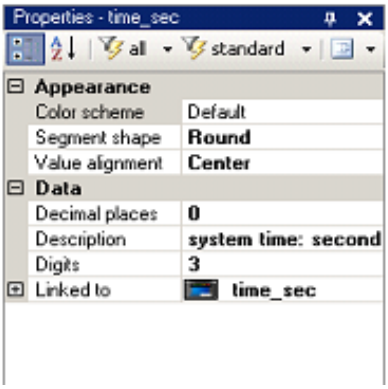
2. Click on 'MSI 60' in the Project Tree to display all measurement channels.

3. Select the desired measurement channel and drop it on the measurement element. If the MSI 60 is online, the value is displayed.

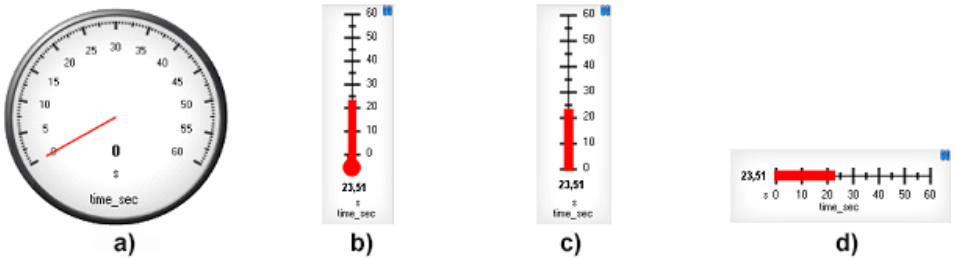


The measurement element's appearance can be changed using the Properties Menu.



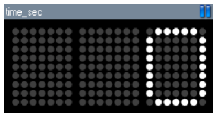


RaceCon offers different types of measurement elements:

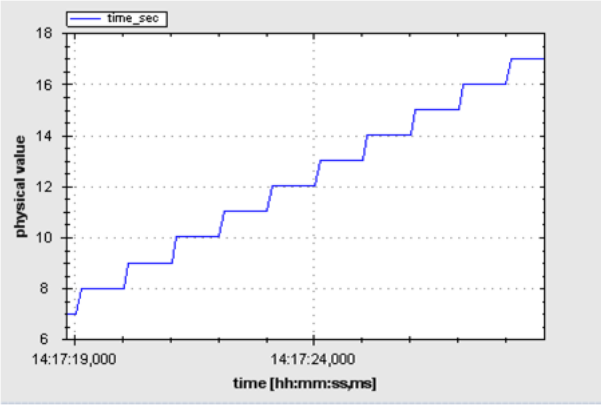


a) Circular gauge
b) Temperature gauge
c) Vertical Bar graph style
d) Horizontal Bar

Measurement label



Numeric indicator



Oscilloscope (Chart)

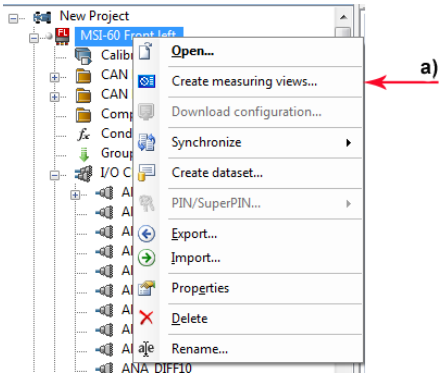
11.2.1 Automatic Creation of Measurement Sheets

RaceCon can create measurement sheets automatically. You can create and use measurement sheets with the MSI 60 as well as with all other devices connected to RaceCon.

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

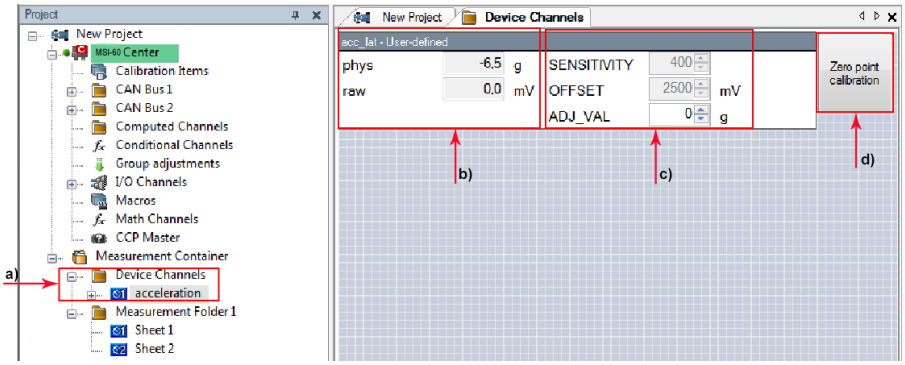
a) Select existing sheet from list or enter name of new sheet.

2. To create the sheets, right-click on 'MSI 60 and select 'Create measurement views …' from the MSI 60 context menu.



a) Click to create measurement sheets.

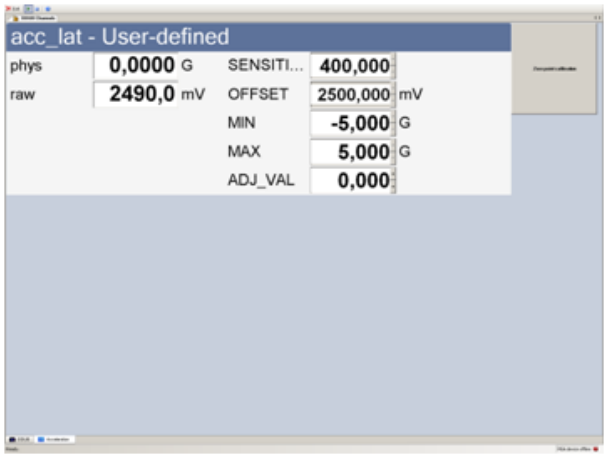
The automatically created sheet is inserted in the Project Tree under ‘Measurement Container’ and ‘Device Channels’. If the MSI 60 is connected to RaceCon, live values of the channels are shown.



a) Access to sheet
b) Raw and physical channel values
c) Characteristic values
d) Button for online offset calibration

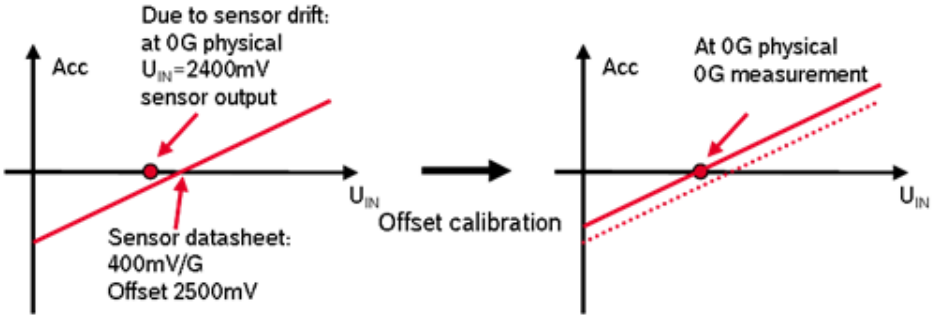
11.2.2 Using the Measurement Sheets

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



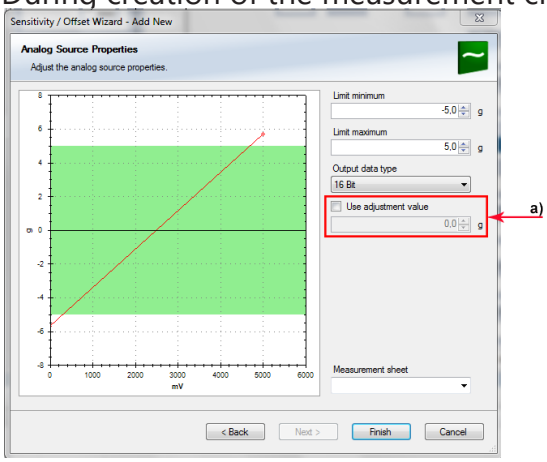
11.3 Online Calibration of Measurement Channels

