BOSCH

Engine Control Unit MS 6

Manual

Version 1.2 14/01/2022

Content

1 Getting Started

Disclaimer

Due to continuous enhancements we reserve the rights to change illustrations, photos or technical data within this manual. Please retain this manual for your records.

Before starting

Before starting your engine for the first time, install the complete software. Bosch Motorsport software is developed for Windows operation systems. 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 backside of this document.

⚠ CAUTION

Risk of injury if using the MS 6 inappropriately.

Use the MS 6 only as intended in this manual. Any maintenance or repair must be performed by authorized and qualified personnel approved by Bosch Motorsport.

⚠ CAUTION

Risk of injury if using the MS 6 with uncertified combinations and accessories

Operation of the MS 6 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 is only permitted when they have been determined to be compliant from a performance and safety standpoint by a representative from Bosch Motorsport.

NOTICE

For professionals only

The Bosch Motorsport MS 6 was developed for use by professionals and requires in depth knowledge of automobile technology and experience in motorsport. Using the system does not come without its risks.

It is the duty of the customer to use the system for motor racing purposes only and not on public roads. We accept no responsibility for the reliability of the system on public roads. In the event that the system is used on public roads, we shall not be held responsible or liable for damages.

2 Technical Data

The MS 6 engine control unit features a powerful digital processing dual-core with floating point arithmetic and a high-end field programmable gate array FPGA for ultimate performance and flexibility.

The software development process is based on MATLAB® & Simulink®. It significantly speeds algorithm development by using automatic code and documentation generation.

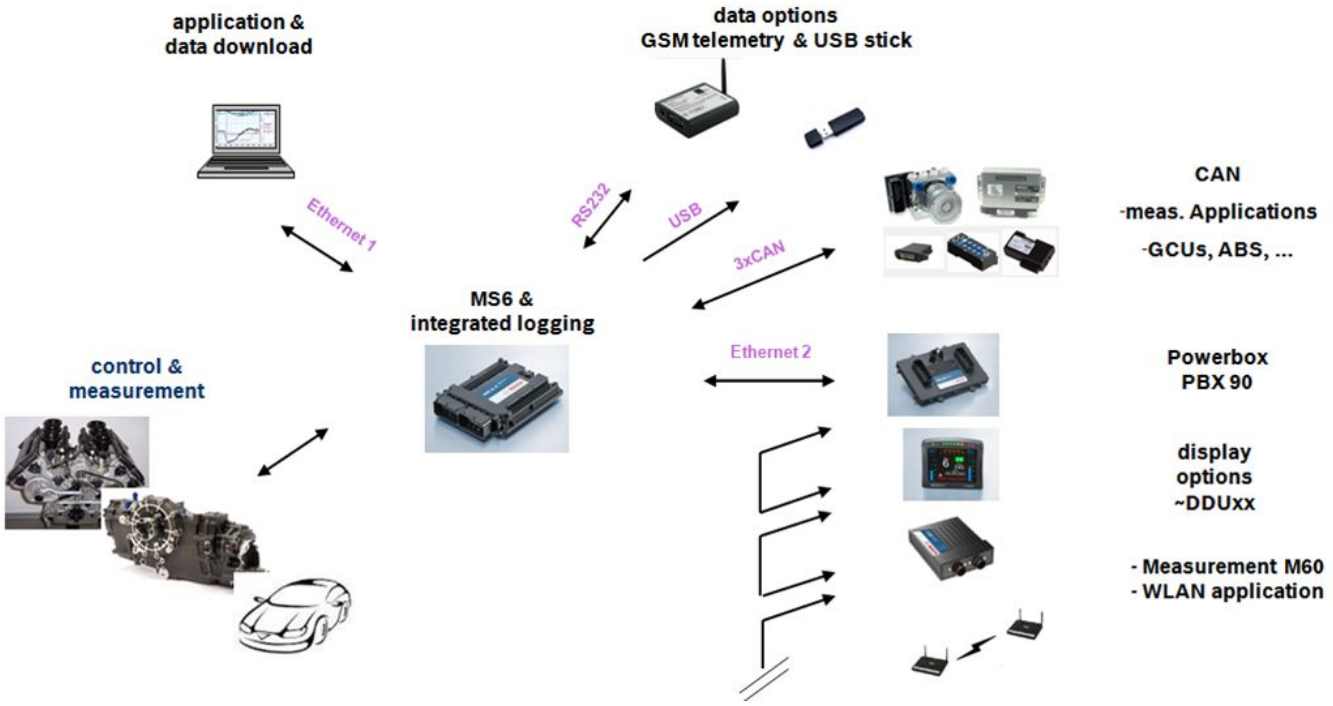
Custom functions can be generated quickly and easily. The flexible hardware design allows the MS 6 to support complex or unusual engine or chassis configurations. Integrated logger control areas present a cost efficient and weight optimized all-in-one solution.

2.1 System Layout

- Controls for max. 12 cylinder engines are available with the selection of low- or high pressure injection.
- Integrated torque-structures for power control functions as speed-, launch, rpm and traction limitations or regulations
- Two engine bank related separated lines for physical air mass determination, influenced by own Lambda corrections
- Options from simple gear cut support up to complete gear change functions
- Different target maps to differ applications like Lambda-, spark- and electrical throttle controls
- State of the art engine functions like fuel cut off, idle control, injection valve corrections and knock control are already integrated in the basic program structure.
- Sequential fuel injection realized also for asymmetric injection and ignition timings
- Various networks like 2 Ethernet-, 1 USB, 1 LIN for system communication, 3 configurable CAN for external device communication and 1 RS232 for online telemetry data.
- Functionalities may be linked to in and outputs for free system design or harness adaptation
- Internal data logger divided into 2 partitions, 1 GB each
- Option to copy all data to removable USB stick

Layout restrictions

Ethernet Network	MS 6, as Time master, permits the extension of two additional devices. Using - MS 6.1 F02U.V01.961-03, - MS 6.2 F02U.V01.867-06, - MS 6.3 F02U.V01.963-03 or - MS 6.4 F02U.V02.019-06 permits the extension of 4 additional devices.
CAN Network	Extended number of members and wiring leads extend the risk of error frames
RS232	Limited to one additional component
USB	Limited to additional Bosch Motorsport USB stick
LIN	Permitted for the use of Bosch Motorsport preconfigured configurations



2.1.1 Structure of Devices and Licenses

To accommodate the wide range of different engine requirements and racetrack operating conditions, the MS 6 Motronic system is classified into the main groups high- and low pressure injection support, subdivided into fully equipped- and functional reduced versions.

Beside the change from low- to high-pressure systems, all limited functions may be activated later. The license concept is related to the individual device and the requested upgrading.

For MS 6.1	
Engine function package I	To activate electronic throttle, camshaft and turbo control
Engine function package II	To activate traction and launch control

For MS 6.1 and MS 6.3	
Measurement package	To increase from 21 to 42 analogue channel inputs

For MS 6.3	
High pressure injection package	To activate 2nd engine bank and 2nd MSV controls

For MS 6.2, 6.3 and 6.4	
Customer Code Area	Enable Customer Code Area

For all MS 6 Versions	
Logger package I	Increase the number of measure channels up to 720 Sampling up to 1,000 Hz or 1 synchro Max. number of 1,080 channels are to respect
Logger package II	Activation of partition 2, 1 GB memory, 720 channels Sampling up to 1,000 Hz or 1 synchro Long term recording, own data protection code
Logger package III	Copy data to USB data stick, USB-port unlocked – Incl. adapter cable to USB-port – Incl. rugged USB flash drive – Incl. connector for wiring harness
Gear control package I	Gear change control, based upon Mega-Line functions (License model via Mega-Line) [included for base versions beginning with MS6A_BASE_0800 or comparable]
-- Link to Mega Line Support Request --	
-- Link to Mega-Line License Request Form --	
Gear control package II	Strategy for pneumatic forced gear change control
Innovation License Device	Activation of engine speed functions* and near/far injection function per unit
Innovation Package Project	Activation of engine speed functions* and near/far injection function per project version
SW Package MS 6 Drag 1	Launch Timer Launch Distance Torque Pre-Control Launch RPM Control Universal Outputs for Time/Distance Controls
SW Package MS 6 Drag 2 (requires Drag 1 License)	Acceleration Sensor MM5.10 included Time/Distance Boost Control Driveshaft Speed Control Driveshaft Gradient Control Acceleration Control Wheelie Control

NOTICE

Verify the necessity of gearbox control licenses by checking the Features info window in RaceCon (see section Feature/License Activation [▶ 19]).

2.2 Mechanical Data

Aluminum housing
2 automotive connectors, 196 pins in total
Vibration suppression via multipoint fixed circuit boards

Size without connectors	226 x 181 x 44 mm
Weight	1,086 g
Protection Classification	IP54
Temperature range	-20 to 80°C
Inspection services recommended after 220 h or 2 years, no components to replace	

2.2.1 Installation

Mounting	4 housing integrated screw sockets
Offer drawing	Available at Bosch Motorsport website on MS 6 product page.
3D Data	Available at Bosch Motorsport website on MS 6 product page.

Recommendation

Use rubber vibration absorbers for soft mounting in the vehicle. To assist the heat flow, especially if HP injection is active, the device has to be mounted uncovered and air circulation has to be guaranteed around the entire surface area.

Inside touring cars placement passenger side is favored, open connectors should not be uncovered to vertical axe. It has to be assured in mounting position that water cannot infiltrate through wiring harness into the ECU and that the pressure compensating element and the sealing in the revolving groove do not get submerged in water. Wiring harness needs to be fixed mechanically in the area of the ECU in a way that excitation of ECU have the same sequence.

2.3 Electrical Data

Power supply	6 to 18 V
CPU	Dual Core 667 MHz; FPGA

2.3.1 Communication

3 x CAN	The MS 6 has 3 CAN buses configurable as input and output. Different baud rates are selectable. Please note that the MS 6 contain integrated switchable 120 Ohm CAN termination resistors.
1 x LIN	The Bus is not configurable by the customer, but Bosch Motorsport offers data selectable protocols to integrate LIN based devices into the system.
2 x Ethernet	Integrated are 100 Mbit full duplex Ethernet communication ports, internally connected with an Ethernet switch. The ports have “cable auto crossover” functionality
1 x USB	For data transfer to an USB-stick
1 x RS232	One serial port with programmable baud rate for online telemetry
1 x Timesync Coordination	For additional devices added via Ethernet

2.3.2 Inputs

The analogue inputs are divided in different hardware classes and qualities.

3.01 kOhm pull-ups are fixed or switchable designed to assist passive sensor elements like NTC temperature sensors or to change to active signal inputs.

Some of the inputs assist only active sensors and offer no pull-up.

To improve measurement tasks, angle related measurements are an option for some inputs, mainly used for engine related leading signals.

The connection between function and related input is free selectable, beside electronic throttle functionalities.

All linearization mappings are open to the customer, some signals offer online modes to calibrate gain and offset.

Digital inputs for speed measuring offer divers hardware options to connect inductive- or digital speed sensors.

Please respect: for camshaft- or wheel speed signals Hall-effect or DF11 sensors have to be used and for wide range Lambda measurement and control the Lambda sensor Bosch LSU 4.9 has to be used.

42 analog inputs in a mix of different hardware designs
6 x reserved for electronic throttle controls
10 x no integrated pull-up
4 x option for time synchronous measurement, no integrated pull-up
2 x option for time synchronous measurement, switchable 1.47 kOhm pull-up
5 x fixed 3.01 kOhm pull-up
13 x switchable 3.01 kOhm pull-up
2 x thermocouple exhaust gas temperature sensors (K-type)

6 internal measurements
1 x ambient pressure
1 x triax acceleration
2 x ECU temperature
2 x ECU voltage

8 function related inputs
2 x Lambda interfaces for LSU 4.9 sensor types
1 x lap trigger/beacon input
4 x knock sensors
1 x digital switch for engine ON/OFF

9 digital inputs for speed and position measurements
1 x switchable Hall or inductive sensor for flywheel measurement
2 x Hall sensor for sync wheel detection
4 x switchable Hall or DF11 sensors for camshaft position or wheel speed
2 x switchable Hall or inductive sensors for turbo speed measurement

2.3.3 Sensor supplies and screens

4 x sensor supplies 5 V / 50 mA
3 x sensor supplies 5 V / 150 mA

7 x sensor grounds
2 x sensor screens

2.3.4 Outputs

19 freely configurable outputs in a mix of different hardware designs
8 x 2.2 amp pwm lowside switch
4 x 3 amp pwm lowside switch
2 x 4 amp pwm lowside switch
2 x 1 amp pwm lowside switch
2 x 1 amp pwm lowside switch, low dump resistant
1 x 8.5 amp H-bridge

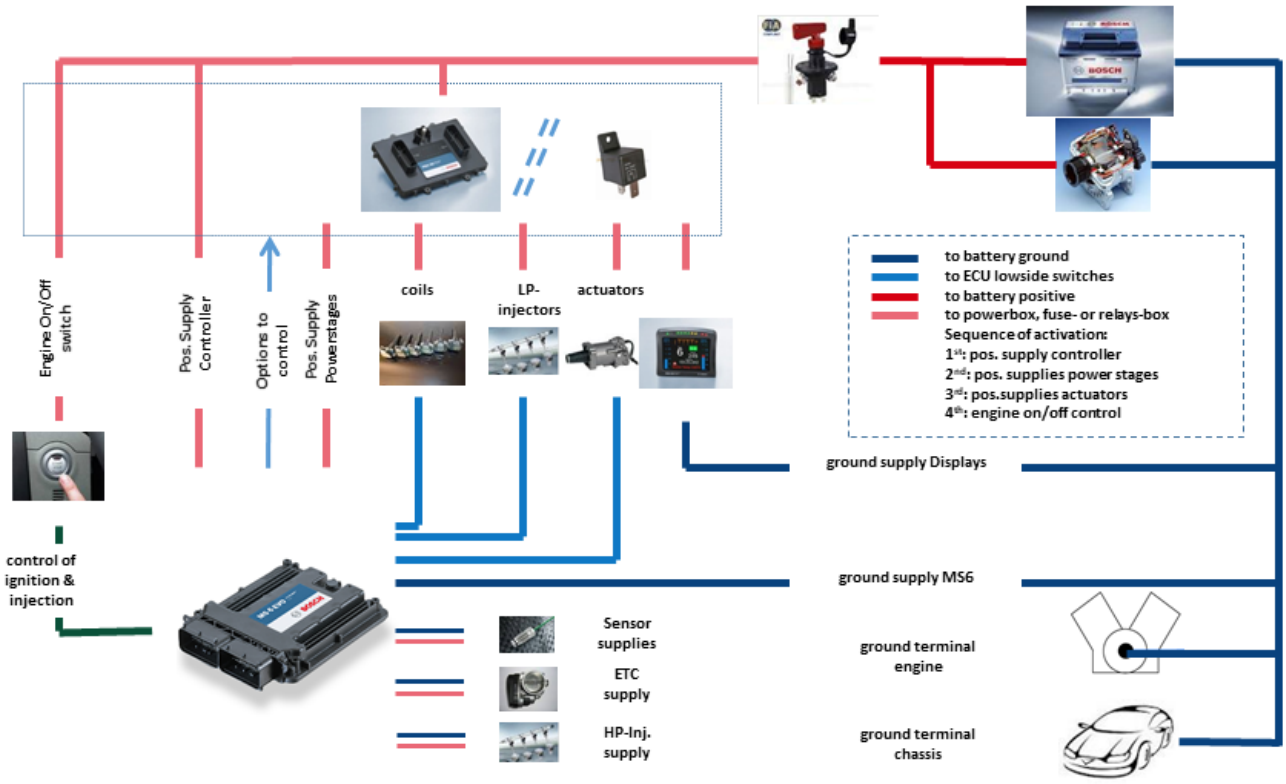
38 function related outputs
12 x ignition controls, support of coils with integrated amplifier only
12 x low pressure injection power stages for high impedance valves (max. 2.2 amps and min. 6 Ohm internal resistance of the injectors)
8 x high pressure injection power stages for magnetic valves (HDEV 5)
2 x outputs for high pressure pump controls (MSV)
2 x 8.5 amp H-bridge for electronic throttle control
2 x 4 amp pwm lowside switch for Lambda heater

3 output signals
1 x flywheel
1 x trigger wheel
1 x engine rpm

2.3.5 Supply System

Please ensure that you have a good ground installation with a solid, low resistance connection to the battery minus terminal. The connection should be free from dirt, grease, paint, anodizing, etc.

