BOSCH


# Modular Sensor Interface M 60

## Manual

Version 1 11/12/2019

# Content

# 1 Preparation

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

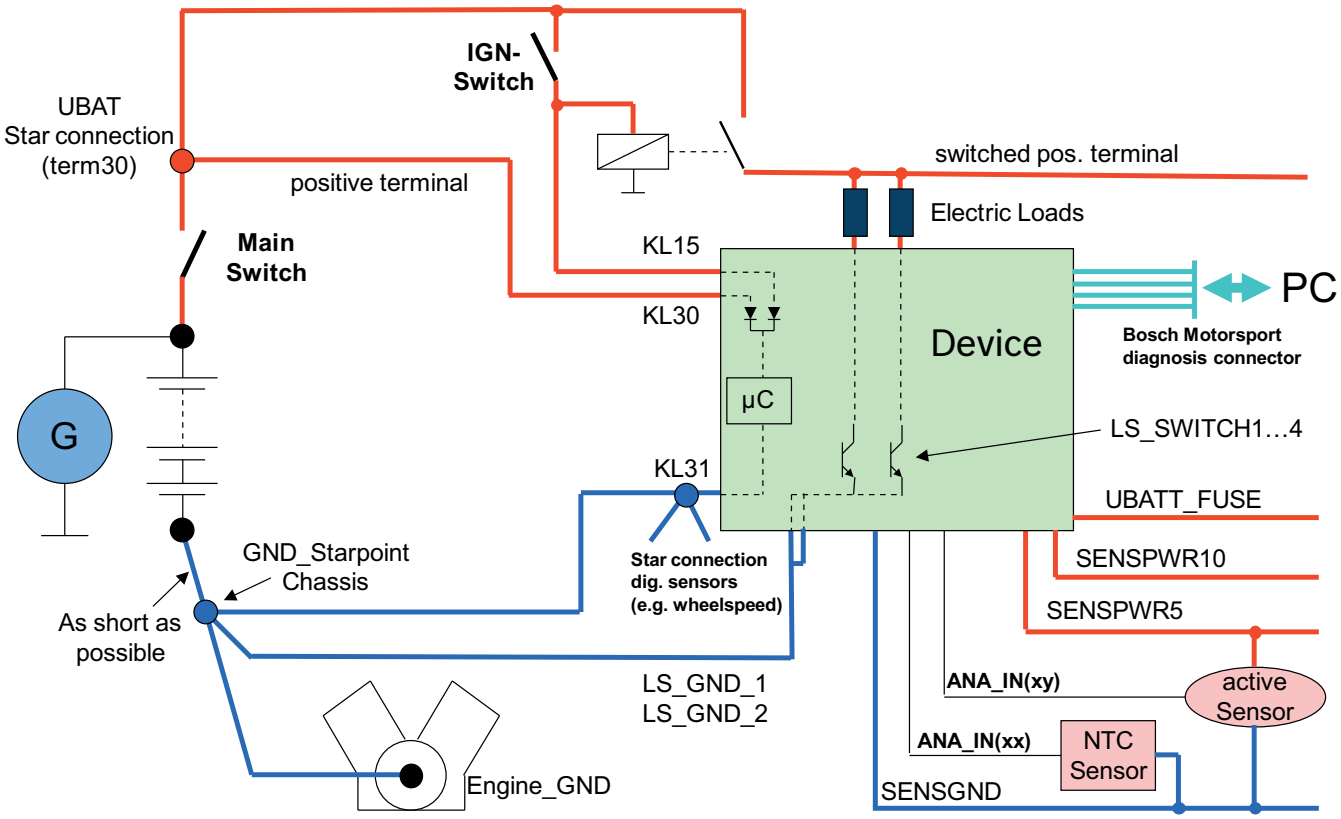
Operation of the M 60 is only certified with the combinations and accessories that are specified in this manual. The use of variant combinations, accessories and other devices outside the scope of this manual are only permitted when they have been determined to be compliant from a performance and safety 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.

Please retain this manual for your records.

# 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 M 60 is a compact and light weight sensor interface unit for analog and digital sensors. Up to eight M 60 can be used to expand the number of input channels of the data logger C 60 as well as the display DDU 9. The M 60 are linked via high-speed Ethernet interface. This allows for synchronized acquisition of data from the different units and the ECU.

The M 60 offers 26 analog inputs, four rotational inputs, four pwm outputs and two independent CAN buses. Each analog input channel features an analog pre-filter, 8 x oversampling and highly linear digital filtering. The cut-off frequency of the digital filter is automatically adjusted to match the acquisition rate. The latency of the digital filters is corrected during recording, yielding zero filter delay in the recorded data.

The evaluation of each M 60 measurement channel is individually configurable with the PC configuration tool RaceCon.

## Application

| |
|---|
| 8 kHz AD converters with digital low pass filter |
| Configurable math channels |
| User configurable CAN in/out messages |
| Up to 1,000 Hz acquisition rate for all channels |
| 3-port network switch |

## Mechanical Data

| | |
|---|---|
| Size | 105 x 34.5 x 137.5 (149) mm |
| Weight | 495 g |
| Operating temperature internal | -20 to 65°C |
| Max. vibration | Vibration Profile 1 (See Appendix or www.bosch-motorsport.com) |

## Electrical Data

| | |
|---|---|
| Supply voltage | 8 to 18 V |
| Max. power consumption (w/o loads) | 10 W at 14 V |

## Inputs

| | |
|---|---|
| Analog channels | 26 |
| Input range | 0 to 5 V |
| Resolution | 12 bit |
| Switchable pull up resistor | 3 kOhm |
| Rotational channels (default Hall, Inductive as option) | 4 |

## Outputs

| | |
|---|---|
| PWM outputs (low side switch 2 A each) | 4 |
| Sensor supply 5 V (350 mA each) | 4 |
| Sensor supply 10 V (350 mA each) | 1 |
| Sensor supply 12 V (1 A, non regulated) | 1 |

## Environment

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

## Connectors and Wires

| | |
|---|---|
| Motorsport connectors double density | 2 x 41 pins |
| Mating connector I<br>ASDD612-41SN | F 02U 002 216-01 |
| Mating connector II<br>ASDD612-41SA | F 02U 004 180-01 |

## Communication

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

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

# 5 Inputs and Outputs

The following chapter introduces the Input and Output Channels.

## 5.1 Input Channels

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

### 5.1.1 Analog Inputs

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

### 5.1.2 Digital Inputs

The digital inputs of the M 60 accept 0 V to 5 V signals of Hall-effect sensors by default. Connect the output of the Hall-effect sensor to the REVn_P pin and leave the REVn_M pin open. Support of inductive speed sensors is available as a hardware option. Inductive sensors are connected to the REVn_P and REVn_M pins.

## 5.2 Output Channels

This chapter describes the PMW Output and Sensor Power Supply of the M 60.

### 5.2.1 PWM Outputs

The M 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 M 60 has three types of sensor power supply:

- 12 V unregulated battery voltage
- 5 V regulated voltage
- 10 V regulated voltage

The 12 V unregulated output is fused and rated 1 A max. The regulated 5 V and 10 V outputs can deliver 350 mA each. They are short circuit protected to battery voltage and GND.

## 5.3 Communication Channels

This chapter describes the Communication Channels of the M 60.

### 5.3.1 CAN Bus

The M 60 has 2 CAN buses configurable as input and output. Different baud rates are selectable. Please note that the M 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 M 60 has three 100 Mbit full duplex Ethernet communication ports. The ports are internally connected with an Ethernet switch. The Ethernet ports have 'cable auto crossover' functionality.

### 5.3.3 RS232 Ports

The M 60 has two RS232 serial ports. The baudrate for both ports is programmable. Port 1 is reserved for online telemetry, port 2 can be used for reception of data from a serial GPS receiver.

### 5.3.4 Vehicle Diagnosis Connector

The Bosch Motorsport vehicle diagnosis connector is used as a standard interface to connect the vehicle to a PC e.g. via a MSA-Box II. Loom Connector: AS012-35SN.

| PIN | Name | Description | Used for M 60 |
|---|---|---|---|
| 1 | Terminal 30 | Permanent positive | + |
| 2 | Terminal 15 | Switched positive | + |
| 3 | Terminal 31 | GND | + |
| 4 | CAN High | Diagnostic CAN bus | |
| 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 ASDD212-41PN (red)

| PIN | Name | Description | Direction | Remark |
|---|---|---|---|---|
| 1 | UBATT (Kl. 30) | power supply Ubat | input | |
| 2 | switched positive Kl.15 | switched power supply Ubat | input | |
| 3 | switched positive Kl.15 | switched power supply Ubat | input | |
| 4 | unit ground (Kl. 31) | ground power supply | input | |
| 5 | unit ground | ground power supply | input | |
| 6 | ETH1_TX+ | Ethernet interface 1 (10/100BaseT) | bidirectional dataline | |
| 7 | ETH1_TX- | Ethernet interface 1 (10/100BaseT) | bidirectional dataline | |
| 8 | ETH1_RX+ | Ethernet interface 1 (10/100BaseT) | bidirectional dataline | |
| 9 | ETH1_RX- | Ethernet interface 1 (10/100BaseT) | bidirectional dataline | |
| 10 | ETH_SCR | screen for Ethernet | screen | |
| 11 | ETH2_TX+ | Ethernet interface 2 (10/100BaseT) | bidirectional dataline | |
| 12 | ETH2_TX- | Ethernet interface 2 (10/100BaseT) | bidirectional dataline | |
| 13 | ETH2_RX+ | Ethernet interface 2 (10/100BaseT) | bidirectional dataline | |
| 14 | ETH2_RX- | Ethernet interface 2 (10/100BaseT) | bidirectional dataline | |
| 15 | ETH3_TX+ | Ethernet interface 3 (10/100BaseT) | bidirectional dataline | |
| 16 | ETH3_TX- | Ethernet interface 3 (10/100BaseT) | bidirectional dataline | |
| 17 | ETH3_RX+ | Ethernet interface 3 (10/100BaseT) | bidirectional dataline | |
| 18 | ETH3_RX- | Ethernet interface 3 (10/100BaseT) | bidirectional dataline | |
| 19 | CAN1_H | CAN interface 1 (up to 1 Mbit/s) | bidirectional dataline | MS 3/MS 4 Card-Memory |
| 20 | CAN1_L | CAN interface 1 (up to 1 Mbit/s) | bidirectional dataline | MS 3/MS 4 Card-Memory |
| 21 | CAN2_H | CAN interface 2 (up to 1 Mbit/s) | bidirectional dataline | |
| 22 | CAN2_L | CAN interface 2 (up to 1 Mbit/s) | bidirectional dataline | |

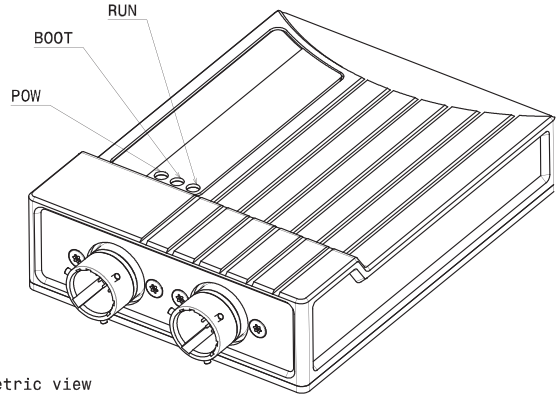
| PIN | Name | Description | Direction | Remark |
|---|---|---|---|---|
| 23 | Not connected | Unused | Spare | |
| 24 | Not connected | Unused | Spare | |
| 25 | Not connected | Unused | Spare | |
| 26 | Not connected | Unused | Spare | |
| 27 | SENSPWR5_1 | 5 V power supply for analog sensors | output | |
| 28 | SENSGND_1 | sensor ground 1 | output | |
| 29 | TimeSync | signal of synchronisation | input | used for timing of system components |
| 30 | LS_GND_1 | PWM ground | output | |
| 31 | LS_SWITCH_1 | PWM lowside switch 1 | input | |
| 32 | LS_SWITCH_2 | PWM lowside switch 2 | input | |
| 33 | LS_SWITCH_3 | PWM lowside switch 3 | input | |
| 34 | LS_SWITCH_4 | PWM lowside switch 4 | input | |
| 35 | LS_GND_2 | PWM ground | output | |
| 36 | ANA01 | analog signal 1 | input | |
| 37 | ANA02 | analog signal 2 | input | |
| 38 | ANA03 | analog signal 3 | input | |
| 39 | ANA04 | analog signal 4 | input | |
| 40 | ANA05 | analog signal 5 | input | |
| 41 | ANA06 | analog signal 6 | input | |

### 5.4.2 Pin Layout Sensor Connector ASDD212-41PA (yellow)

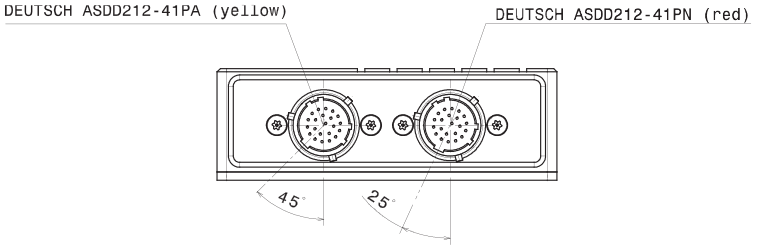
| PIN | Name | Description | Direction | Remark |
|---|---|---|---|---|
| 1 | UBATT_FUSE1 | battery voltage supply | output | |
| 2 | SENSPWR10_1 | 10 V power supply for analog sensors | output | |
| 3 | SENSPWR5_2 | 5 V power supply for analog sensors | output | |
| 4 | SENSPWR5_3 | 5 V power supply for analog sensors | output | |
| 5 | SENSPWR5_4 | 5 V power supply for analog sensors | output | |
| 6 | SENSGND_2 | sensor ground 2 | output | |
| 7 | SENSGND_3 | sensor ground 3 | output | |
| 8 | Not connected | Unused | Spare | Do not connect |
| 9 | Not connected | Unused | Spare | Do not connect |
| 10 | RS232_2_TX | RS232_2 transmit data | bidirectional dataline | used for GPS-sensor |

| PIN | Name | Description | Direction | Remark |
|---|---|---|---|---|
| 11 | RS232_2_RX | RS232_2 receive data | bidirectional dataline | used for GPS-sensor |
| 12 | RS232_GND | RS232 ground | | |
| 13 | REV1_P | speed signal 1 positive (ind. and hall) | input | |
| 14 | REV1_M | speed signal 1 negative (ind.) | input | |
| 15 | REV2_P | speed signal 2 positive (ind. and hall) | input | |
| 16 | REV2_M | speed signal 2 negative (ind.) | input | |
| 17 | REV3_P | speed signal 3 positive (ind. and hall) | input | |
| 18 | REV3_M | speed signal 3 negative (ind.) | input | |
| 19 | REV4_P | speed signal 4 positive (ind. and hall) | input | |
| 20 | REV4_M | speed signal 4 negative (ind.) | input | |
| 21 | ANA07 | analog signal 7 | input | |
| 22 | ANA08 | analog signal 8 | input | |
| 23 | ANA09 | analog signal 9 | input | |
| 24 | ANA10 | analog signal 10 | input | |
| 25 | ANA11 | analog signal 11 | input | |
| 26 | ANA12 | analog signal 12 | input | |
| 27 | ANA13 | analog signal 13 | input | |
| 28 | ANA14 | analog signal 14 | input | |
| 29 | ANA15 | analog signal 15 | input | |
| 30 | ANA16 | analog signal 16 | input | |
| 31 | ANA17 | analog signal 17 | input | |
| 32 | ANA18 | analog signal 18 | input | |
| 33 | ANA19 | analog signal 19 | input | |
| 34 | ANA20 | analog signal 20 | input | |
| 35 | ANA21 | analog signal 21 | input | |
| 36 | ANA22 | analog signal 22 | input | |
| 37 | ANA23 | analog signal 23 | input | |
| 38 | ANA24 | analog signal 24 | input | |
| 39 | ANA25 | analog signal 25 | input | |
| 40 | ANA26 | analog signal 26 | input | |
| 41 | Not connected | Unused | spare | |

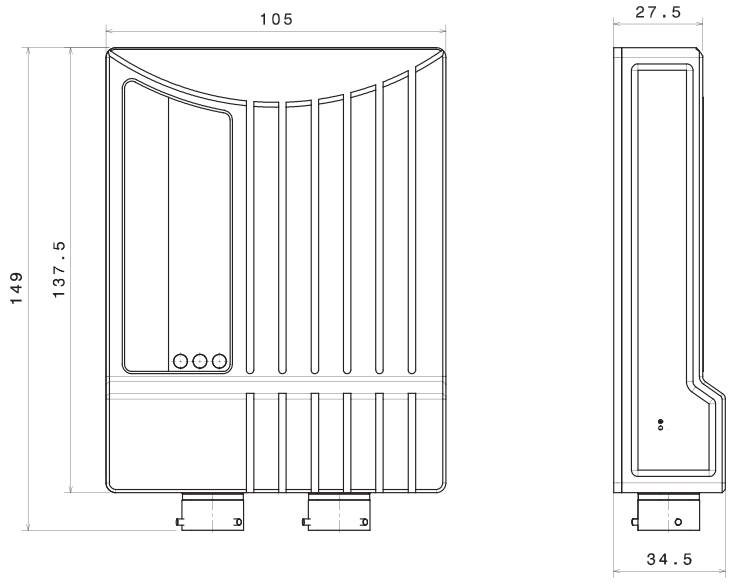
# 6 Mechanical Drawing




Isometric view




Bottom view




Front view

Left view

# 7 Starting up

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

## 7.1 Before Starting

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

- M 60 setup, configuration and calibration: RaceCon 2.1.0
- Measurement data analysis: WinDarab V7

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

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

Minimum wiring loom of the Life connector (red):

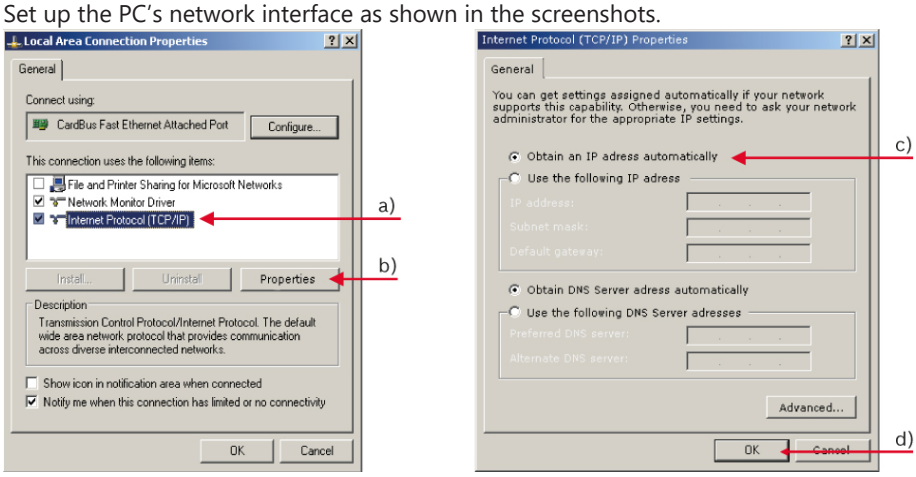
| PIN | Description |
|---|---|
| 1+2+3 | 12 V Supply Voltage |
| 4+5 | GND Supply Voltage |
| 6 | Ethernet Tx+ |
| 7 | Ethernet Tx- |
| 8 | Ethernet Rx+ |
| 9 | Ethernet Rx- |
| 10 | Ethernet Screen |

### 7.1.1 Setting up the Network Interface

The M 60 contains a DHCP server, network addresses can be assigned automatically to the configuration PC.

1. Switch off the PC’s firewall.

2. Set up the PC's network interface as shown in the screenshots.




*a) Select 'Internet Protocol (TCP/IP)'.*
*b) Click 'Properties'.*
*c) Select 'Obtain an IP address automatically'.*
*d) Click 'OK' when done.*

## 7.1.2 Starting the M 60

The M 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.

## 7.1.3 About RaceCon

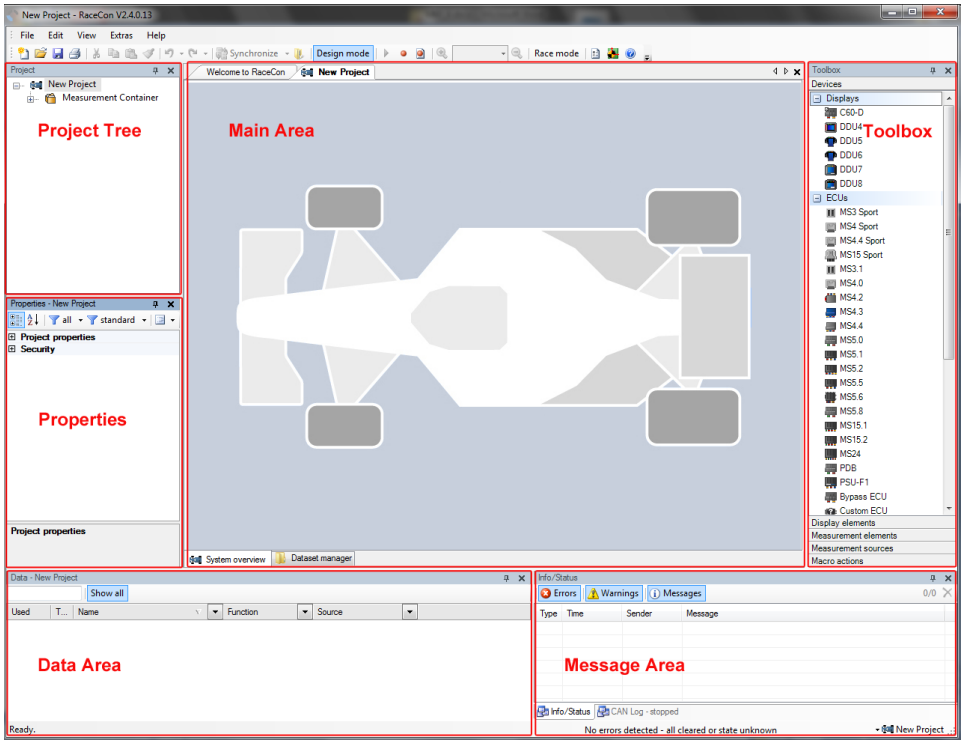
RaceCon is an all integrated software tool for configuration and calibration of Bosch Motorsport hardware products. It is used to set up, configure and calibrate the M 60.

For better understanding, Bosch Motorsport offers a video tutorial that explains many functions of RaceCon.

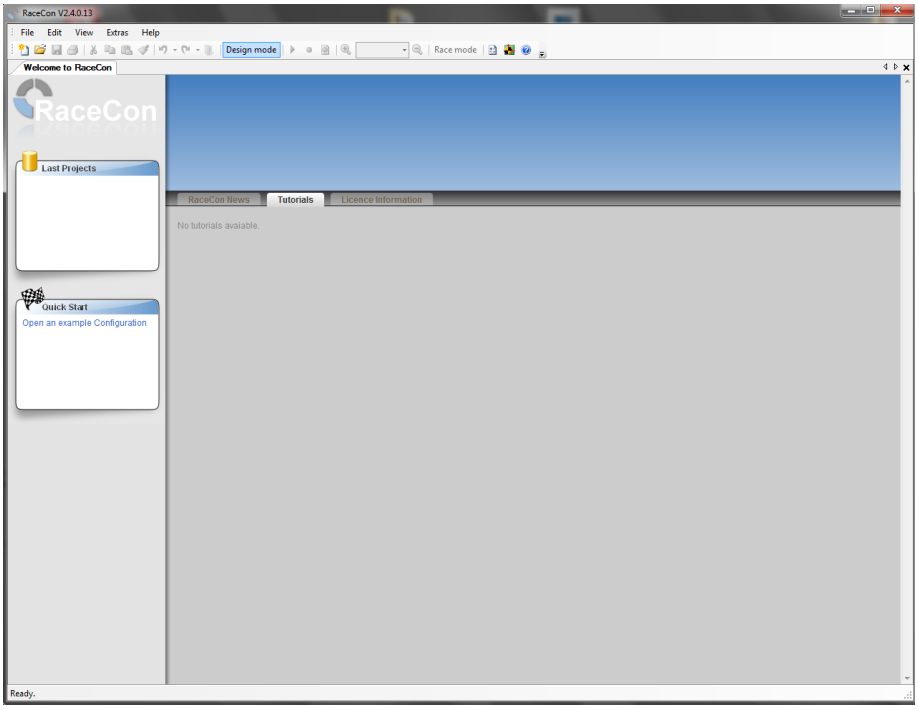
The video tutorial is available in the 'Software Download' section of www.bosch-motorsport.com.

## 7.1.4 Connecting the M 60 to RaceCon

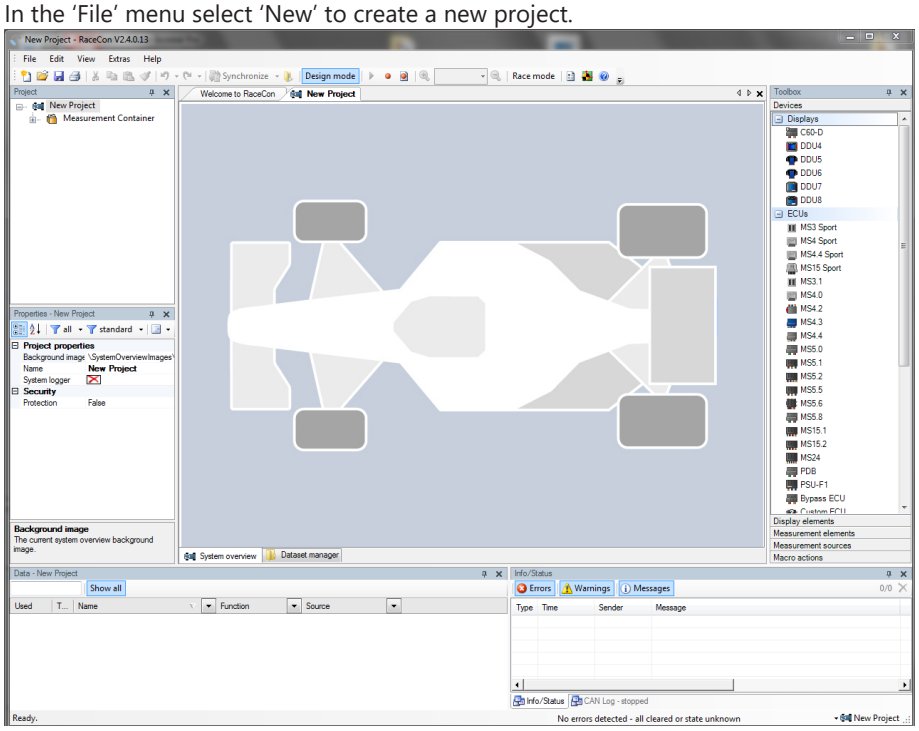
The following screenshot shows an overview of the RaceCon main screen with its areas. All (sub-)windows are resizable and dockable.



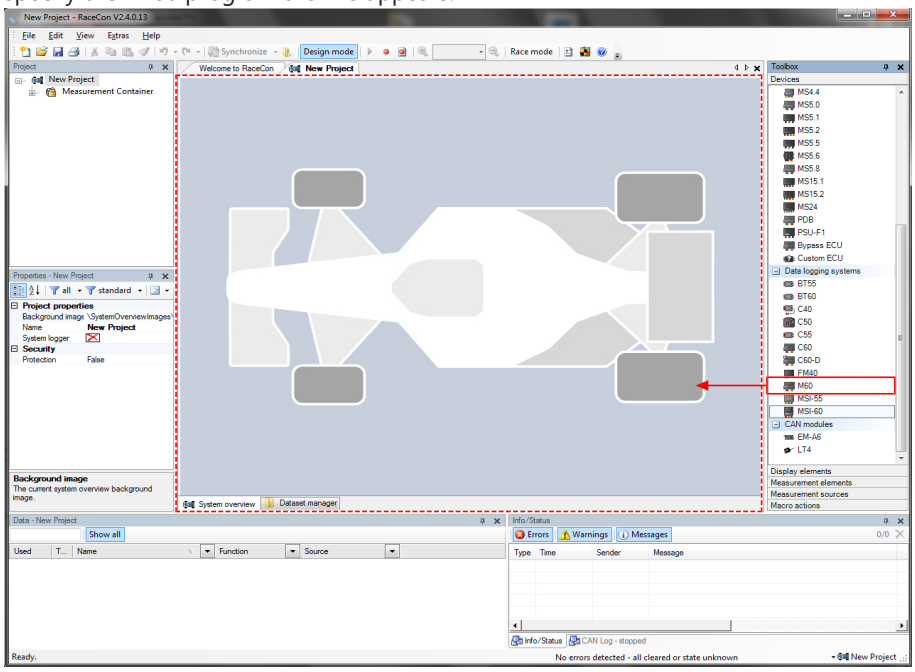

1. Start the RaceCon software.



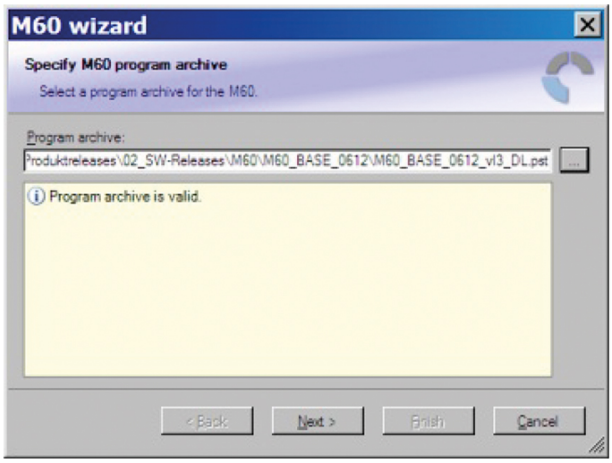
2. In the ‘File’ menu select ‘New’ to create a new project.