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



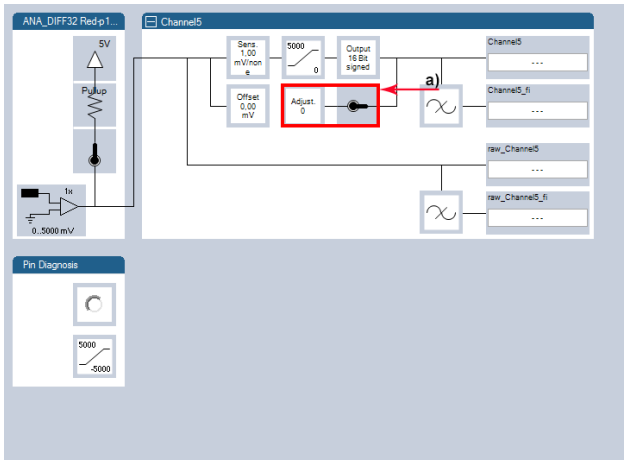
11.3.1 Enable online offset Calibration for Measurement Channel

During creation of the measurement channel



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

In the channel view

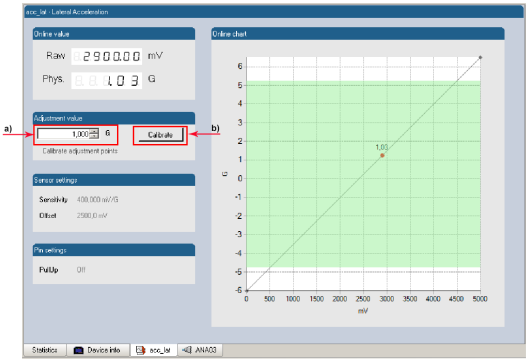


a) Activate switch to enable online calibration.

11.3.2 Performing the online offset Calibration

1. MSI 60 has to be connected to RaceCon to calibrate the sensor's offset.
2. Apply the desired physical condition to the sensor (e.g. 1 G to an acceleration sensor).

3. Open the measurement channel's online page by double-clicking on the measurement channel name in the Data Area.
4. Enter the physical target value (e.g. 1 G) and press the 'Calibrate' button.



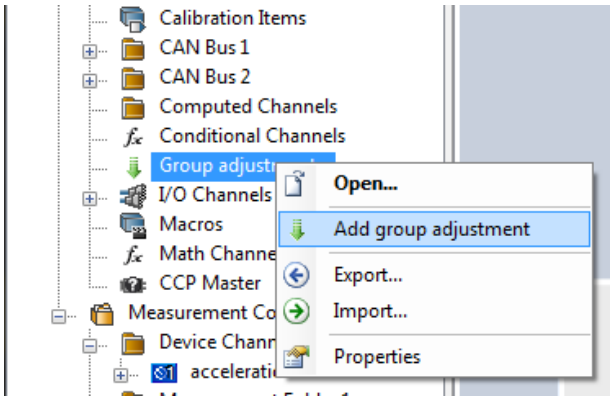
a) Calibration target value
b) Initiate calibration

The sensor's offset is now calibrated.

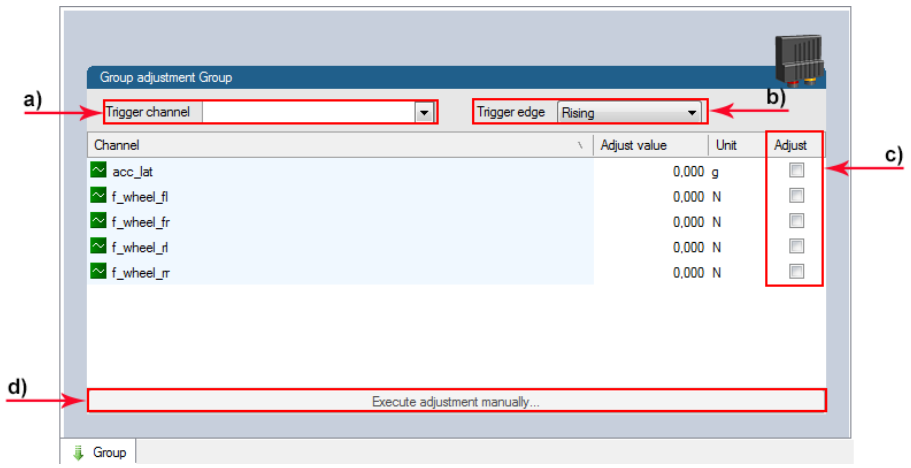
11.4 Group Adjustment

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

To setup a group adjustment, right-click on 'Group adjustments' in the project tree and select 'Add group adjustment'.

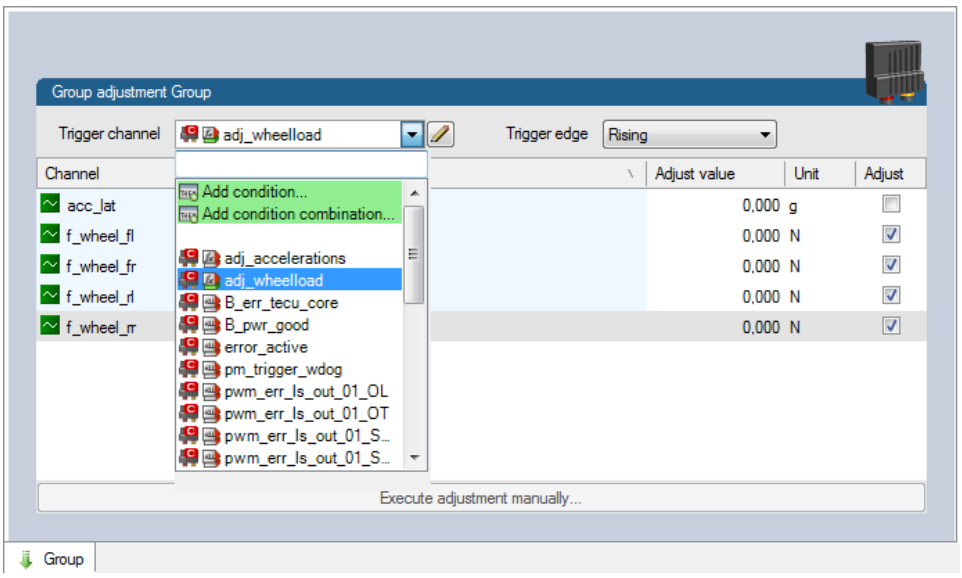


Group adjustment window is opened in the Main area with all adjustable configured channels listed.

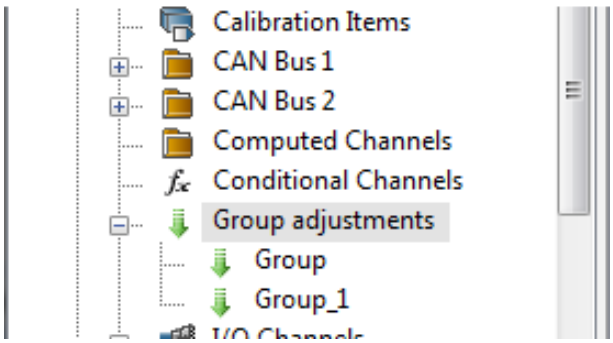


a) Click to select a trigger channel.
b) Click to select activation condition.
c) Check box to add channel to group adjustment.
d) If device is online, click to test adjustment.

Select or create a trigger channel, set the trigger edge and assign the channels to be adjusted by this trigger condition.