- MS 6 power consumption at appr. 13 V (vary according to use cases)
  - ~ 25 - 30 amps (4 cyl. FDI at 8,500 1/min/200 bar single injection, 1 MSV, 1 electronic throttle, standard chassis equipment)
  - ~ 35 - 40 amps (8 cyl. FDI at 8,500 1/min/200 bar single injection, 2 MSV, 2 electronic throttle, standard chassis equipment)
- Power consumption of LP-injectors, actuators and coils are to calculate separately.
- The MS 6 power supply is separated into the maintenance of controller and power stages.
- Ensure controller supply UBAT is activated before the power stages.
- The MS 6 is able to control a main relay or even the power box itself via a low side output.
- As long as the controller is activated, data logging, telemetry and communication is also ongoing.
- The engine On/Off switch activates the ignition and injection outputs to enable engine start separately from power supply.



2.3.6 Ignition Trigger Wheel

To detect the engine position and to calculate the exact crankcase position, the system assumes toothed trigger wheels for proper operation. Recommended is to use 60 (-2) teeth for the flywheel and one teeth for the camshaft detection. Modifications of the mechanical designs are possible, such as using quick-start production designs for the camshaft or different number of teeth for the flywheel **(limited to 30 to 60 teeth)**.

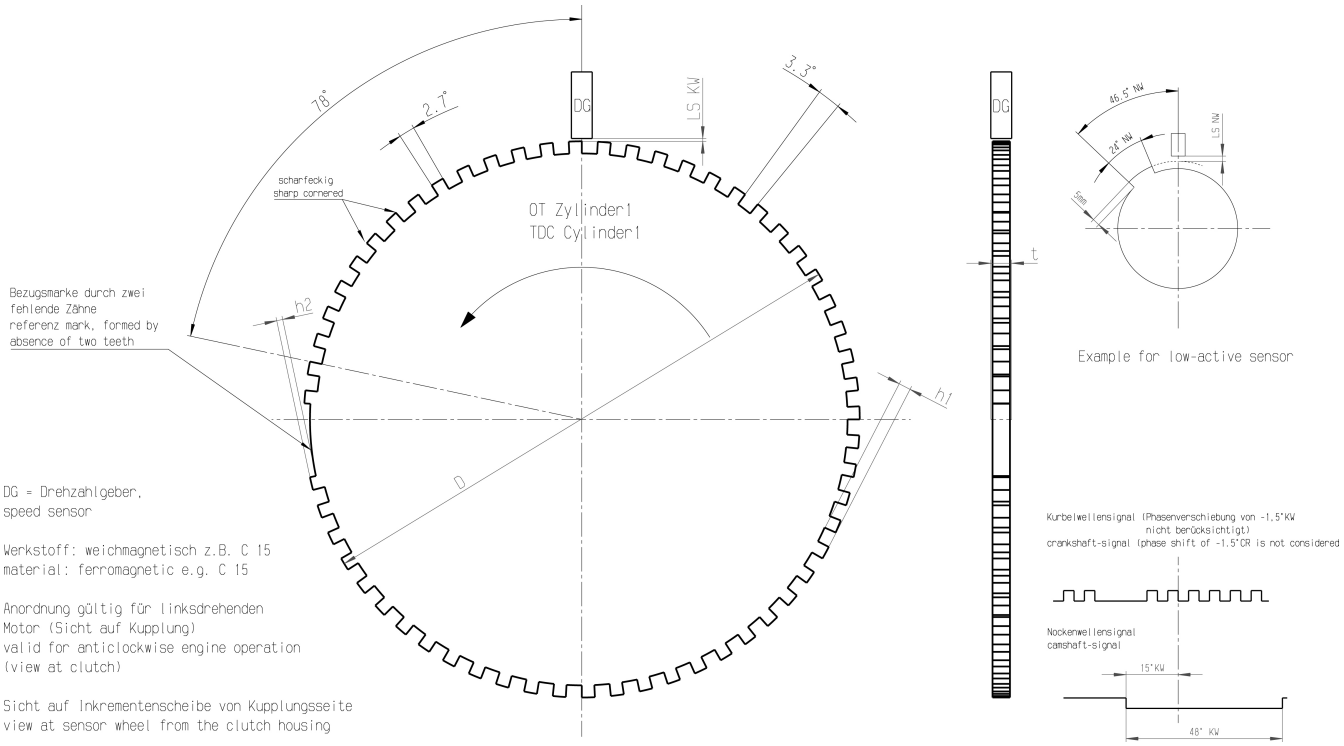
NOTICE

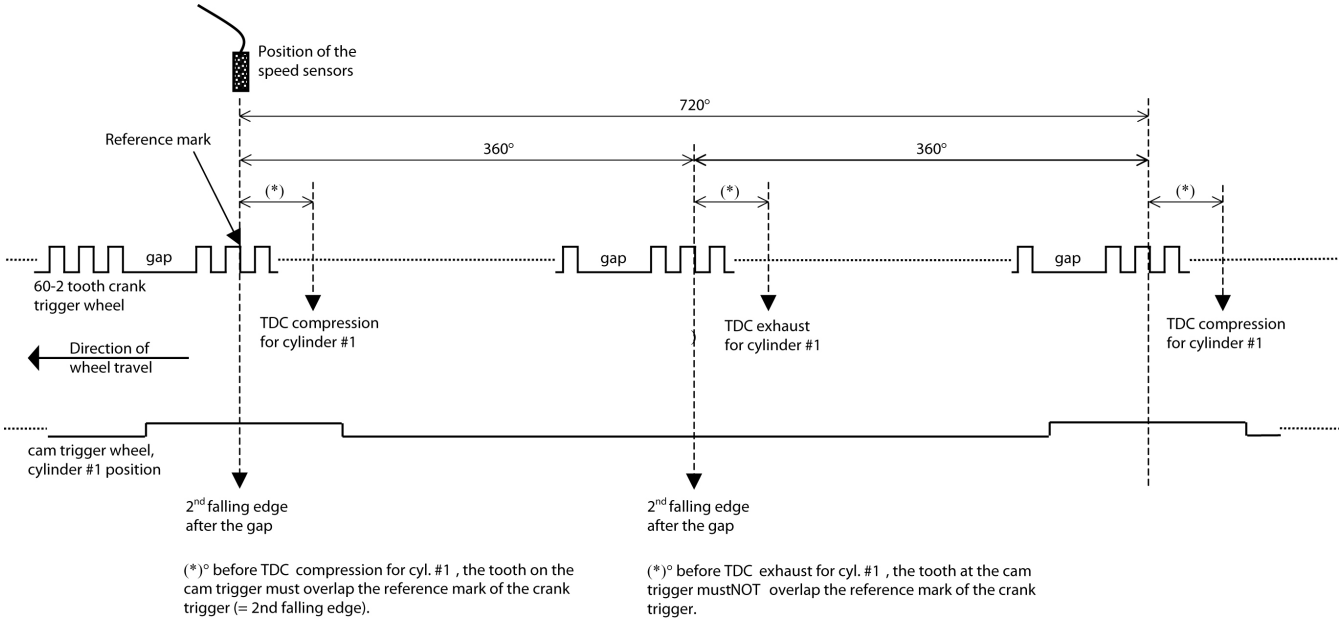
Less number of teeth reduces the accuracy of the system angle measurement.

Not usable are flywheels with 4-1 or 6-1 teeth. Please follow the description below as recommendation for the mechanical dimensions.

Recommended values:

- D = min. 160 mm
- h1 = 3.5 mm
- h2 = h1/2 (important for the use of inductive sensor)
- LSKW = 0.8 mm +/- 0.3 mm
- t = min. 5 mm
- LNSW = 1.0 mm +/- 0.5 mm





NOTICE

All angles are shown and indicated in crankshaft degrees.

The width of the cam trigger tooth is not important, however it is recommended to use at least 48 crankshaft degrees (24 cam degrees).

The Hall effect signal may be the inversion of its cam trigger: the tooth effects a “low” signal at the sensor and vice versa for other trigger wheel configurations the indicated values may vary.

2.4 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.

3 Starting up

NOTICE

All following chapters (Starting up to Harness / Wiring) refer to the MS 6 base family. Some screenshots were taken from the MS 6 family.

3.1 Installation of Software Tools

PC tools and ECU programs for the MS 6 system are available at Bosch Motorsport homepage for free download.

RaceCon V2.5.1.400 or higher	System configuration, data application and online measurement
WinDarab V7	Data analysis tool, Light version as shareware or Expert version if license available
MS 6 customer_delivery	ECU programs and function description

All tools are delivered as self-installing executable files.

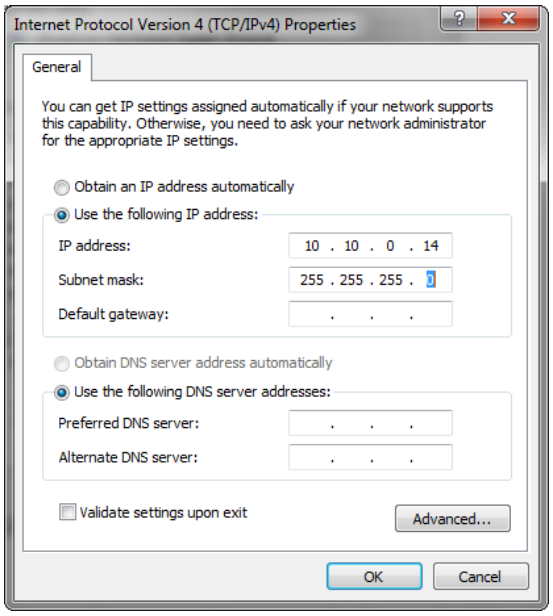
Select your personal installation folder.

3.1.1 Communication PC to device

Ethernet as used network may have some restrictions by firewall and IT protections. Be assure no firewall is active at the PC.

For assistance, Bosch Motorsport homepage explains the necessary PC installations.

The MS 6 system requests a defined IP-adress at the PC, for example 10.10.0.14.



Middle of 2016, programs and basic systems were extended to handle automatic TCP/IP selection also. Former produced devices and program versions may be modified to customer request and -order.

MS 6 devices are connectable via commercial CAT7 cables to the PC; also Bosch Motorsport offers diagnostic cable and programming harnesses as track- and office connections.

Successful connection between PC and MS 6 is shown as green marked connection in the top left corner of RaceCon.

3.2 Configuration of the system

Bosch MS 6 devices are delivered in a not engine executable mode. The customer has to include the correct programs, data applications and licenses.

The MS 6 offers two mainly different configuration areas, related to the two core areas of the controller.

MS 6 ECU

1st core area for the functional part of the MS 6 program. The available content is documentated in the functional descriptions Bosch Motorsport adds to the customer deliveries. Application works will be done via opening the data labels in the edition windows of INCA or RaceCon.

MS 6 Logger

2nd core area for the tool displayed parts like logger-, lap trigger, telemetry and CAN-network configurations. Application work will be done in the predefined function windows of RaceCon.

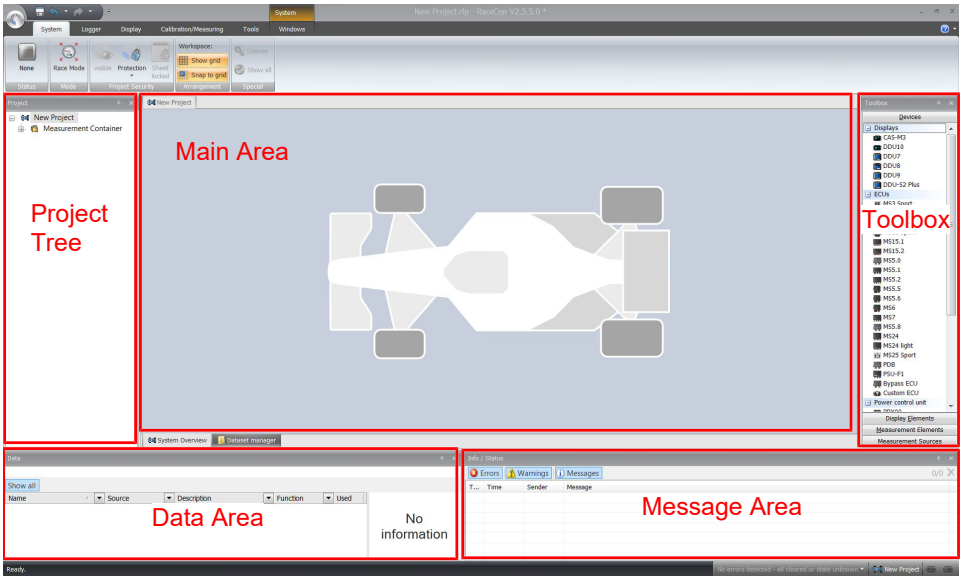
MS 6 Programming

For system programming or flashing of the device we developed the system configuration tool RaceCon. After the start of the tool, RaceCon opens the screen “Welcome to RaceCon”.

With “Last Projects” former projects can be opened directly.

3.2.1 First Steps to create and configure a Project

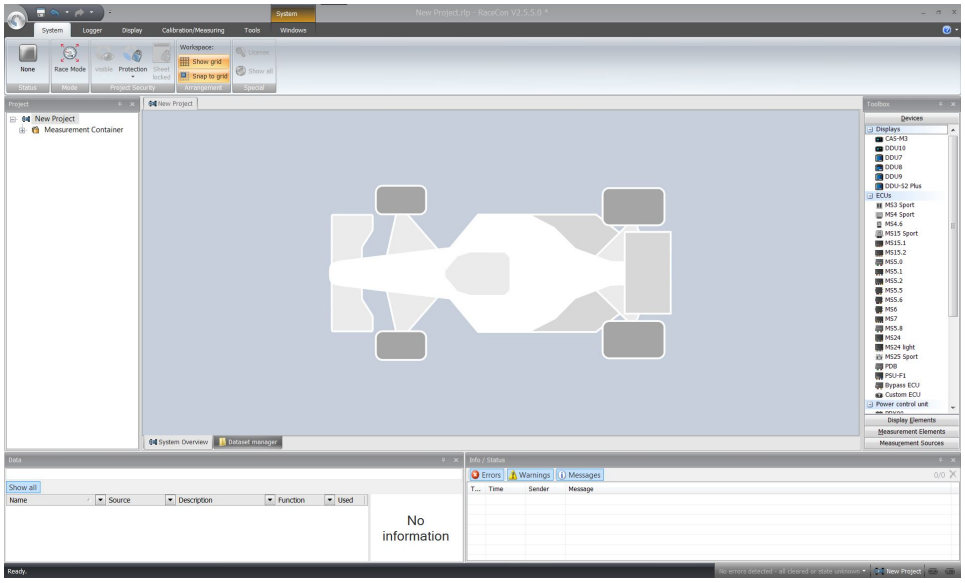
File / New / RaceCon Project opens a new project in RaceCon.



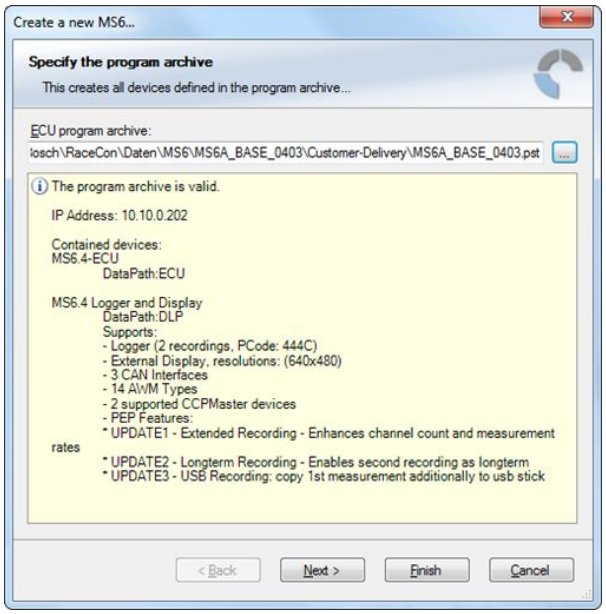
To create a new vehicle configuration, the devices can be pushed via drag & drop from the toolbox to the vehicle. Then they are part of the project and can be configured.

Select an ECU model MS 6 from the Toolbox / Devices / ECUs.

Drag the ECU icon with pressed left mouse click on the vehicle view, then a dialog opens.