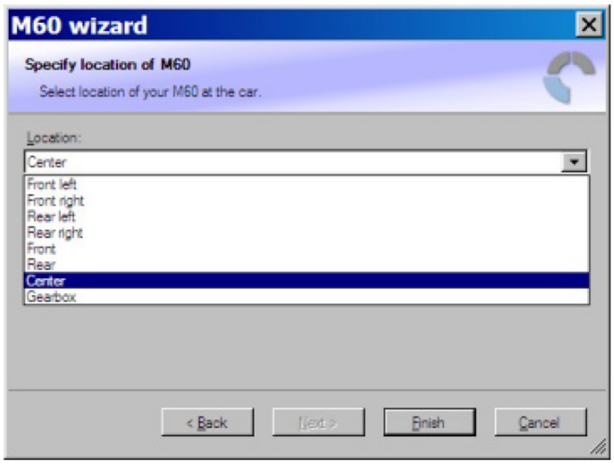

3. In the Toolbox select the M 60 and drag it into the Main Area. A pop-up window to specify the M 60 program archive appears.



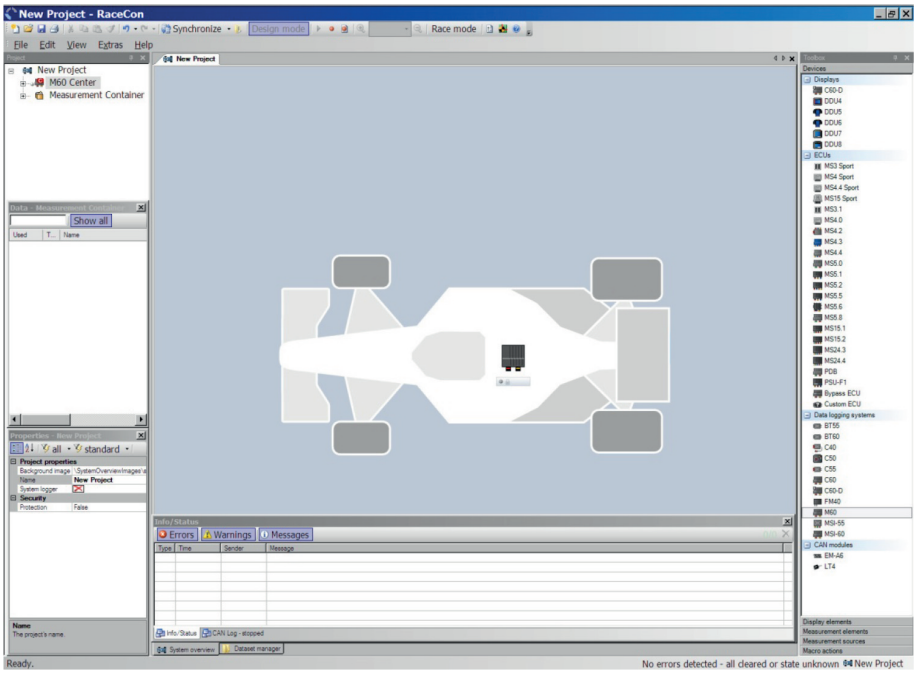
4. Select the program archive delivered with the M 60 (.PST file). An information shows if the archive is valid or not.




5. Click ‘Next’.
6. Select location of M 60.




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




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

8. Click ‘OK’ to proceed.

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

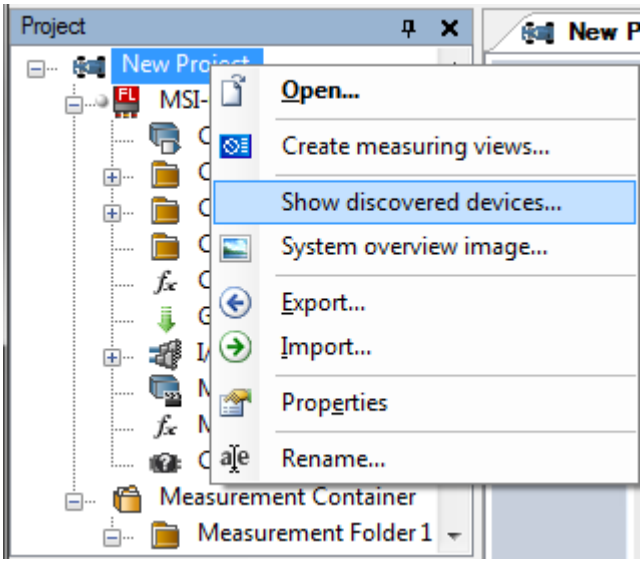
## 7.2 Assign the Mounting Location

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

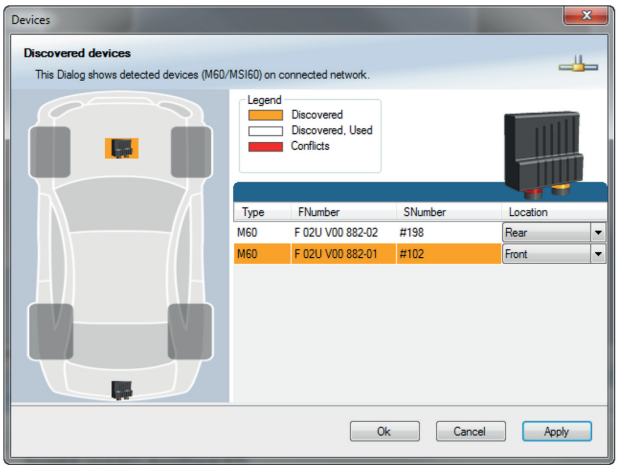
At delivery no mounting location is set. This is signaled by an orange ‘RUN’ LED on the device. Therefore one must first assign a mounting location to the M 60 before it can be used in the project. The mounting location is permanently saved in the M 60. If necessary you can at any time reassign a different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

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

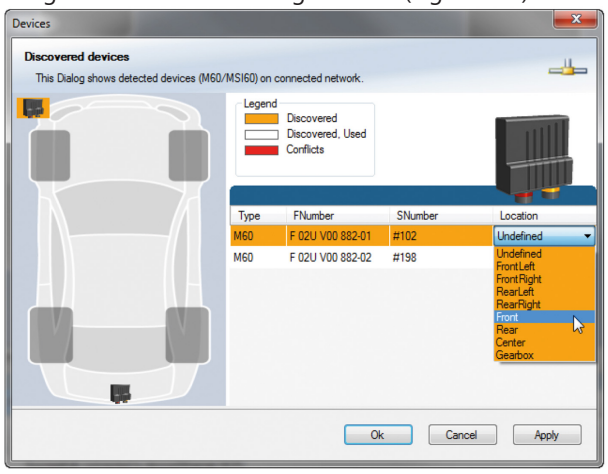



All connected M 60 are listed.

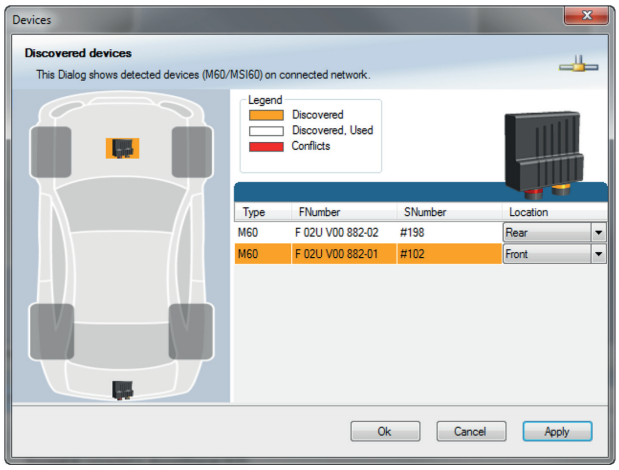



2. Compare the listed device Type, FNumber and SNumber to the identification plate to identify the device you want to make changes to:

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.

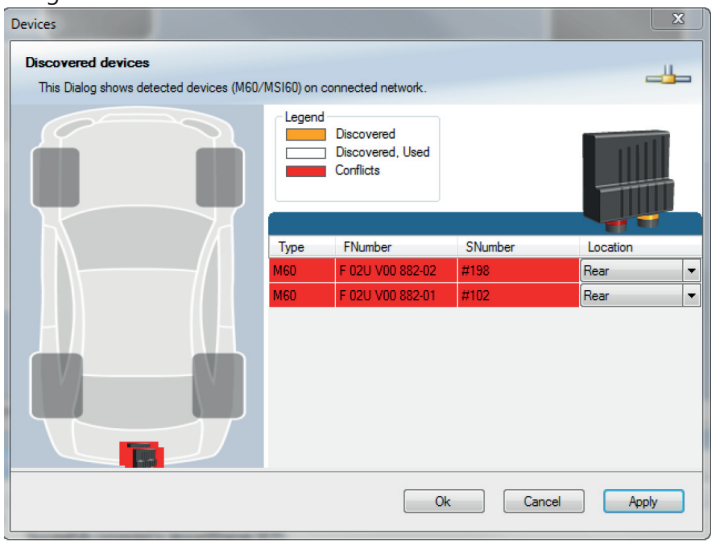



It is good practice to physically label the M 60 with its mounting location.

Now the device is ready to be used.

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

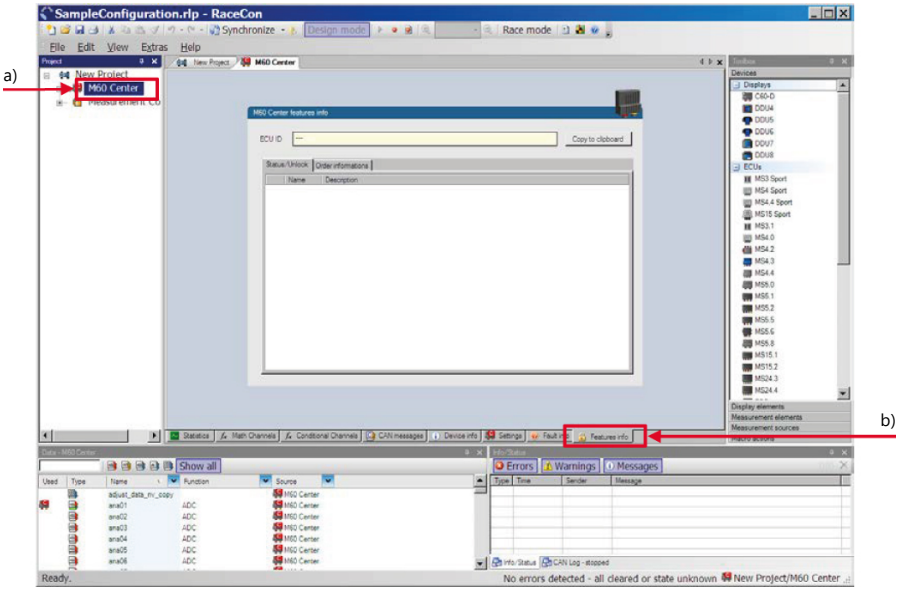
A conflict of several connected M 60 using the same location is indicated by red coloring the involved devices:



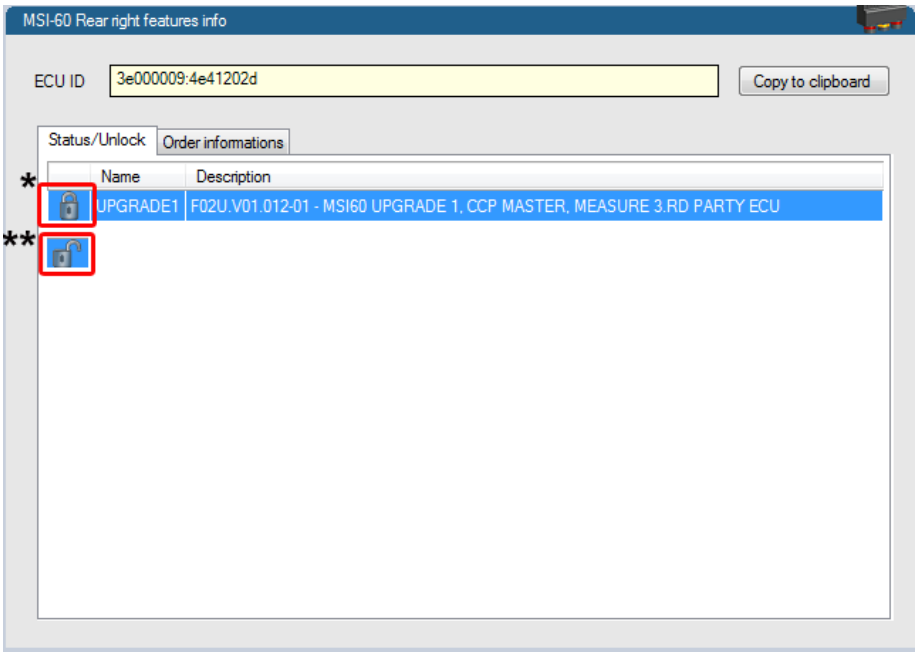
# 7.3 Feature Activation

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

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

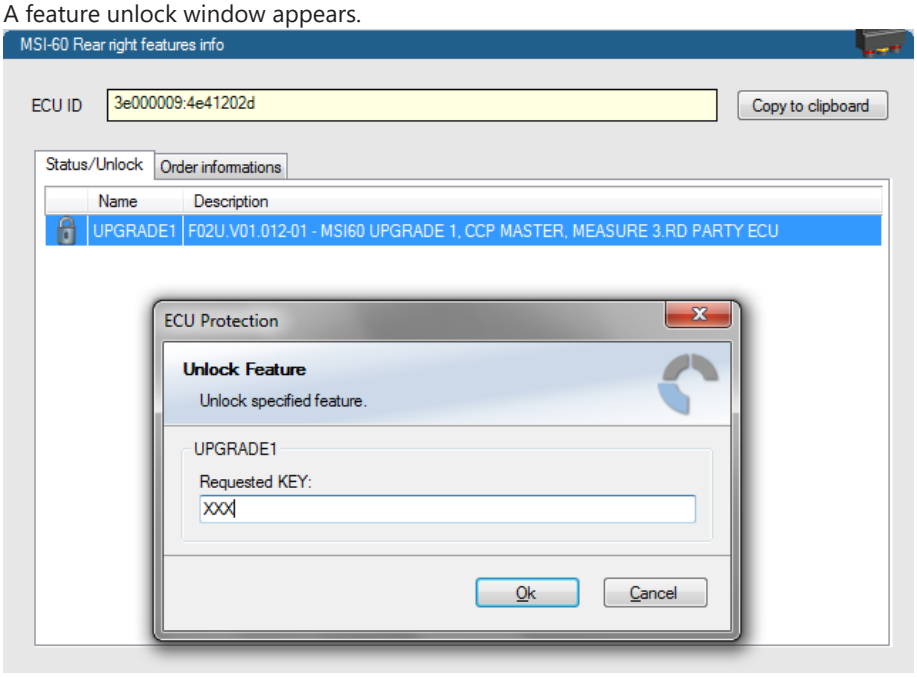



*a) Double-click on 'M 60'.*
*b) Click on 'Features Info'.*



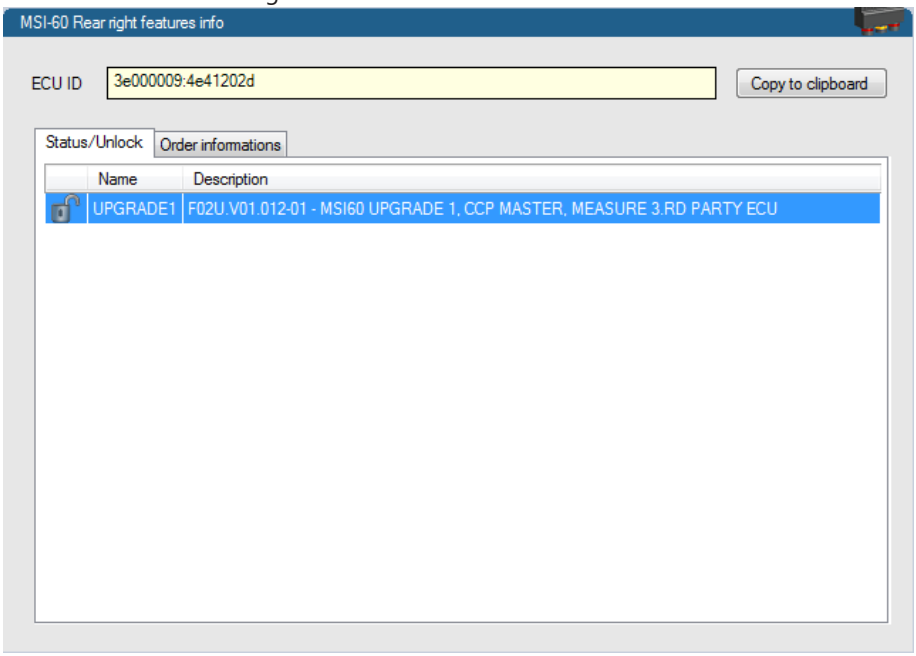

2. Double-click on the feature you want to activate.

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 M 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

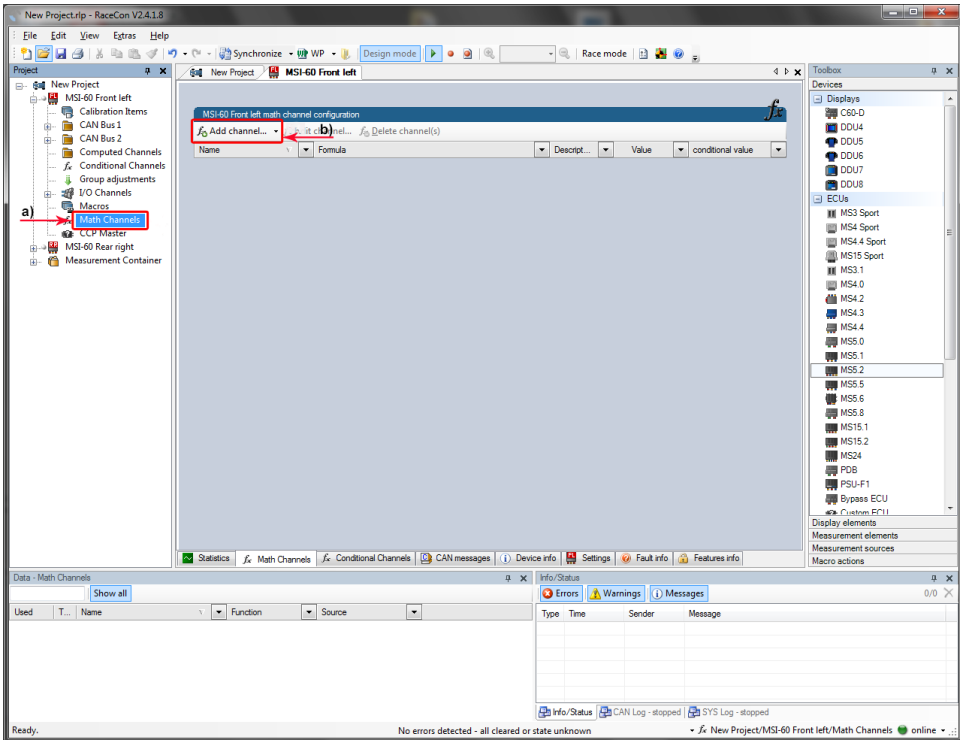
**Conditional function**

- 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 M 60 project.

### 8.1.1 Creating a new Math Channel

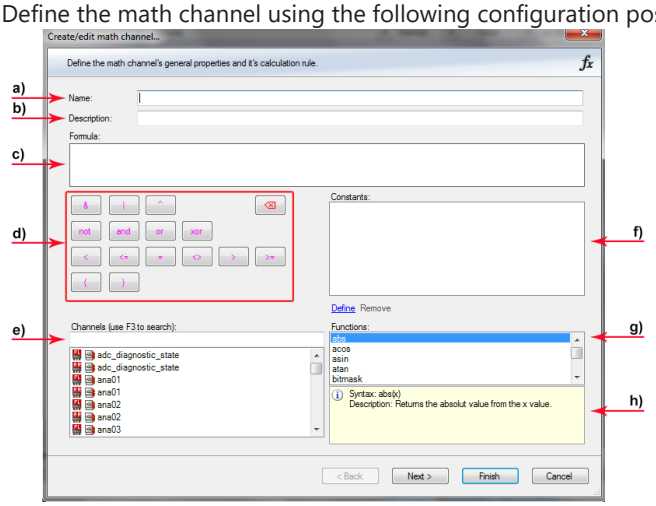
Follow the steps shown in the screenshots.




*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.*

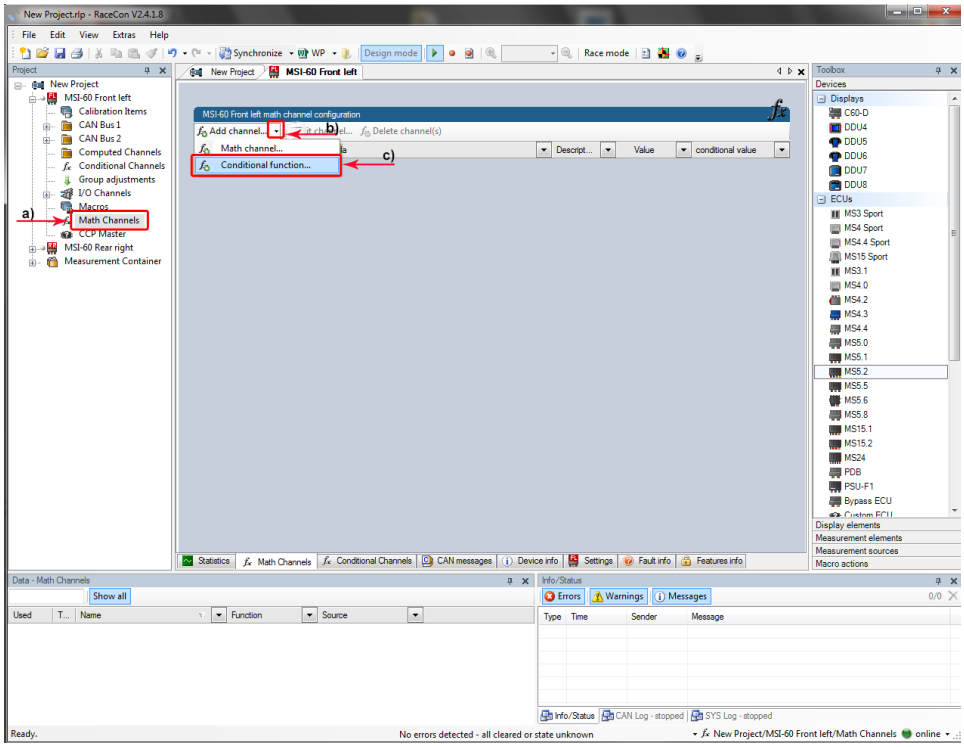
**NOTICE**

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

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

## 8.1.2 Creating a new Conditional Function

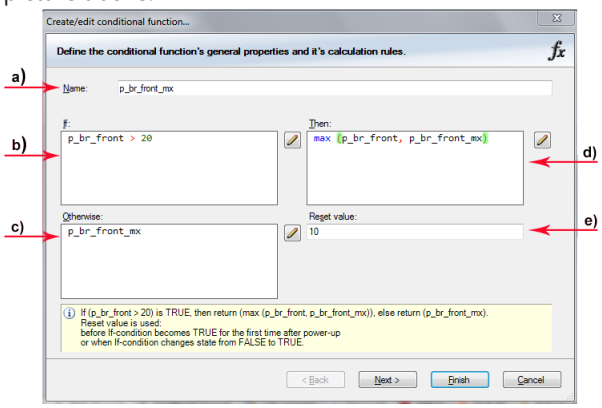
Follow the steps shown in the screenshots.




*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 M 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. #M 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').

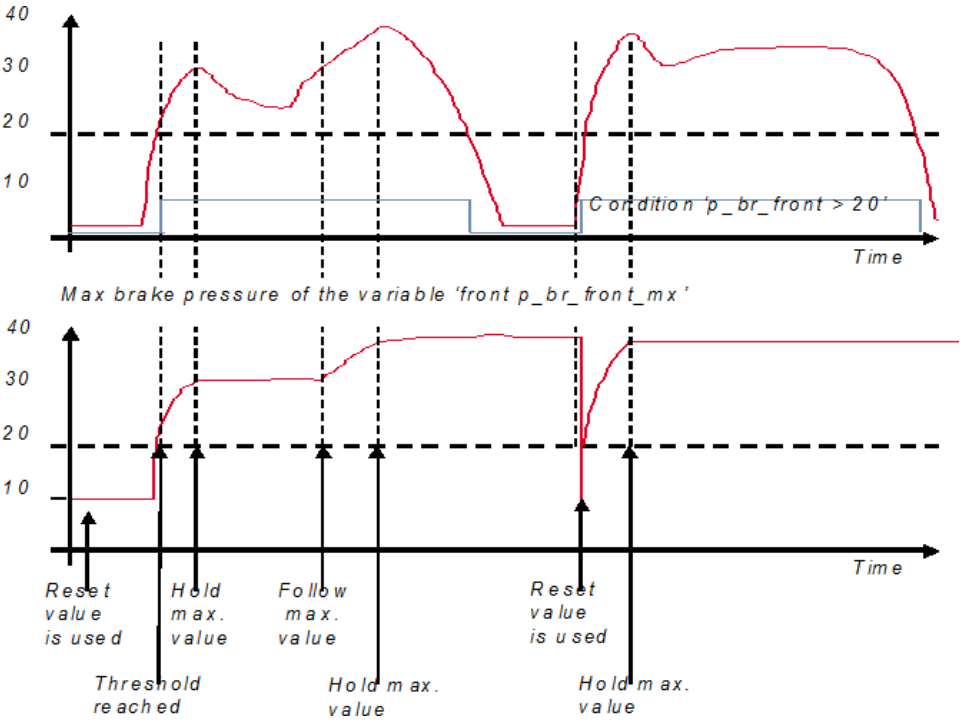
If the condition entered in the IF window is FALSE, the program calculates the condition entered in the OTHERWISE window. The returned value is the content of the new variable (entered in 'Name').