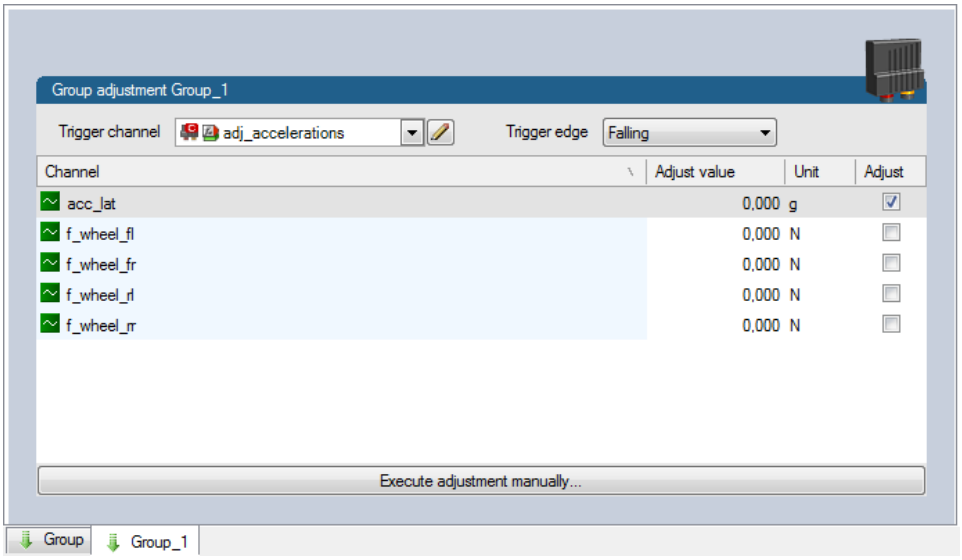


Add a further group by right-click on 'Group adjustments' in the project tree and select 'Add group adjustment'.



From the context menu it is possible to rename the group.

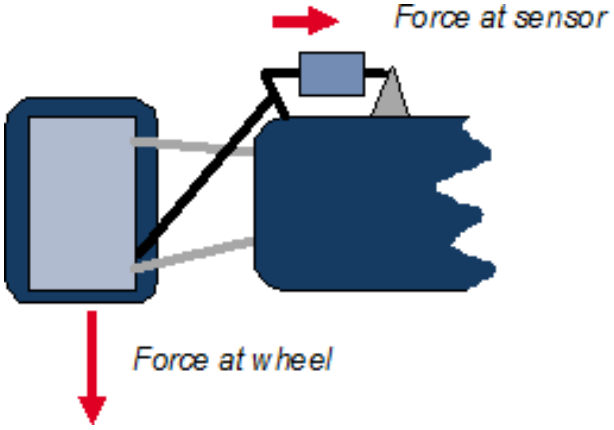
Select the trigger channel, trigger edge and assign the channels to be adjusted.



11.5 Online Calibration of Multipoint Adjustment Channels

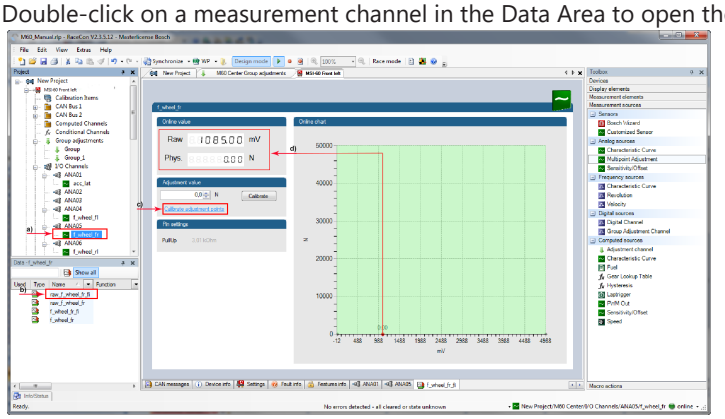
Example: Measurement of wheel force

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



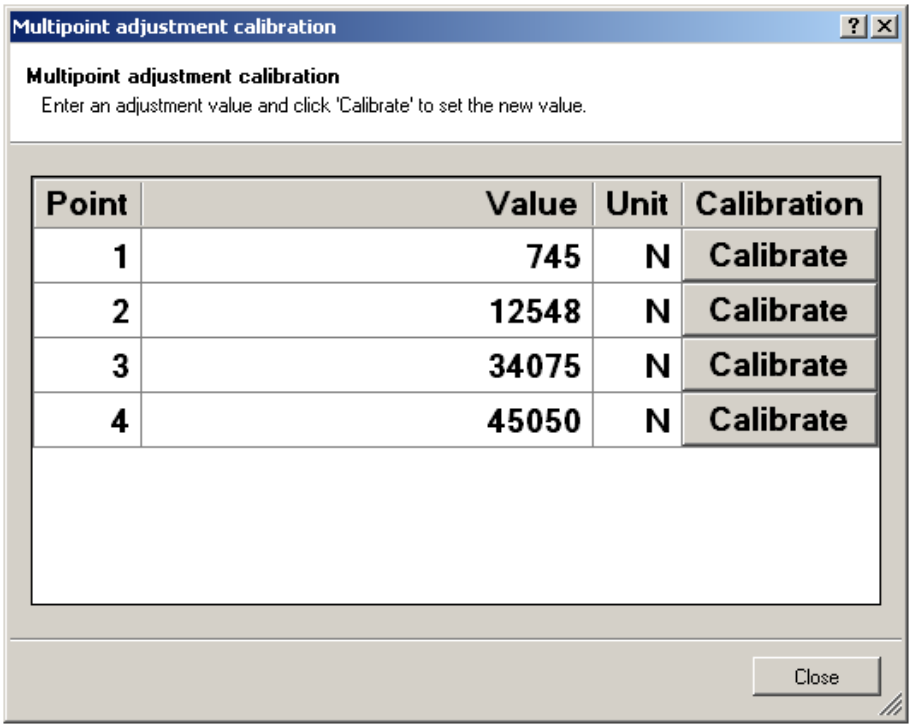
1. Create a multipoint adjustment measurement channel. To create a multipoint channel, see chapter 'Configuring a Multipoint Adjustment [▶ 69]'.
2. Download the configuration on the MSI 60. To connect the MSI 60 to RaceCon, see chapter 'Connecting the MSI 60 to RaceCon [▶ 21]'.
3. Click on the desired channel in the MSI 60 Project Tree.

4. Double-click on a measurement channel in the Data Area to open the online view.



a) Click to open measurement channels in data view.
b) Double-click to open online view.
c) Click to open calibration window.
d) Analog and physical value.

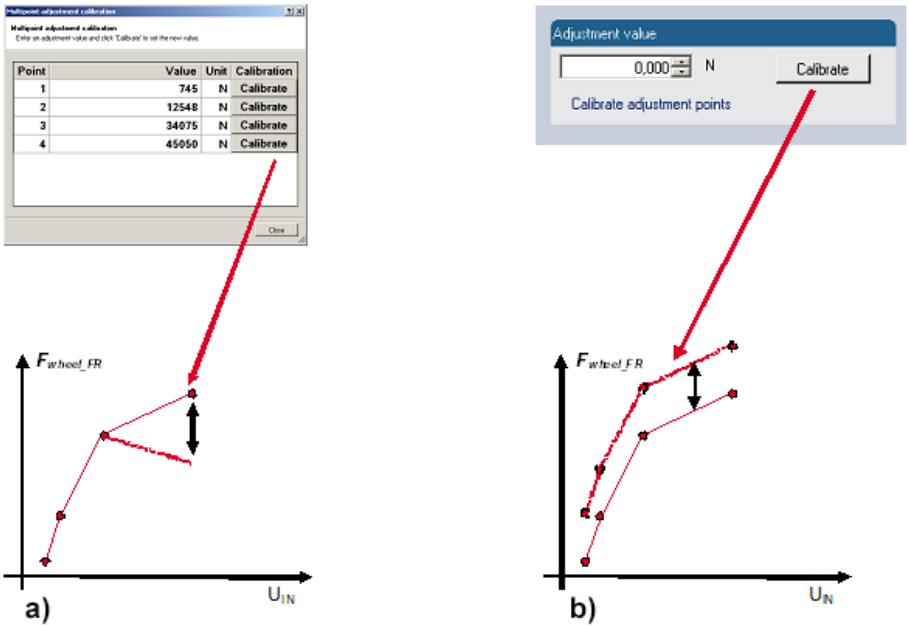
5. Click on 'Calibrate adjustment points' to open calibration window.



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

    The calibration curve is displayed in the online view.