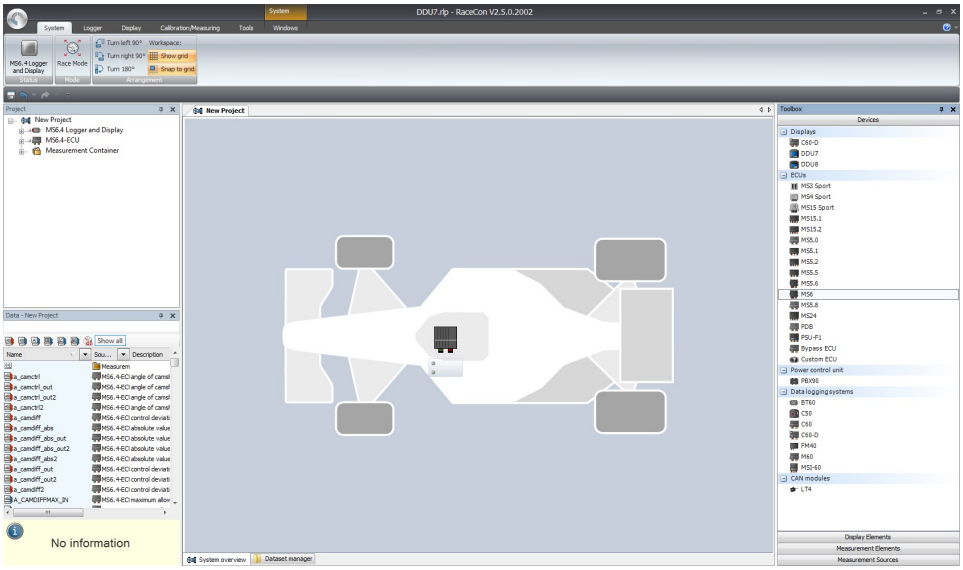


Now the ECU program archive PST files must be selected. These archives are delivered by Bosch or are available at Bosch Motorsport homepage. Specify the MS 6 program archive: MS6B_XXX_xxx.pst.



Access to all configurable data is now available.

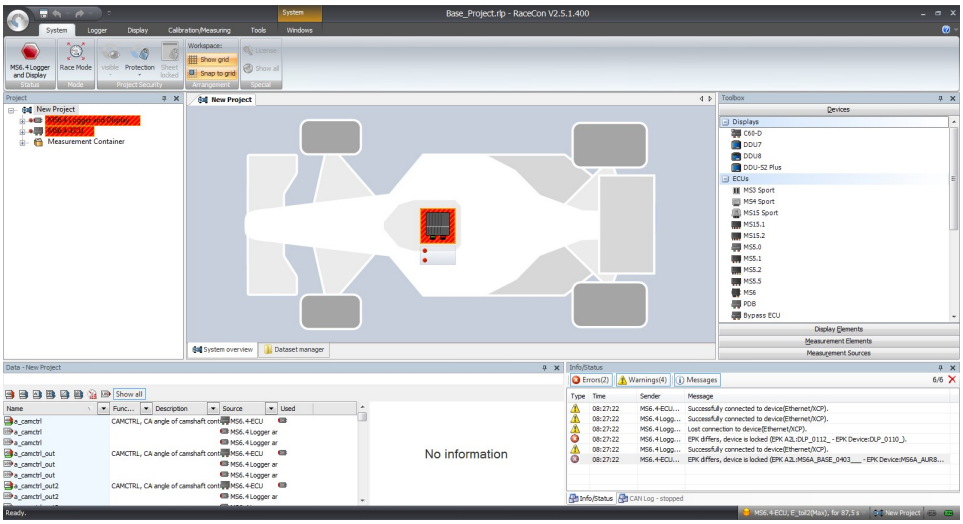
Installation may now be saved as customer project for further data application.



3.2.2 Programs Installation

Going Online for program and license configuration

In the project tree both parts of the MS 6 core are shown as >red<, means MS 6 device and RaceCon project differ in the used program version.

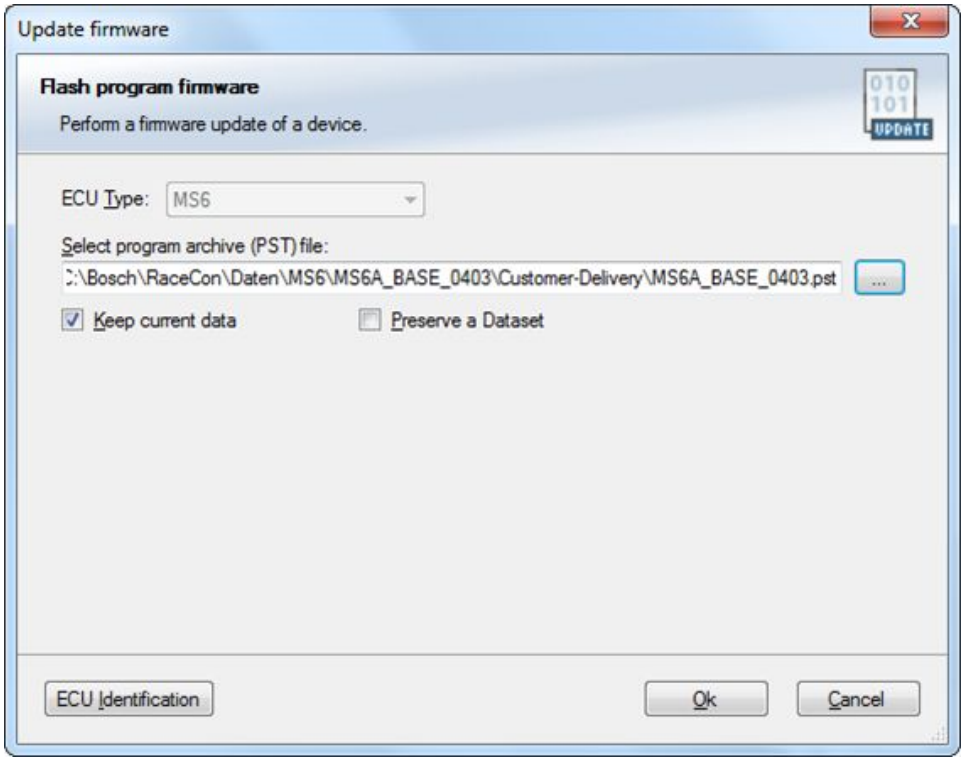


Synchronize MS 6 and RaceCon program version / update the firmware of the device:

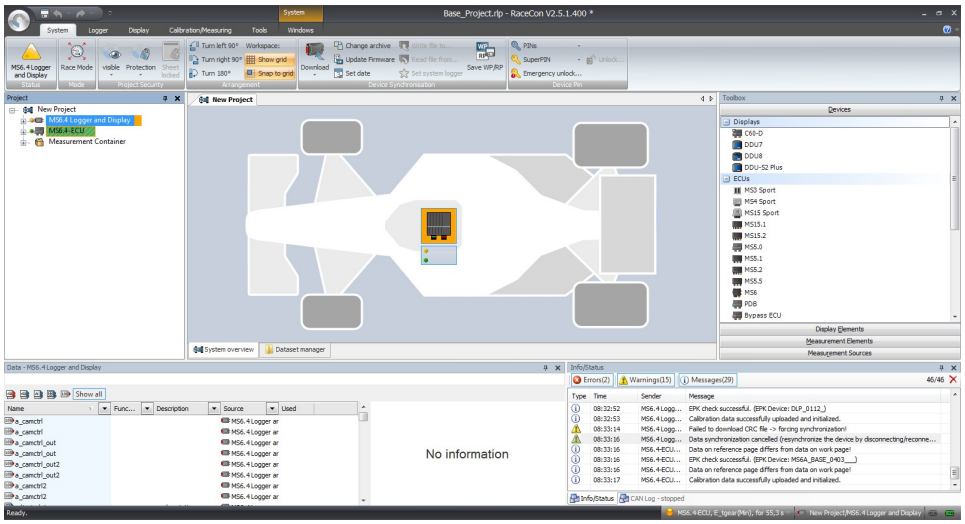
Project-tree / right mouse button to one of the red MS 6 core / synchronize / update firmware >select customer software of the MS 6 (file with extension: -.pst)

NOTICE

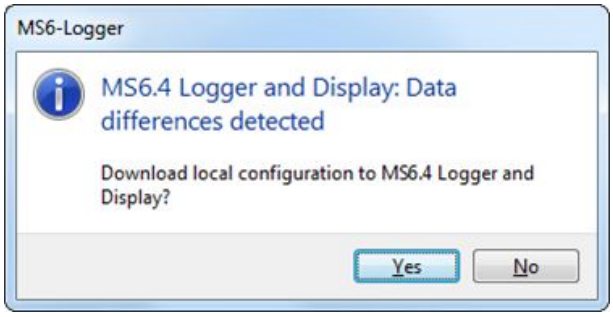
Do not interrupt flash process.



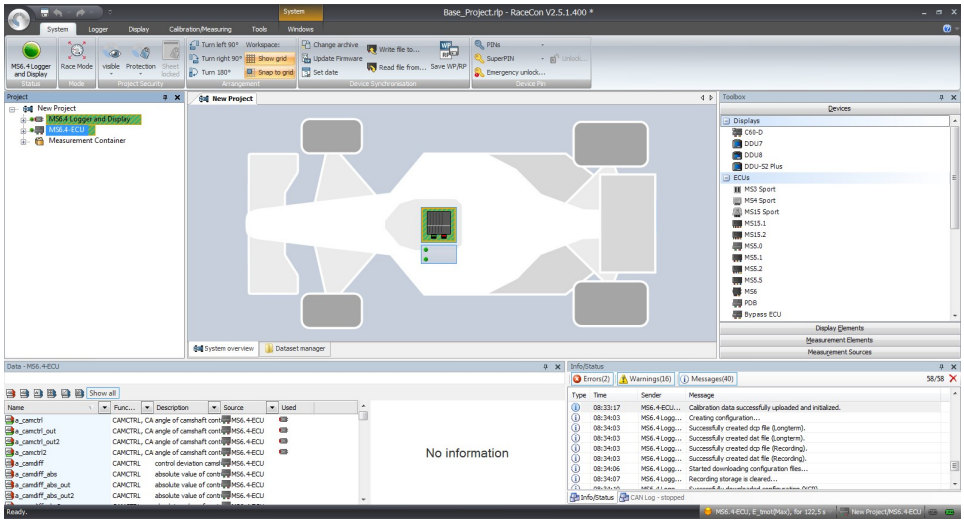
In the project tree, the MS 6 logger core is shown as >yellow<, means the firmware of MS 6 device and project are identical, but the data differs.



The offline preconfigured data have to be sent to the MS 6. Option one, select: Project tree / right mouse button to the yellow MS 6 core / synchronize / or follow the RaceCon menu:

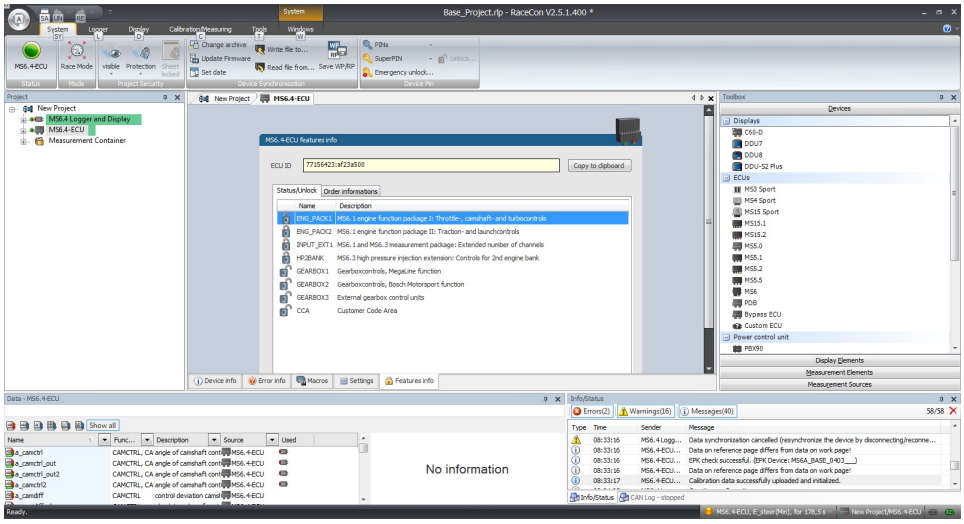


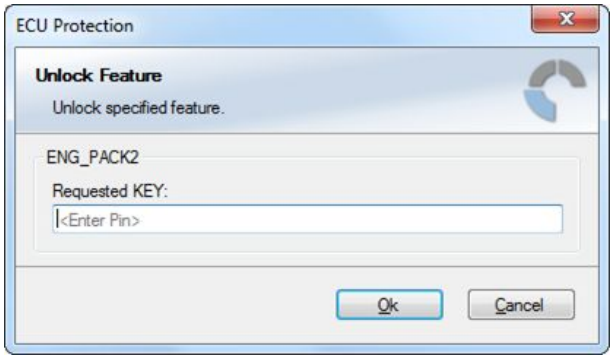
Both MS 6 cores are shown as green, means firmware and data of device and project are now identical.



3.2.3 Feature/License Activation

For code area generation, additional functionalities and/or data logging licenses may be requested for activation. Generally all MS 6 licenses are related to one specific device and the delivered code is only to activate for this ECU. Both cores, MS 6 ECU and MS 6 logger, content own license structures. Double-click to the core symbol at the project and choice features info. Select the license feature and activate the functionality using the related license code.





The licenses for gearbox and engine controls are to activate at the MS 6 ECU core. The licenses for USB or logger packages are handled in the MS 6 logger core. MS 6 ECU is now ready for customer data and use.

4 Prepare Data Base

Using RaceCon, the data base is already generated and the modification may start immediately. For information, please see RaceCon manual.

4.1 Initial Data Application

The following chapter deals only with the main parameters which should be checked before a first engine startup. Several functions are recommended to be switched off, many software labels will not be explained in detail. To work on these functions and labels after the first startup, please refer the full-scope function description. The offline data application guide shall help to get the engine started the first time without problems.

⚠ CAUTION

Wrong engine setup data may lead to serious engine damages.

4.1.1 Basic Engine Data

The MS 6 system can be used for engines up to 12 cylinders. Please ensure that the correct software variant is loaded in your ECU. Define the engine parameters like number of cylinders, firing order, injection system and cam- and crankshaft designs in relation to TDC.

4.1.2 Crank- and Camshaft Wheel

The system initially supports wheels with 60-2 teeth. Other configurations **in** the limits between **30- and 60 teeth** may be possible to configure also. Please refer also to the chapter Ignition Trigger Wheel [▶ 12].

Main Data Labels to configure for crank- and camshaft wheel	
CRANK_TOOTH_CNT	Number of teeth of the flywheel (including the missing teeth) **(limited to 30-60 teeth)**
CWINTF_A047_A048	Selection of used crankshaft sensor type (Hall or inductive type)
CRANK_GAP_TOOTH_CNT	Number of missing teeth on the flywheel
CAM_MODE	Camshaft position detection mode
CAM_TOOTH_CNTx	Number of teeth on the camshaft
CAM_POS_EDGESx	Position [°CRK] of positive camshaft edges
CAM_NEG_EDGESx	Position [°CRK] of negative camshaft edges (online measurement, see channels cam_neg(pos)_edges_xxx)
ANG_CAM_CATCHx	Max. deviation of cam edges angles allowed
SYNC_CAM	Camshaft signal used for engine synchronization

4.1.3 Initial Steps

The following data must be set initially to start injection calibration for the first time.

Main Data Labels to configure for firing order and engine design	
DISPLACEMENT	Displacement of all cylinders
CYLBANK	Cylinder allocations bank 1 or bank 2 Example typ. 8 cyl. engine: Cylinder 1 2 3 4 5 6 7 8 9 10 11 12 CYLBANK 1 1 1 1 2 2 2 2 0 0 0 0 Engines with one Lambda sensor (e.g. 4-in-a-row) run as 1-bank-systems Set CYLBANK to 1.
CYLNUMBER	Number of cylinders
CYLANGLE	Angle of cylinder TDCs relative to reference mark (RM → TDC)
CWINJMODE	Selection of injection mode
QSTAT	Static valve quantity for n-heptane in g/min (injectors are typically measured with n-heptane)
TDTEUB	Battery voltage correction low-pressure injection. Characteristics can be requested at the injector valve manufacturer.
TECORPRAIL	Battery voltage correction high-pressure injection. Characteristics can be requested at the injector valve manufacturer.

4.1.4 Basic Path of Injection Calculation

The ECU MS 6 is a so called physically based system. This means in particular that corrections are made according to their origin influence (e.g. air temperature, fuel pressure etc.). For it, the initial engine load signal (throttle angle ath) or the engine charge signal rl (relative load) is defined as 100 %, if the cylinder is filled with air of 20°C and 1013 mbar ("standard condition"). Corrections related to the air path (air temperature, ambient pressure) are therefore performed to this value rl. Based on this central value most of the relevant ECU signals are calculated, first and foremost injection and ignition.