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

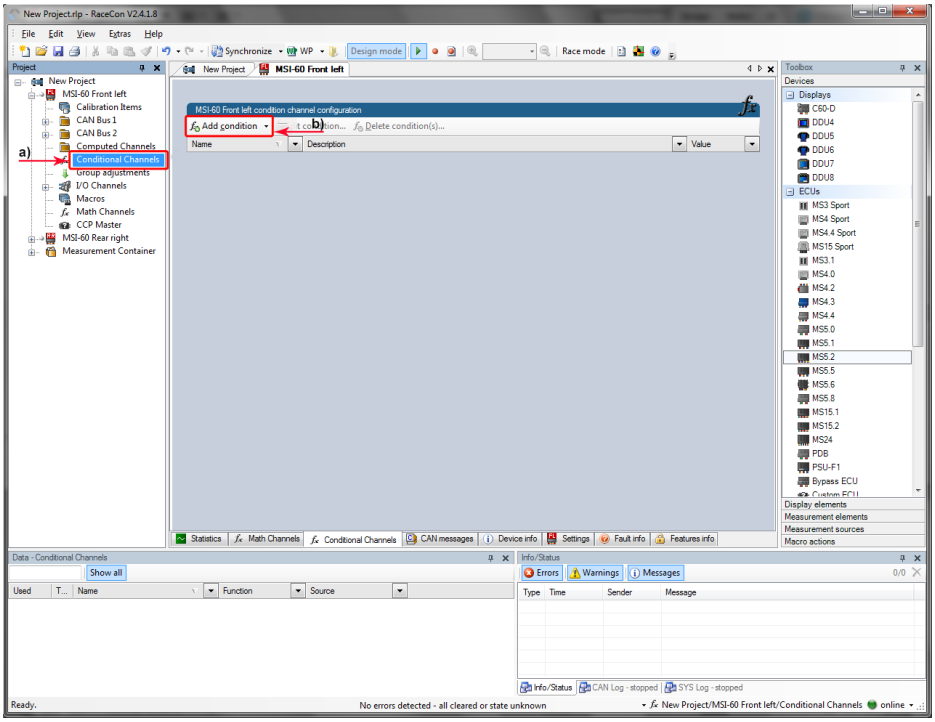
**Condition combination**

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

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

### 8.2.1 Creating a new Condition Channel

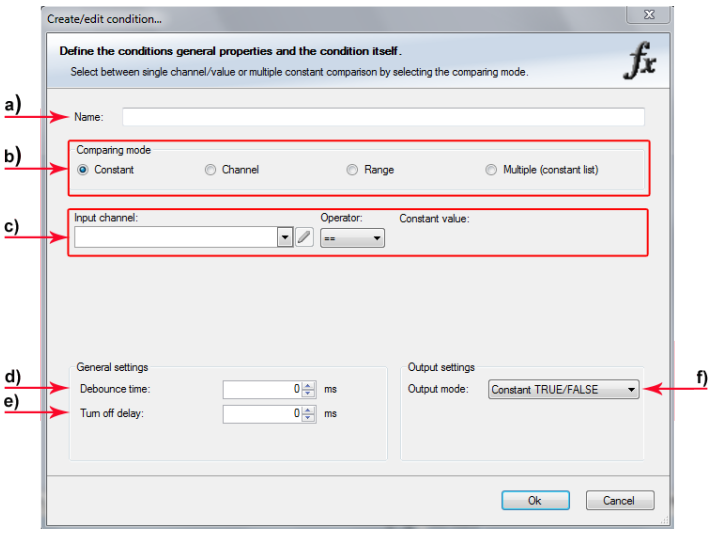
Follow the steps shown in the screenshot.




*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:

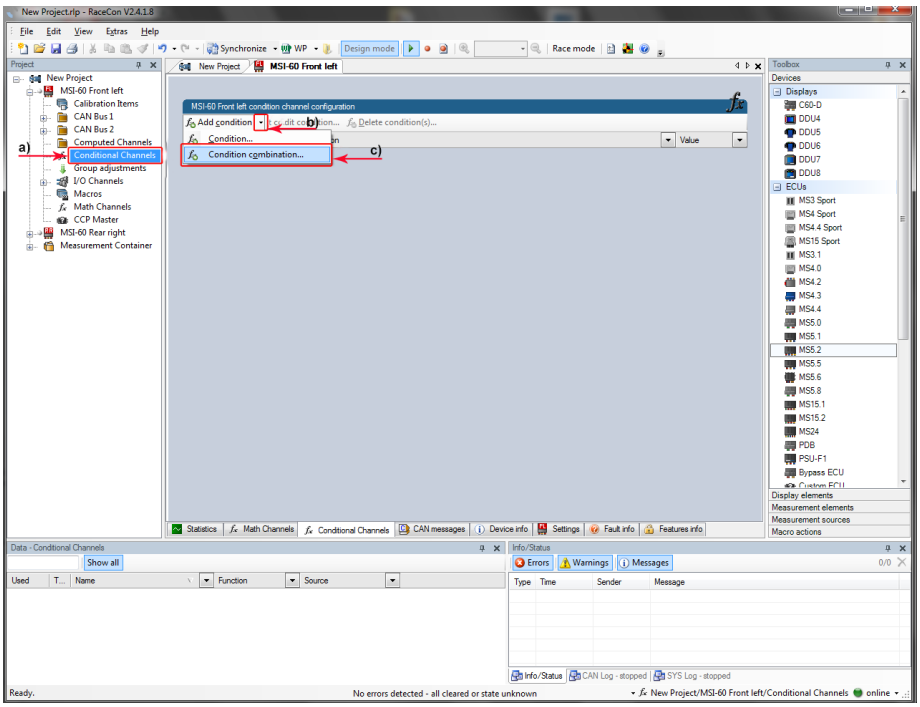



*a) Enter the name of the condition channel.*
*b) Select the comparing mode:*
*• Constant: Compare a measurement channel with a constant value.*
*• Channel: Compare a measurement channel with a measurement channel.*
*• Range: Compare a measurement channel with a defined value range.*
*• Multiple: Compare 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 M 60 condition channel window.

## 8.2.2 Creating a new Condition Combination

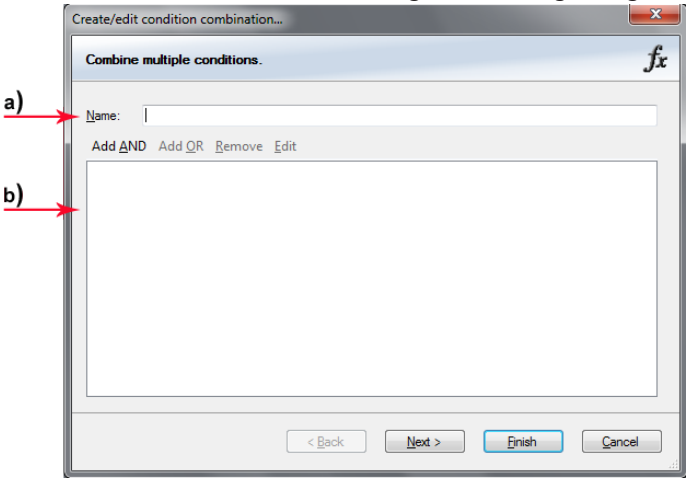
Follow the steps shown in the screenshot.




*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 M 60 condition channel window.

# 9 CAN Bus

M 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 M 60 measurement/display variables. CAN bus supports row counter configuration.
- Output configuration: Write M 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

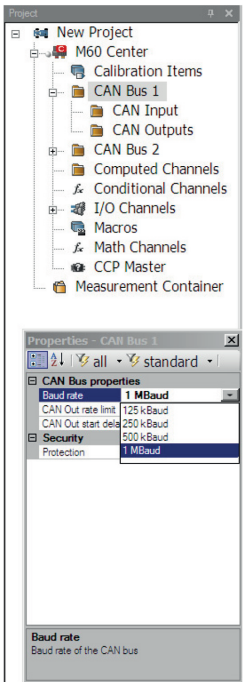
**CAN message**

- 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 M 60 bus data rate in 'Properties' menu.




**Row counter concept**

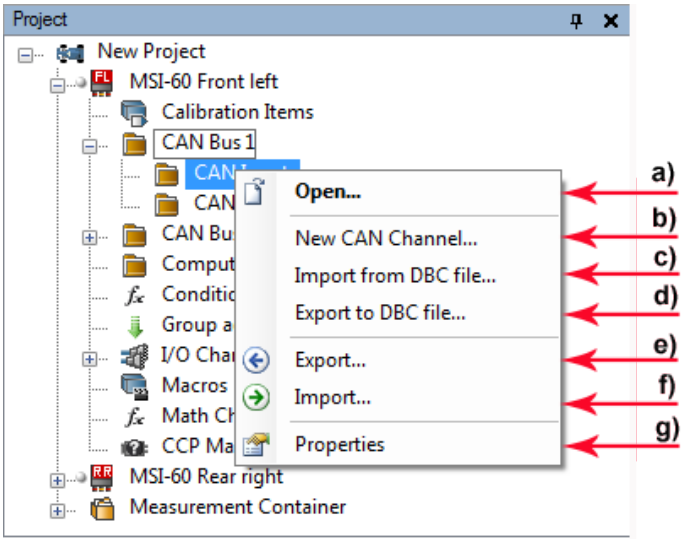
- Re-use (multiplex) of message identifiers
- One byte of message contains row counter
- 7 bytes payload remaining
- Position of row counter is configurable

| | 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

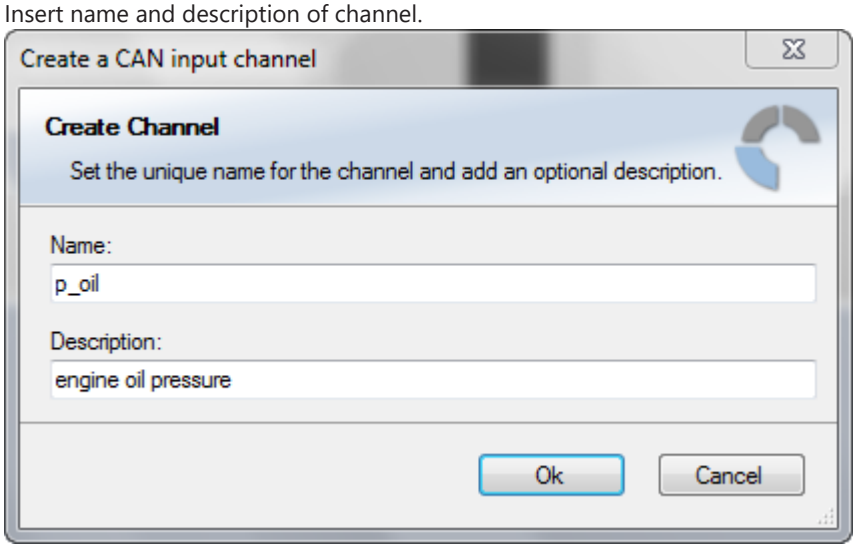



*a) Open CAN messages overview window.*
*b) Create new channel to read from CAN bus.*
*c) Import Vector CAN database (DBC) channel configuration.*
*d) Export channel configuration to vector CAN database (DBC).*
*e) Export RaceCon CAN input configuration to file.*
*f) Import RaceCon CAN input configuration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

## 9.2.2 Create new CAN Channel

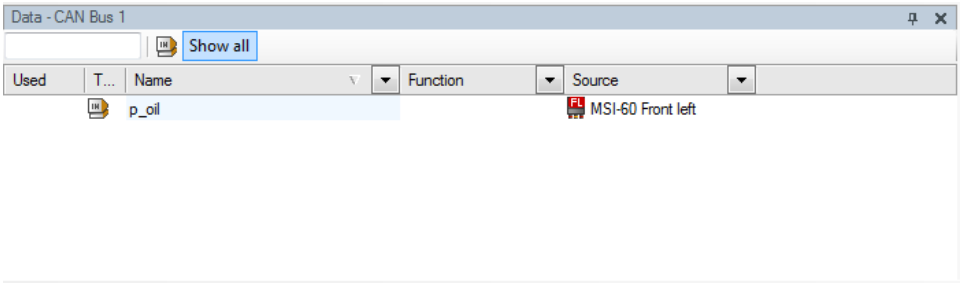
1. Right-click on 'CAN Input' of desired bus (CAN1 or CAN2).
2. Select 'New CAN Channel' from menu.

3. Insert name and description of channel.

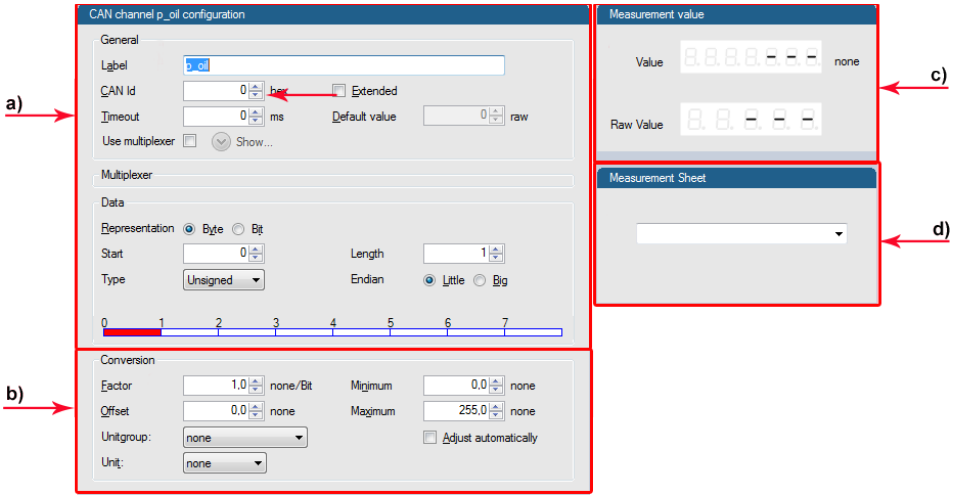



4. Click 'OK' when done.

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




## 9.2.3 CAN Channel Configuration

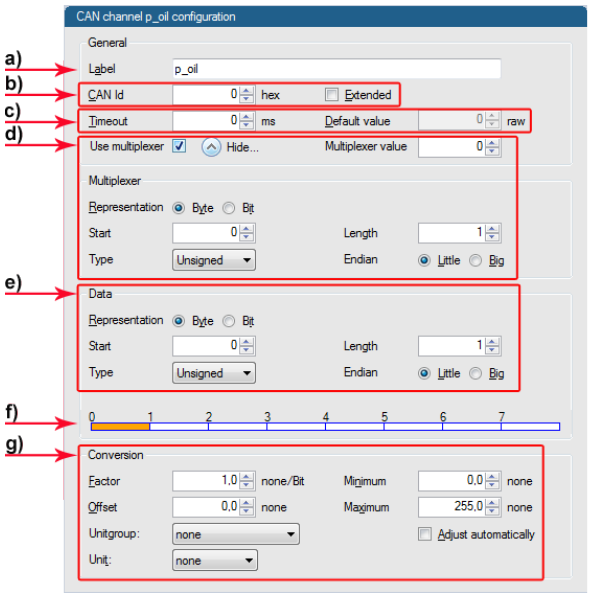



*a) Extraction of data from CAN bus.*
*b) Conversion to physical values.*
*c) Mini CAN analyzer functionalit.*
*d) Automatic assignment to measurement view.*

## 9.2.4 Extracting Data from CAN Bus

**Representation: Byte**

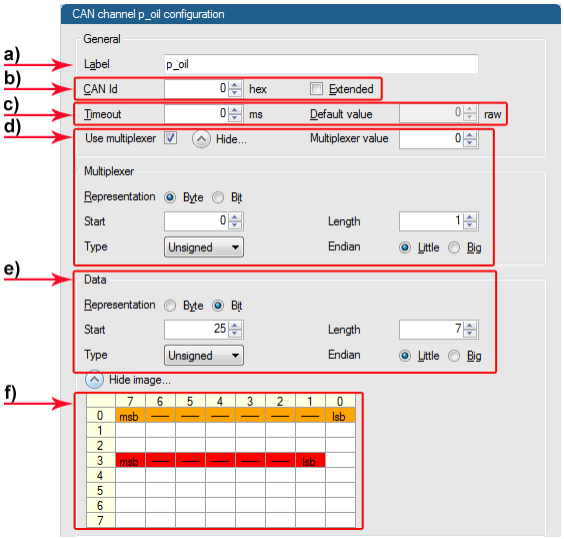
Some CAN devices need to be addressed by a byte represented CAN channel. The address can be assigned in this window and is illustrated by a bargraph.




*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.*

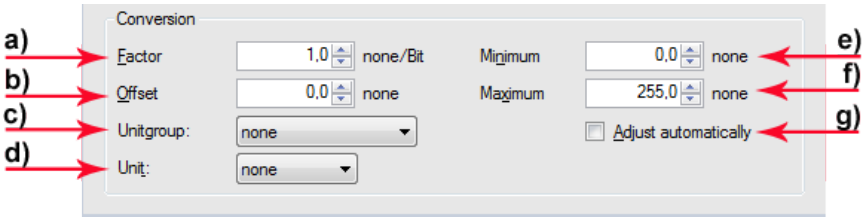
**Representation: Bit**

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



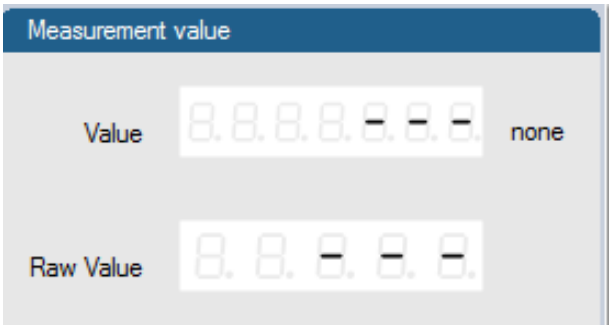

*a) Enter factor (gain) for conversion to physical value.*
*b) Enter offset for conversion to physical value.*
*c) Select type of physical value.*
*d) Select unit of physical value.*
*e) Enter minimum physical limit of the channel (for manual setup).*
*f) Enter maximum physical limit of the channel (for 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 M 60 to the PC.

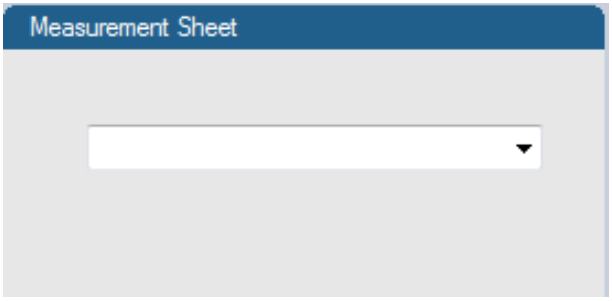
Choose the CAN bus that is connected to the MSA-Box to display the raw value and the converted physical value here.




**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.

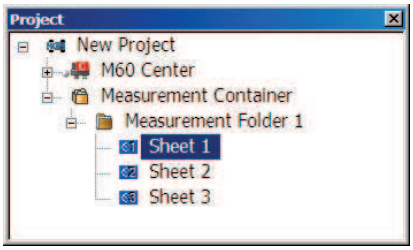
For an online view of the value measured by the M 60, insert the channel in an online measurement sheet which is described in the next chapter.



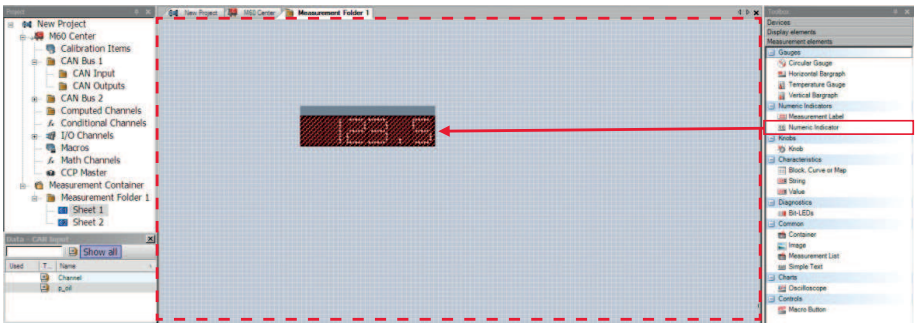

## 9.2.7 Online View of CAN Channels in Vehicle

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

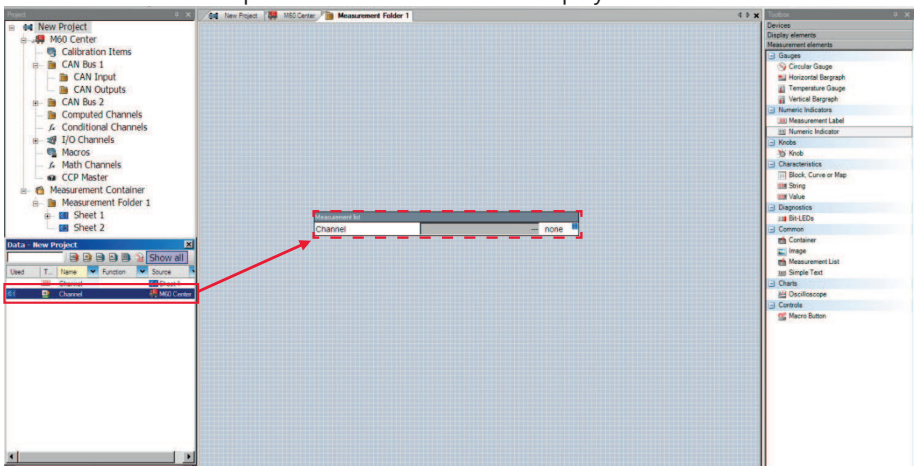
   Measurement Sheet 1 is displayed in Main Area.




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.

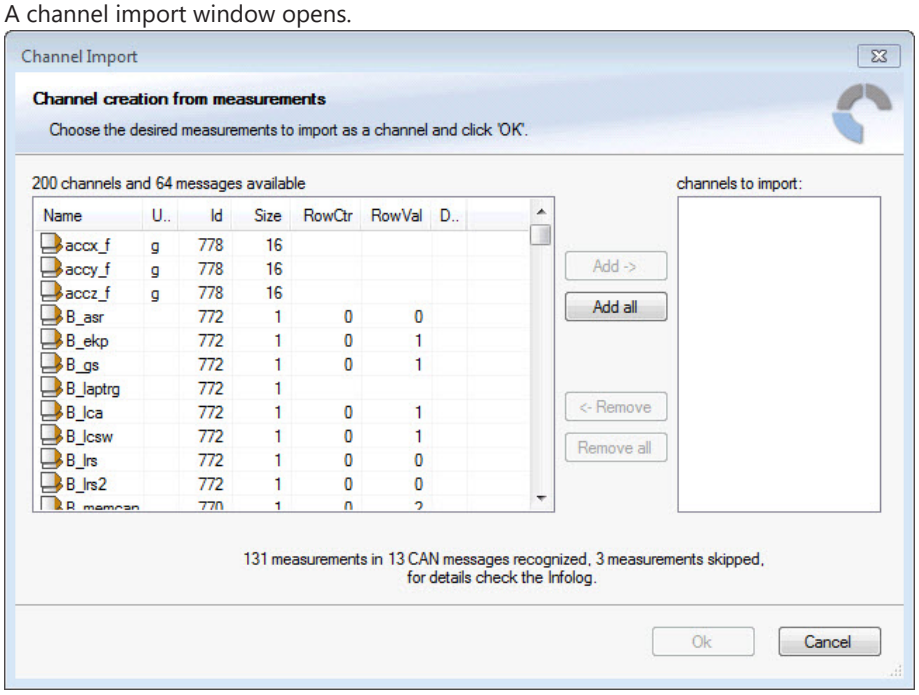
## 9.2.8 Import a CAN Database (DBC) File

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.



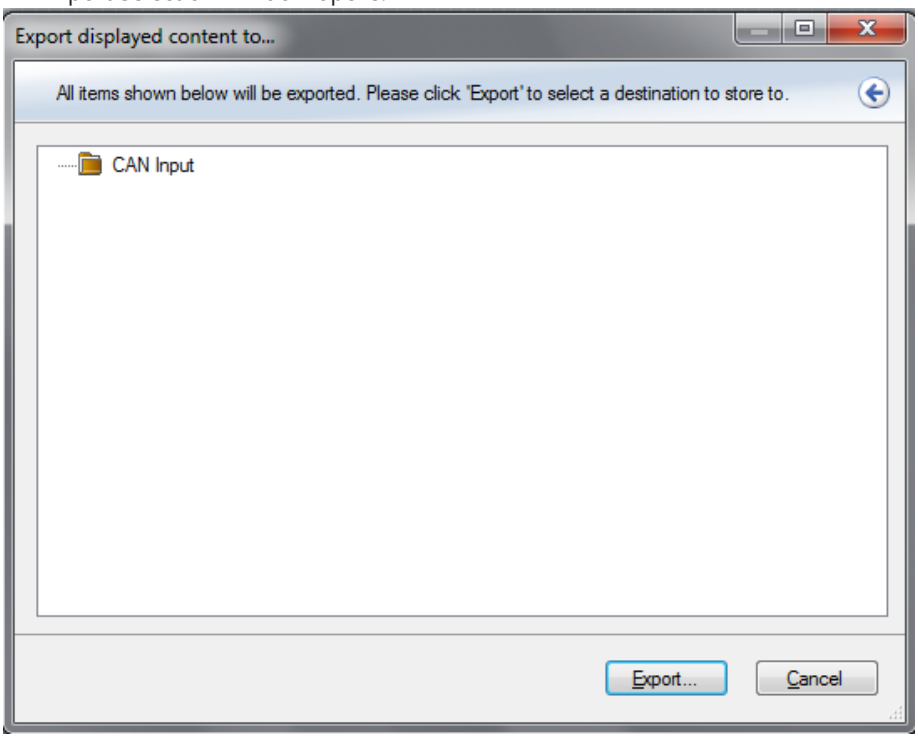

4. Select desired channels on the left and use the ‘Add’ button to add them to import list.
5. Click ‘OK’ when complete.

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.

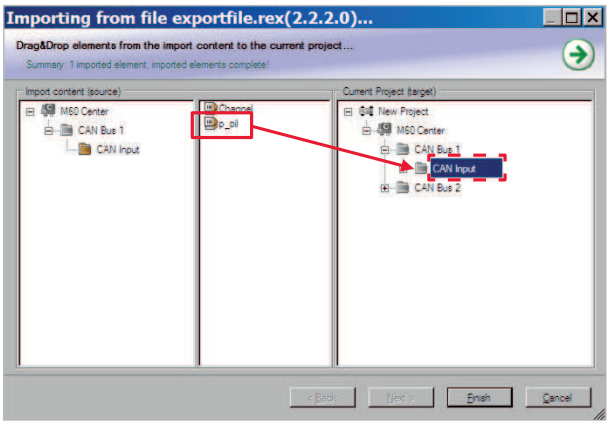
### 9.2.10 Import RaceCon CAN Configuration

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'.

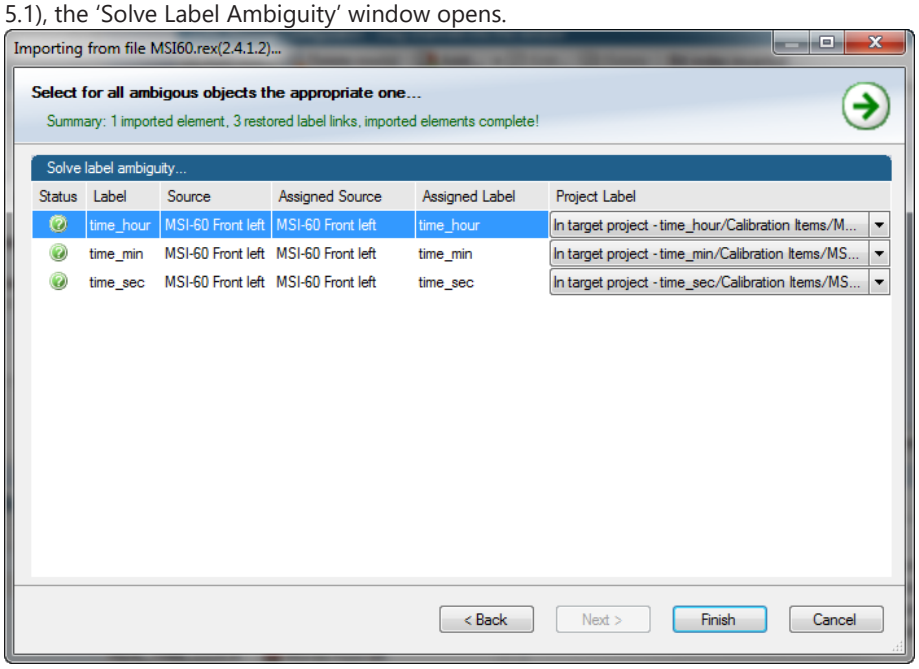
   An 'Import Selection' window opens.




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. M 60 and ECU MS 5.1), the ‘Solve Label Ambiguity’ window opens.