Adjustment points vs. offset adjustment

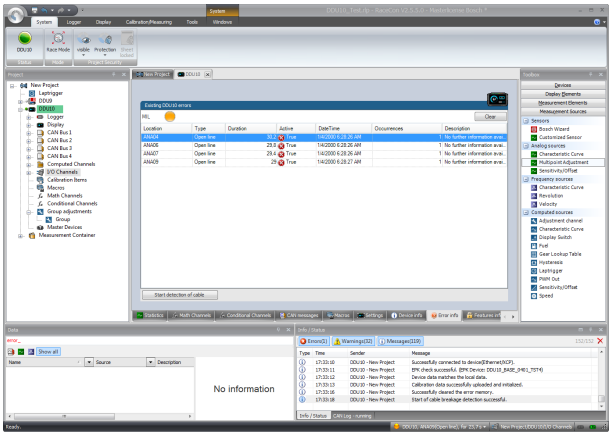


12 Error Memory

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

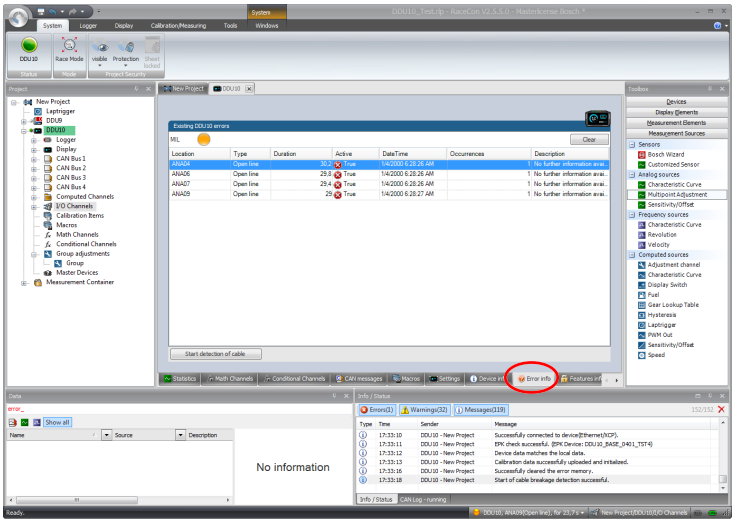
12.1 Error memory representation in RaceCon

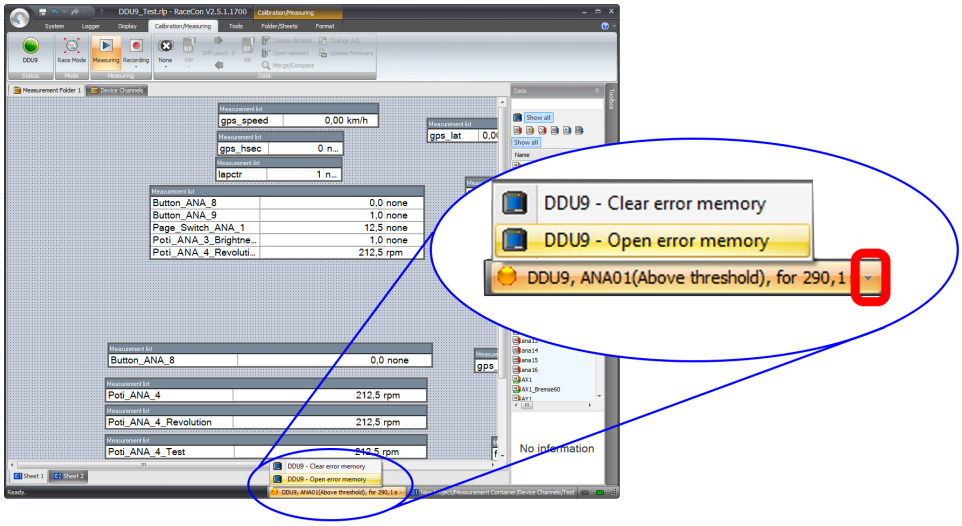
Bosch Motorsport devices feature an error memory. Information on errors can be visualized via RaceCon (online measurement) or can be transmitted via telemetry.



12.1.1 Accessing the memory

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





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

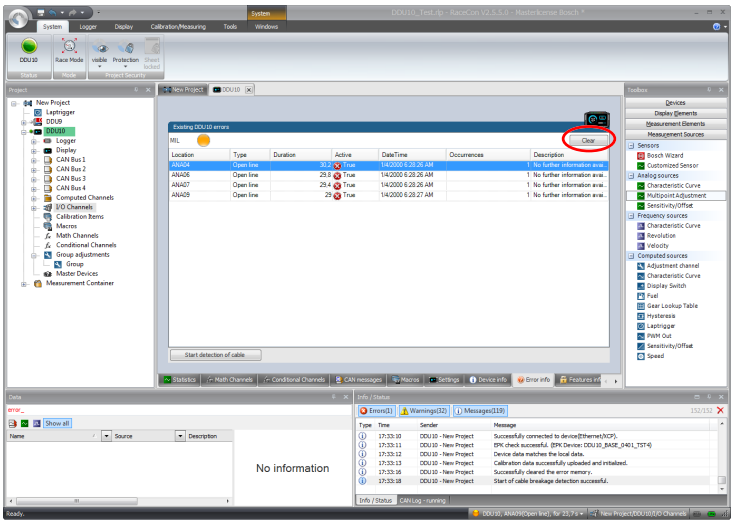
An error is deleted from the list when

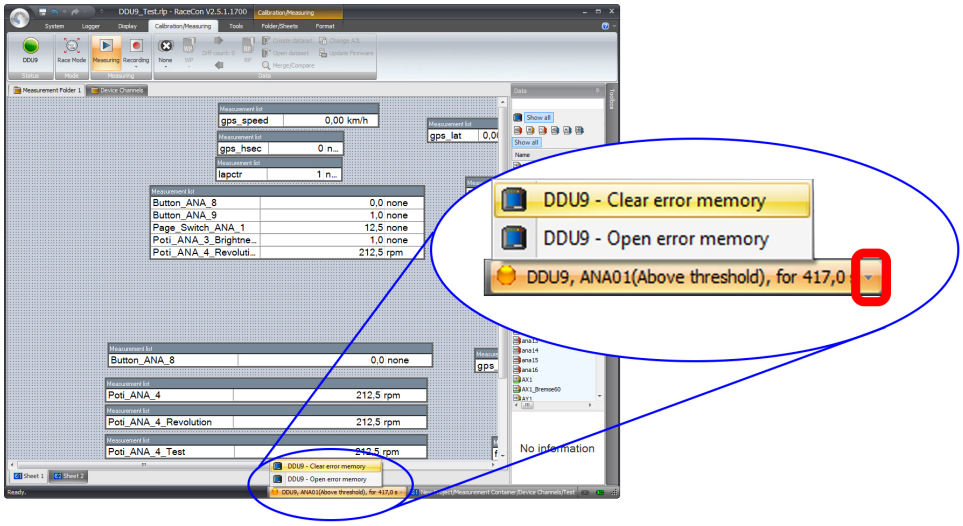
- the user actively clears the error memory
- the user updates the firmware

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

12.1.2 Clearing the error memory

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





12.2 Information on errors available from the error memory

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

12.2.1 Error Memory Properties

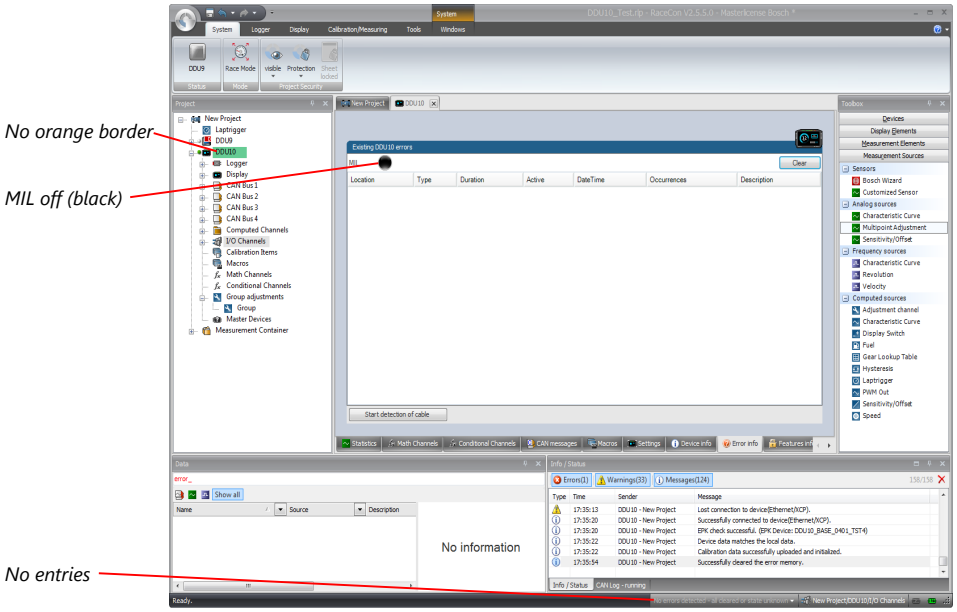
The following property is available for the error memory itself:

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

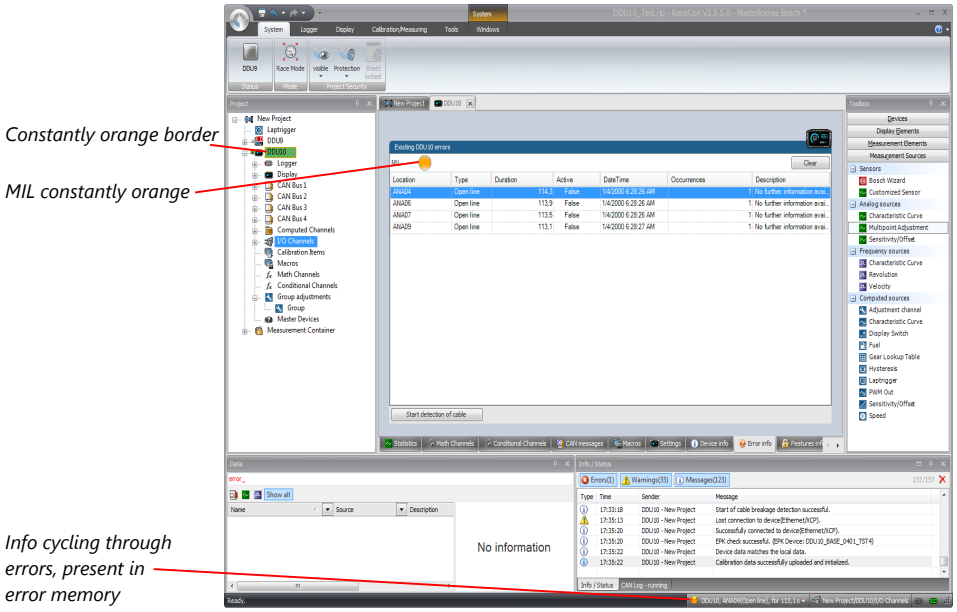
If displayed in a measurement sheet, this property’s value (0, 1 or 2) is translated into a verbal description:

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

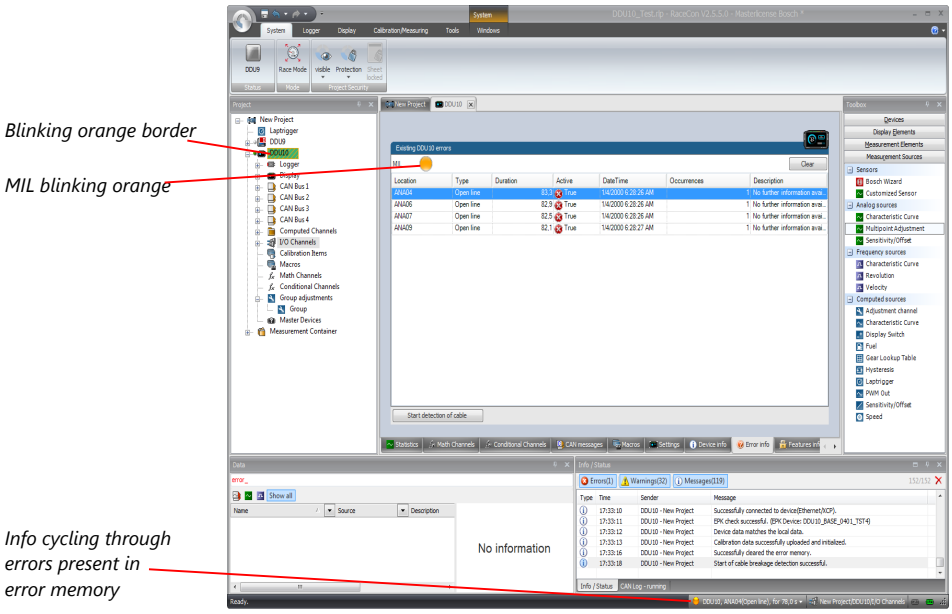
0 (no error present in memory):



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

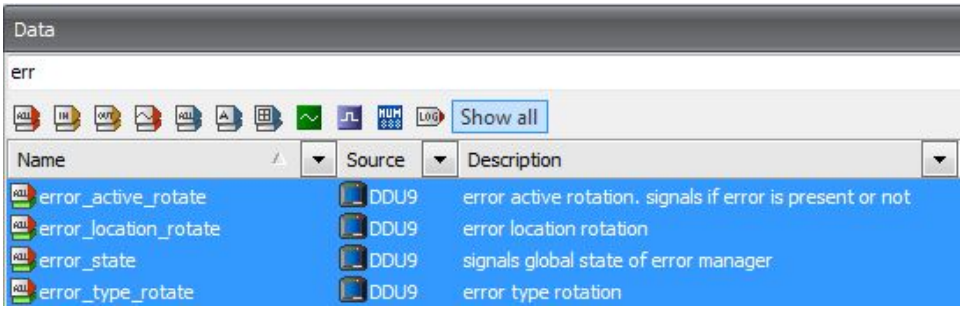


2 (at least one active error present in memory):



12.2.2 Error Properties

The following channels are recognized and memorized inside the devices:

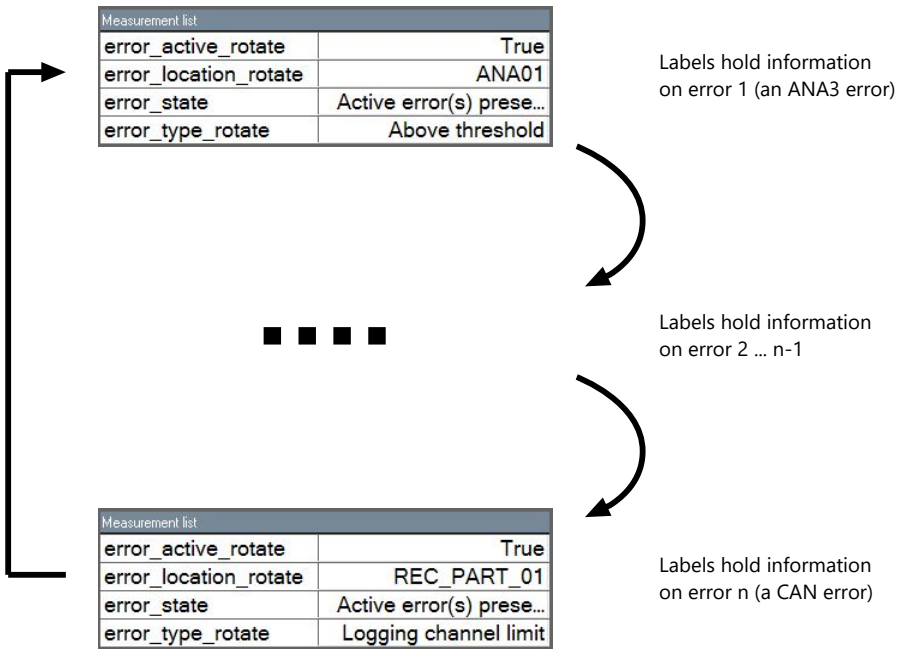


- Error type (device label “error_type_rotate”):
  e.g. “below_threshold” for a violation of the minimum voltage range defined in the configuration, “shortcut_Batt” for a shortcut to battery voltage etc.
- Error locations (device label “error_location_rotate”):
  e.g. “ANA01” for an error concerning the first ANA channel
- Error durations
  How long has the error been active? If an error encounters a non-active period before being cleared from the memory and is then detected again, the error duration keeps on accumulating. The number of active periods can be seen from the “number of occurrences”.
- Number of occurrences
  How many times has the error been detected since the last time the error memory was cleared.
- Error active state (device label “error_active_rotate”)
  All failure modes are continuously diagnosed; any error detected will be written to the error memory. Once an error is detected, it is qualified as “active”.
  - 1 (TRUE) Error was detected in most recent diagnose run (active)

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

The aforementioned channels (error_active_rotate, error_location_rotate, error_type_rotate) are device specific properties (e.g. C 60) and are not related to the complete RaceCon project (e.g. “error no. 3 from the error memory”). Therefore, only one property label is available in each device. The errors from the error memory (possibly more than one error possible per device) share these three labels. The labels cycle through the errors currently present in the memory and represent the respective property of each error periodically.