Due to this constellation changes in the air path are centrally considered for all following functions, independently whether they are caused by ambient influences, mechanical changes of the intake system or even a change from alpha/n-system to p/n-system.

Using this rl value, a relative fuel mass rfm is constructed. For an operating point of rl = 100 %, a fuel amount of 100 % is needed, if the desired Lambda = 1. All corrections to the desired fuel quantity like start enrichment, warm up factor, transient compensation, but also the desired Lambda value and the correction factor of the Lambda control are considered as an adjustment of this relative fuel mass. I.e. all corrections are still made independently of the size and other specifications of the injectors.

Next step is the conversion of the relative fuel mass to a desired injection time te. Here the engine´s displacement, the fuel flow through the injector and influences of the fuel pressure are considered.

Finally the actual duration of the control pulse ti is calculated, considering pick-up delays of the injectors, fuel cutoff (e.g. overrun cutoff, speed limiter, gear cut) and cylinder individual correction factors. Please refer also to the system overview in the Function Description ECOV.

4.1.5 Main Data Labels to configure for Engine Start up

Main Data Labels to configure for engine start up	
MP_MIXCORR(2)	Mixture correction, set to 1.0 for startup
MIXCORR_APP	Global factor for mixture correction, set to 1.0 for the begin of startup
CWPRAILCOR	If a correction by fuel pressure is intended, set = 1. In this case please set PRAILREF according to the referenced fuel pressure. Also refer to MP_P22MOD. Usually the predefined values are suitable. If unsure, set CWPRAILCOR to 0 for first startup.
FINJ_WARMUP	Correction via engine coolant temperature. Usually the predefined values are suitable. Ensure, that for coolant temperatures driven on your dyno during calibration, no warm up factor applies (i.e. FINJ_WARMUP is 0.0 for this temperature).
MP_LAM_MP1	Desired Lambda value, valid for map position 1. According to your expectations, e.g. 0.9. For alternative positions of your map switch the maps MP_LAM_MP2 (3) or (_PACE) apply, therefore ensure correct switch position

4.1.6 Main Data Labels for Load Calculation

Main Data Labels for Load Calculation	
CWLOAD	Decision between alpha/n or p/n related load calculation
CWLOADP1	Decision between P1 and ambient pressure
alpha/n system	
FRLPAMB_P1	Correction via intake air pressure
FRLTINT	Correction via ambient temperature Usually the predefined values are suitable. If unsure, set FRLTINT to 1.0 for first startup.
MP_RL	Relative load depending on throttle angle and engine speed. Set value until your desired Lambda is matched.
p/n systems	
FRLPAMB_P1	Correction via intake air pressure
FRLPTINT	Correction via ambient temperature. Usually the predefined values are suitable. If unsure, set FRLPTINT to 1.0 for first startup.
FRLPTHR	Factor to throttle dependence. If unsure, set to 1.0 for startup.
MP_RLP1 ... P4	Relative load depending on throttle position 1-4

Main Data Labels for Load Calculation	
PALTCOR	Altitude correction for relative load. If unsure, set PALTCOR to 0.0.
MP_RL	Relative load depending on throttle angle and engine speed. Set value until your desired Lambda is matched.
Notice: For details please refer to the Function Description LOADCALC.	

4.1.7 Main Data Labels for Injection

Main Data Labels for injection	
CWHPI	Choice LP- or HP battery voltage correction
CWINJANGMODE	Choice of angle of injection relation
MP_AOINJ	Map begin/end of injection
LP-system	Standard choice to end of injection pulse, refers to combustion TDC (degrees before TDC). Make sure, the injection is finished before the inlet valve closes. Try 200° - 300° for first startup.
HP-system	Standard choice to start of injection pulse.
Notice: Before calibration starts, turn off Lambda closed loop control.	
CWLC	Codeword for enabling of the Lambda closed loop control. Set to 0 during initial calibration, afterwards = 1

4.1.8 Labels to configure Injection during Start Conditions

After initial calibration the start factors for injection may be optimized.

Injection during start conditions	
AOINJ_START_NMOT	Map begin/end of injection during start
MP_INJSTART	Decay of the start enrichment factor over the number of engine revolutions
FINJSTART_TMOT	Basic start enrichment factor depending on the engine temperature
FINJSTART_NMOT	Basic start enrichment factor depending on the engine speed
Notice: For details please refer to the Function Description INJPRECTRL	

4.1.9 Main Data Labels for Ignition

Main Data Labels for ignition	
Notice: Positive values stand for ignition angles before TDC, negative values after TDC. Begin with moderate values to protect your engine from damages.	
MP_TDWELL	Coil dwell time. Consult the coil manufacturer for details. Most coils need dwell times about 1.5 to 2.5 ms at 12 to 14 V. For further background information please refer to the Function Description IGNITION.
DIGN_CYL1-...12	Cylinder individual corrections. Set to 0.0. Numbering refers to mechanical cylinders.
MP_IGN_START/DIGN_ST_TINT	Base spark advance during engine start. Set to 5 to 10 deg, according to the requirements of the engine.
MP_IGN(2/3)	Base ignition timing in deg crankshaft before TDC. Use modest values at the first time. Atmospheric engines may run safe at 20 to 25 deg in part load, turbo engines at high boosts may demand even less spark advance. These values are strongly dependant on compression ratio, fuel quality, temperature and engine specifics. If you know you're using "poor" fuel, run at high temperatures or your engine is very sensitive on spark advance, go to the safe side.
MP_DIGN_TEMP/MP_DIGN_TEMPW	Ignition angle temperature dependent
DIGN_APPL	Delta value for spark advance, use for application work. Start at 0.0 for first startup.
IGN_IDLE_STAT	Ignition timing during idle. 10 deg are suitable for most applications
NIDLE_NOM / DIGN_IDLECTRL	Desired engine idle speed for idle stabilization. Set value to desired speed or deactivate stabilization by setting DIGN_IDLECTRL to 0.0.

4.1.10 Main Data Labels for Engine Speed Limitation

The rev limiter works in two steps:

- Soft limitation by ignition retardation or cylinder individual cutoff of injection and/or ignition
- Hard limitation by injection cut off and/or ignition cutoff of all cylinders

To achieve a good dynamic behavior by advanced intervention, the engine speed is predicted by means of the speed gradient.

Main Data Labels for engine speed limitation	
CWNMAX_CUTOFF	Codeword for type of intervention during soft limiter: 0 = only ignition retard 1 = injection cutoff 2 = ignition cutoff, 3 = injection and ignition cutoff
CWNMAXH_CUTOFF	Codeword for type of intervention during hard limiter: 1 = injection cutoff 2 = ignition cutoff, 3 = injection and ignition cutoff
NMAX_GEAR	Engine speed limit, gear dependent
NMAX_P	Determines the slope of the soft limiter between soft limit and hard limit. Predefined. Vary according to your engine´s dynamic behavior.
TC_GEARNMAXPR	Prediction time for rev limiter, depends on the inertial torque of the engine. If oscillations occur, reduce value or turn off by setting = 0.0.

4.1.11 Main Data Labels for Cutoff Pattern

Cutoff Pattern	
MP_COPATTERN	Defines the appropriate cylinders for torque reduction by cylinder cutoff. At the beginning of an intervention the next possible cylinder for starting the cutoff pattern is determined. Based on this info the actual pattern is taken out of the map. Pattern should be defined in view of minimized oscillations of the crankshaft. Usually a regular distribution of firing and non-firing cylinders leads to the best result. However, investigations of the individual engine are recommendable. For it, cutoff pattern can be also turned on manually via CUTOFF_APP and CWCUTOFF_APP Example: 4-cylinder engine Start Cyl./Cutoff stage 1 2 3 4 1 1 (=0001b) 2 (=0010b) 4 (=0100b) 8 (=1000b) 2 9 (=1001b) 6 (=0110b) 6 (=0110b) 9 (=1001b) 3 11 (=1011b) 14 (=1110b) 7 (=0111b) 13 (=1101b) 4 15 (=1111b) 15 (=1111b) 15 (=1111b) 15 (=1111b) The cylinders are assigned bitwise, the lowest bit represents cylinder 1. Numbering refers to mechanical cylinders, e.g. pattern = 9: Mechanical cylinders 1 and 4 are fade out.

Cutoff Pattern	
CUTOFF_APP	Cutoff pattern for test purposes. Bit representation as described at MP_COPATTERN
CWCUTOFF_APP	Codeword for type of intervention during test cutoff: Set: 1 = injection cutoff 2 = ignition cutoff 3 = injection and ignition cutoff.
Notice: This option is also useful for searching a misfiring cylinder. Select one cylinder after the other during test cutoff and watch your engine.	

4.2 Peripherals

Sensors and peripherals can be checked when the system is powered up electrically.

Do not start the engine before all steps in this chapter are carried out.

NOTICE

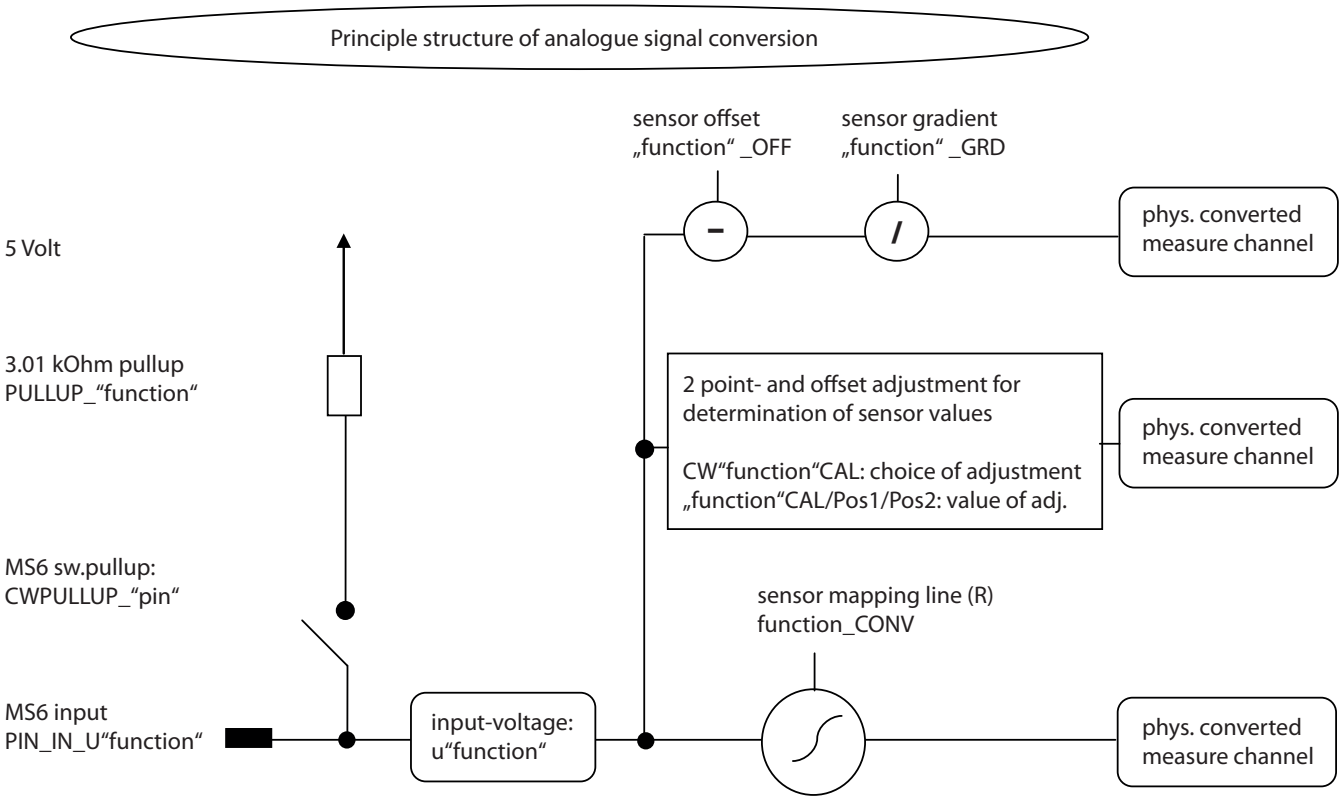
Make sure the battery is connected properly, all sensors are connected and ground wiring is fixed before powering up the system. Check all sensors for errors (E_...) and reliable measure values before starting the engine.

Sensor configuration

The MS 6 has the option to link a lot of functionalities to a possible hardware input. The chapters “ECUPINS, SWITCHMATRIX and Input Signal Processing” of the functional description explains the details. All functions of Base MS 6 programs are linked like described in the MS 6 documents (e.g. function description ADC_ECU_MAP) or the wiring diagrams.

Analogue sensor inputs

The physical way of conversion from sensor signal voltage to physical values follow the same structures. The hardware input may be connected to different kinds of pull-up options. Inputs with fixed 1.47 kOhm or 3.01 kOhm pull-up resistors are prepared to handle passive sensor elements, for instance temperature sensors with integrated resistors (NTC- or PT100 sensors). Inputs without any pull-up resistors are prepared to handle active sensor elements, which deliver 0 to 5 V signals, for instance pressure-, potentiometer- or acceleration sensors. Inputs with switchable 1.47 kOhm pull-ups are designed to handle mainly active sensors with disabled pull-up, but are prepared for future measuring of digital signals. Inputs with switchable 3.01 kOhm pull-ups offer the most options and are recommended to link after the standard sensors are connected. The pull-up resistor itself is not modifiable and for better measure results may be, the version of sensor/mapping line has to be changed. To activate the Pin-Selection, first the label “PIN_IN_function” has to be enabled. Error detection of an analogue input signal detects short cuts to ground, U“function”_MIN recommended to be set to 0.2 V and short cuts to power supply U“function”_MAX recommended to be set to 4.8 V. Failure are activated after the adjustable debounce time of diagnosis TD“function”. If a sensor error is set, the output is switched to the default value “function”_DEF.



Pressure measurements

The system offers many different pressure channels; please see function description input signal processing for details. For gradient and offset information contact sensor manufacturer.

Example: Ambient Pressure	
PAMB_OFF, PAMB_GRD	Sensor offset and gradient
UPAMB_MIN, UPAMB_MAX	Minimum and maximum accepted sensor voltage. When violated, an error is set (E_pamb = 1).
PAMB_DEF	Default value if an error occurred.
FCPAMB	Filter constant. For ambient pressure use 1 second, for other pressures choose appropriate values, ~ 100 to 200 milliseconds

All other variables are named by the same rule; replace “pamb” by e.g. “poil” to apply data for the oil pressure sensor.

Temperature measurements

The system offers many different temperature channels; please see function description input signal processing for details.

Example: Intake Air Temperature	
UTINT_MIN, UTINT_MAX	Minimum and maximum accepted sensor voltage. When violated, an error is set (E_tint = 1).
TINT_CONV	Sensor characteristic. Consult the sensor manufacturer.

Example: Intake Air Temperature	
PULLUP_TINT	Value of the used pull-up resistor. If only the ECU´s pull-up is used (standard case). Keep the predefined value of 3.01 kOhm.

Thermocouples

The exhaust gas temperatures are measured via thermocouple elements, using a special evaluation circuit. Predefined values should be suitable for NiCrNi or k-type elements. For further details and project specific variants, please refer to the function description.

Digital sensor inputs

MS 6 digital sensor inputs used for frequency measurements are possible to configure to different of sensor types.

CWINTF_A047_A048	Selection between Hall effect or inductive sensor for flywheel measurement, related to MS 6 contact A047 (use ground A048 if inductive type is selected).
CWINTF_K045/K046	Selection between Hall effect or inductive sensors for frequency measurements, like turbo- or driveshaft speeds, related to MS 6 contacts K045 or K046 (use ground K062 if inductive types are selected).
CWINTF_A049/A050/A051/A052	Selection between Hall effect or DF11 sensors for frequency measurement, like wheel speeds or cam position detection, related to MS 6 contacts A49, A50, A51 or A52.

4.3 Throttle Control

The system supports mechanic and electronic throttle controls.

Using an MS 6.1 EVO device, respect the necessary license for electronic throttle is activated. Electronic Throttle Control is a safety-critical function. The Bosch Motorsport Electronic Throttle Control System (ETC) is designed and developed exclusively for use in racing cars during motorsport events and corresponds to prototype state. Therefore the driving of an ETC equipped vehicle is limited exclusively to professional race drivers while motorsport events and to system-experienced drivers on closed tracks for testing purposes. In both cases the driver must be instructed regarding the functionality, possible malfunctions of the system and their consequences and must be familiar with possible emergency actions (e.g. pressing the emergency stop switch or the main switch). The system must have emergency switch, whose activation at least cuts the throttle valve actuator from the power supply. Depending on specific use and/or construction, the safety functions, fault detections and fault responses of the ETC system may differ in several points from ETC systems used in series production. Hence before each vehicle-commissioning the system must be checked for accuracy and faultlessness.