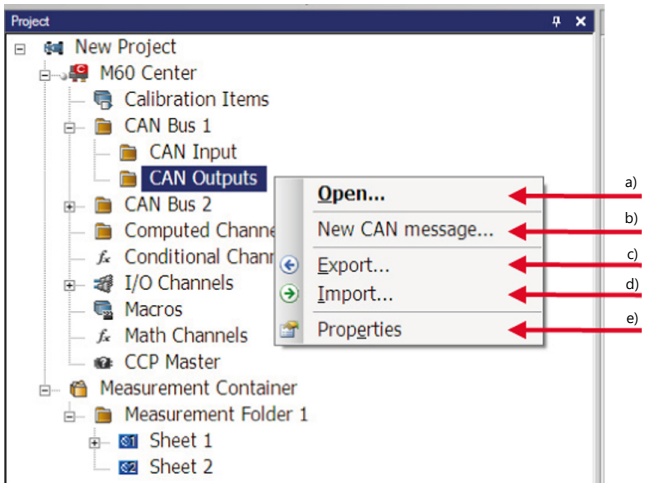



7. Assign the ambiguous channels to the desired source.
8. Click ‘Finish’.

## 9.3 CAN Output

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

### 9.3.1 Output Configuration



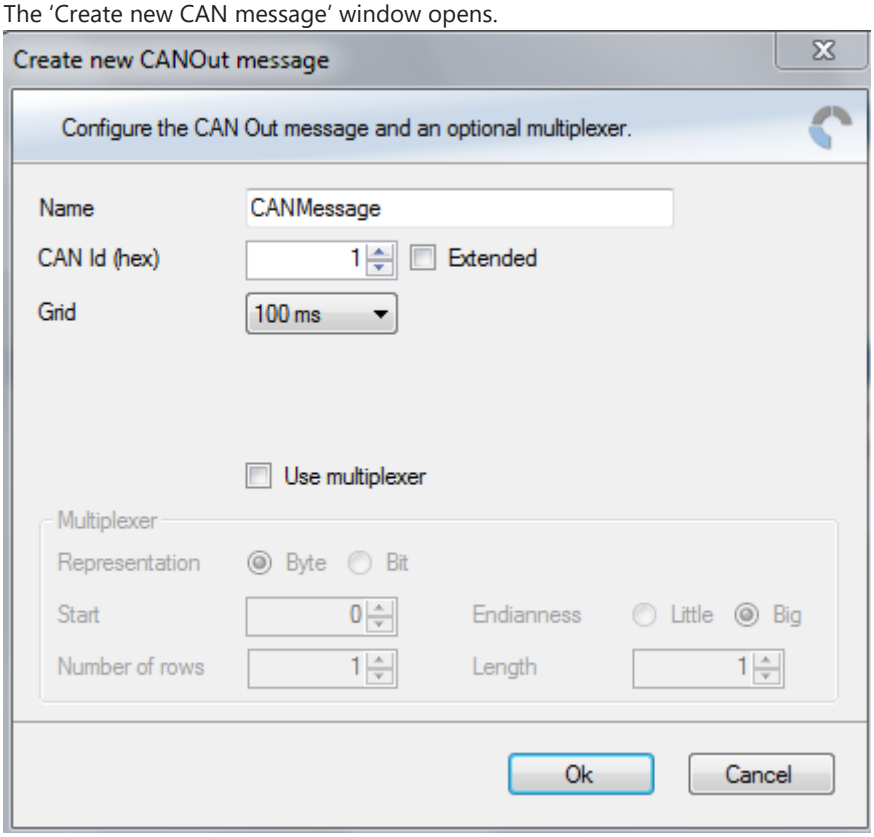

*a) Open CAN output message.*
*b) Create new CAN output message.*
*c) Export RaceCon CAN output configuration to file.*
*d) Import RaceCon CAN output configuration from file.*
*e) Display CAN bus properties (Baudrate).*

### 9.3.2 Create new CAN Output Message Channel

1. Right-click on CAN Output of desired bus (CAN1 or CAN2).

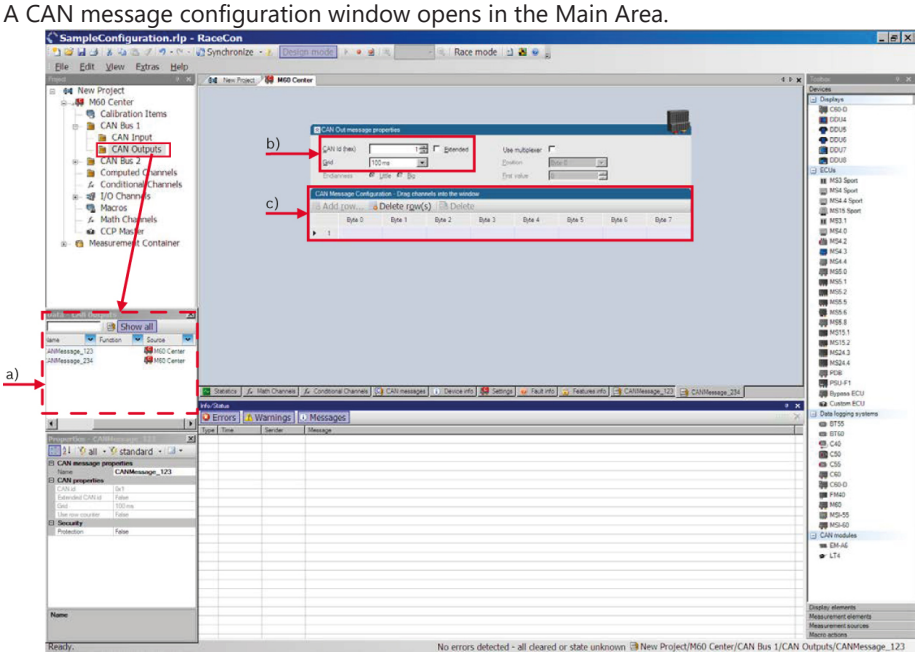
2. Select ‘New CAN Message’ from menu.

   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.

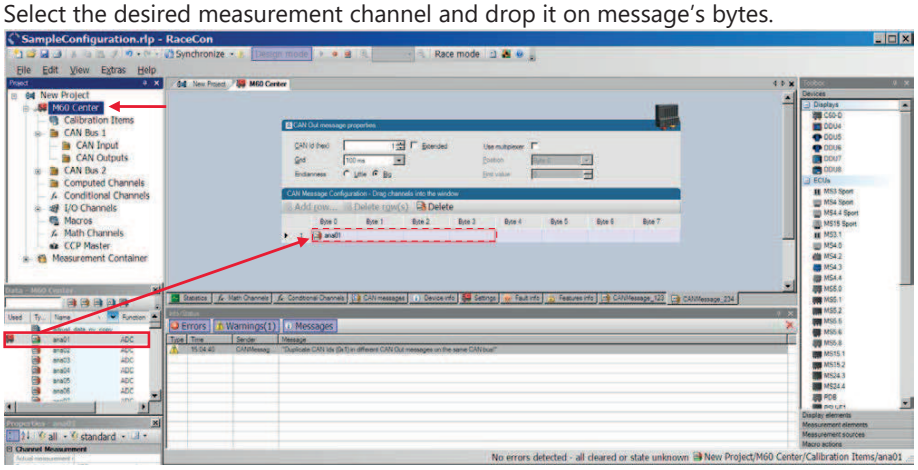
   A CAN message configuration window opens in the Main Area.




*a) Output messages on CAN bus1.*
*b) Definition of CAN message.*
*c) Content of message.*

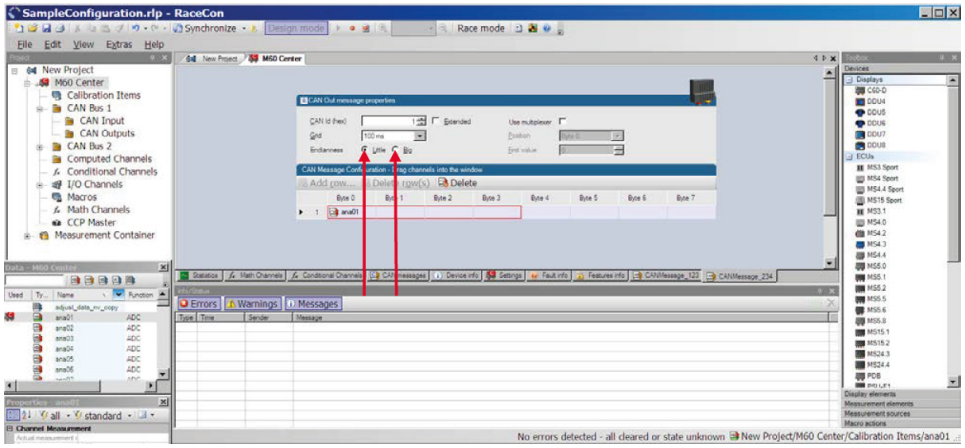
6. Click on ‘M 60’ in the M 60 Project Tree to display all labels.

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




*Set byte order of channel on CAN bus*

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

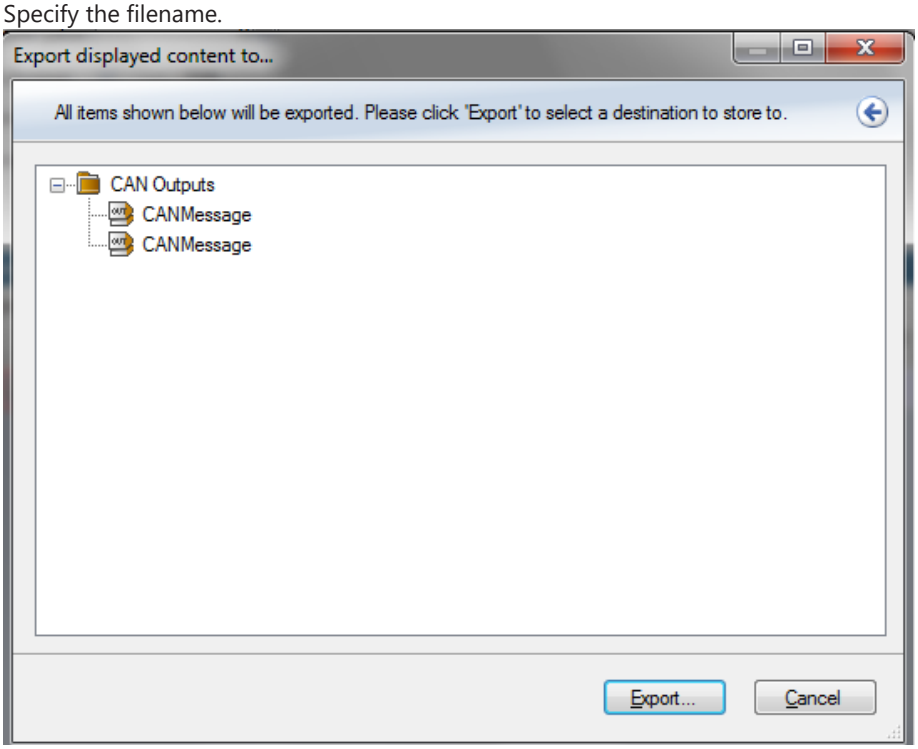
Byte Order can only be changed if a channel allocates more than one byte.

## 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.



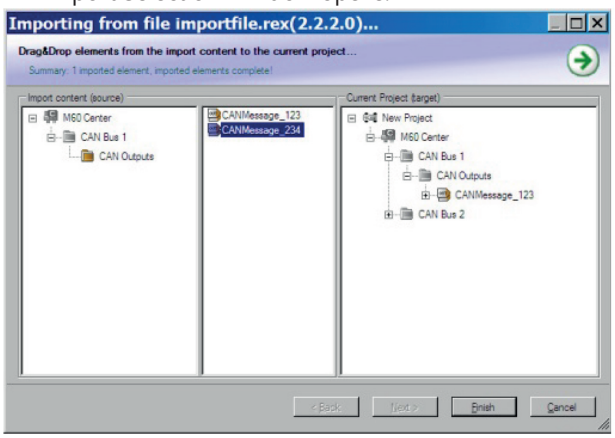

4. Click ‘OK’ when done.

## 9.3.5 Import RaceCon CAN Configuration

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

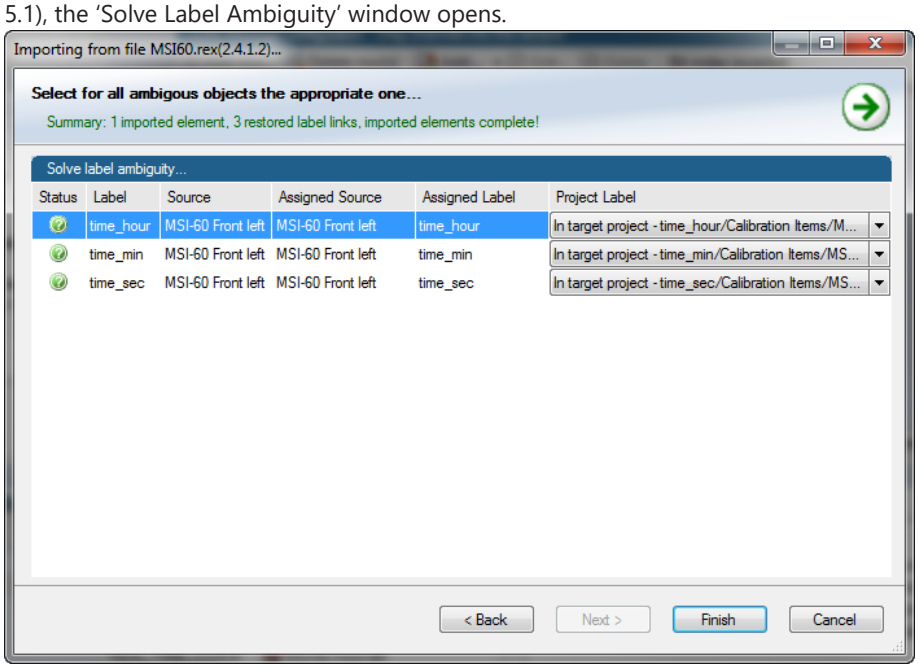
   A file browser opens.
3. Select the input file and click ‘OK’.

   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

26 analog inputs (with Software Upgrade 2; 6 analog inputs available without upgrade)

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

4 frequency inputs (with Software Upgrade 2; no frequency inputs available without upgrade)

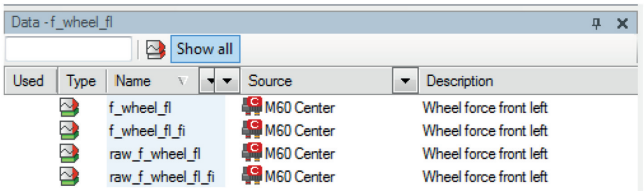
- 5 V Hall-effect type, 2.5 V trigger level
- 20 kHz max. frequency
- 10 ms measurement window

4 PWM outputs

- Low-side switch
- Up to 2 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:

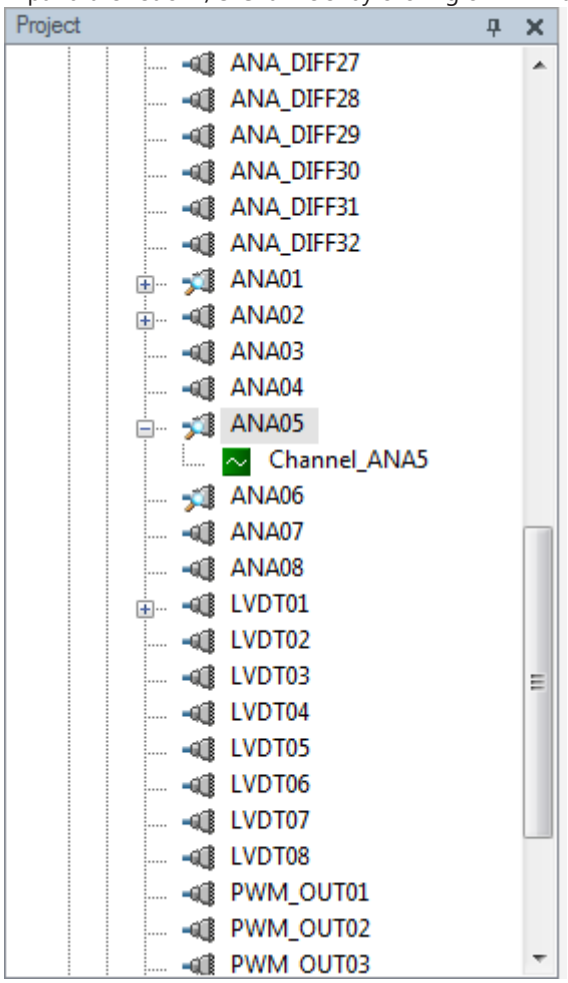
- M 60 uses A/D converter oversampling and digital filtering to recording rate.
- Digital filters eliminate 'out-of-band' noise.
- Cut-off frequency automatically adjusted to recording rate.
- Linear phase – no signal distortion.

– Latency compensation – no filter delay in recorded data.

## 10.3 Configuring Inputs

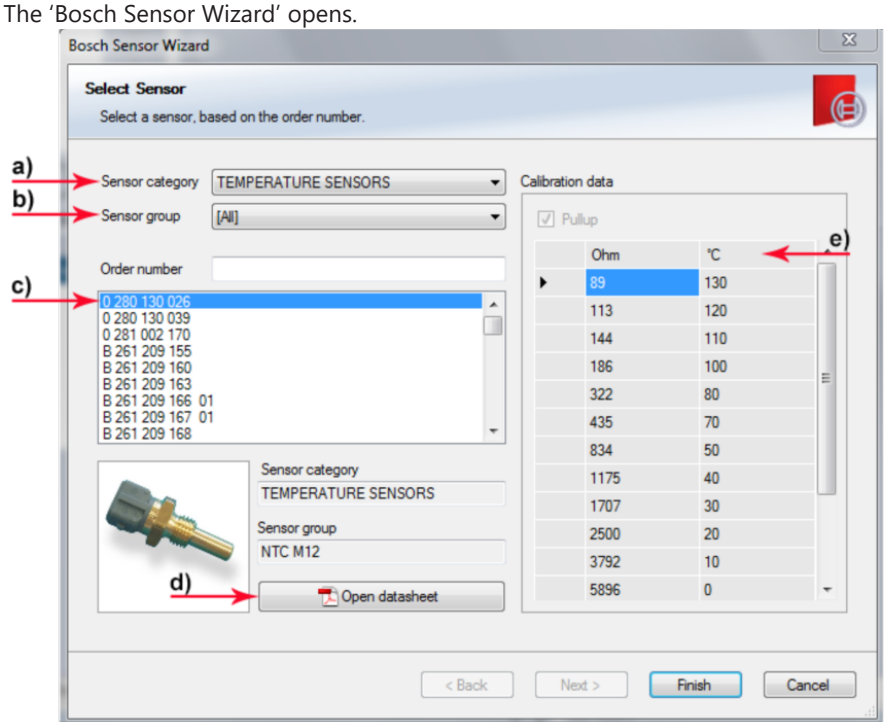
### 10.3.1 Configuring a predefined Bosch Sensor with the 'Bosch Sensor Wizard'

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



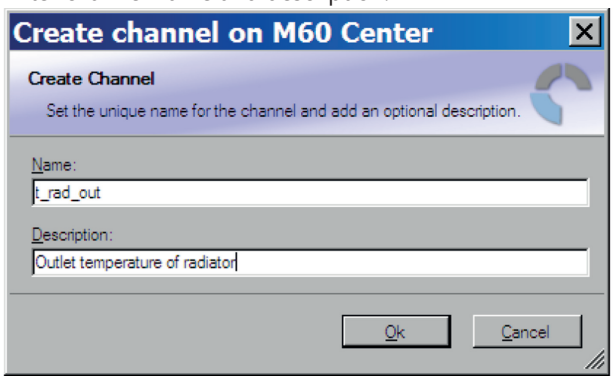

3. Drag the ‘Bosch Wizard’ from the Toolbox and drop it on the desired analog input channel in the M 60 Project Tree.

The ‘Bosch Sensor Wizard’ opens.



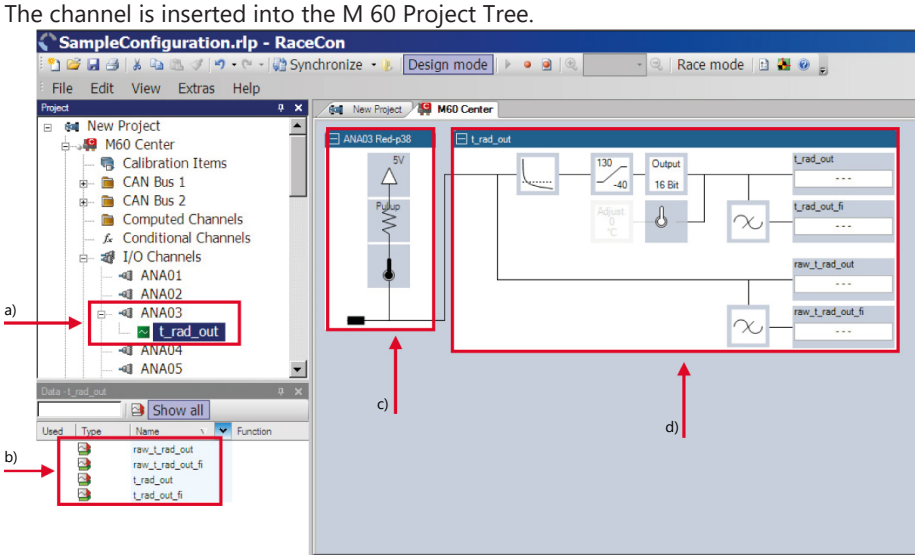

*a) Choose the sensor’s category.*
*b) Narrow your choice by choosing a type.*
*c) Select the exact type.*
*d) Opens sensor’s datasheet.*
*e) These calibration values will be used.*

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




7. Click ‘Ok’ when done.

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




*a) Channel is linked to ANA03.*
*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 |

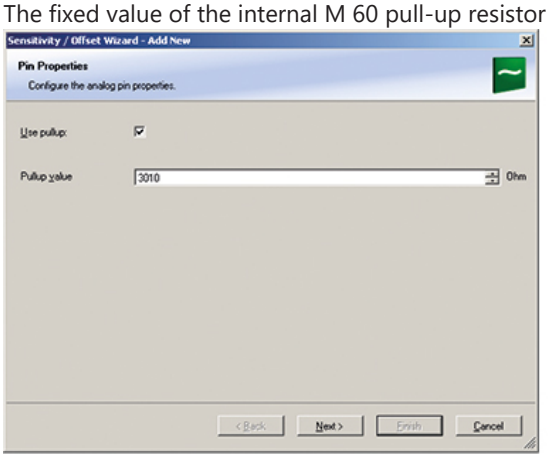
– Sensitivity 400 mV/g, Offset 2,500 mV

– 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 M 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 M 60 Project Tree.
   A ‘Sensitivity/Offset Wizard’ opens.
4. To activate the internal M 60 pull-up resistor, check the box.

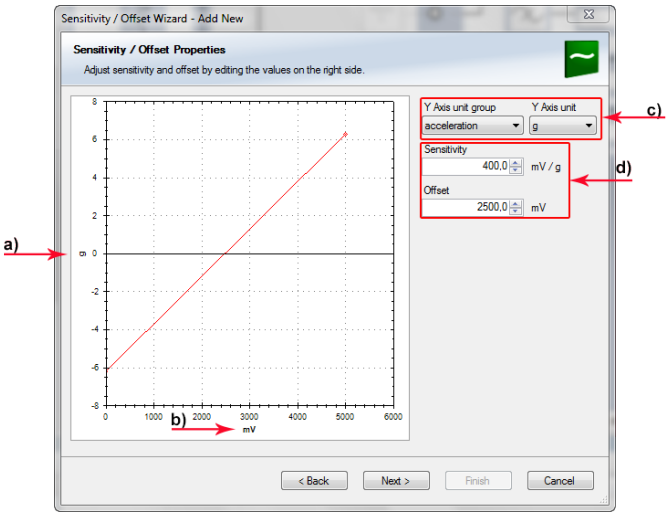
   The internal M 60 pull-up resistor is used to get a 5 V signal at the analog channel of the M 60. It allows you to use a push-button.

The fixed value of the internal M 60 pull-up resistor is 3,010 Ohm.




5. Click ‘Next‘ when done.

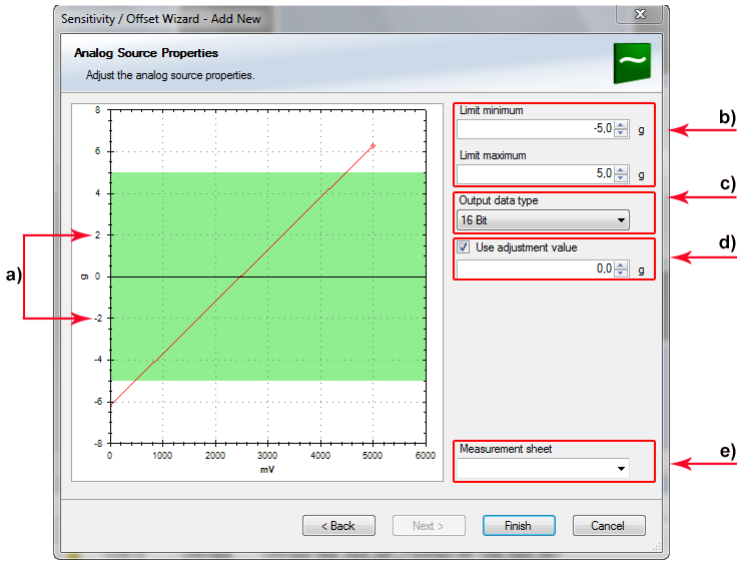
   The second part of the ‘Sensitivity/Offset Wizard’ opens.




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

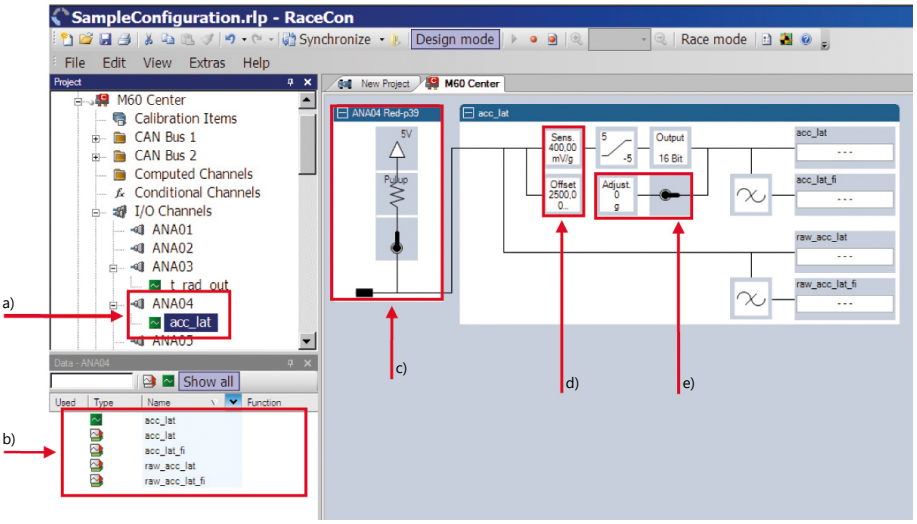
6. Click ‘Next‘ when done.

The third part of the 'Sensitivity/Offset Wizard' opens. Working with automatically created measurement sheets is explained in chapter Setting up an online Measurement.'




*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.




*a) Channel is linked to ANA04.*
*b) Available measurements for channel.*
*c) Input pin pull-up resistor is activated.*
*d) Sensitivity and offset value for sensor.*
*e) Adjustment is enabled.*

The channel is inserted into the M 60 Project Tree.

## Available measurements for channel

| Measurement label | Function |
|---|---|
| raw_name | mV value of sensor |
| raw_name_fi | filtered mV value of sensor |

| Measurement label | Function |
|---|---|
| name | physical value of sensor |
| name_fi | filtered physical value |

## 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] |
|---|---|
| -40 | 166 047 |
| -35 | 119 950 |
| -30 | 87 600 |
| -25 | 64 643 |
| -20 | 48 179 |
| -15 | 36 250 |
| -10 | 27 523 |
| -5 | 21 078 |

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

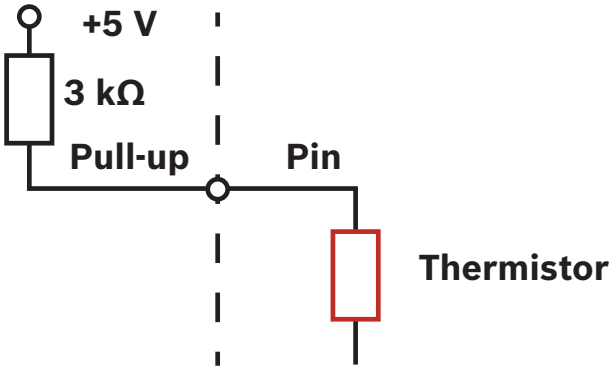
| Toper [°C] | RT [Ω] |
|---|---|
| 40 | 2 685 |
| 45 | 2 166 |
| 50 | 1 903 |
| 55 | 1 494 |
| 60 | 1 245 |
| 65 | 1 024 |
| 70 | 876 |
| 75 | 740 |

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

– The sensor has a nonlinear behavior.

– Use characteristic curve for linearization.

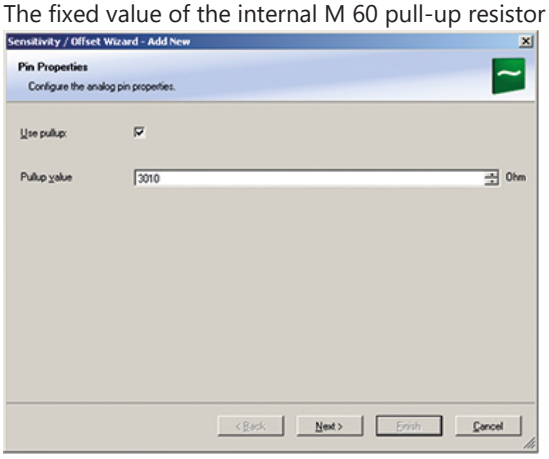
– Input voltage is the ratio between pull-up resistor and thermistor.




1. Click on ‘Measurement Sources’ in the Toolbox.
2. Expand the list of ‘I/O Channels’ by clicking on ‘+’ in the M 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 M 60 Project Tree.
   A ‘Characteristic Curve Wizard’ opens.
4. To activate the internal M 60 pull-up resistor, check the box.