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

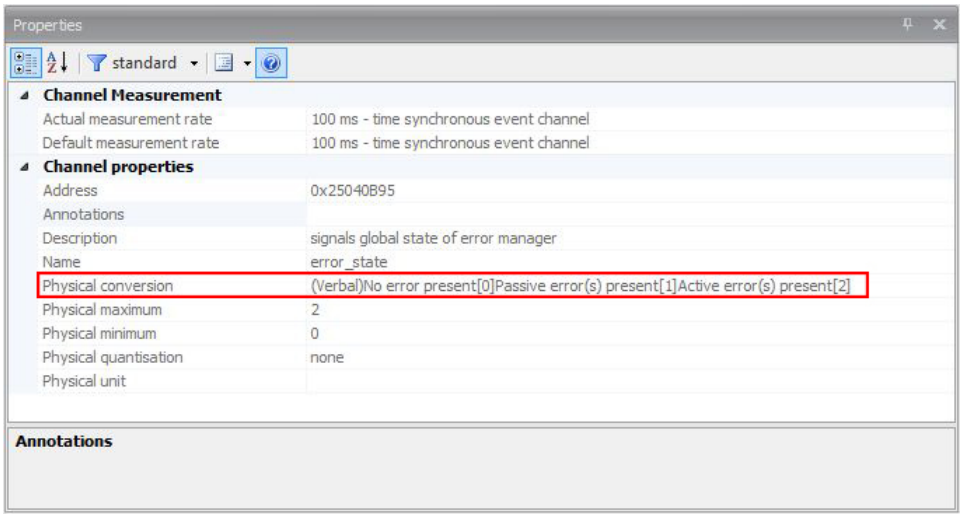


After the last error and its error properties have been displayed, the labels will start again with the first error in the error memory stack and its error properties will be displayed again. Therefore, monitoring these labels over a sufficiently long period provides the information on all individual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

To understand this behavior, it is recommended to observe the three labels in a measurement sheet (while more than one error is active) and watch the values change periodically:

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

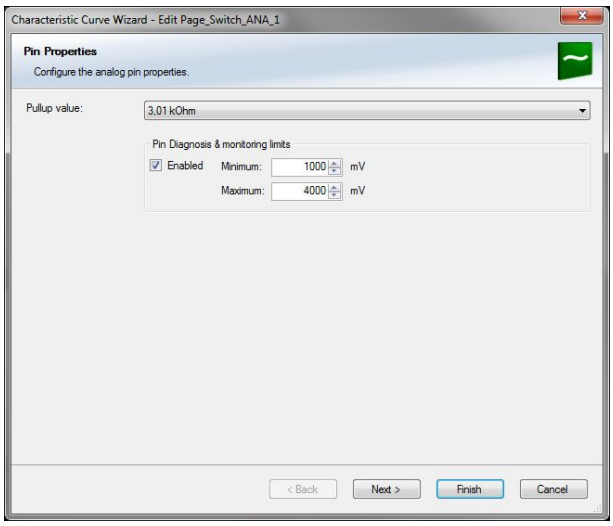
The verbal representation of the numerical codes of these labels can be visualized in the properties window of the measurement page:

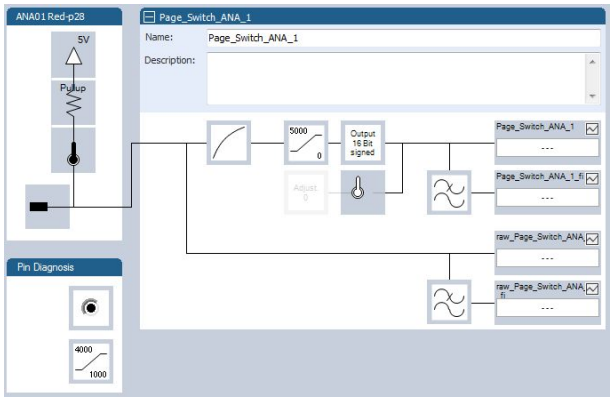


12.3 Analog Input Diagnosis

12.3.1 Monitoring limits / Shortcut Detection / Cable Breakage

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

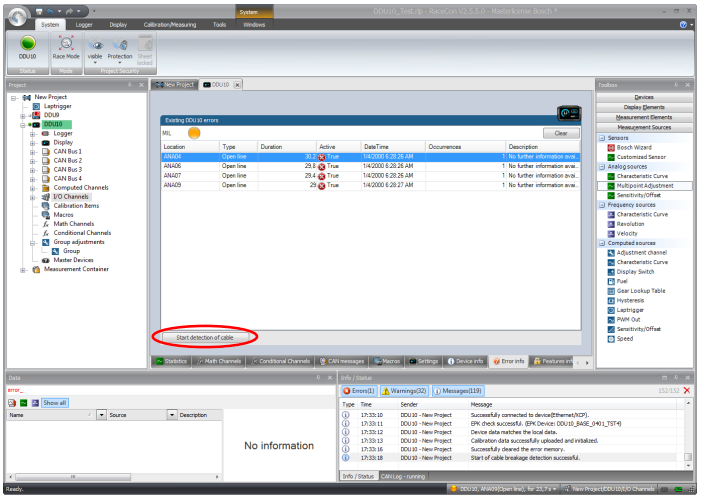




12.3.2 Open Line Detection

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

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

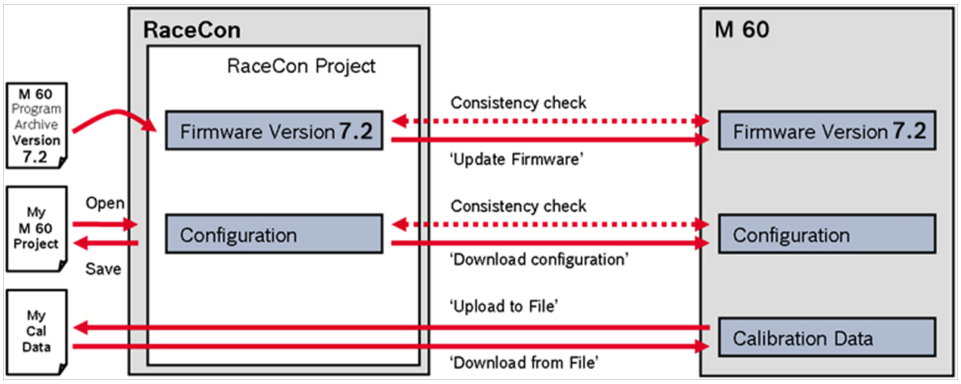


13 Firmware

13.1 Firmware and Configuration

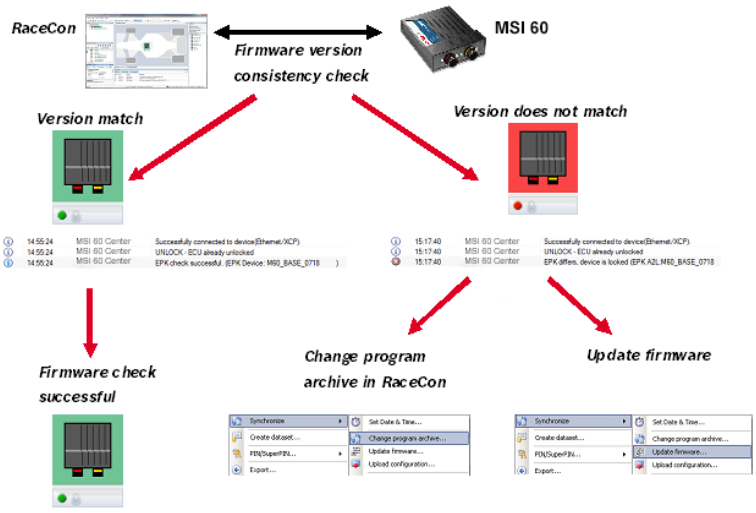
MSI 60 holds 3 types of data:

- Firmware: the software (PST program file) of the MSI 60
- Configuration: the configuration of Input channels, CAN I/O, PWM
- Calibration data: Characteristic curves and offsets created by online calibration at the vehicle.