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The functionality of the ETC diagnosis and the fault responses are described in the technical documents, handed over to the customer together with the system. Each driver must be briefed regarding the system description. Further information you will find in document “SICHERHEITSHINWEISE-Systemanforderungen zum Betrieb eines Bosch Engineering GmbH EGas-Systems” or can be enquired at Bosch Motorsport.

The customer is responsible for the activation of all ETC-relevant diagnosis and for their correct parameterization. By disregarding this information the functionality of the ECU and the safety cannot be ensured.

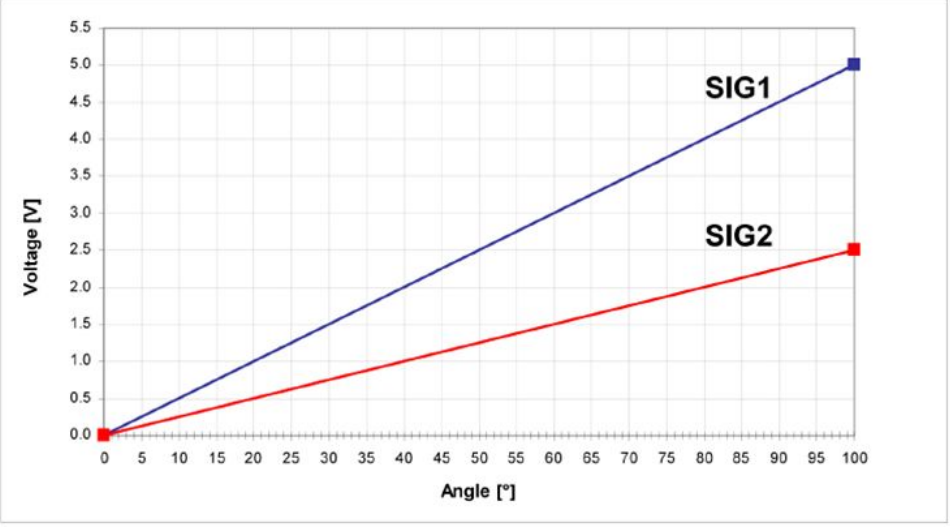
Notice: For detailed information see function description ETC

The usual route of ETC determines the drivers input measuring the pedal position and transferring this leading signal via functionality options into the control of an electrical throttle actuator. Pedal- and actuator positions are generally measured in a secondary redundant way to verify the reliability of the function. To activate the system, first verify the signal tolerances and error messages by moving acceleration pedal and throttle actuator manually. An inactive system usually is the result of inverted wired sensor signals or actuator controls. Calibrate the pedal- and throttle positions.

Verification of acceleration pedal signals:

The mathematic value of voltage pedal signal 1 - 2*voltage pedal signal 2 has to be below 0.5 V or below value of “UAPSCM_MAX”.

Signal principle of an acceleration pedal sensor:



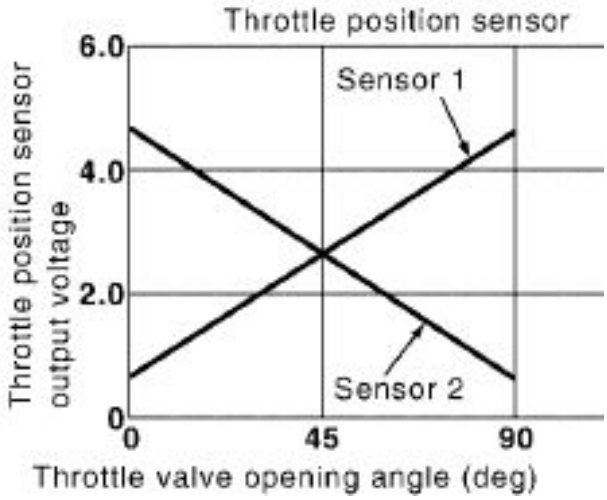
uaps_a	Voltage APS potentiometer a
uaps_b	Voltage APS potentiometer b
aps	Acceleration pedal position

UAPS_MIN, UAPS_MAX:	Minimum and maximum accepted sensor voltage. Set to approx. 200 mV/4,800 mV. Check if the uaps(x) outputs are changing when the pedal is moved.
CWAPSADJ	Codeword to adjust acceleration pedal signal: 0 = calibration inactive 1 = calibrate release pedal 2 = calibrate full-pressed pedal
E_APS	Detected error messages of acceleration pedal functionality. If errors are detected, the ETC functionality will become inactive.

Verification of throttle position signals:

The mathematic value of voltage throttle signal 1 + voltage throttle signal 2 - 5 V has to be below value of “UDTHRCM_MAX” (recommended 0.2 V)

The signal sequences of a throttle position sensor:



Throttle position main data labels:

CWTHR	Codeword for type of throttle controls: 0 = mechanical throttle 1 = mechanical throttle with backup potentiometer 2 = electric throttle single bank 3 = electric throttle dual bank

Throttle position signals:

UDTHR_MIN, UDTHR_MAX	Minimum and maximum accepted sensor voltage. When violated, an error is set (E_thr = 1). Set to approx. 200 mV/4800 mV Check if the uthrottle(xx) outputs are changing when throttles are moved
uthrottle	2 sensor output values and their redundant

uthrottle_b	signals (_b). The system expect a rising up
uthrottle2	voltage for the main signals and a falling signal
uthrottle2_b	for the redundant one.
UDTHRCM_MAX	max. allowed difference between sensor output and redundant signal abs (uthrottle(x)+uthrottle(x)_b)-5V < UDTHRCM_MAX

Calibration:

CWTHRADJ	Codeword for throttle adjust: 1 = automatical calibration process 2 = calibrate lower mechanical stop 3 = calibrate upper mechanical stop 4 = calibrate limp home position

Manual Procedure:

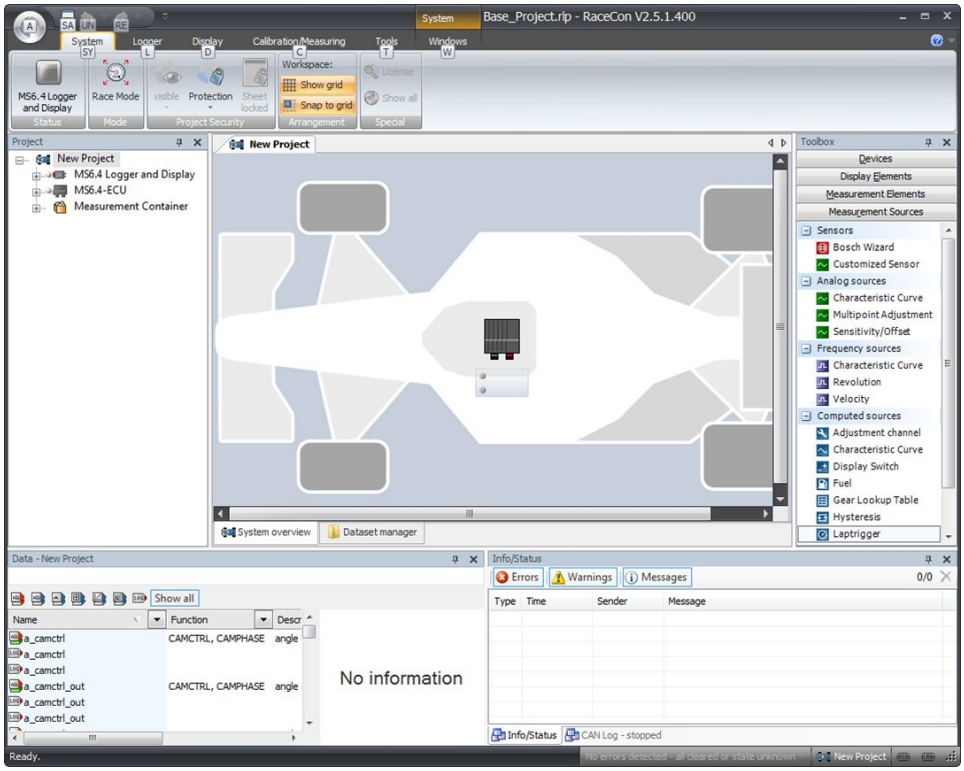
- Close throttle and set CWTHRADJ to 2.
- Open throttle fully and set CWTHRADJ to 3.
- Adjust the throttle to idle point.
- Do not forget to set CWTHRADJ back to 0. Check calibration by moving throttle.

4.4 Vehicle Test

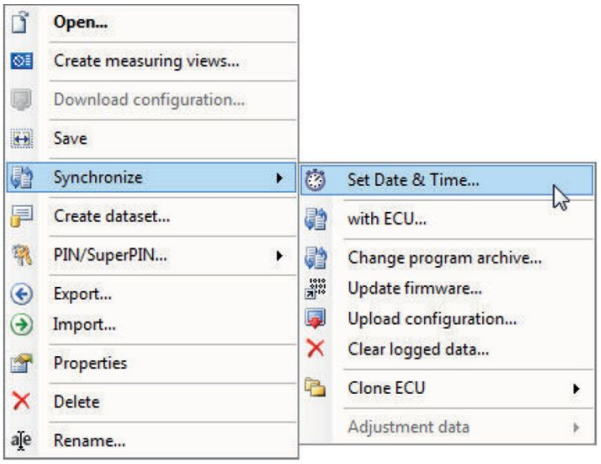
Before starting with your vehicle test, some initial data should be set:

Speed & distance measurements	The signals for speed calculation may be available from different sources, like MS 6 own measurement, GPS data or via CAN received information from ABS calculation. For MS 6 own calculation, mechanical influenced data like number of available sensors, front wheel drive, number of detected increments, wheel circumferences and dynamic corrections like corner speed application a lot of functional options assist the calculation of the effective vehicle speed. Distance measure channels may be derived from speed information. For detailed information see function description >CARSPEED<
CWWHEELCAN	Selection for car speed from CAN signal
CWWHEEL	Connected number of wheel speed sensors or -signals
CWFWD	Selection of front driven vehicle
CWSPEEDDYN	Release of dynamic speed calculation

INC_FRONT	Number of pulses per revolution of the front speed signal
INC_REAR	Number of pulses per revolution of the rear speed signal
CIRCWHEEL_F	Wheel circumference of the front wheels
	Consider dynamic increase of the tire
CIRCWHEEL_R	Wheel circumference of the rear wheels. Consider dynamic increase of the tire.
Vwheel_xx	Measure channel of the individual wheel speeds
Speed	Result of calculated vehicle speed
Accv	Result of speed based derivation of longit-udinal acceleration
Ltdist	Lifetime distance as accumulated result of speed derivation
Lap information and -functions	The necessary data application is integrated in the system configuration tool RaceCon. The wizard leads to configure the beacon input, asks for trustable limits of lap- and signal detection. Additional options for track segmentation, additional on track beacons are also available. Drag and drop the subfolder lap trigger of the measure-ment sources into the project and follow the wizard.



	Depending to the configuration, values for lap-and outing counter, lap time, segment times and differential lap- or segment times for data analysis and driver information will be created.
Laptrigger_xxxx_yy	Results and measure channels of lap-functionalities
Consumption-calculation	Is designed in the same way as lap-information, drag and drop the subfolder to the project and follow the wizard
Set time & date	MS 6 device is equipped with a real time clock which is supplied for max. 14 days, if the ECU is disconnected from power supply. Please connect the ECU to the PC and click on “SET DATE & TIME” in the context menu of the MS 6.
time_xx	The measure channels of the real time clock.



5 ECU plus Data Logger

The MS 6 combines ECU and data logger in one common housing for a cost efficient and weight optimized all-in-one solution.

5.1 Software Tools

RaceCon	Create and configure a project Configuration & management of recordings Create a new recording Add channels to a recording Create user-defined conditions for the recording Download recording configuration
WinDARAB	Upload recorded data Display and analyze the data

5.2 First Recording (Quick Start)

Starting up the data logging

The following chapters demonstrate how to set up data logging and how to analyze the recorded data. It shows the most important functions and features of RaceCon and WinDarab. For this tutorial we assume, that you have a MS 6 connected to your computer via an Ethernet line.

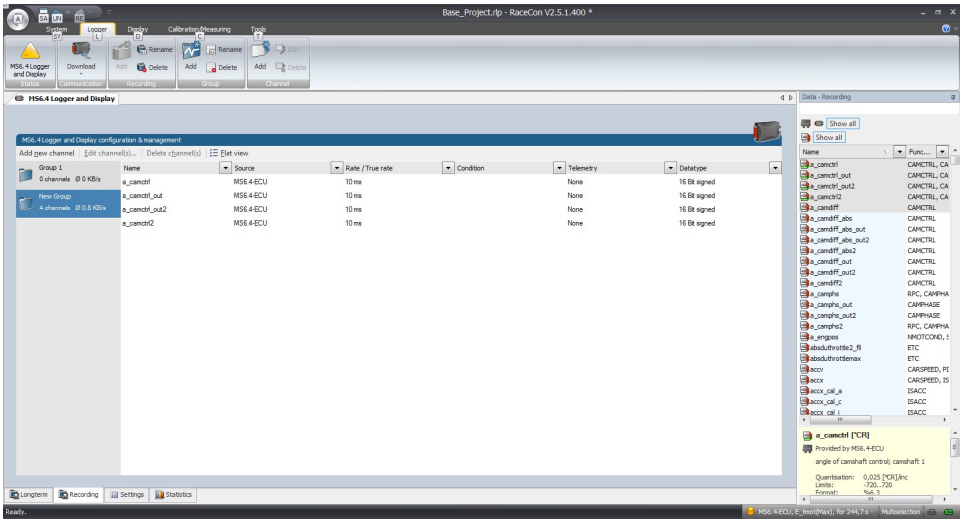
The MS 6 data recording is separated in two partitions. Both are completely independent. The free of license storable channels have to be selected into the >Recording< folder. Data logging extensions for more than 100 channels or the 2nd partitioning have to be activated in front of the configuration.

Select topic >Logger< in the menu bar.

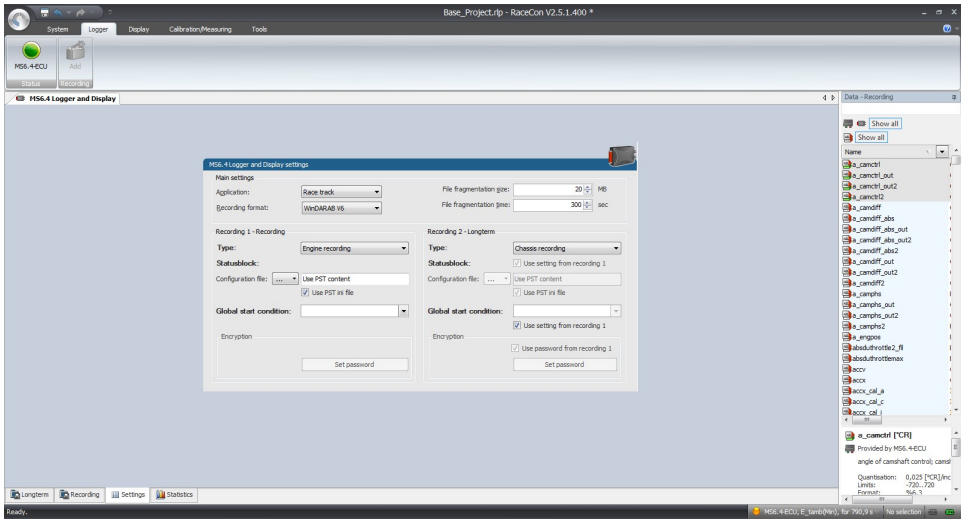
>Recording< selects data logging package I or the free area for data logging.

>Longterm< selects data logging package II.