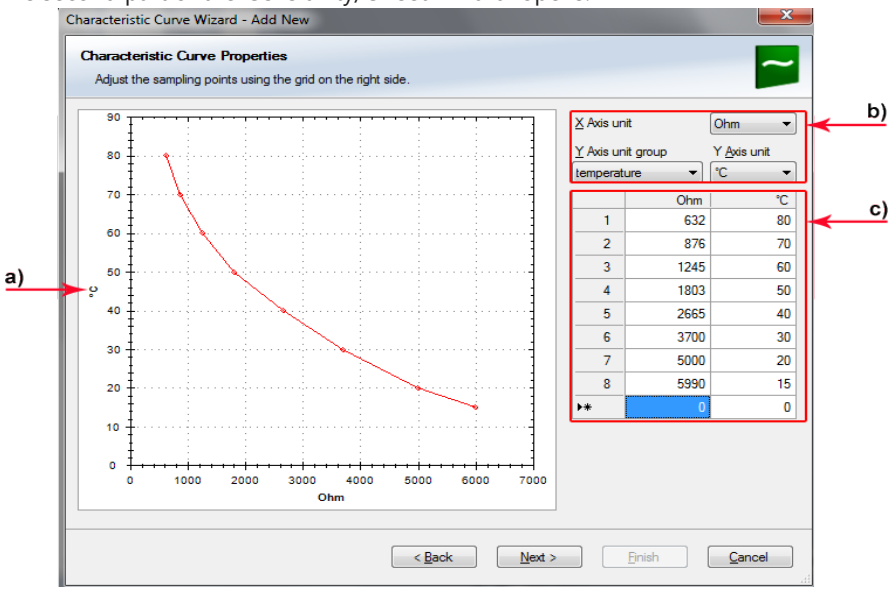
   The internal M 60 pull-up resistor is used to get a 5 V signal at the analog channel of the M 60.

It allows you to use a push-button.
The fixed value of the internal M 60 pull-up resistor is 3,010 Ohm.




5. Click ‘Next’ when done.

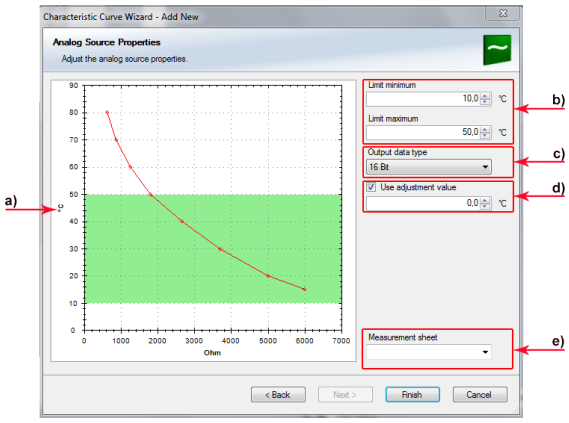
The second part of the ‘Sensitivity/Offset Wizard’ opens.




*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.

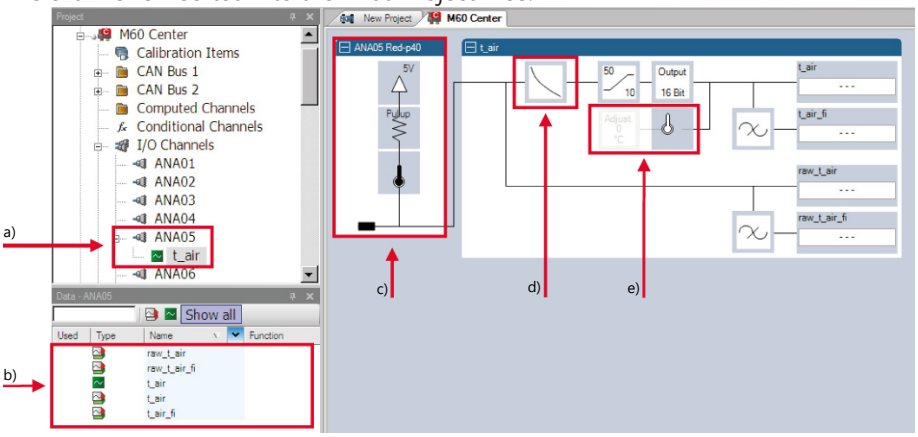
The third part of the 'Characteristic Curve Wizard' opens. Working with automatically created measurement sheets is explained in chapter '11.2 Setting up an online measurement'.




*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 M 60 Project Tree.




*a) Channel is linked to ANA05.*
*b) Available measurements for channel.*
*c) Input pin pull-up resistor is activated.*
*d) Characteristic curve for sensor.*
*e) Adjustment is disabled.*

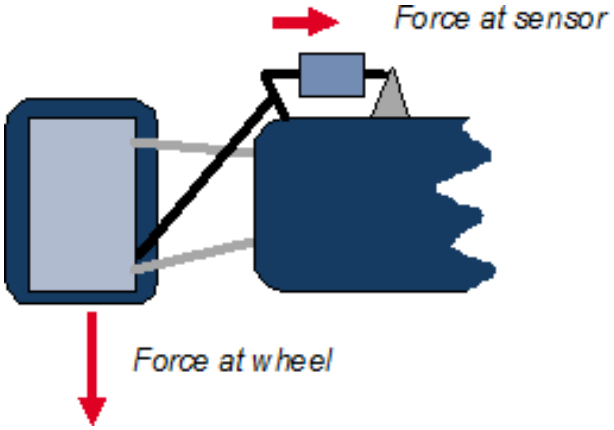
## Available measurements for channel

| 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 |

## 10.3.4 Configuring a Multipoint Adjustment

### Example: Measurement of wheel force

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

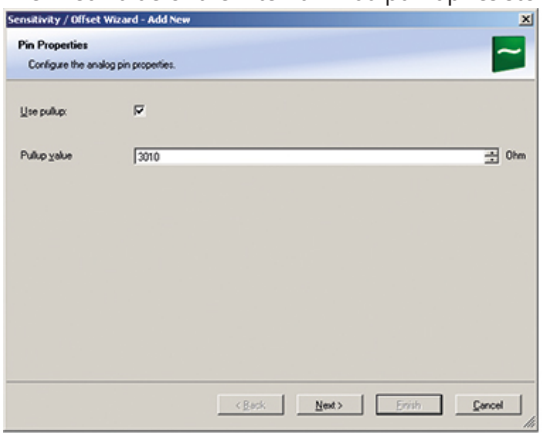



1. Click on ‘Measurement Sources’ in the Toolbox.
2. Expand the list of ‘I/O Channels’ by clicking on ‘+’ in the M 60 Project Tree.
3. Drag the ‘Multipoint Adjustment’ analog signal source from the Toolbox and drop it on the desired analog input channel in the M 60 Project Tree.

   A ‘Multipoint Adjustment Wizard’ opens.
4. To activate the internal M 60 pull-up resistor, check the box.

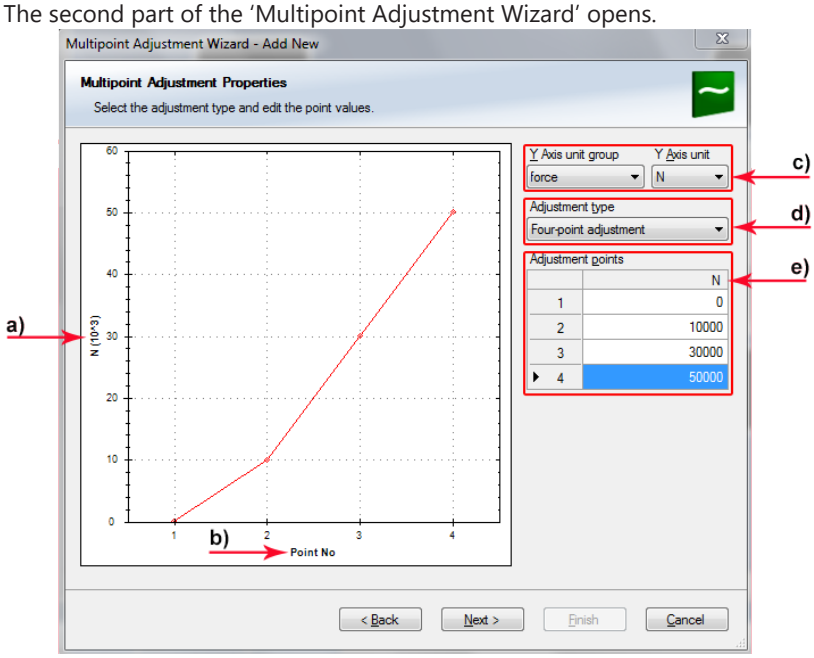
   The internal M 60 pull-up resistor is used to get a 5 V signal at the analog channel of the M 60. It allows you to use a push-button.

   The fixed value of the internal M 60 pull-up resistor is 3,010 Ohm.




5. Click ‘Next’ when done.

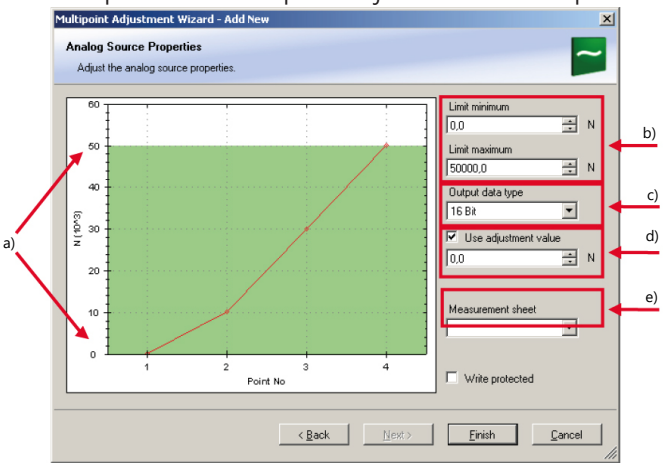
The second part of the ‘Multipoint Adjustment Wizard’ opens.




*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).*

6. Click ‘Next’ when done.

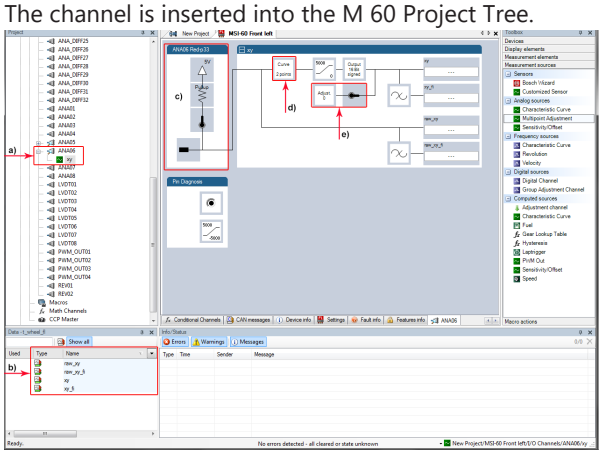
   The third part of the ‘Multipoint Adjustment Wizard’ opens.




*a) Physical limits of channel.*
*b) Enter physical limits of the sensor.*
*c) Choose data type of the measurement variable.*
*d) Enable additonal online 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 M 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.*

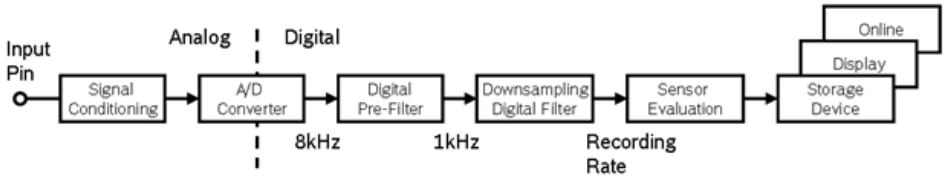
### Available measurements for channel

| 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 |

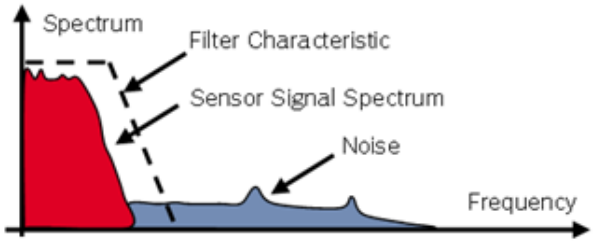
Online definition of the curve is covered in the chapter ‘Online Calibration of Measurement Channels [▶ 76]’.

## 10.3.5 Digital Filter Details

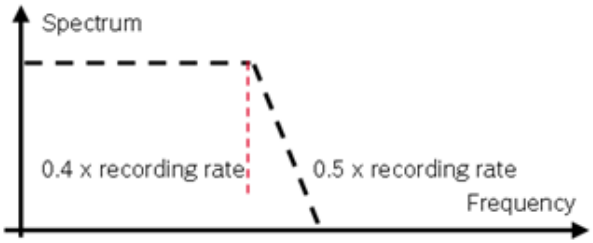
M 60 uses A/D converter oversampling and digital filtering to recording rate.




*Digital filters eliminate ‘out-of-band’ noise*



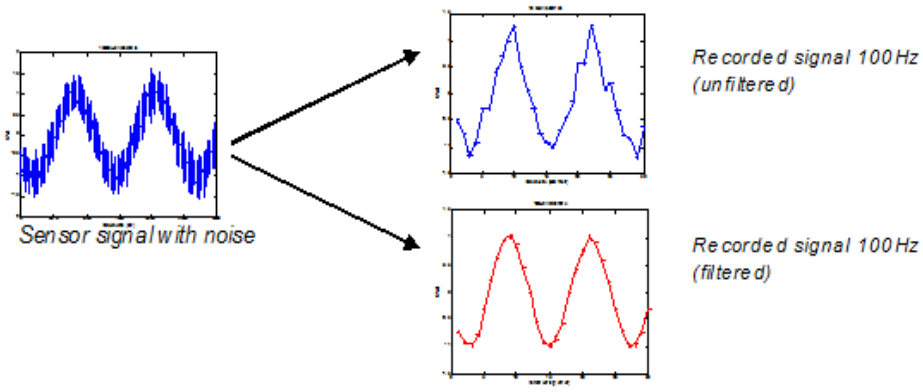

*Cut-off frequency automatically adjusted to recording rate*




*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*

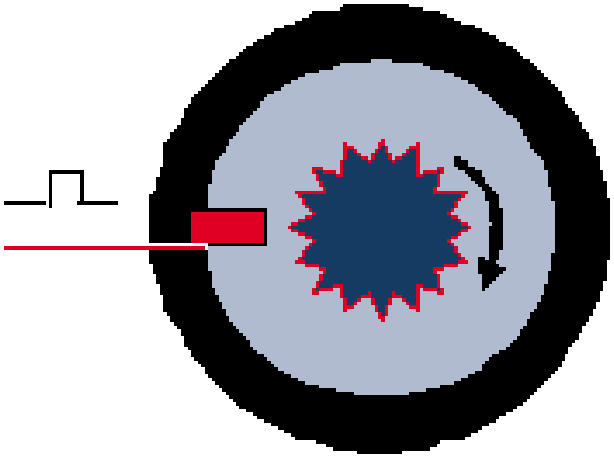
- Filtering is (smart) averaging over several samples.
- Filtered signal is delayed with respect to real time signal.
- M 60 filters have constant, frequency independent delay.
- Delay (e.g. 22 samples at 10 ms) is corrected during recording.
- No delay filtered vs. unfiltered in recorded data.
- Correction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

## 10.3.6 Configuring a Frequency Input

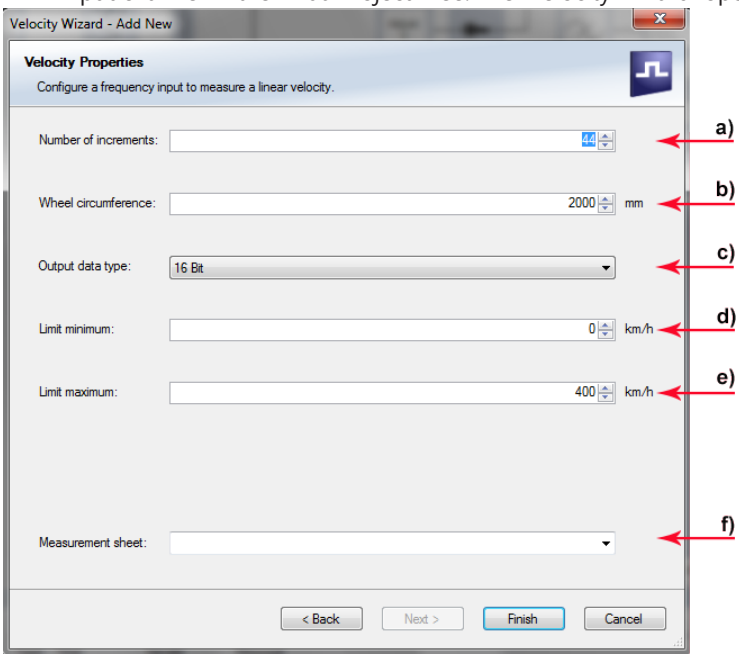
This function requires the installation of Software Upgrade 2.

### 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



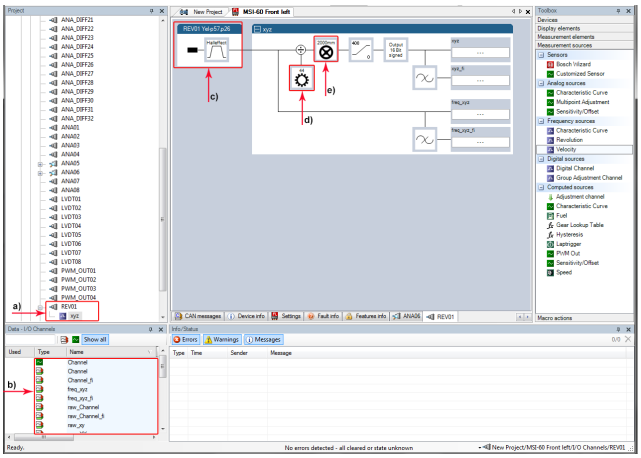
1. Click on ‘Measurement Sources’ in the Toolbox.
2. Expand the list of ‘I/O Channels’ by clicking on ‘+’ in the M 60 Project Tree.
3. Drag the ‘Velocity’ digital signal source from the Toolbox and drop it on the desired ‘REV’ input channel in the M 60 Project Tree. The ‘Velocity Wizard’ opens.




*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 M 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 |
| 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 Source

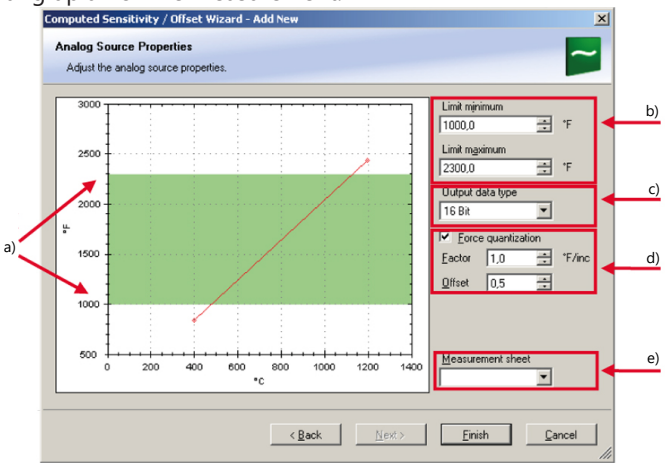
Computed sources receive data from a measurement channel rather than an input pin.

- 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 M 60 Project Tree.
   A ‘Computed Sensitivity / Offset Wizard’ opens.

3. Click ‘Next’ when done.
   The second part of the ‘Computed Sensitivity / Offset Wizard’ opens.
   Working with automatically created measurement sheets is explained in chapter Setting up an online Measurement.




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

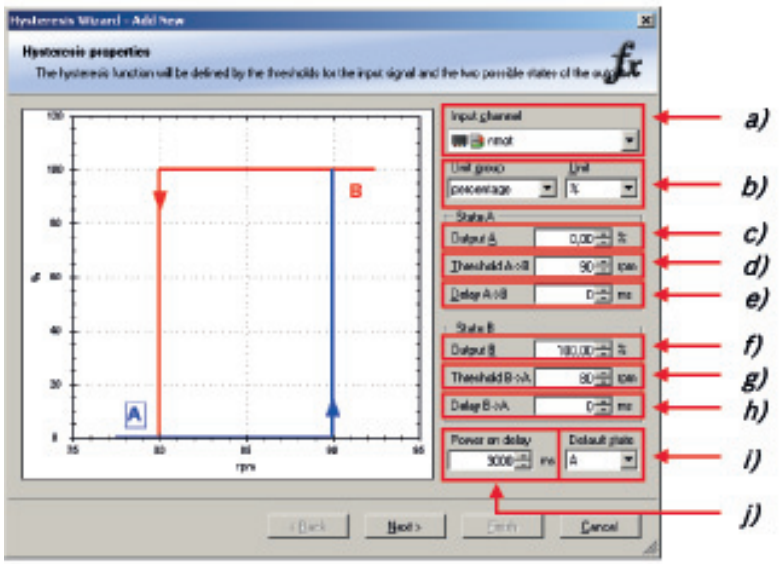
4. Click ‘Finish’ when done.
5. Enter channel name and description.
6. Click ‘OK’ when done.

The channel is inserted into the M 60 Project Tree.

## 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.

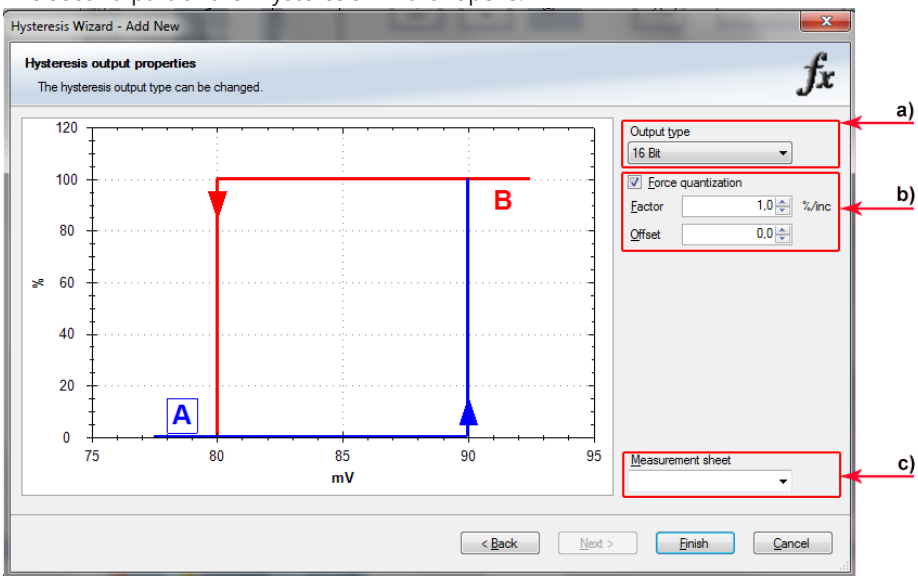
1. Click ‘Measurement Sources’ in the Toolbox.
2. Drag the ‘Hysteresis’ computed source from the Toolbox and drop it on ‘Computed Channels’ in the M 60 Project Tree.
   A ‘Hysteresis Wizard’ opens.




*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.*

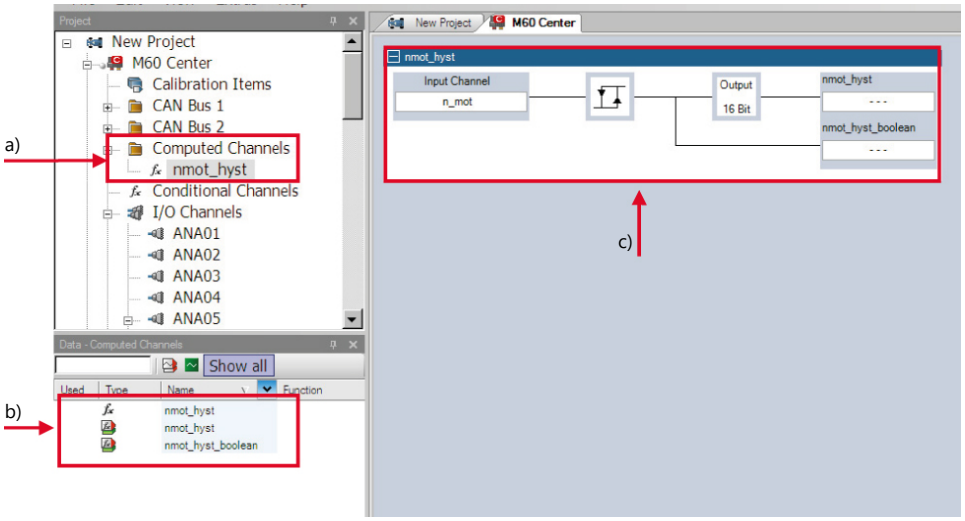
3. Click 'Next' when done.

   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 M 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.

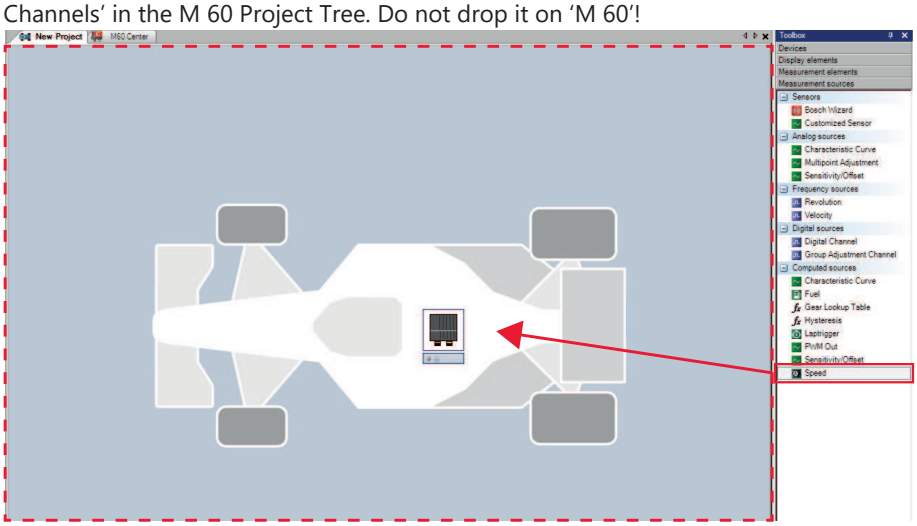
- Calculating vehicle speed of 4 wheel drive: (Wheel speeds of all wheels as input).

  Calculated speed is speed of 2nd fastest wheel.

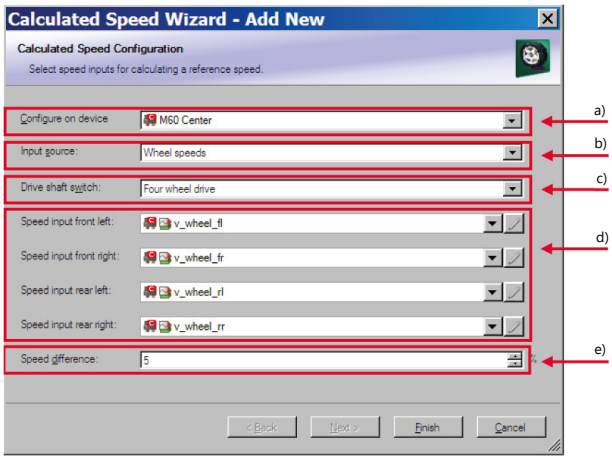
## 10.5.2 Setting up calculated Speed

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 M 60 Project Tree. Do not drop it on ‘M 60’!

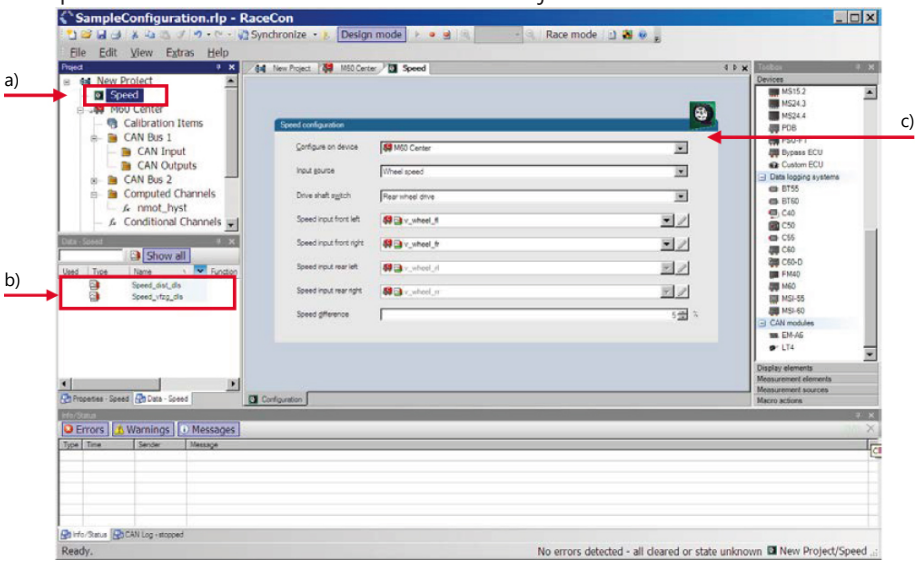



A ‘Calculated Speed Wizard’ opens.