13.2 Firmware Update

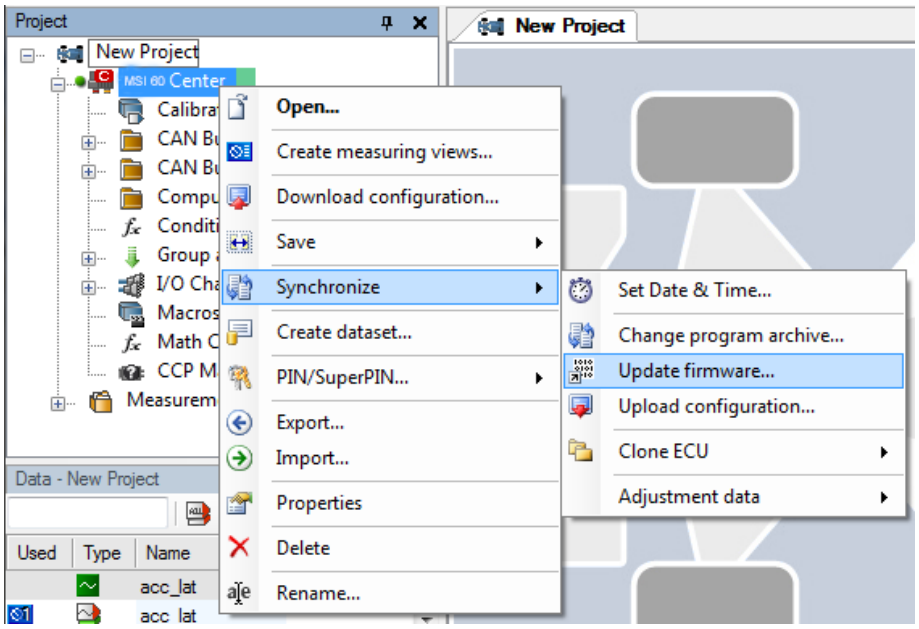
The scheme shows the process during each connection between RaceCon and MSI 60.



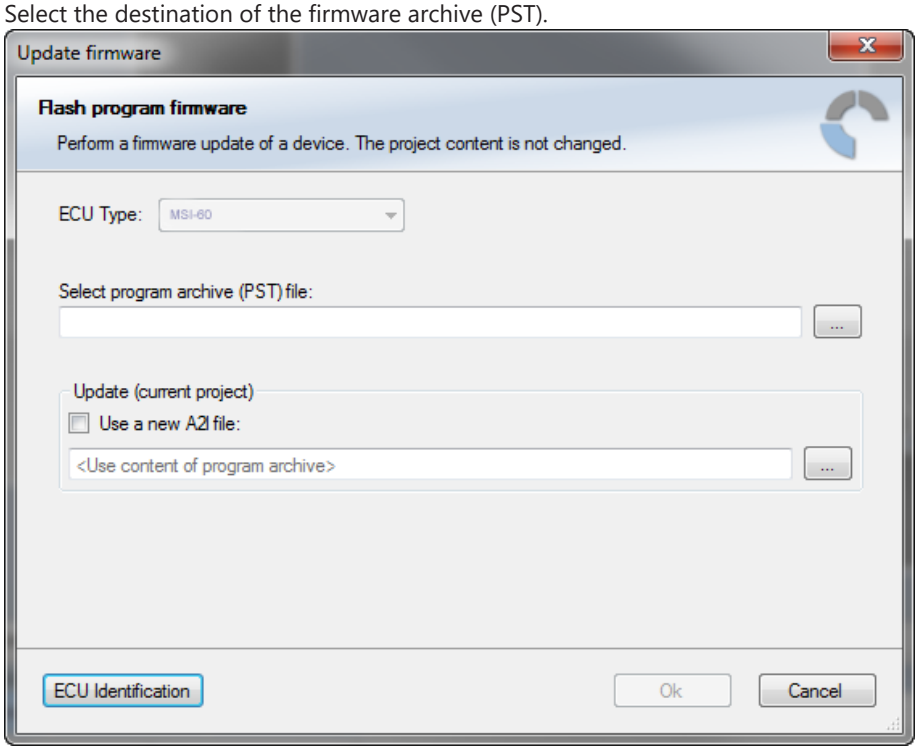
Firmware update is only possible if the MSI 60 is connected to RaceCon.

The configuration of input channels, CAN I/O and PWM will not be changed.

1. In the MSI 60 Project Tree, right-click on 'MSI 60' and choose 'Synchronize' then 'Update firmware ...'.



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

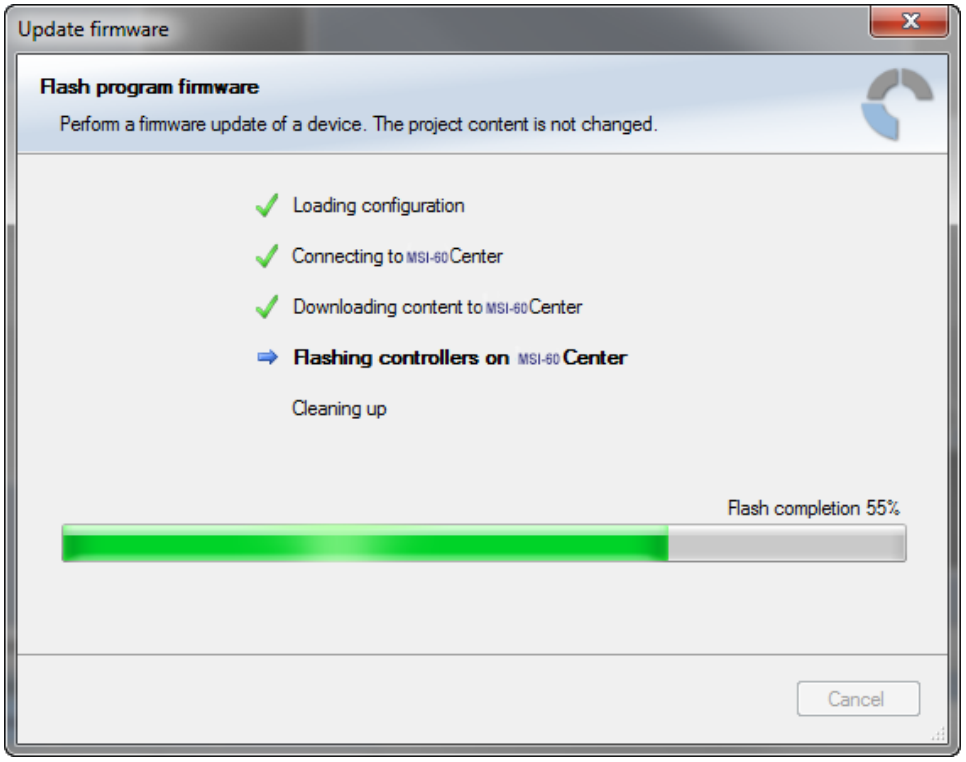


3. Click 'OK' when done.
   The firmware update starts. The MSI 60 displays the message 'Updating firmware'. When the firmware update is complete, the MSI 60 displays the message 'Updating firmware finished. Do a power cycle.'

NOTICE

Do not switch off the car's ignition or interrupt the power supply during the update!

In case of interruption the power data will be lost or the device could be damaged.