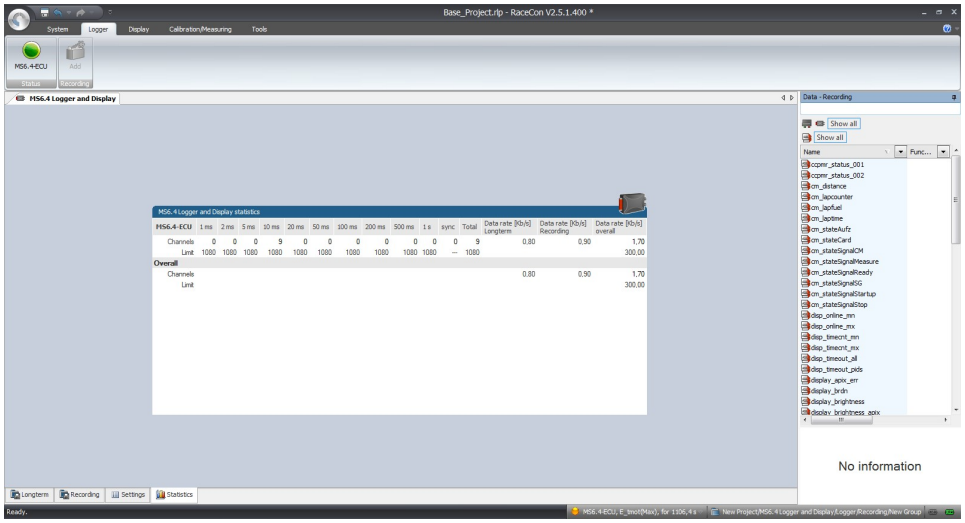
Drag and Drop the channels of your selection.



>settings< For limited recording, please follow the wizard.

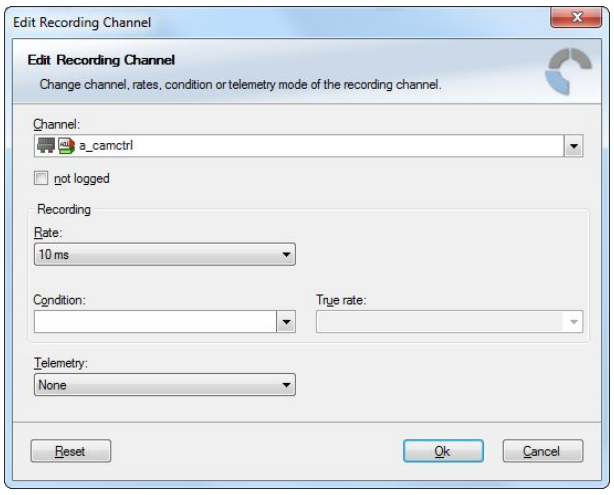


>statistics< check the selection to ensure the system limits are respected.



>group< to separate measure channels into different groups, referring to customer- or functional structures.

>edit recording channel< right mouse button to one or a selection of recorded channels opens the option to modify the sampling rate and/or the selection for online telemetry.



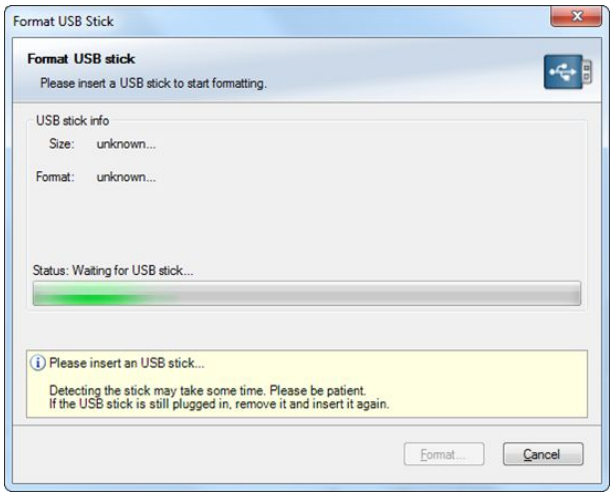
>Project Window / MS 6 Logger / right mouse button / download configuration.

>download configuration< Send your configuration to the device, the recording will start within the defined limits (without defined condition, the recording will start immediately).

5.3 USB Data Recording

The MS 6 data recording contents the feature to send a copy of the recorded data to an USB stick. Required is just an activated USB-license and wire installation. Technical aspects of commercial USB sticks may lead to connection- and data storage problems. Therefore Bosch Motorsport recommends and offers just USB drive with the Bosch Order Number F02U.V01.342-02.

Please format the storage medium to Bosch file system available at >RaceCon / menu bar / tools / format USB stick< before the first use. Please press >format USB stick< first, then insert the stick.



Measure channels to verify USB data recording	
usb_mediastate	0: not found
	1: stick detected
	2: stick installed
	3: stick unplugged
	4: (access)
	5: error
	6: corrupted
meas_cnt_forked	counter of recorded data blocks

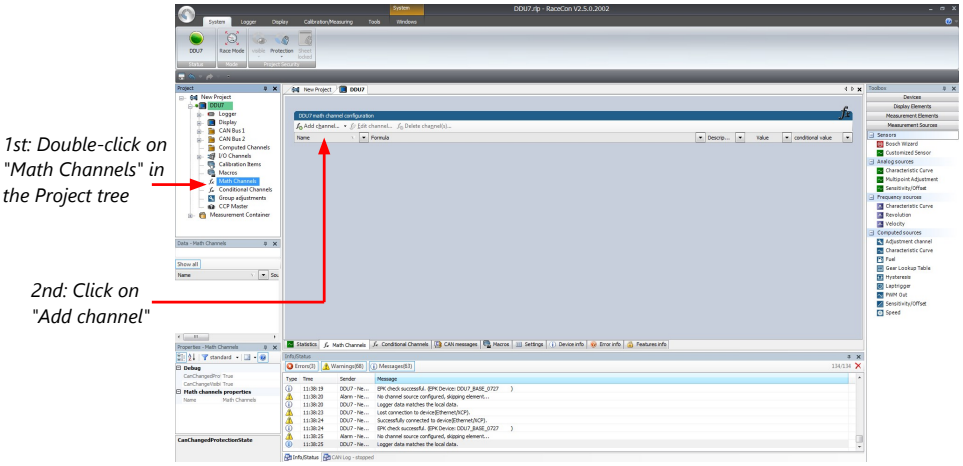
6 Project Configuration

6.1 Math Channels

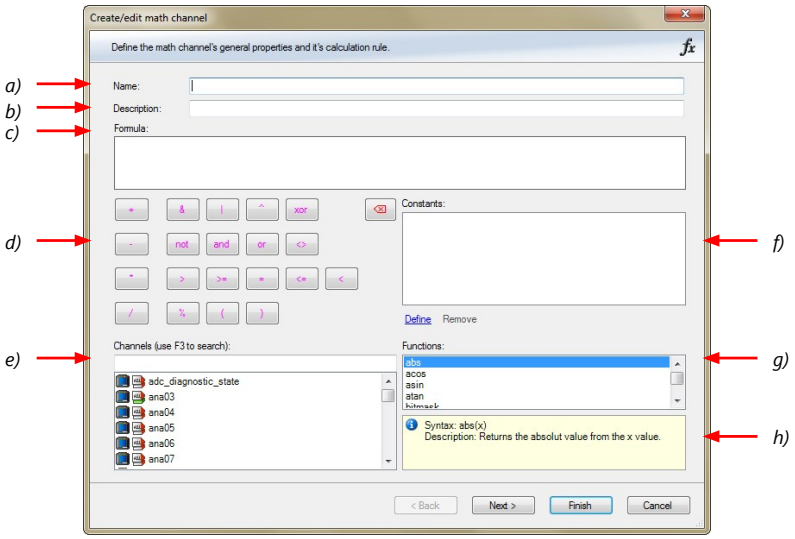
- Arithmetic and logical operations on up to 4 measurement channel(s)
- Numerical result
- Result can be used as input source for various display elements (numeric elements, alarms, bargraphs) and further calculations in the whole RaceCon project

Creating a new Math Channel

1. Follow the steps shown in the screenshot. The “Create/edit math channel” window appears.



2. 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.

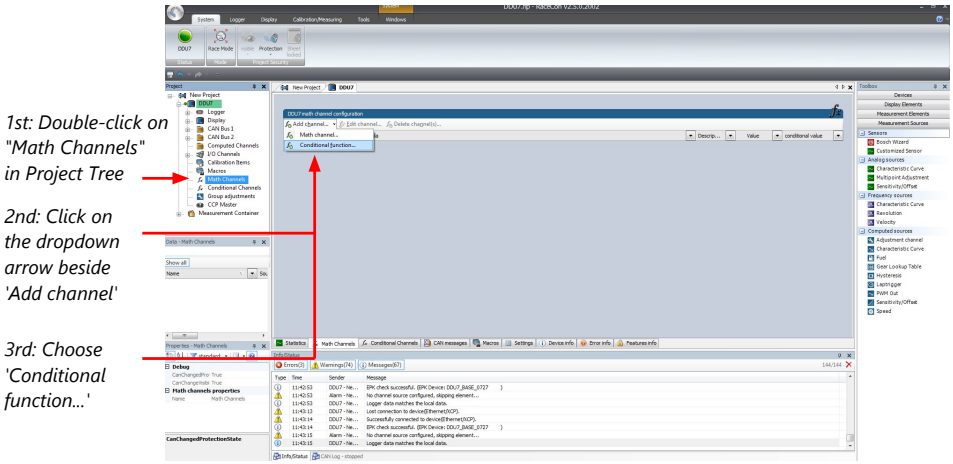
Click ‘Finish’ when done. The math channel is displayed in the math channel window.

6.2 Conditional Functions

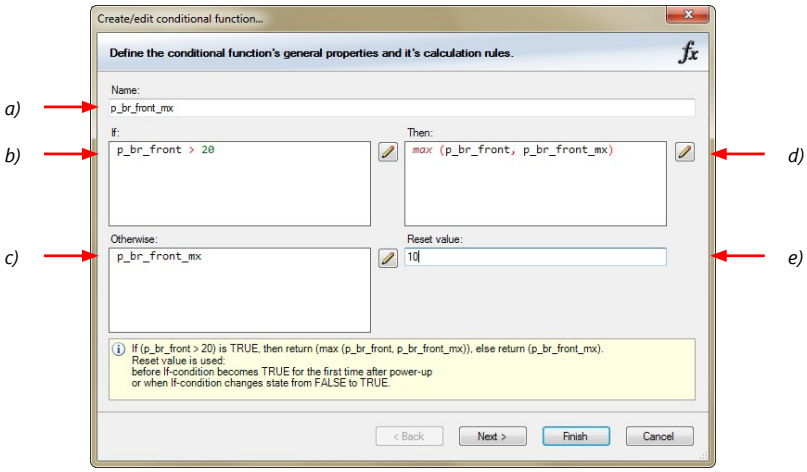
- Arithmetic and logical operations on one or more measurement channel(s)
- If-Else structure with reset
- Numerical result
- Result can be used as input source for various display elements (numeric elements, alarms, bargraphs) and further calculations in the whole RaceCon project.
  All math and conditional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

Creating a new Conditional Function

1. Follow the steps shown in the screenshot. The “create/edit math channel” window appears.



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



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

Click ‘Finish’ when done.

The conditional function works the following way:

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

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

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

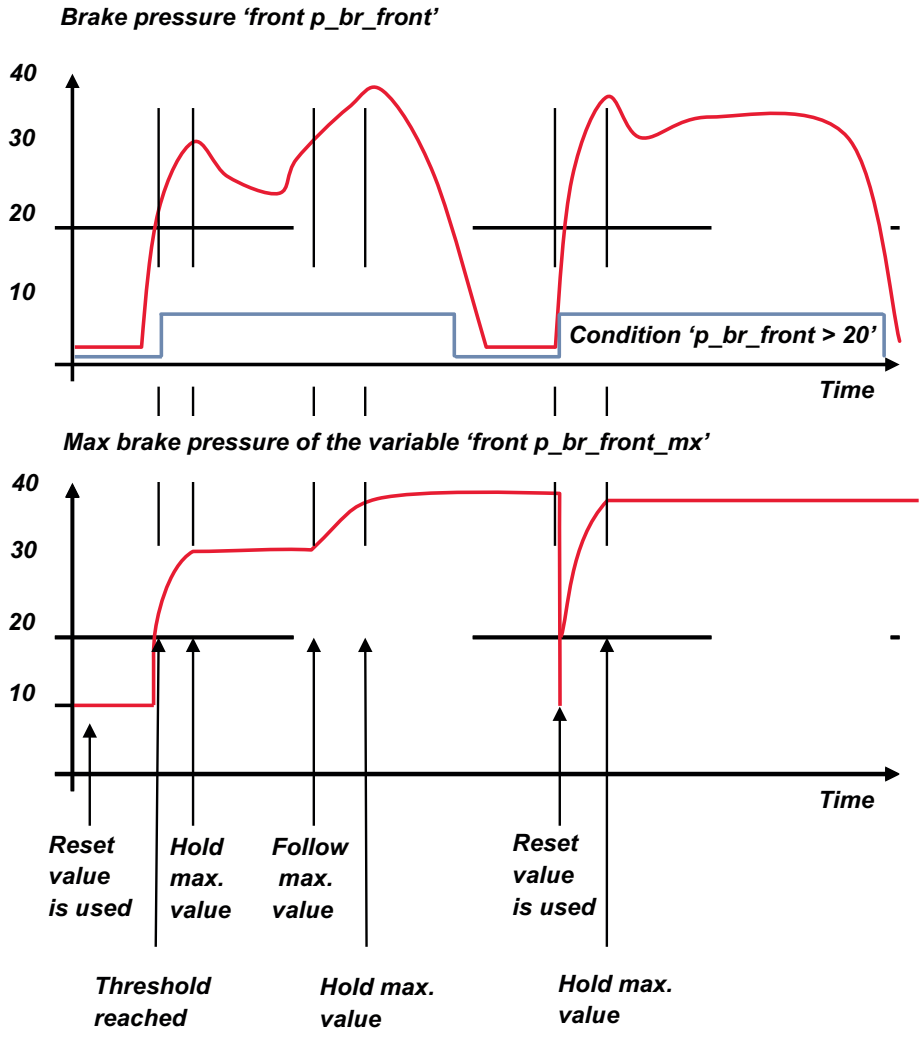
The reset value is always set for the new variable (entered in “Name”):

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

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

The conditional function is displayed in the MS 6 math channel window.

Example: Setting up a condition for maximum front brake pressure



- At power-up, the reset value (10) is used for ‘p_br_front_mx’.

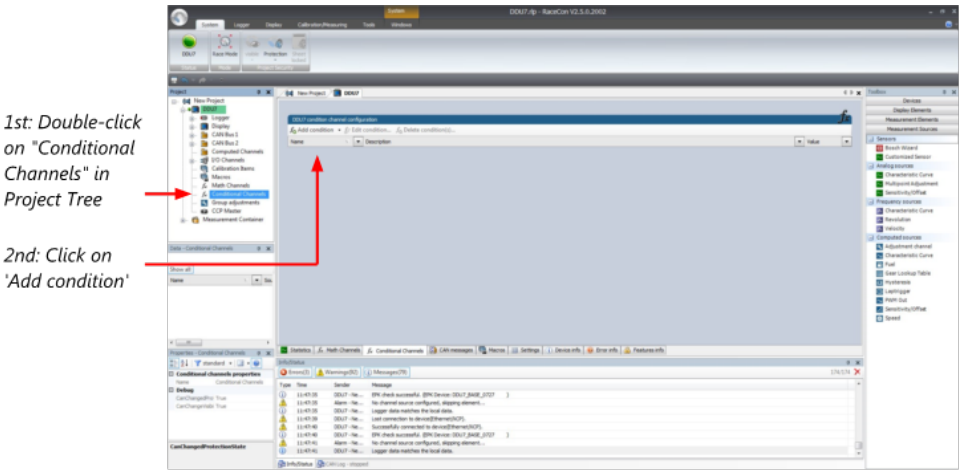
- ‘p_br_front’ rises to 30. As ‘p_br_front’ is > 20 (condition is TRUE), the condition ‘max (p_br_front, p_br_front_mx)’ in the THEN window is triggered. The condition sets the bigger value as new value for ‘p_br_front_mx’. As ‘p_br_front’ (30) is bigger than ‘p_br_front_mx’ (10), the new value for ‘p_br_front_mx’ is set to 30.
- Although ‘p_br_front’ falls to 25, the value of ‘p_br_front_mx’ stays 30. This is caused by the THEN-condition, because p_br_front_mx’ (30) is still bigger than p_br_front’ (25).
- ‘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 is already set to 40, 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.
- The new value of ‘p_br_front_mx’ is 40 because 40 is bigger than 10.