*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 M 60 Project Tree.

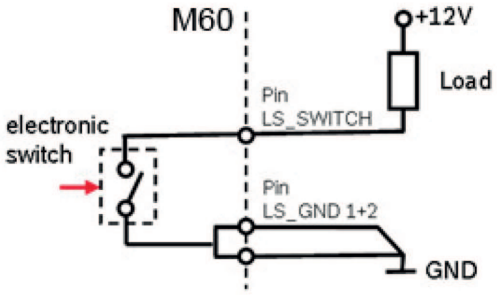



*a) Speed calculation in M 60 Project Tree.*
*b) Measurement channels calculated speed and calculated distance.*
*c) Configuration window.*

# 10.6 Configuring PWM Outputs

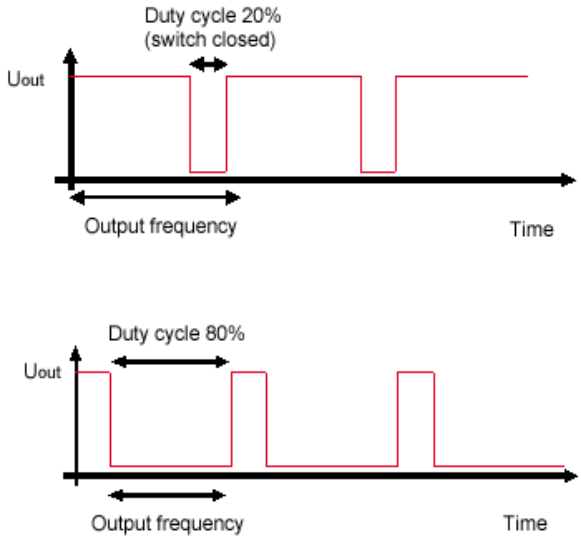
## PWM

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




M 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

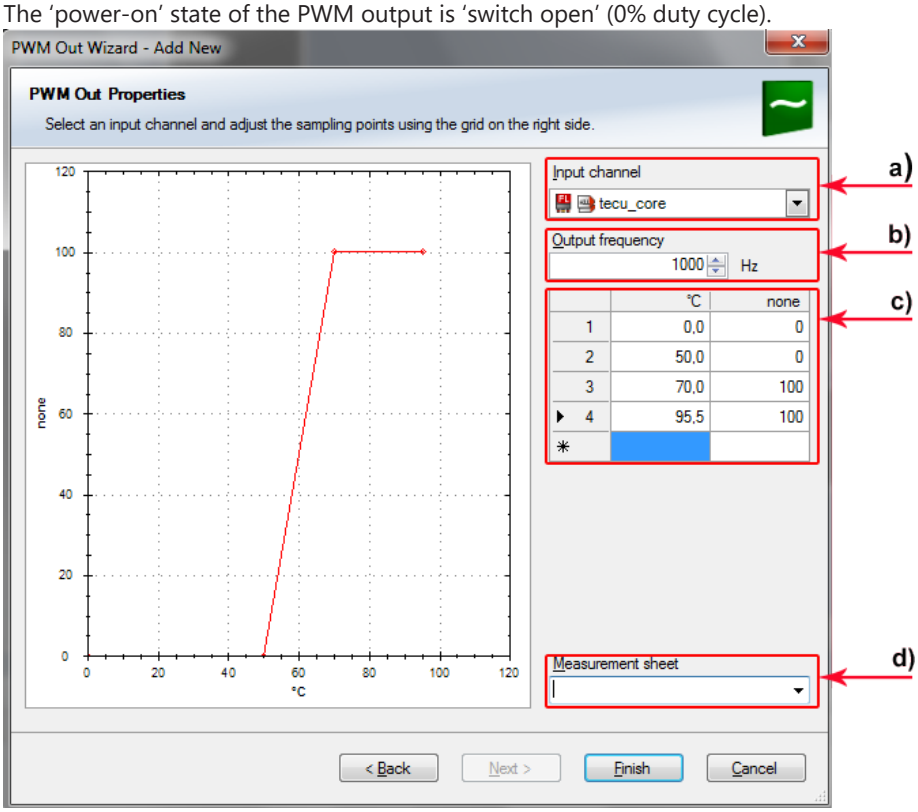
1. Click on ‘Measurement Sources’ in the Toolbox.
2. Drag the ‘PWM Out’ computed source from the Toolbox and drop it on the desired ‘PWM_OUT’ channel in the M 60 Project Tree.

   A ‘PWM Out Wizard’ opens.

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

   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.

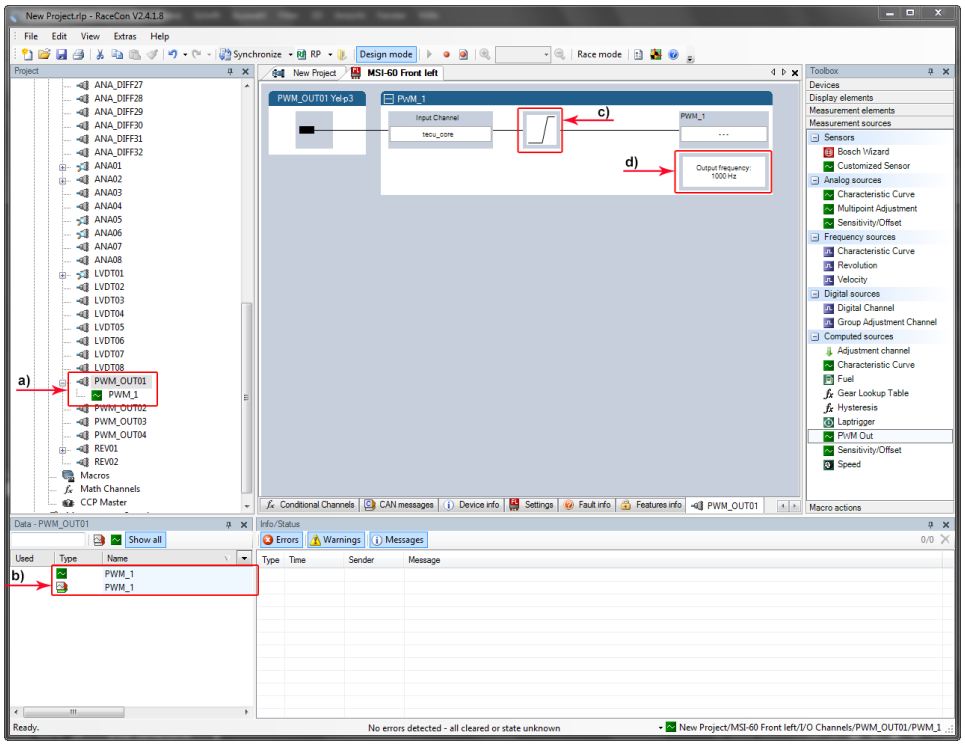
   The ‘power-on’ state of the PWM output is ‘switch open’ (0% duty cycle).




3. Click ‘Finish’ when done.
4. Enter channel name and description.

5. Click ‘OK’ when done.

The channel is inserted into the M 60 Project Tree.




## 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

M 60 **configuration**

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

**Online measurement and calibration**

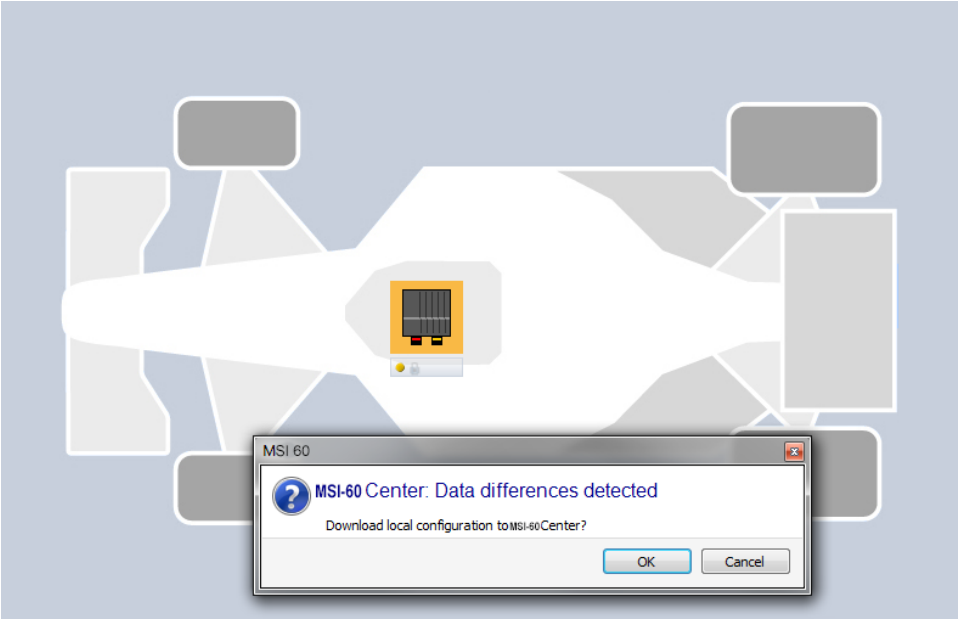
- System status and diagnosis
- Check and calibrate sensors in the vehicle.
- Live display of sensor values on the PC
- Use RaceCon for diagnosis, online measurement and calibration.
- Communication interface: Ethernet
- Communication protocol: XCP

## 11.1 Achieving an online Connection

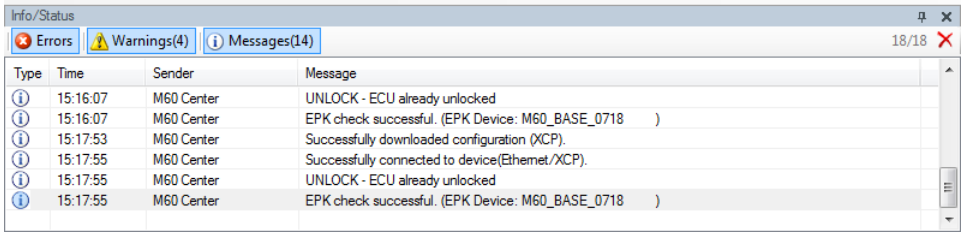
This chapter describes how to set up the PC for access, going online and how to update the firmware.

### 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). See chapter Setting up the Network Interface [▶ 15] for details.
3. Start RaceCon.
4. Establish the Ethernet connection to the vehicle.
5. Power on the vehicle.
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 M 60's configuration.

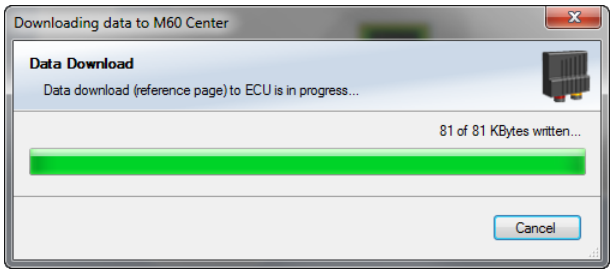



*Status message window*

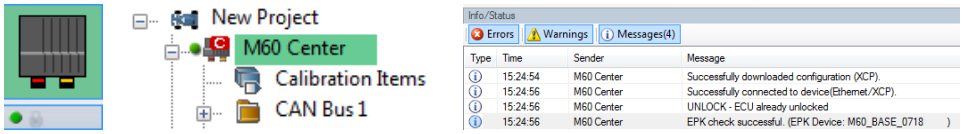
## 11.1.2 Going online

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

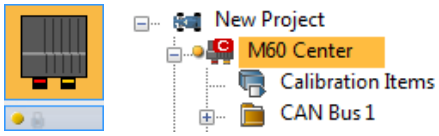
The download starts.




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



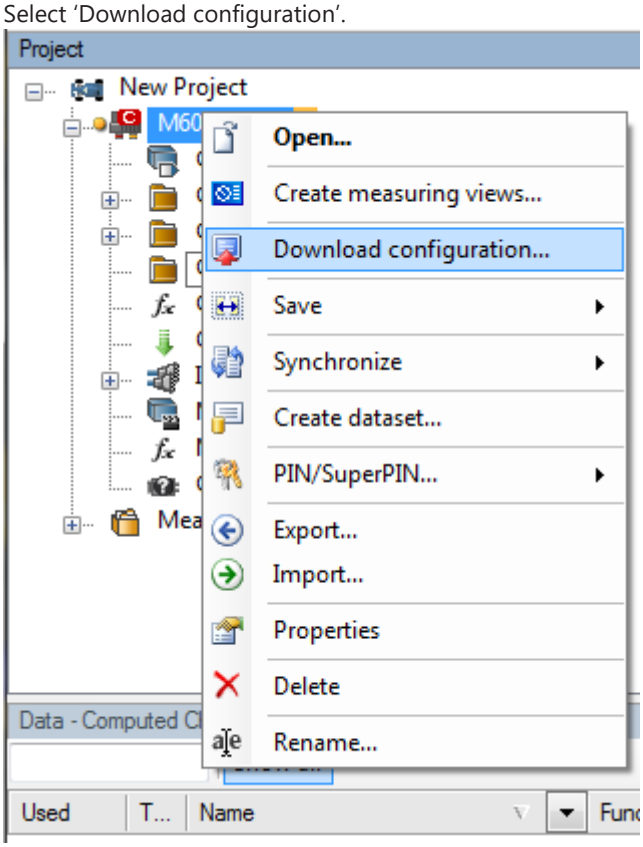

If the system's configuration in RaceCon has been changed, the dot and background becomes yellow and a configuration download is necessary.




## 11.1.3 Configuration Download

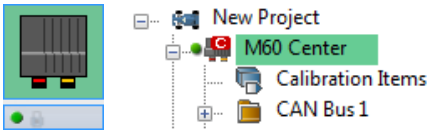
1. Right-click on M 60 in the M 60 Project Tree.

2. Select ‘Download configuration’.




The configuration download starts.

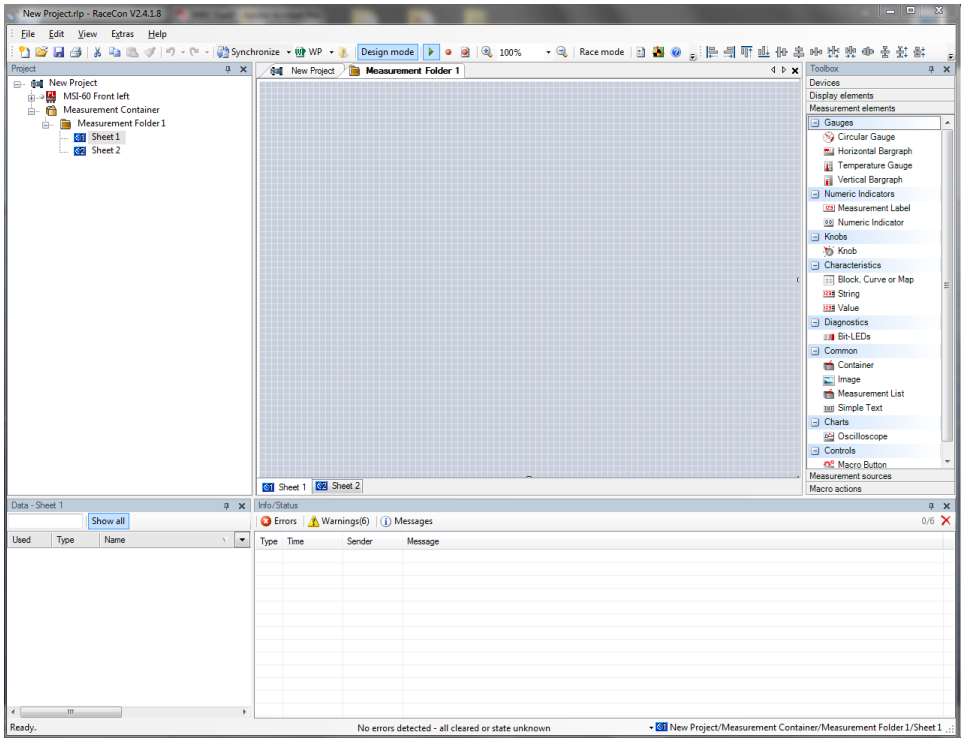
A green dot and background indicate a successful download.



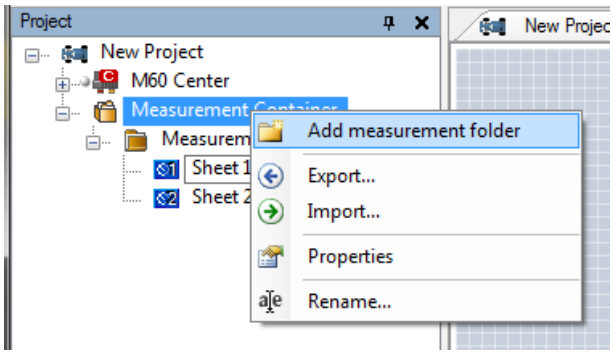

## 11.2 Setting up an online Measurement

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

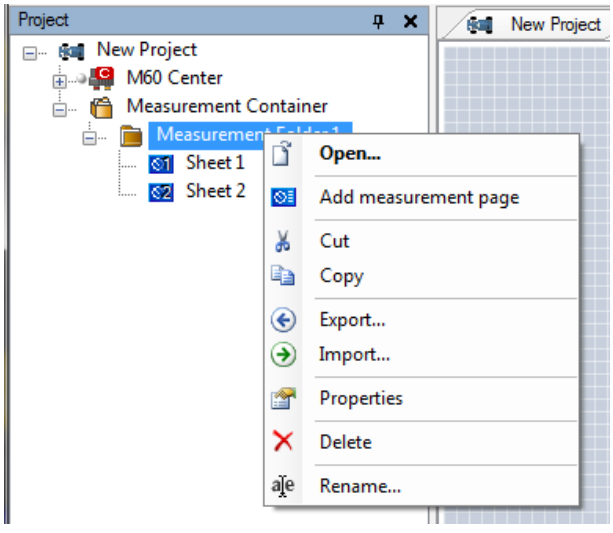
Expand ‘Measurement Container’ and ‘Measurement Folder 1’ in the Project Tree and double-click on ‘Sheet1’. The ‘Sheet 1’ is opened in the Main Area.



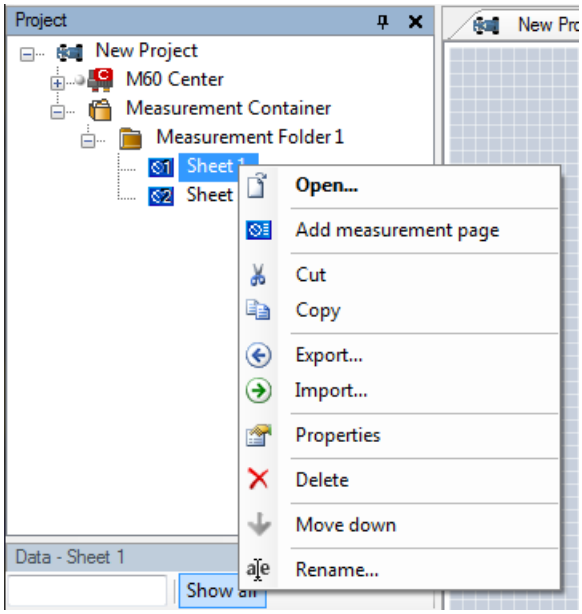
From the context menu of the project, new measurement folders can be created.



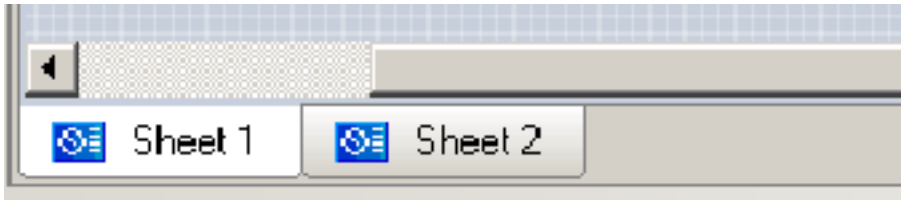

From the context menu of a measurement folder, the folder can be renamed and deleted. It also allows the creation of measurement pages.




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

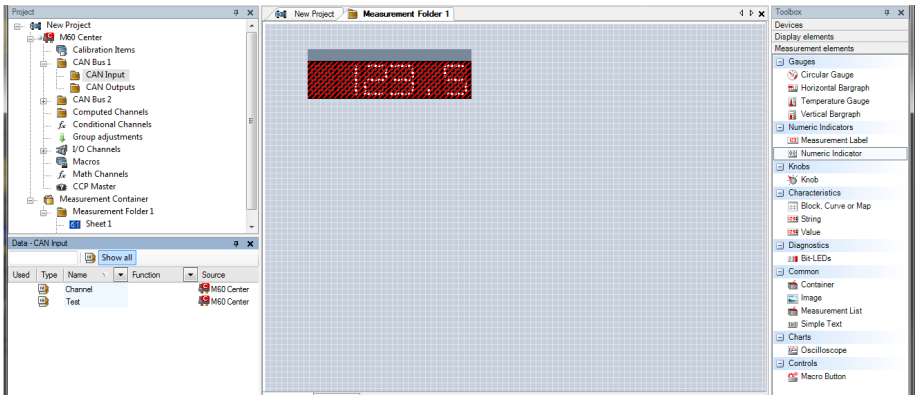



To change between different pages, click on the tabs on the bottom of the Main Project Area.



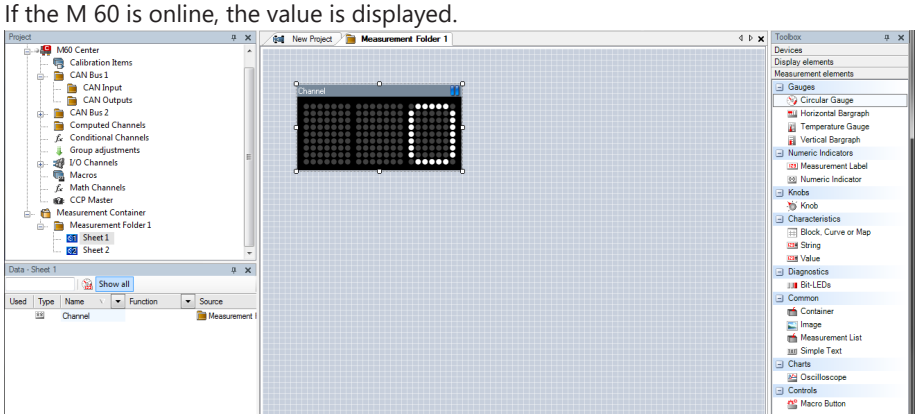

To add an element to a measurement sheet do following steps:

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

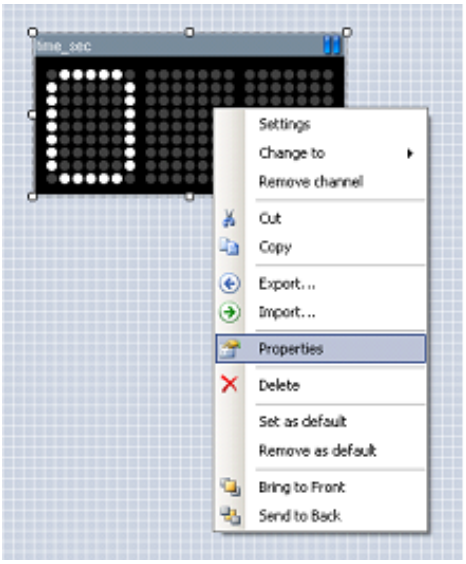


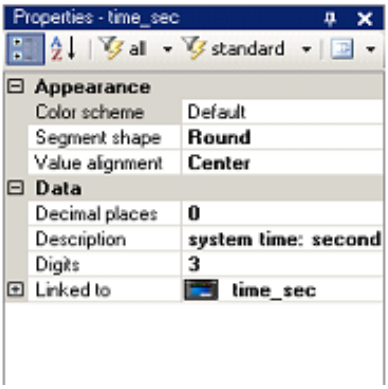
2. Click on ‘M 60’ in the Project Tree to display all measurement channels.

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

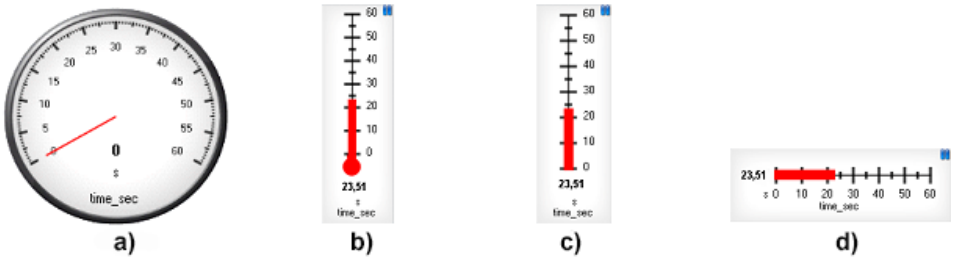


The measurement element's appearance can be changed using the Properties Menu.



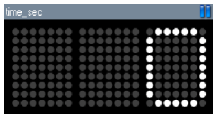




RaceCon offers different types of measurement elements:

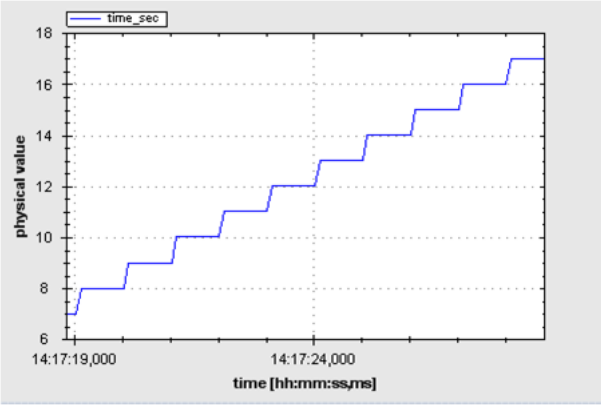



*a) Circular gauge*
*b) Temperature gauge*
*c) Vertical Bar graph style*
*d) Horizontal Bar*


*Measurement label*



*Numeric indicator*




*Oscilloscope (Chart)*

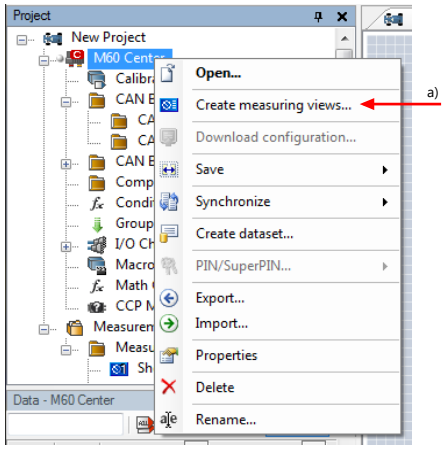
## 11.2.1 Automatic Creation of Measurement Sheets

RaceCon can create measurement sheets automatically. You can create and use measurement sheets with the M 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.

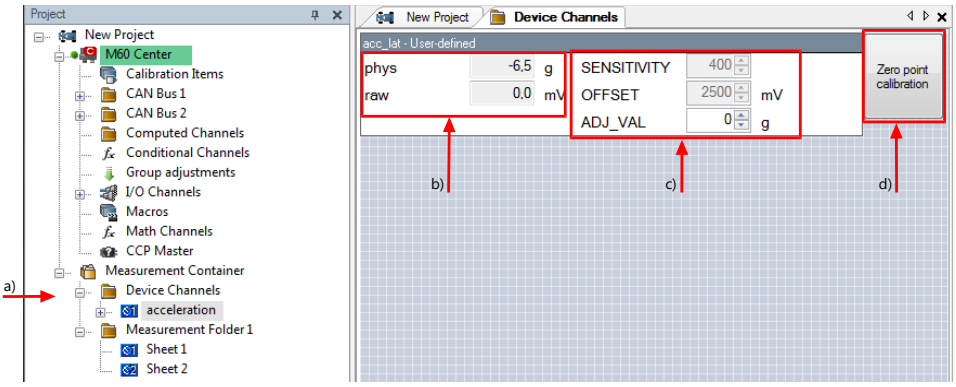

*a) Select existing sheet from list or enter name of new sheet.*

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




*a) Click to create measurement sheets.*

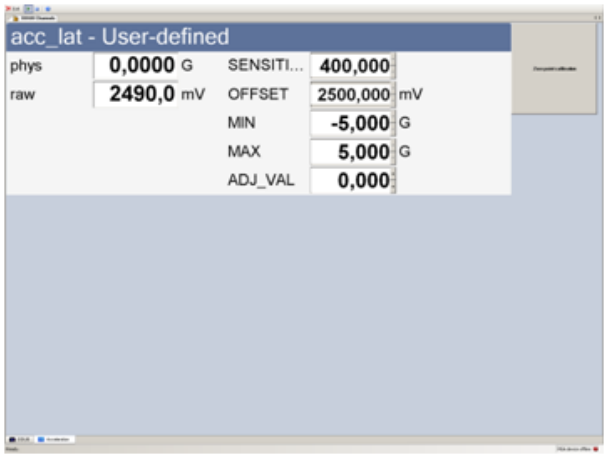
The automatically created sheet is inserted in the Project Tree under 'Measurement Container' and 'Device Channels'. If the M 60 is connected to RaceCon, live values of the channels are shown.