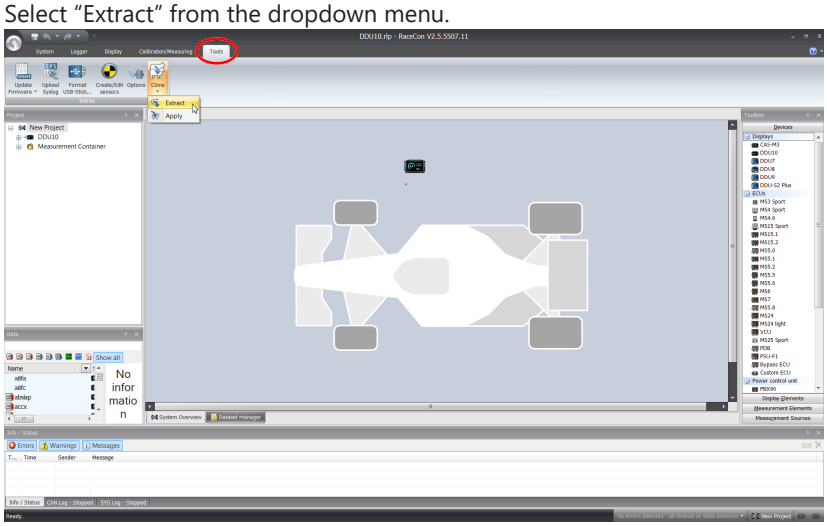
4. Switch the car's ignition off and on again to cycle the power of the MSI 60.

14 Clone the Unit

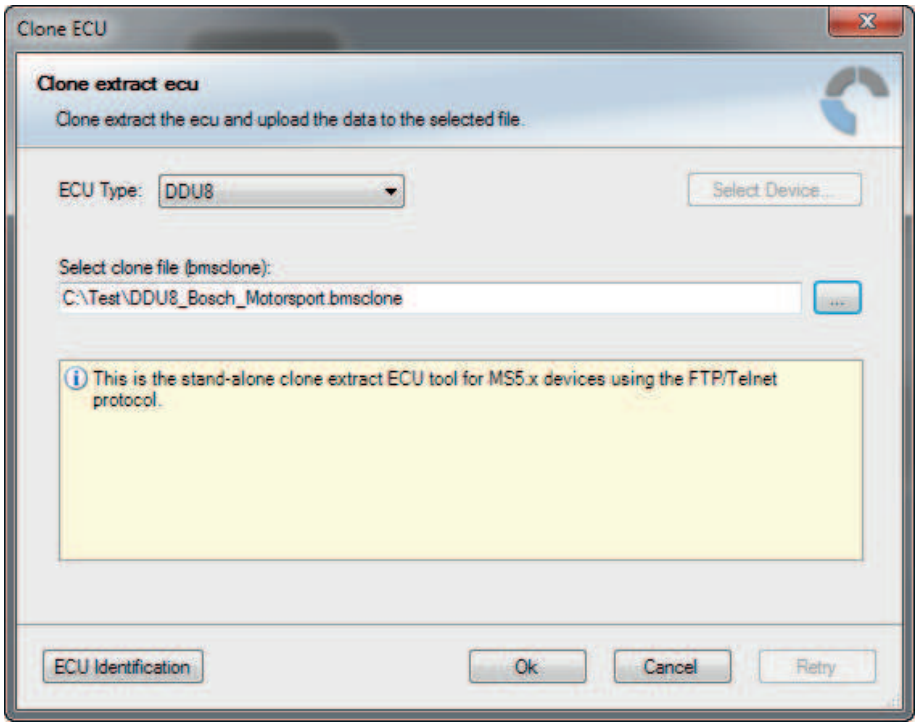
To replace a MSI 60 by another device, it is possible to clone it. A clone is a 1:1 copy of a device. This can be useful for copying specific data, like sensor-offset calibration to a spare unit for a specific car.

Creating a clone file

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



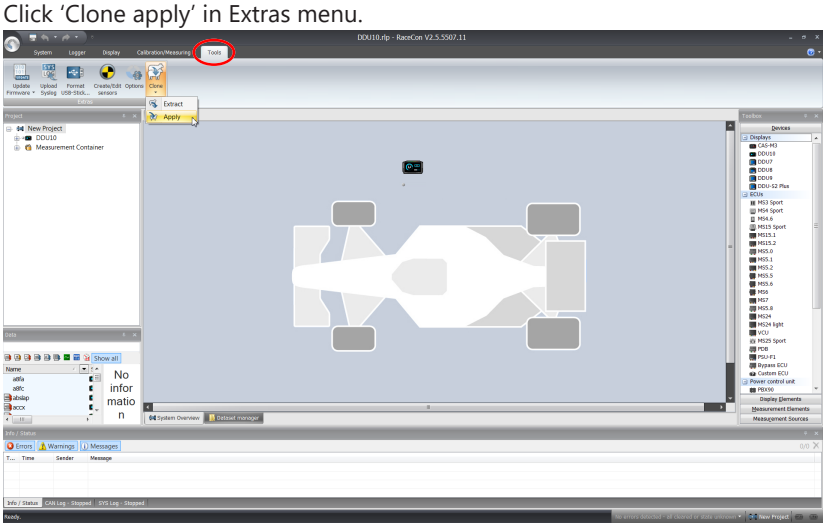
3. Choose the hardware device, which should be cloned.
4. Define destination and filename.



5. Click 'OK' to start procedure.

Applying a clone file to a device

1. Click ‘Clone apply’ in Extras menu.



2. Choose clone file.
3. Click ‘Ok’.

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

- Lifetime of device
- Serial number
- Upgrade features

15 GPS Sensor

15.1 GPS (Global Positioning System)

- Space-based global navigation satellite system.
- GPS provides positioning, navigation, and timing services to worldwide users.
- GPS receiver (sensor) gives digital information about position (longitude, latitude, height), ground speed, course, and status.

Two types of GPS receivers:

- CAN output -> Read in messages via CAN Input of MSI 60 (not covered here).
- Serial output -> Read in messages via RS232 Interface of MSI 60.

Serial Interface Characterization

- Voltage levels: RS232 is standard (+/-12 V), UART (0 V/ 5 V) needs level shifter.
- Baud rate: 9,600 is standard for GPS, MSI 60 supports 1,200 to 115,200 baud. GPS Rx interface baud rate must match the device baud rate. MSI 60 baud rate can be set with the 'GPS_BAUDRATE' characteristic.
- Data format: MSI 60 expects 8 data bits, no parity bit, 1 stop bit (8N1).

15.2 Protocol

MSI 60 expects NMEA Protocol (ASCII).

The following messages are decoded:

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

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

15.3 Sensor Recommendation

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

15.4 Measurement Labels

The decoded NMEA messages are copied to these MSI 60 measurement labels.

Measurement label	Function
gps_PDOP	Position Dilution Of Precision
gps_HDOP	Horizontal Dilution Of Precision
gps_VDOP	Vertical Dilution Of Precision
gps_lat	Latitude 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)

These measurement labels are arrays, where the indexed element points to the same satellite (E.g. gps_info_satsigstrength[3] tells the receiving signal strength of satellite 3. Satellite 3 has the SAT-ID given in gps_info_satid[3]).

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

15.5 GPS Troubleshooting

Electrical

- Is the transmitter signal of the GPS sensor connected to the receiver pin of the serial interface of the MSI 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 device 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.

GPS sensor start-up

- Does the GPS sensor ‘view’ the sky?
- Did the GPS sensor complete its initial start-up procedure? This may take up to 20 min.
- A correct reception is indicated when ‘gps_fix’ is showing ‘3D Fix’.

16 RaceCon Shortcuts

The table shows important shortcuts simplify controlling the MSI 60 in RaceCon.

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

17 Disposal

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

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

18 Error Memory

18.1 General Note

18.2 Error Memory Representation in RaceCon

18.2.1 Accessing the Memory

18.2.2 Cleaning the Error Memory

18.3 Information on Errors available from the Error Memory

18.3.1 Error Memory Properties

18.3.2 Error Properties

18.4 Configuration

18.4.1 Monitoring limits / Shortcut Detection / Cable Breakage

18.4.2 Open Line Detection

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