6.3 Conditional Channels

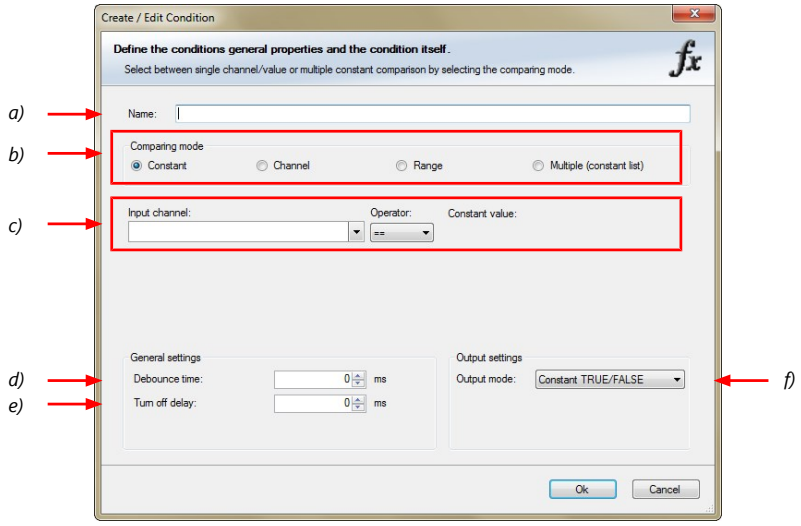
- Logical operations on measurement channel(s)
- If-Else structure with reset
- Logical result
- Result can be used as input source for alarm display elements and further calculations in the whole RaceCon project.

Creating a new Conditional Channel

1. Follow the steps shown in the screenshot. The “Create/edit condition” window appears.



2. Define the condition channel, using the following configuration possibilities:



a) Enter the name of the conditional channel.

b) Select the comparing mode:

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

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

- Constant: Choose the measurement channel or condition, the operator and enter the value of the channel.
- Channel: Choose the measurement channel or condition, the operator and the measurement channel or condition to be compared.
- Range: Choose the measurement channel or condition, the operator and define the minium 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 by which the signal of the measuring channel is delayed after its end.

f) Choose the output setting of the result.

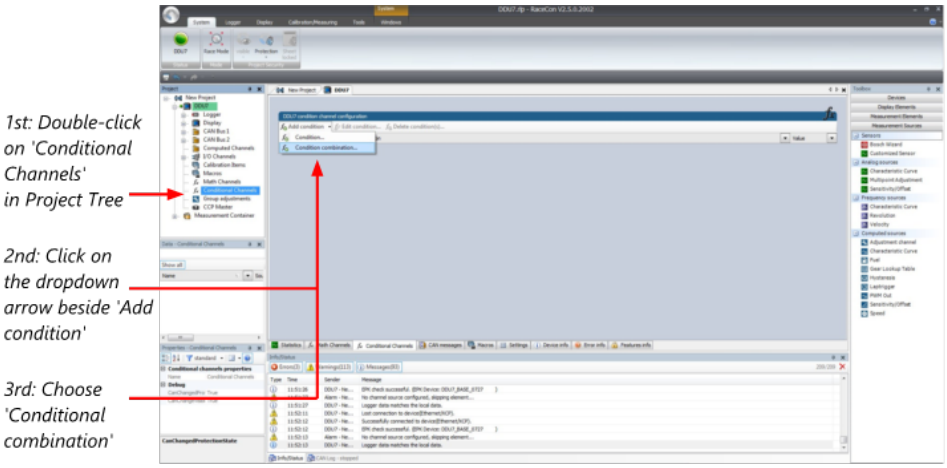
- Constant TRUE/FALSE: Result is as a constant with the value TRUE or FALSE.
- Blinking: Result is a blinking, if the condition is fulfilled.
- Pulse: Result is a short one-time pulse, if the condition is fulfilled.
- Toggling output: Result is a pulse that lasts until the next condition is fulfilled.
- Click ‘Ok’ when done. The conditional channel is displayed in the MS 6 condition channel window.

6.4 Condition Combination

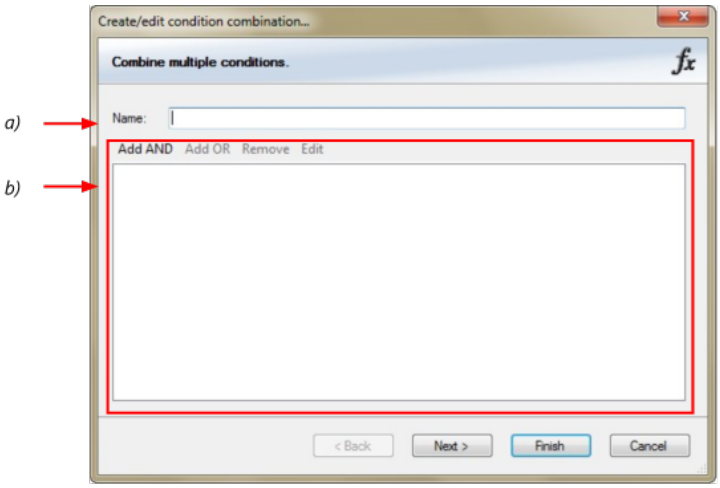
- Combination of several (up to 16) conditional channels for more complex calculations
- Logical results
- All conditions can be used globally in the whole MS 6 project.

Creating a new Condition Combination

Follow the steps shown in the screenshot.



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

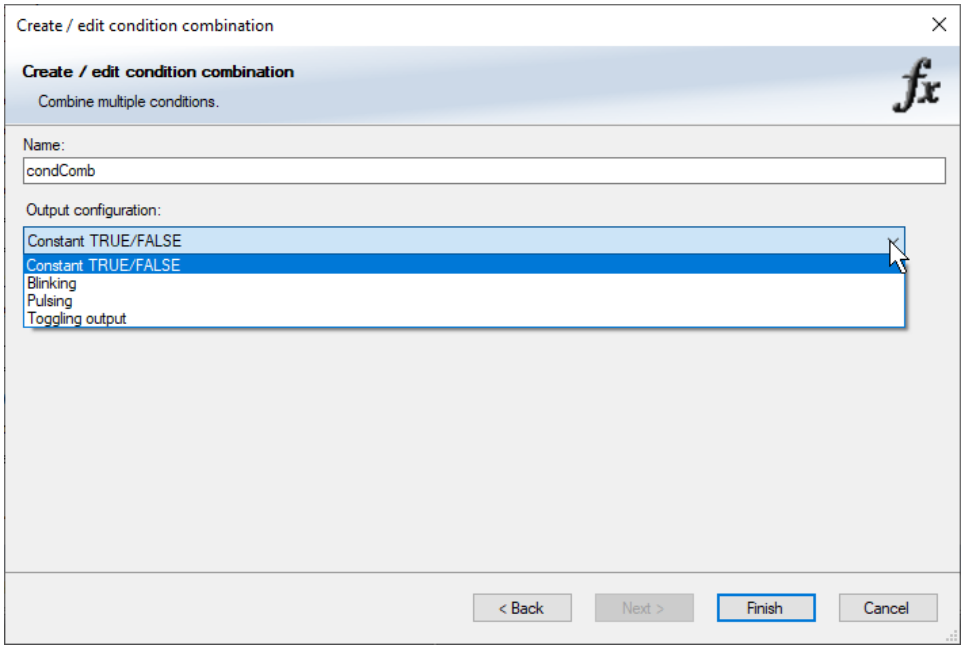


a) Enter the name of the condition combination.

b) Create the condition combination in the window.

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

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



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

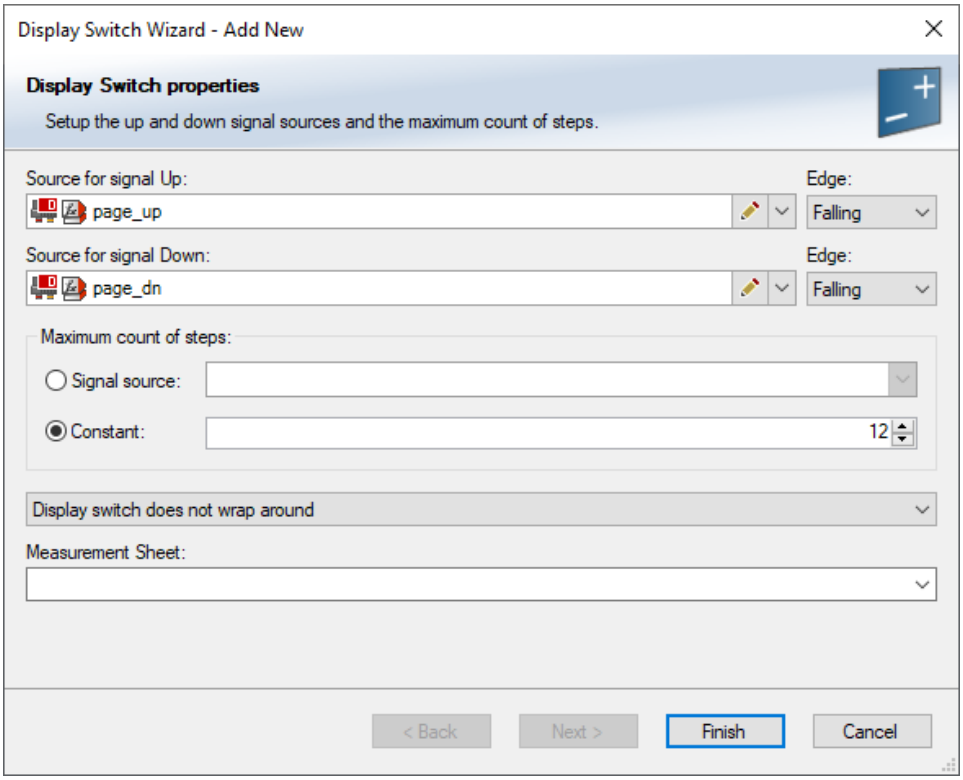
Click ‘Finish’ when done. The conditional combination is displayed in the MS 6 condition channel window.

6.5 Display Switch Module

You can use the Display Switch Module to switch display pages and brightness. The output is a display page or brightness output that can be used in display configurations. The value sustains over a power cycle.

The conditions for incrementing/decrementing the value can be set freely. The maximum value can be set as constant or read from a measurement.

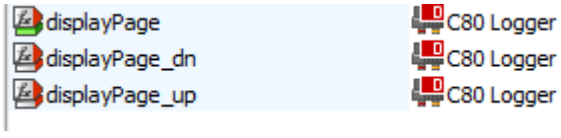
The page can be configured to wrap around. In this case, no page down condition is needed.



The resulting outputs are the display switch value and the input conditions.

Measurement label	Function
name	page or brightness value
name**_dn**	input condition for decrement
name**_up**	input condition for increment

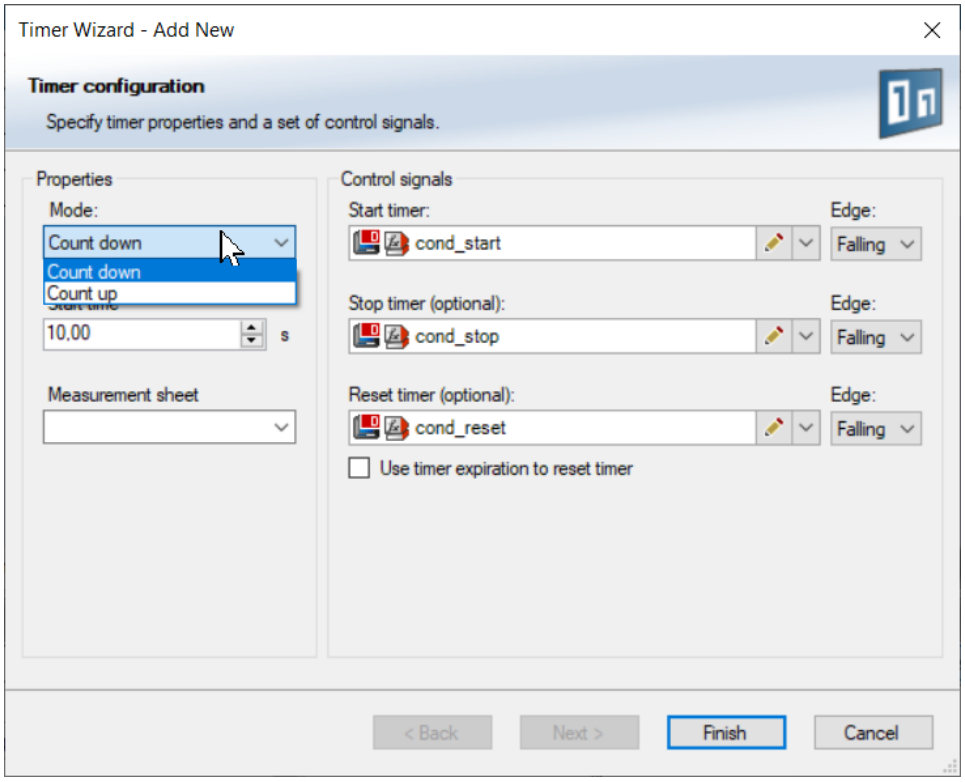
Example:



6.6 Timer Module

The Timer Module is designed to implement timing triggers, i.e. for rallye stage timing or minimum pit time calculations. Any event in the system can be used for starting, stopping and resetting the timer.

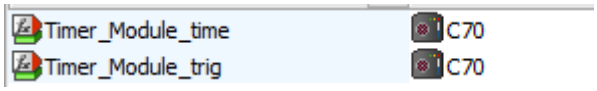
Up counting mode and down counting mode are available, triggers are fired at set time (up counting) or at zero (down counting). The running timer will keep its state over a power cycle.



The output channels for this module depend on the name used for the module and are called ..._time and ..._trig.

Measurement label	Function
name_**time**	actual timer value
name_**trig**	trigger set by timer alarm

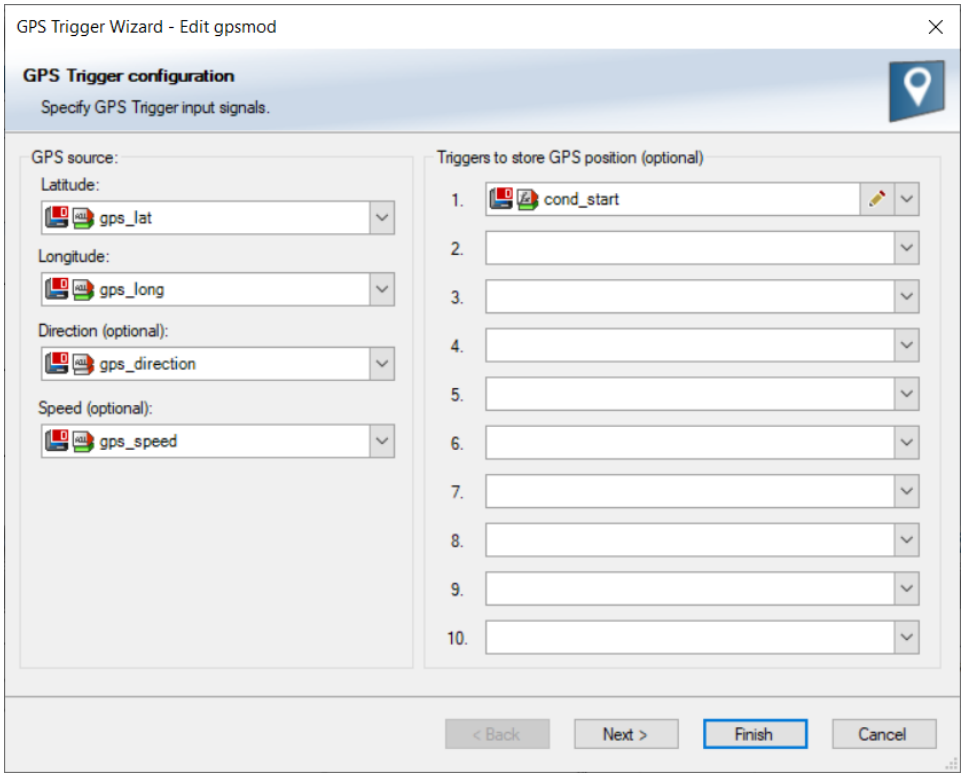
In this example, the module is named “Timer_Module”. Resulting channels are:



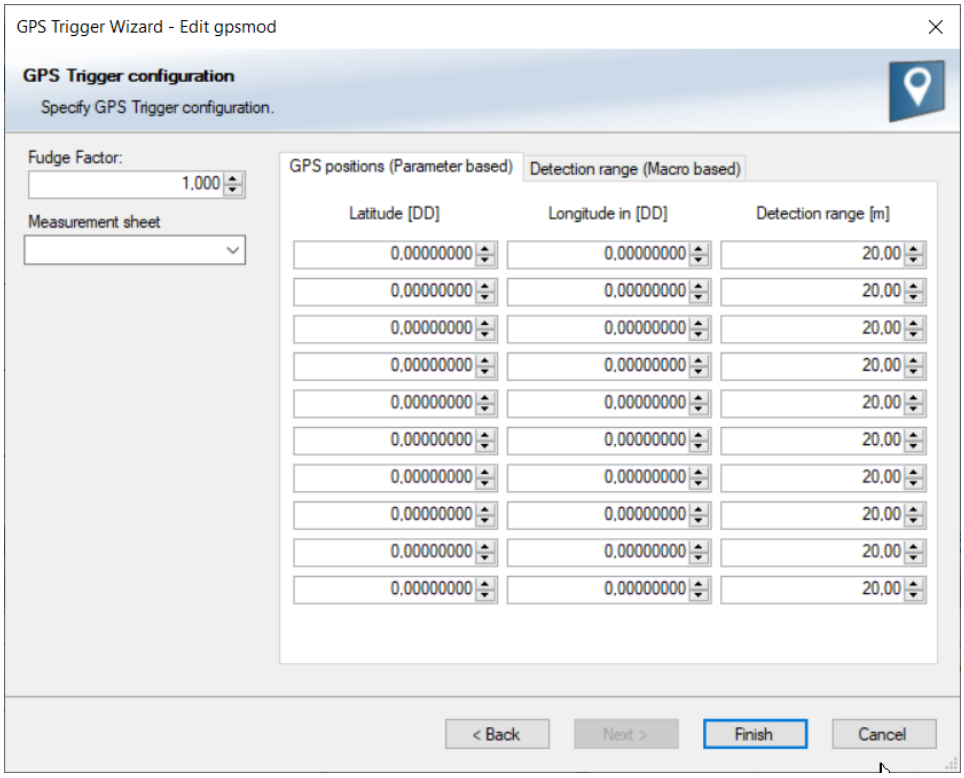
6.7 GPS Trigger Module

The GPS Trigger Module triggers depending on GPS-position, similar to the GPS-laptrigger. There are 2 x 10 GPS trigger points available, 10 in the parameter and 10 in the macro-based mode.