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

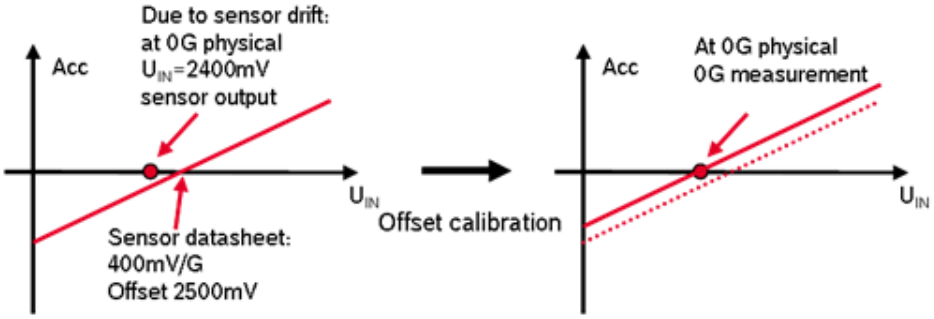
## 11.2.2 Using the Measurement Sheets

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'.



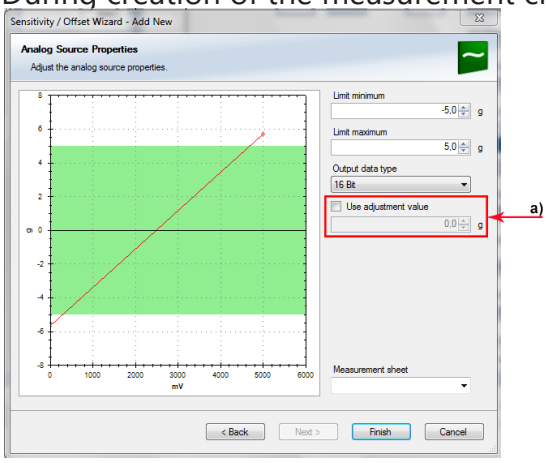

# 11.3 Online Calibration of Measurement Channels

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



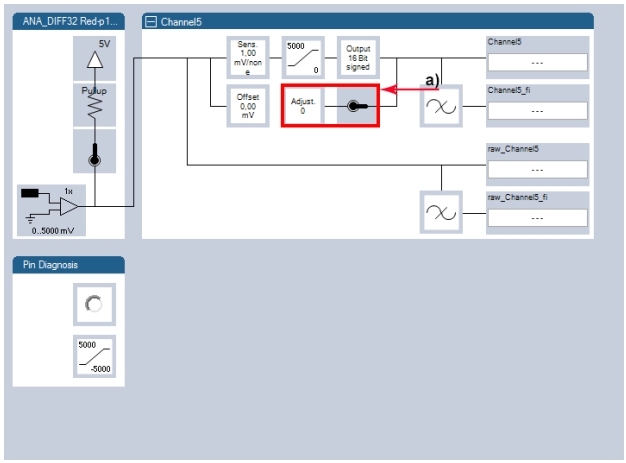

## 11.3.1 Enable online offset Calibration for Measurement Channel

### During creation of the measurement channel




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

### In the channel view

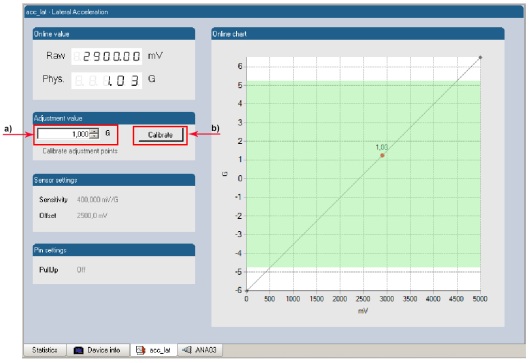



*a) Activate switch to enable online calibration.*

## 11.3.2 Performing the online offset Calibration

1. M 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.



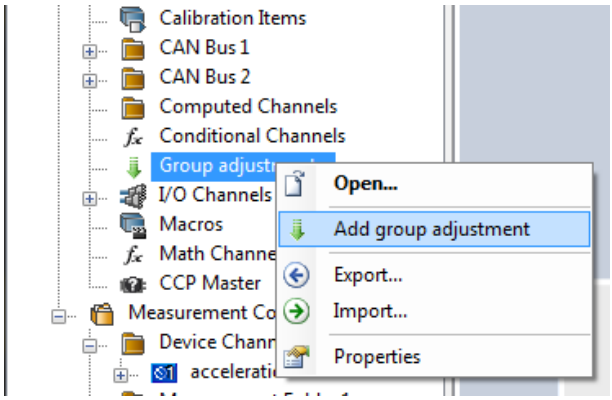

*a) Calibration target value*
*b) Initiate calibration*

The sensor's offset is now calibrated.

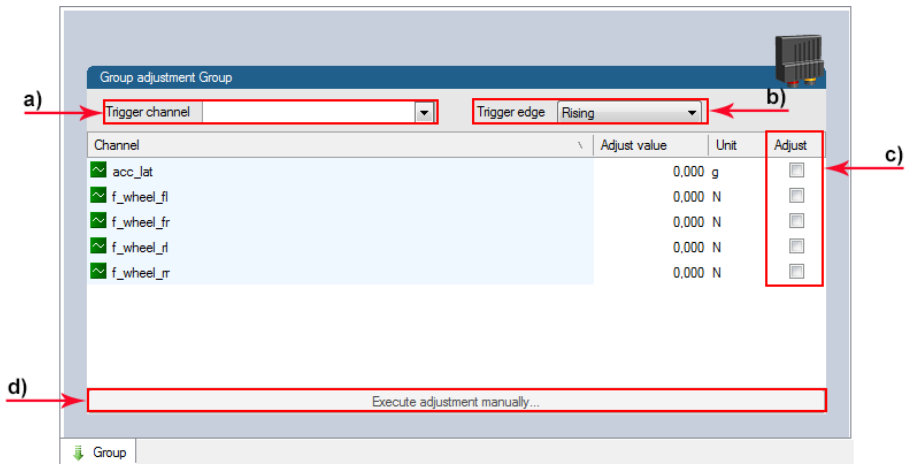
## 11.4 Group Adjustment

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'.

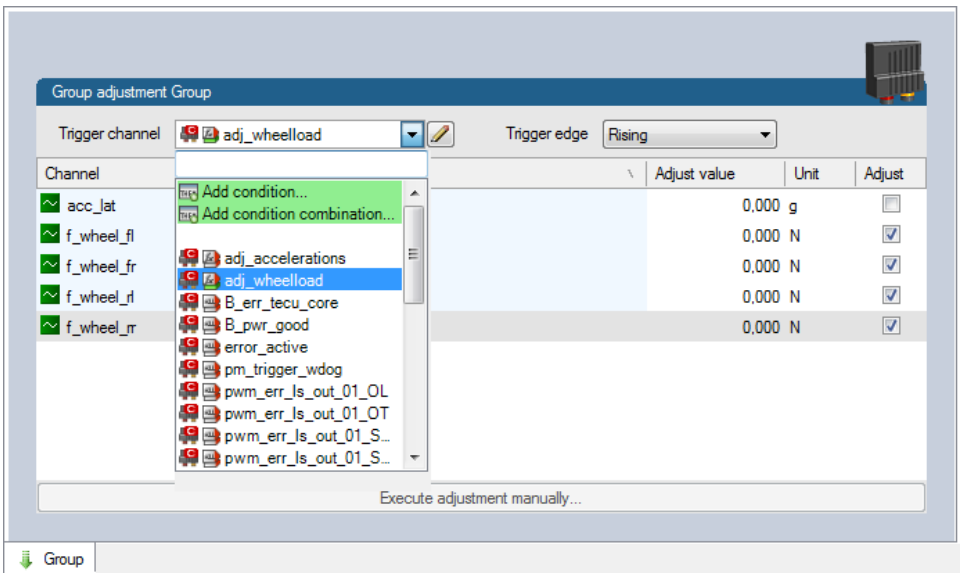



Group adjustment window is opened in the Main area with all adjustable configured channels listed.

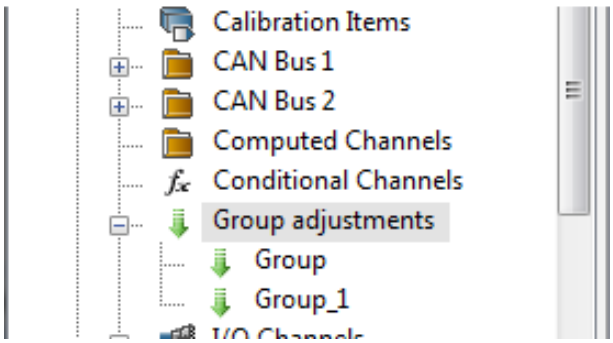



*a) Click to select a trigger channel.*
*b) Click to select activation condition.*
*c) Check box to add channel to group adjustment.*
*d) If device is online, click to test adjustment.*

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

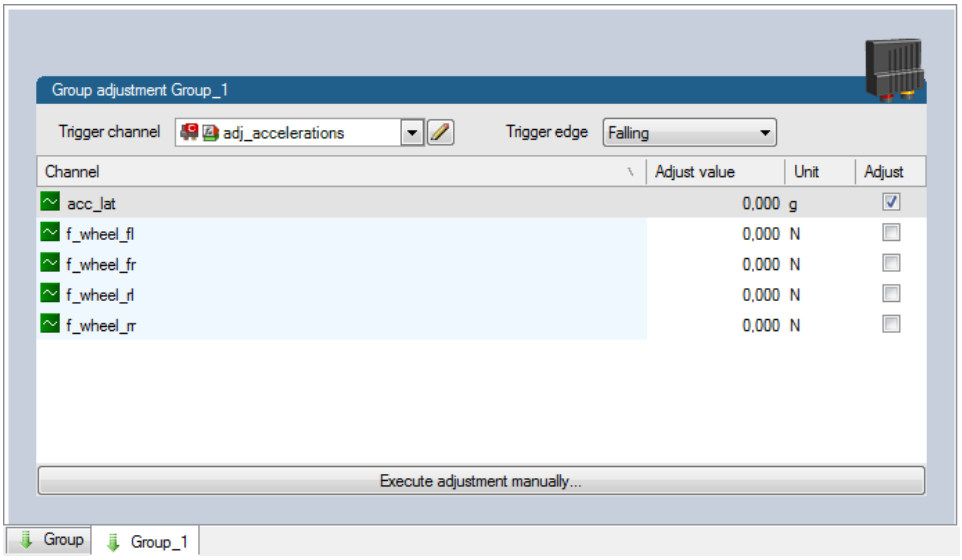



Add a further group by right-click on 'Group adjustments' in the project tree and select 'Add group adjustment'.




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

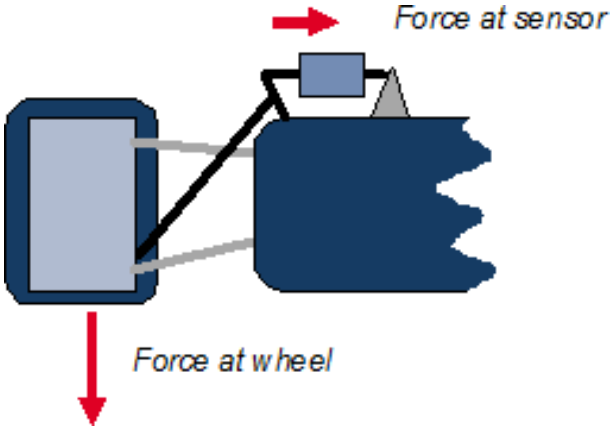
Select the trigger channel, trigger edge and assign the channels to be adjusted.




## 11.5 Online Calibration of Multipoint Adjustment Channels

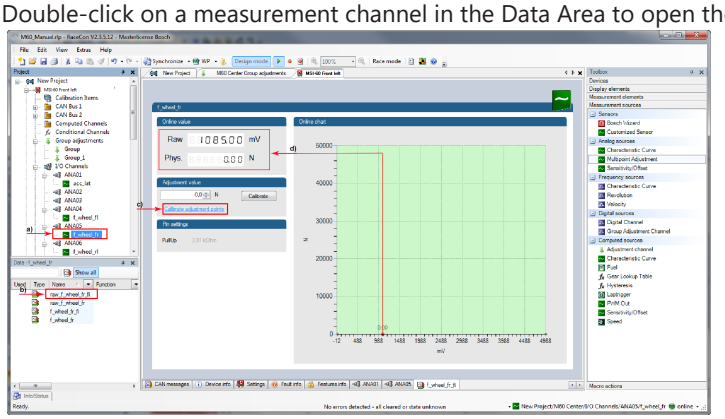
### Example: Measurement of wheel force

- 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



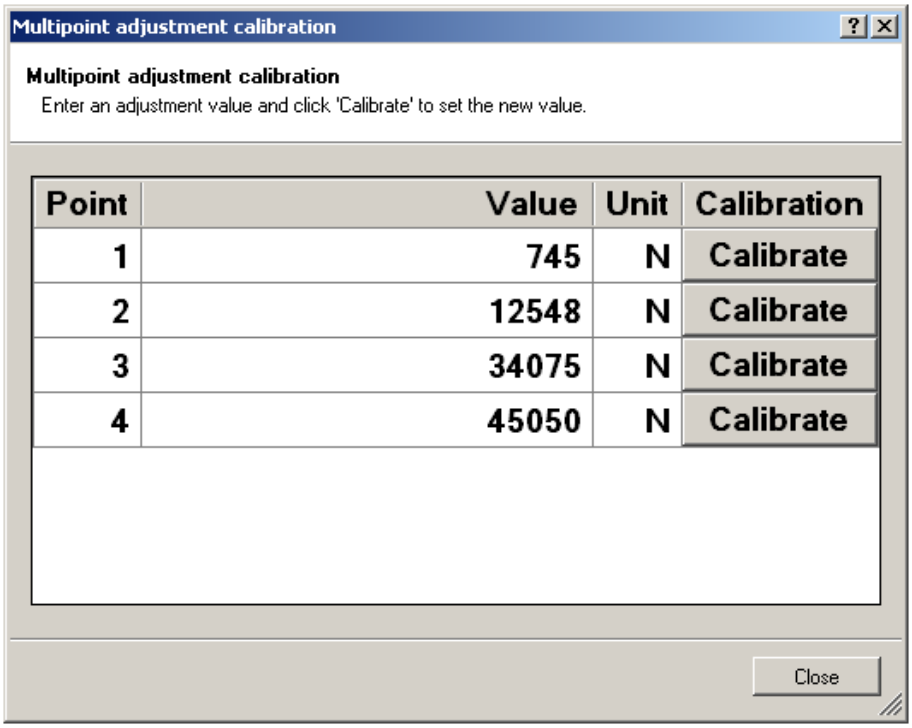

1. Create a multipoint adjustment measurement channel. To create a multipoint channel, see chapter Configuring a Multipoint Adjustment [▶ 56].
2. Download the configuration on the M 60. To connect the M 60 to RaceCon, see chapter Connecting the M 60 to RaceCon [▶ 16].
3. Click on the desired channel in the M 60 Project Tree.

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



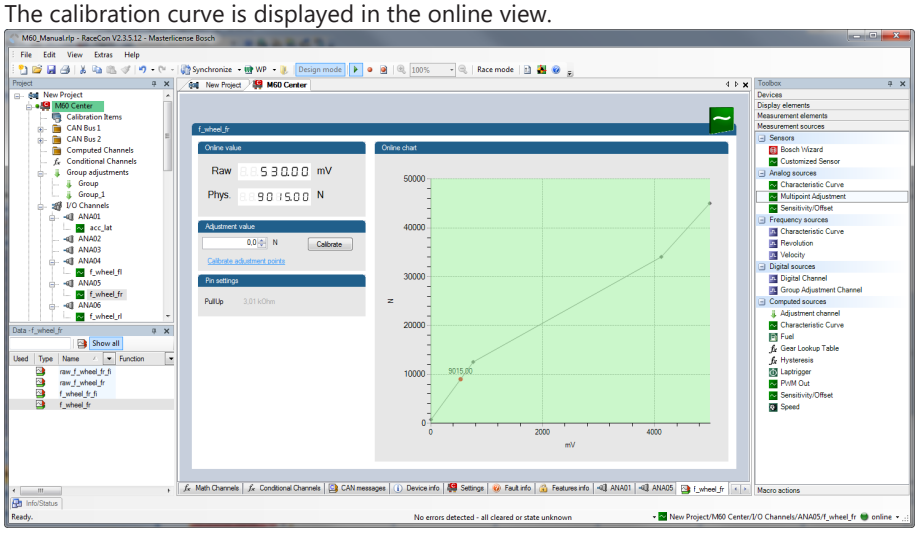
*a) Click to open measurement channels in data view.*
*b) Double-click to open online view.*
*c) Click to open calibration window.*
*d) Analog and physical value.*

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

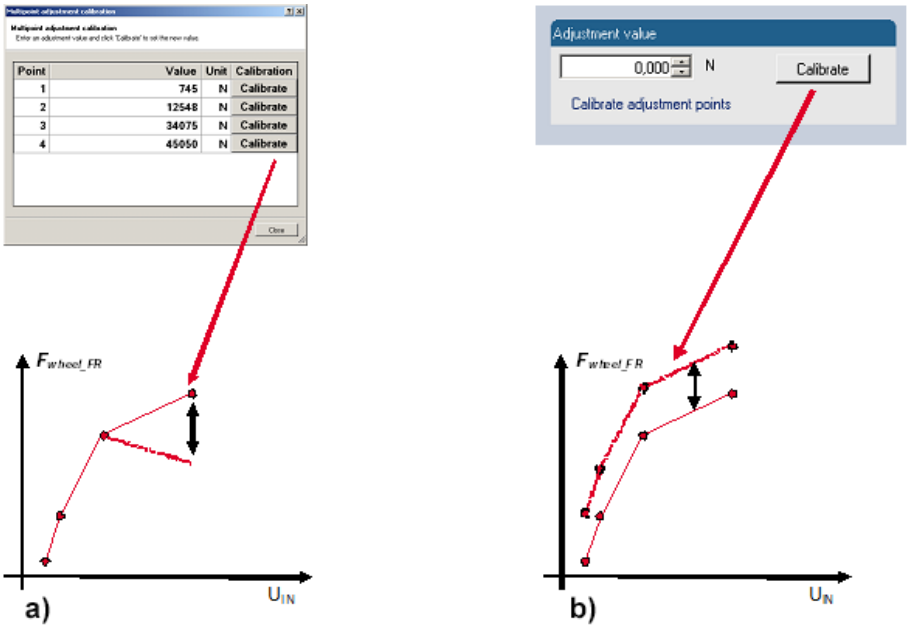



6. Apply the desired physical condition to the sensor (e.g. by applying a force on the wheel).
7. Enter the physical value in the value column of the desired calibration point (e.g. 745 N).
8. Press the ‘Calibrate’ button of the desired calibration point.
9. Repeat for all curve points.
10. Click ‘Close’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

The calibration curve is displayed in the online view.



## Adjustment points vs. offset adjustment

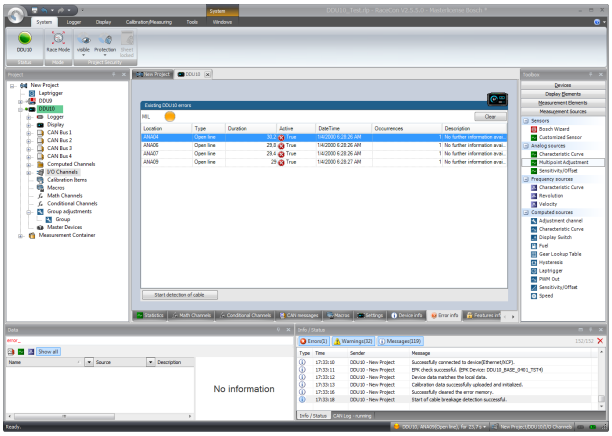


# 12 Error Memory

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.

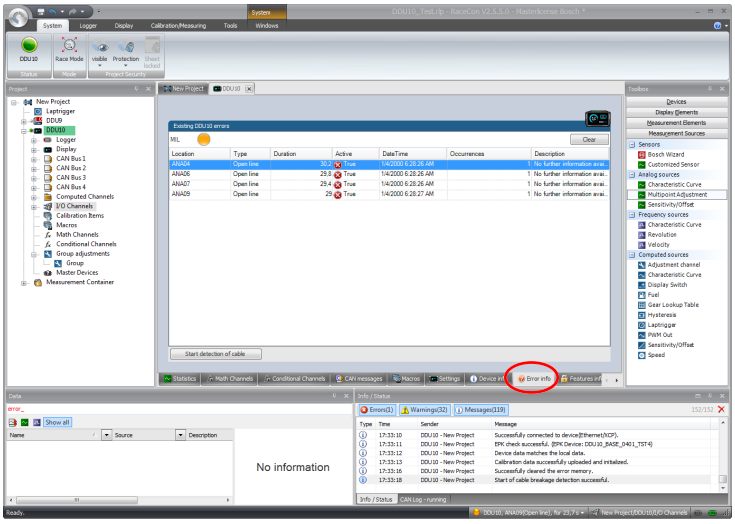
## 12.1 Error memory representation in RaceCon

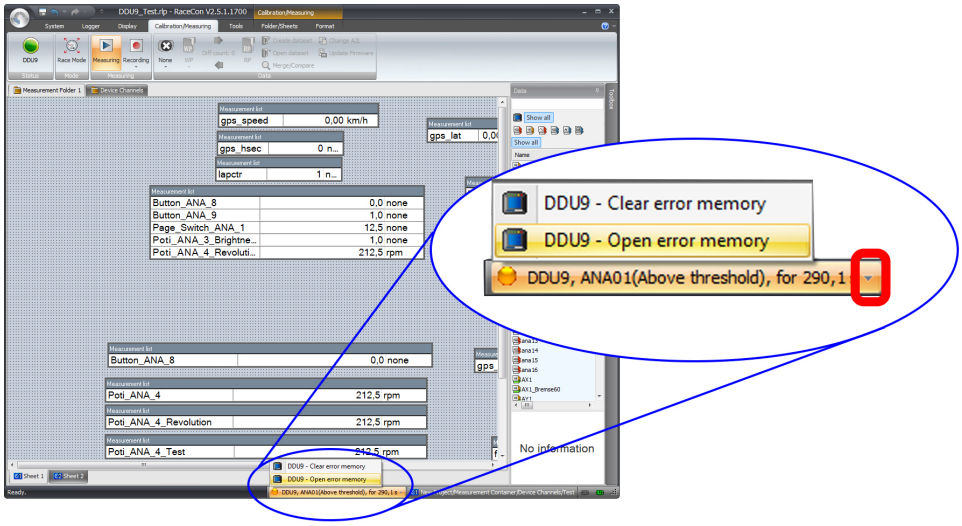
Bosch Motorsport devices feature an error memory. Information on errors can be visualized via RaceCon (online measurement) or can be transmitted via telemetry.




### 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.

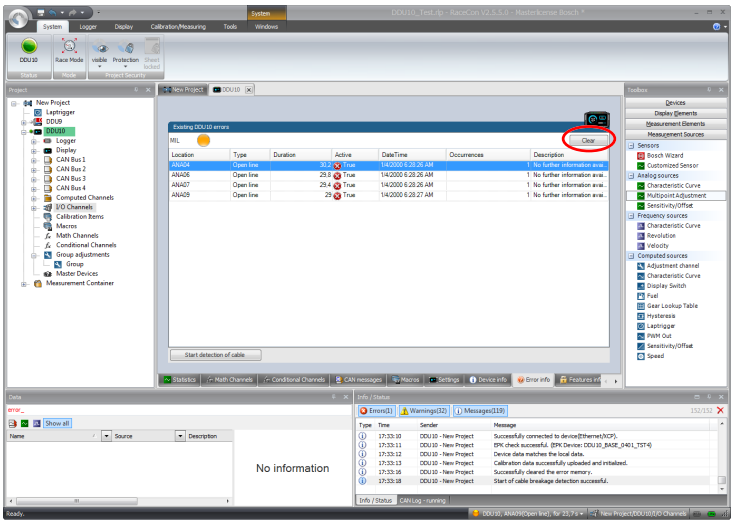
An error is deleted from the list when

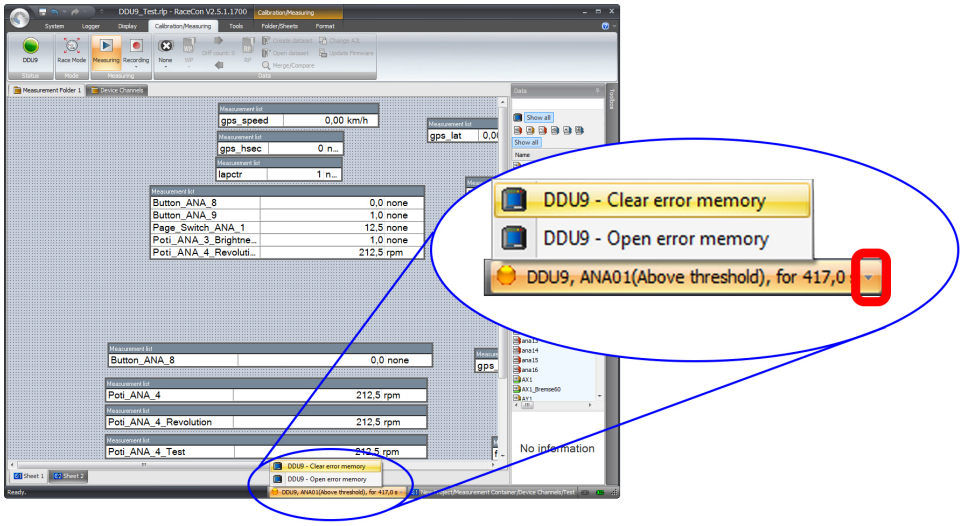
- the user actively clears the error memory
- the user updates the firmware

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

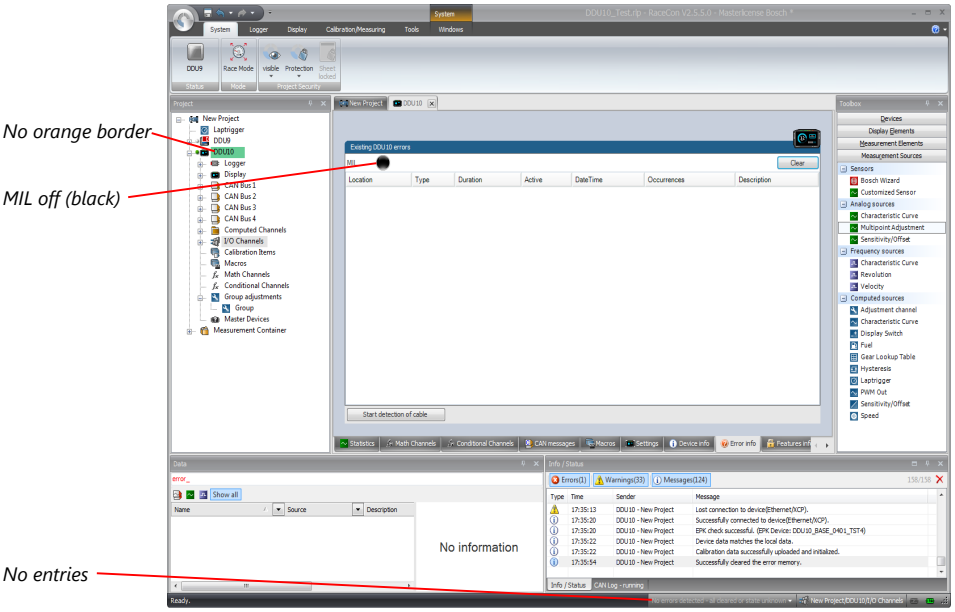
The following property is available for the error memory itself:

- 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

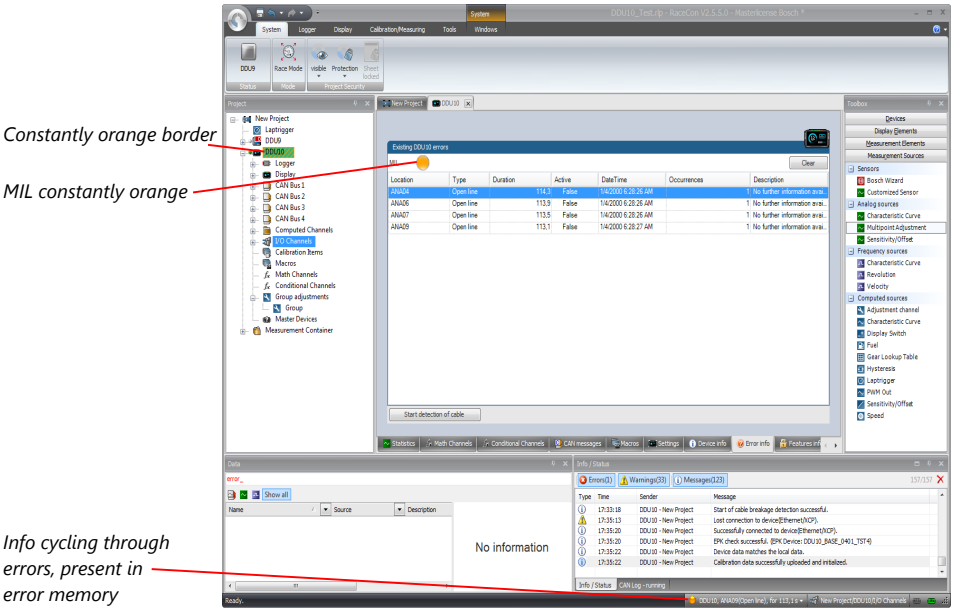
If displayed in a measurement sheet, this property’s value (0, 1 or 2) is translated into a verbal description:

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

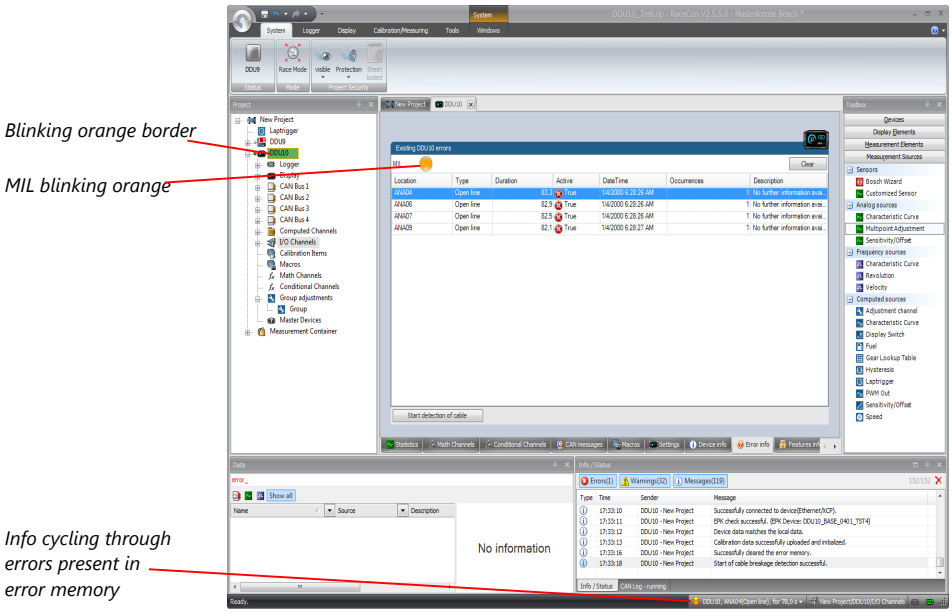
0 (no error present in memory):




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

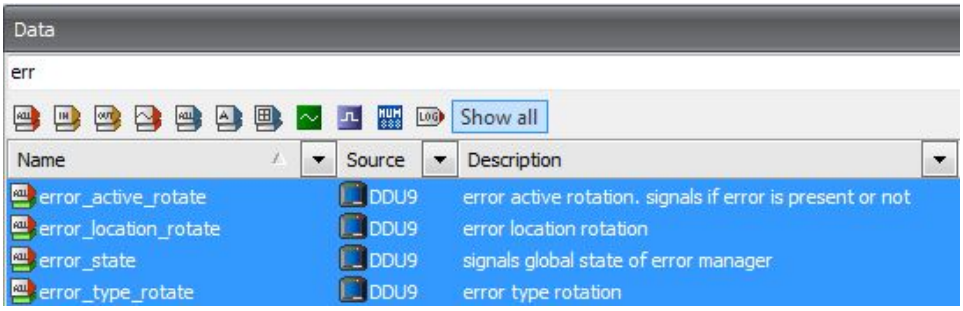


2 (at least one active error present in memory):




## 12.2.2 Error Properties

The following channels are recognized and memorized inside the devices:

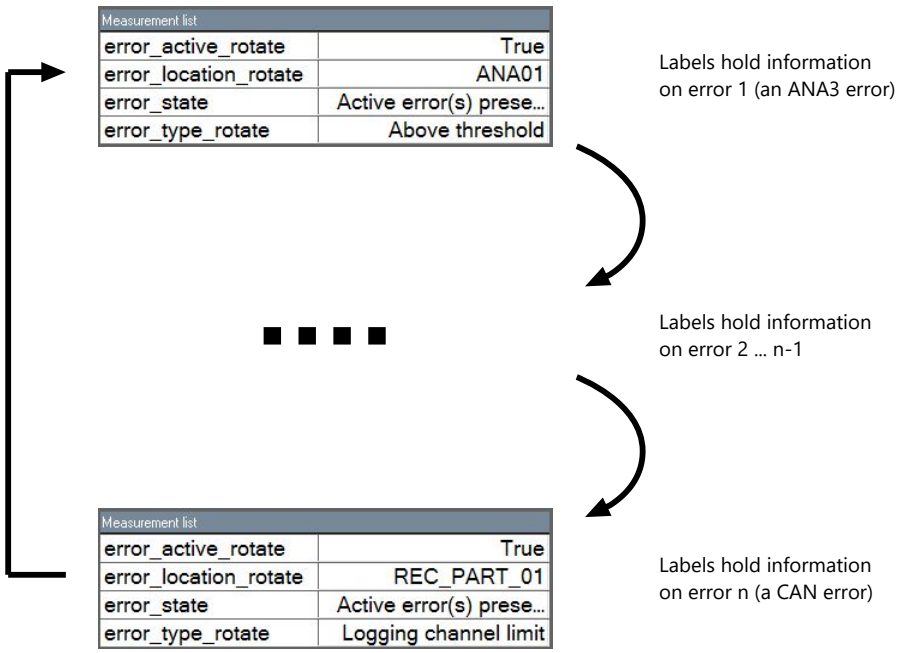



- Error type (device label “error_type_rotate”):
  e.g. “below_threshold” for a violation of the minimum voltage range defined in the configuration, “shortcut_Batt” for a shortcut to battery voltage etc.
- Error locations (device label “error_location_rotate”):
  e.g. “ANA01” for an error concerning 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:

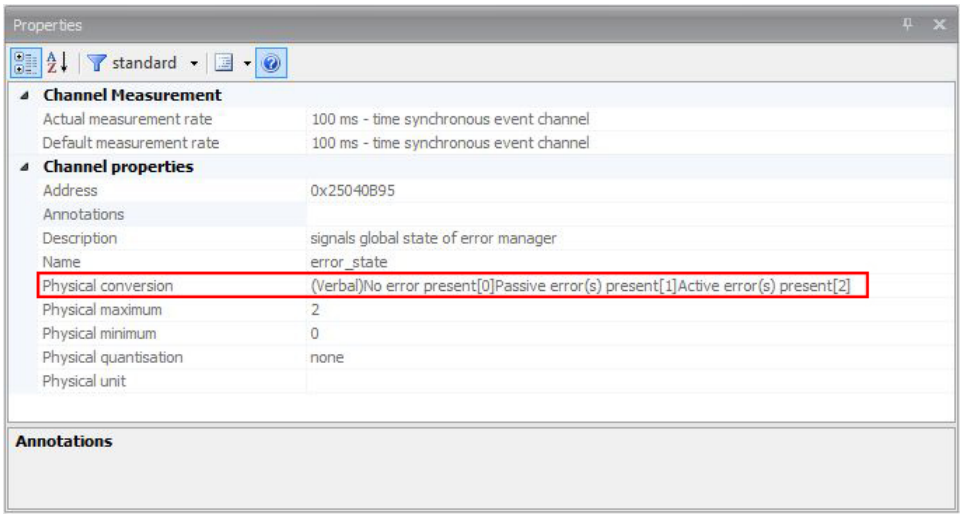



After the last error and its error properties have been displayed, the labels will start again with the first error in the error memory stack and its error properties will be displayed again. Therefore, monitoring these labels over a sufficiently long period provides the information on all individual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

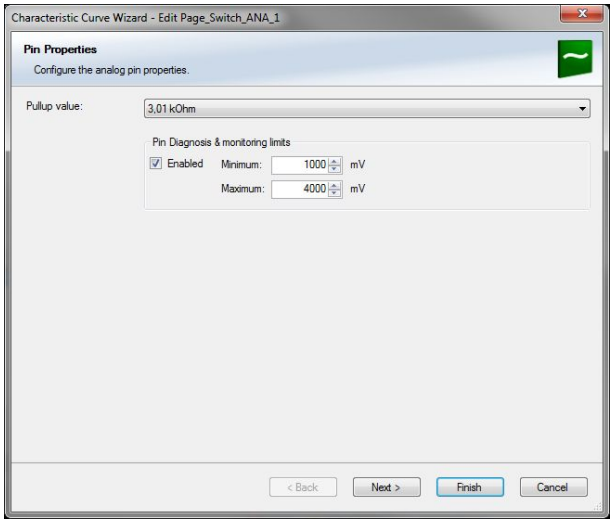
The verbal representation of the numerical codes of these labels can be visualized in the properties window of the measurement page:

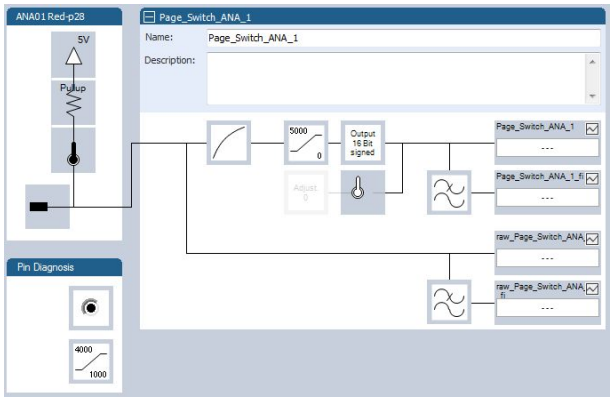



## 12.3 Analog Input Diagnosis

### 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.

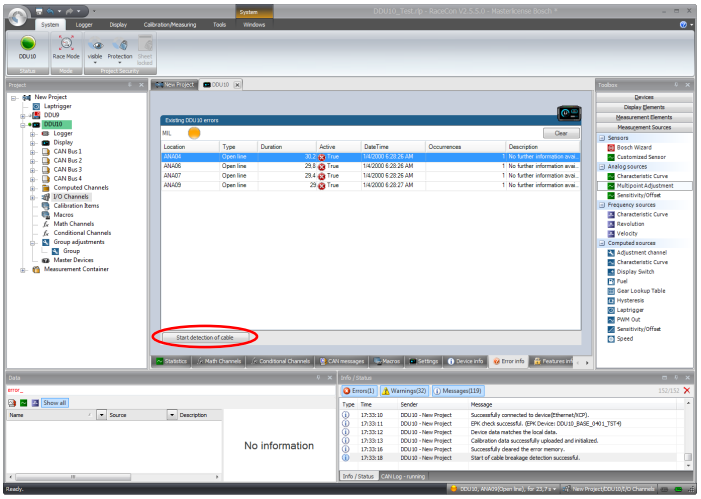


## 12.3.2 Open Line Detection

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".

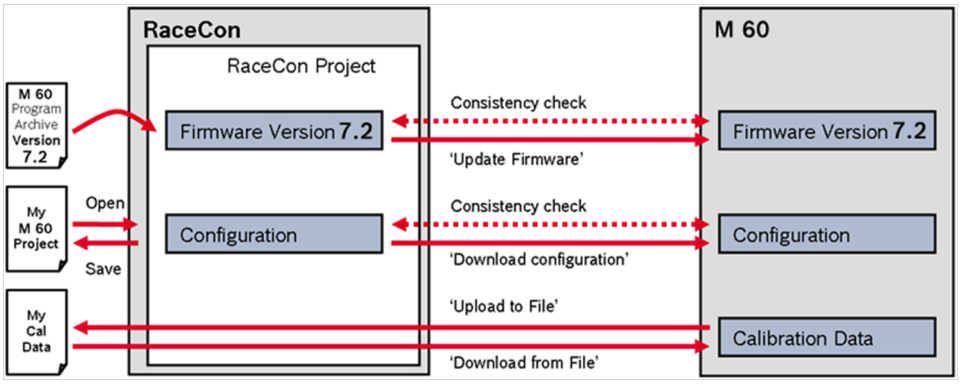


# 13 Firmware

## 13.1 Firmware and Configuration

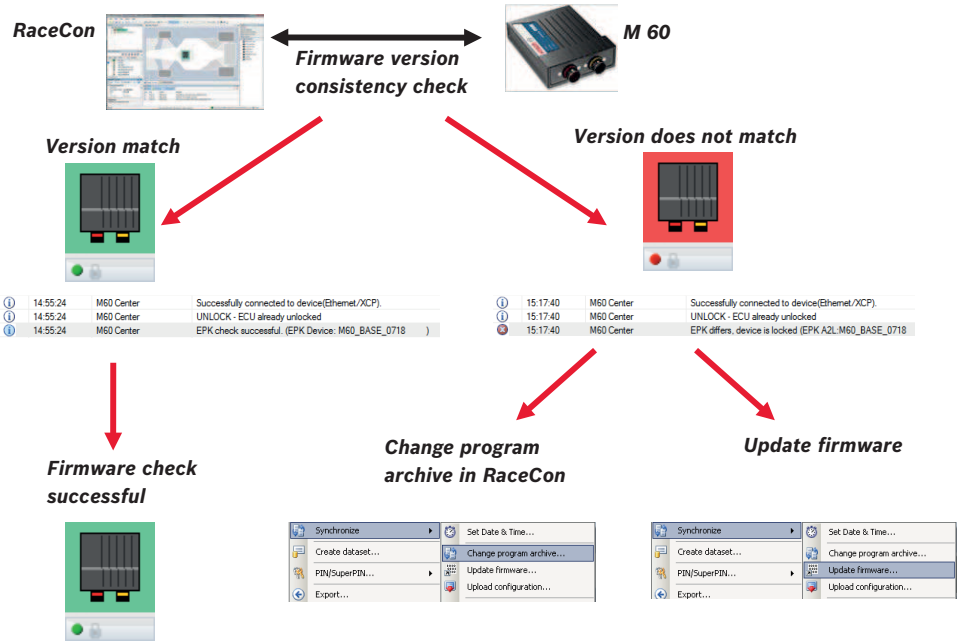
M 60 holds 3 types of data:

- Firmware: the software (PST program file) of the M 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

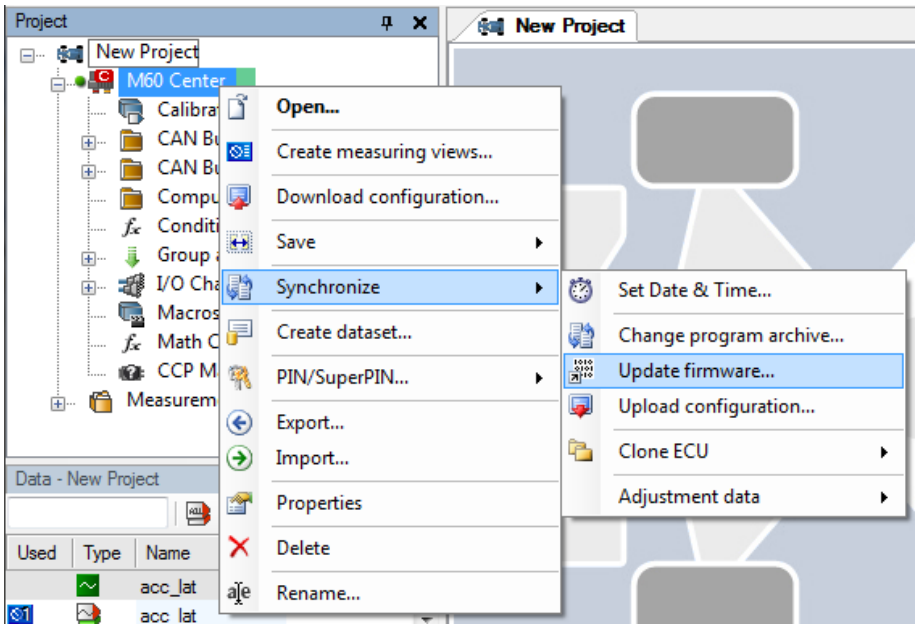
The scheme shows the process during each connection between RaceCon and M 60.



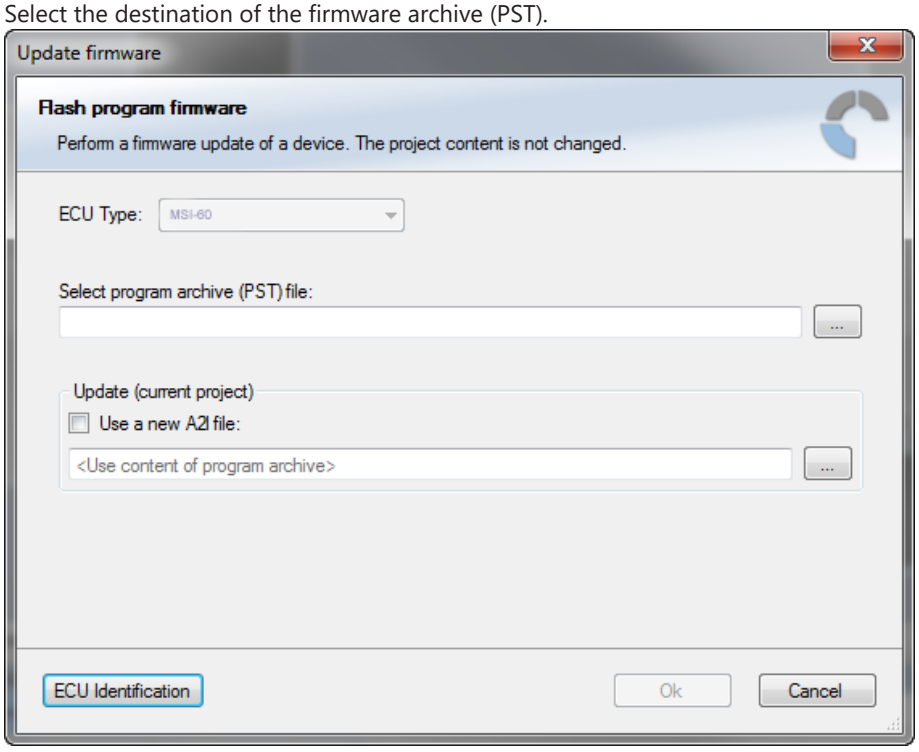

Firmware update is only possible if the M 60 is connected to RaceCon.

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

1. In the M 60 Project Tree, right-click on ‘M 60’ and choose ‘Synchronize’ then ‘Update firmware ...’.




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

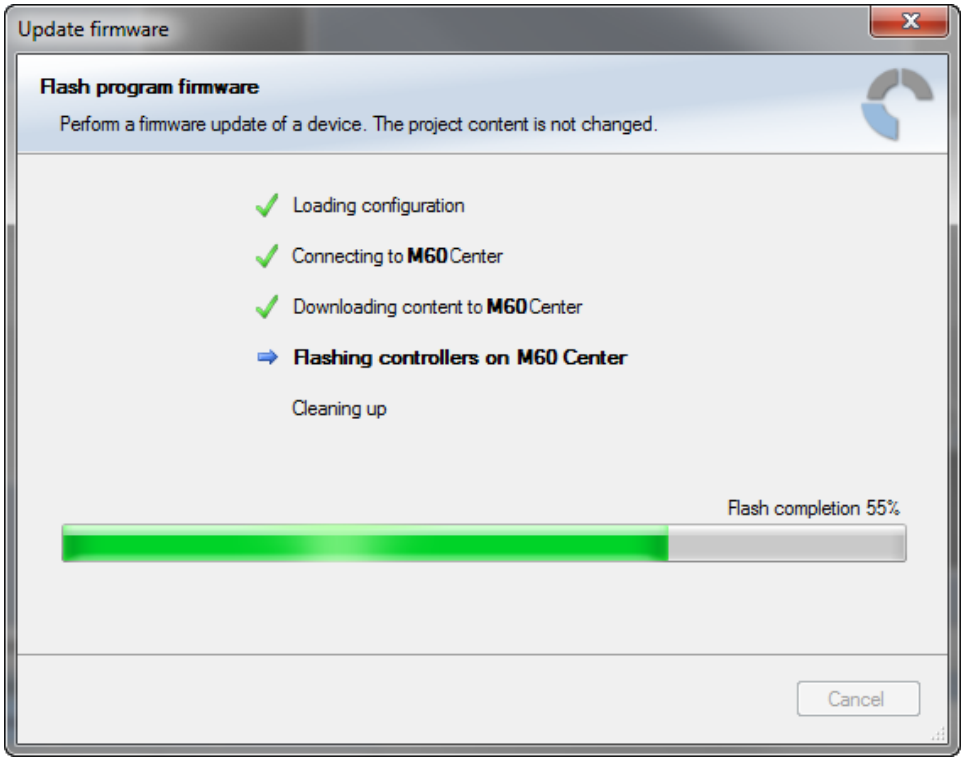



3. Click ‘OK’ when done.
   The firmware update starts. The M 60 displays the message ‘Updating firmware’. When the firmware update is complete, the M 60 displays the message ‘Updating firmware finished. Do a power cycle.’

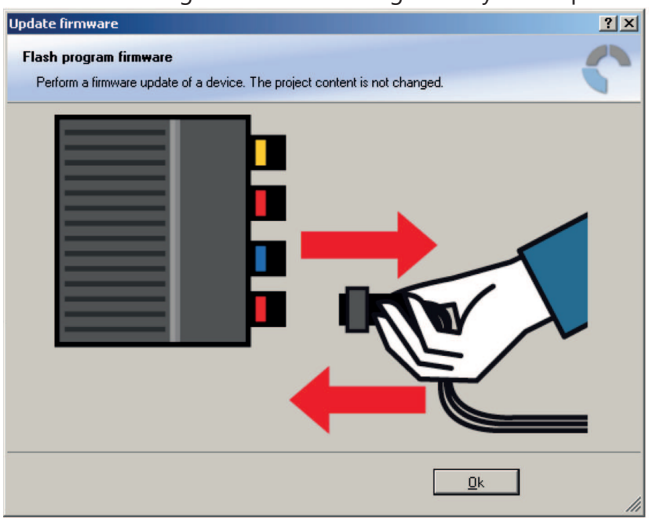
**NOTICE**

**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 M 60.

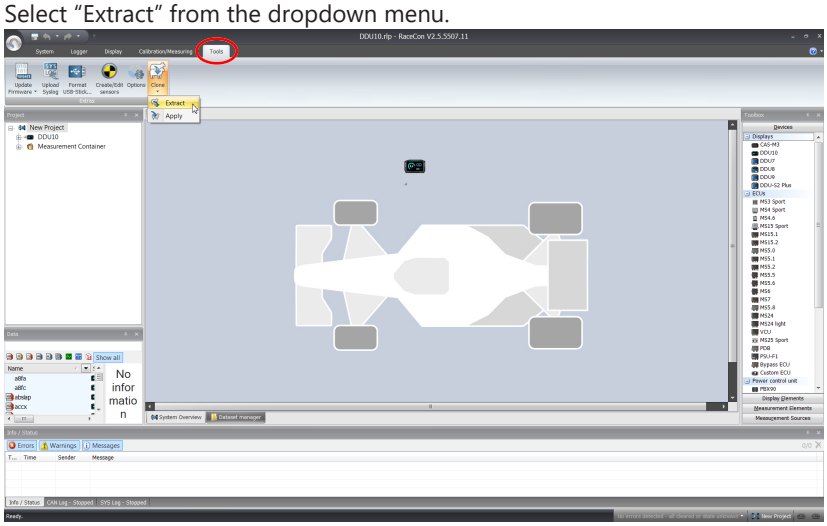


# 14 Clone the Unit

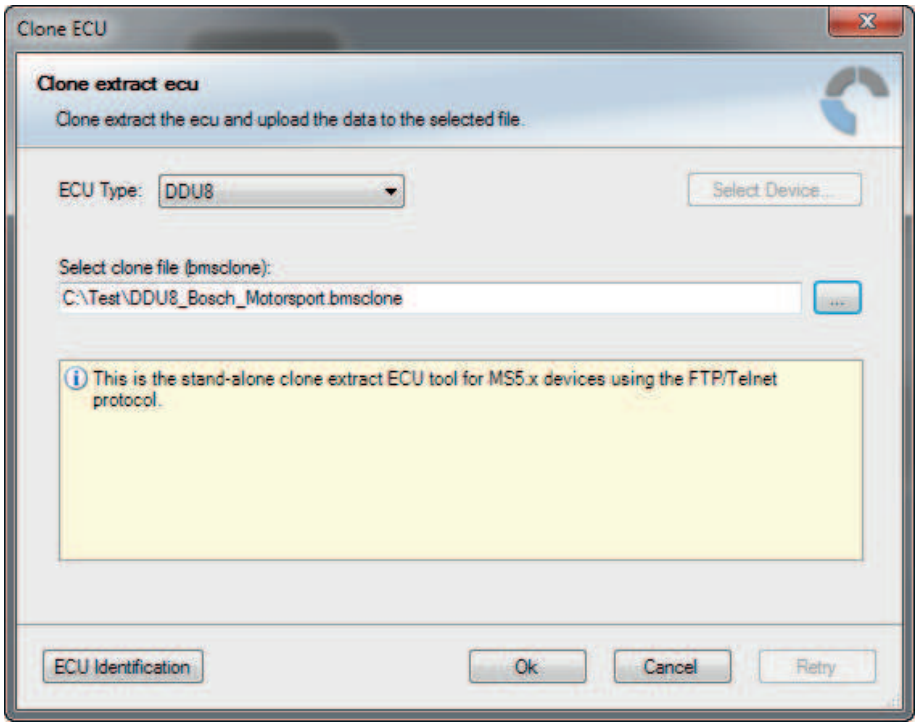
To replace a M 60 by another device, it is possible to clone it. A clone is a 1:1 copy of a device. This can be useful for copying specific data, like sensor-offset calibration to a spare unit for a specific car.

## 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.



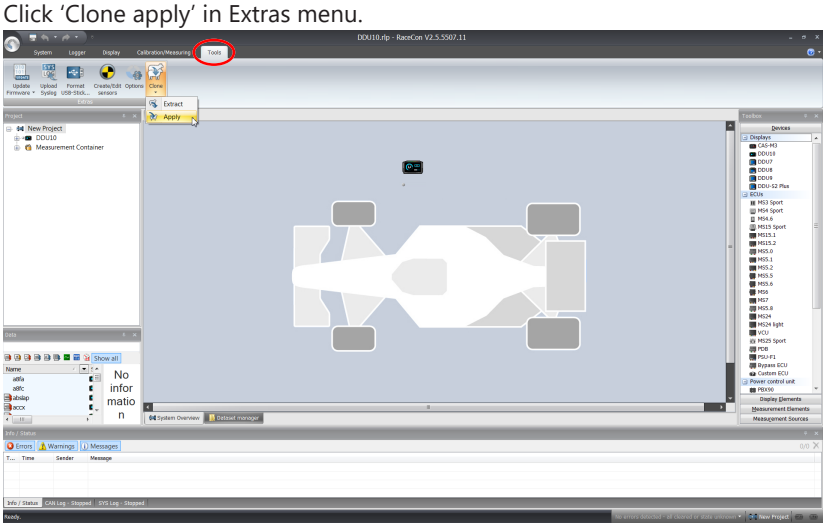

3. Choose the hardware device, which should be cloned.
4. Define destination and filename.




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 M 60 (not covered here).
- Serial output -> Read in messages via RS232 Interface of M 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, M 60 supports 1,200 to 115,200 baud. GPS Rx interface baud rate must match the device baud rate. M 60 baud rate can be set with the 'GPS_BAUDRATE' characteristic.
- Data format: M 60 expects 8 data bits, no parity bit, 1 stop bit (8N1).

## 15.2 Protocol

M 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 M 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 M 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 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.**

**Bosch Engineering GmbH**
Motorsport
Robert-Bosch-Allee 1
74232 Abstatt
**Germany**
www.bosch-motorsport.com