If the car passes one of the trigger points, an output signal is set to 1 shortly. Each trigger requires a defined latitude, longitude and detection range.



The parameter-based trigger points need to be set manually in RaceCon, the macro-based trigger points will store latitude and longitude values when the configurable trigger condition comes true (i.e. steering wheel button). This trigger condition and the detection range need to be configured in RaceCon.

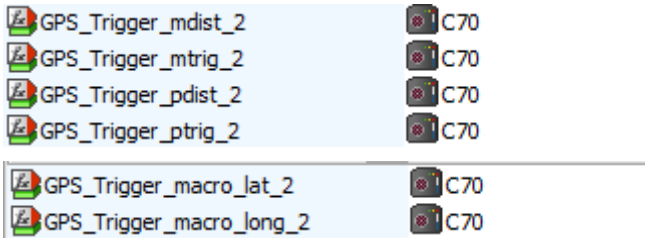


The GPS trigger points can also be used for segment triggering. If used as segment triggers and i.e. 3 trigger points are selected, the laptrigger module will use the first 3 trigger points on the list.

The channel names depend on the name used for the module, in this example GPS_Trigger. Each trigger has a distance and a trigger channel with the abbreviation m for macro or p for parameter based. The trigger channel will be set to 1, when the lowest distance to the trigger point is detected. For the macro-based trigger, the stored latitude and longitude values can be seen with the channels.

Measurement label	Function
name_**lat**	interpolated gps latitude
name_**long**	interpolated gps longitude
name_**ptrig_1..10**	trigger output of parameter based trigger (n)
name_**pdist_1..10**	distance to trigger of parameter based trigger (n)
name_**mtrig_1..10**	trigger output of macro based trigger (n)
name_**mdist_1..10**	distance to trigger of parameter based trigger (n)
name_**macro_lat_1..10**	stored latitude for macro based trigger (n)
name_**macro_long_1..10**	stored longitude for macro based trigger (n)

Example:



6.8 CPU Load Limits

As all microprocessors, the two processors of the MS 6 have limited capacities. The current load of the processors can be monitored using the channel “cpu_load_001” or “cpu_load_002”. When configuring your device, please make sure the used CPU load is in a save range below 100 %.

Bosch recommends a maximum CPU load of 85 % (averaged). Exceeding this limit might result in the MS 6 not being able to fulfill its required measuring/logging/display tasks or even in crashing and rebooting.

Main factors influencing the CPU load are:

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

To help respecting the limit of 85 % CPU load, the MS 6 creates an error memory entry. To trigger this error entry, the CPU load must exceed the limit for 5 minutes without interruption.

When being confronted with this error memory entry (see ‘Error info’ in RaceCon) or when being confronted with MS 6 resets due to complex configuration setups, please consider reducing the demands on the MS 6 adapting the influencing factors mentioned above.

7 CAN Configuration

MS 6 has 3 fully configurable CAN buses.

- Baudrate (125 kBaud to 1 MBaud)
- Input configuration: read messages from CAN bus and convert to MS 6 measurement variables
- CAN bus supports row counter configuration
- Output configuration: write MS 6 measure variables to CAN messages
- Configurable output frequency and row counter
- CAN gateway functionality (transfer from one bus to another)
- Verify errors on the CAN bus and configurable default values

7.1 CAN Bus Trivia

CAN message

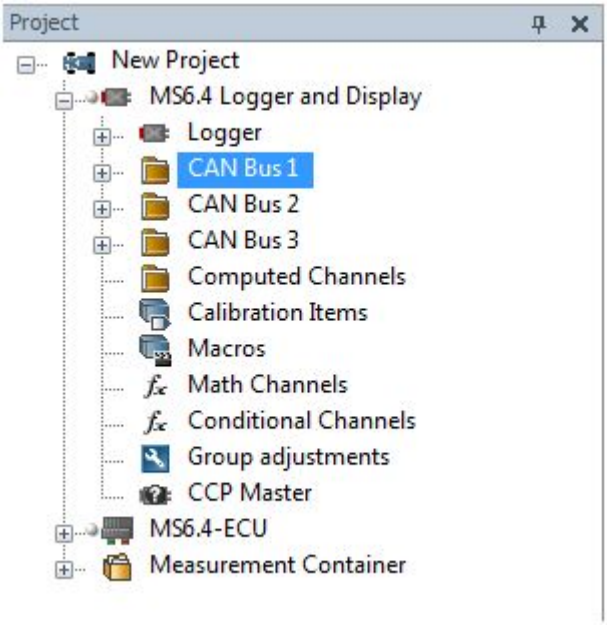
- 11 Bit (standard) or 29 Bit (extended) identifier
- Up to 8 bytes of data payload

CAN bus

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

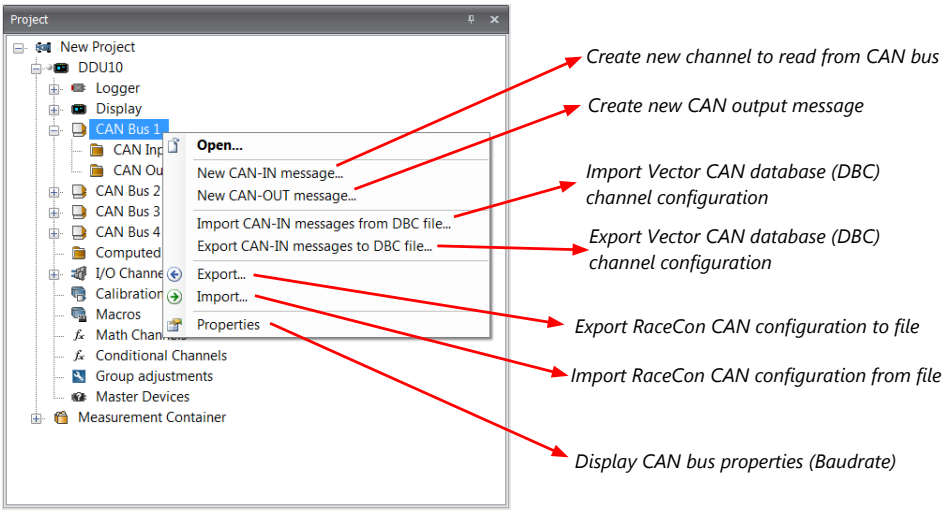
Configuration of MS 6 data rate in ‘Properties’ menu

by double click on the CAN bus in project tree (1 MBaud, 500 kBit, 250 kBit, 125 kBit)



7.2 CAN Input

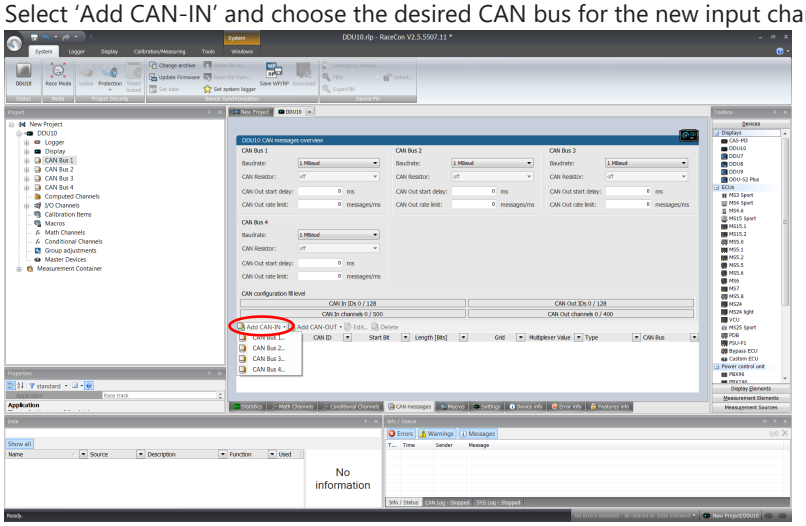
7.2.1 Input configuration



7.2.2 Create a new CAN channel

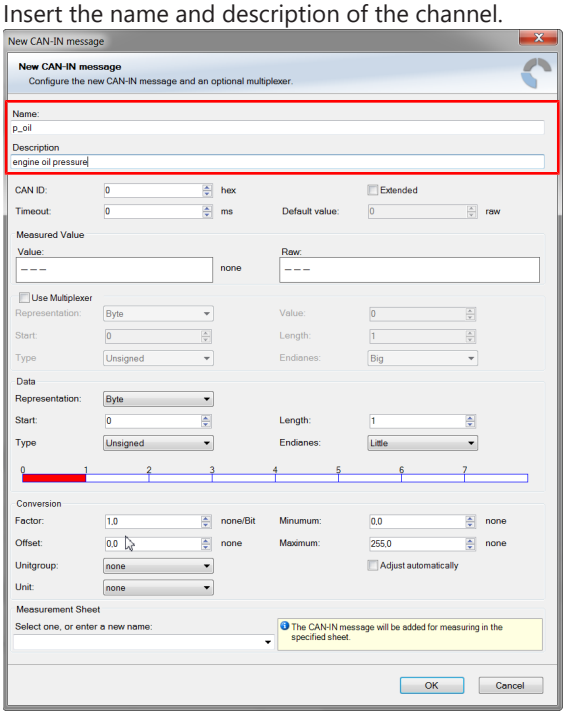
Double-click on any CAN bus item, to open the "CAN messages overview".

Select ‘Add CAN-IN’ and choose the desired CAN bus for the new input channel.



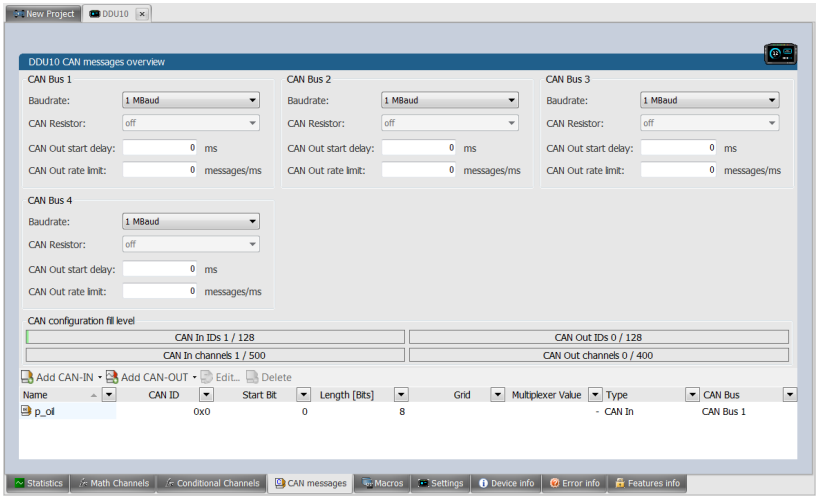
A CAN channel configuration window opens.

Insert the name and description of the channel.

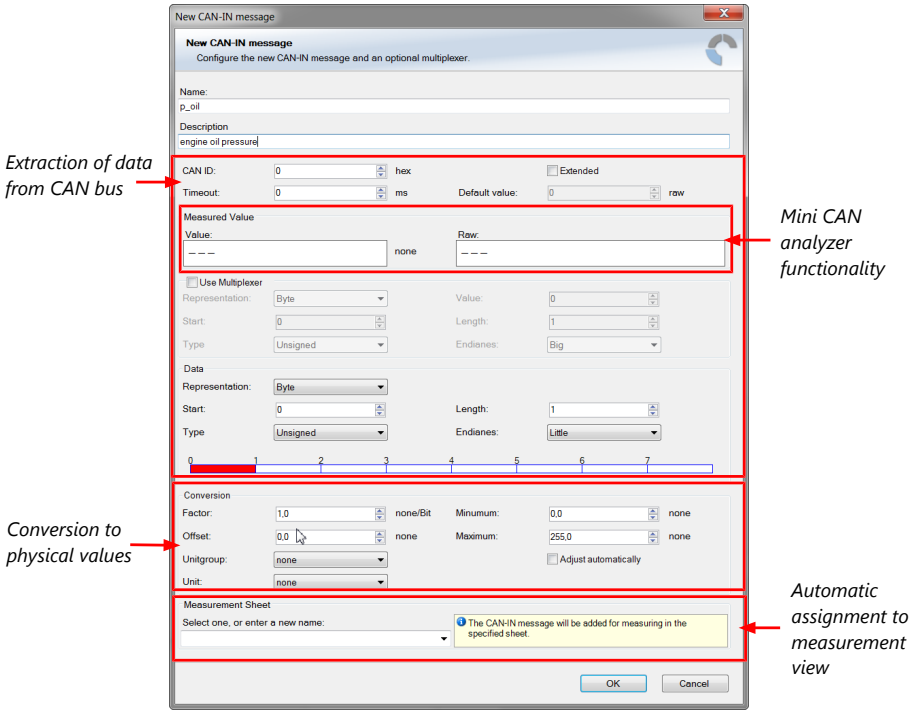


Click ‘OK’ when done.

The channel is listed in the Data window.



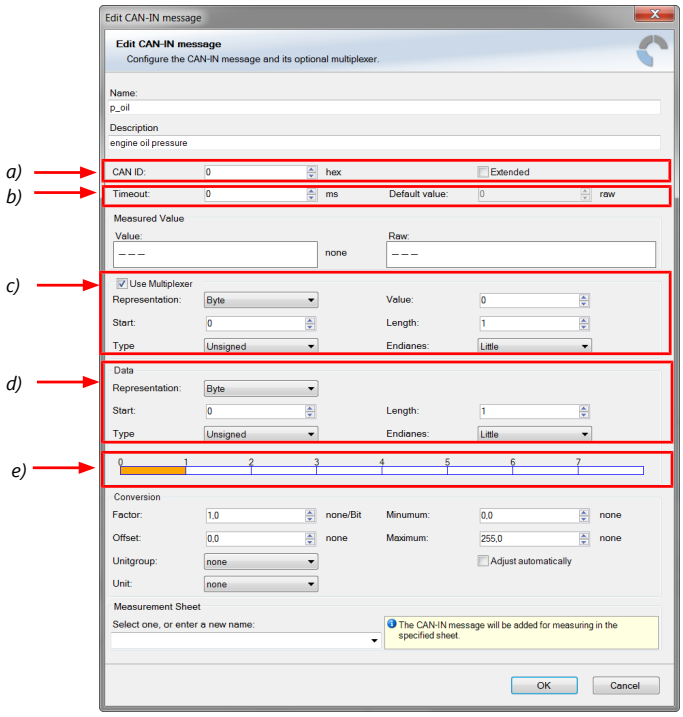
7.2.3 CAN channel configuration



7.2.4 Extracting data from CAN bus

Representation: Byte

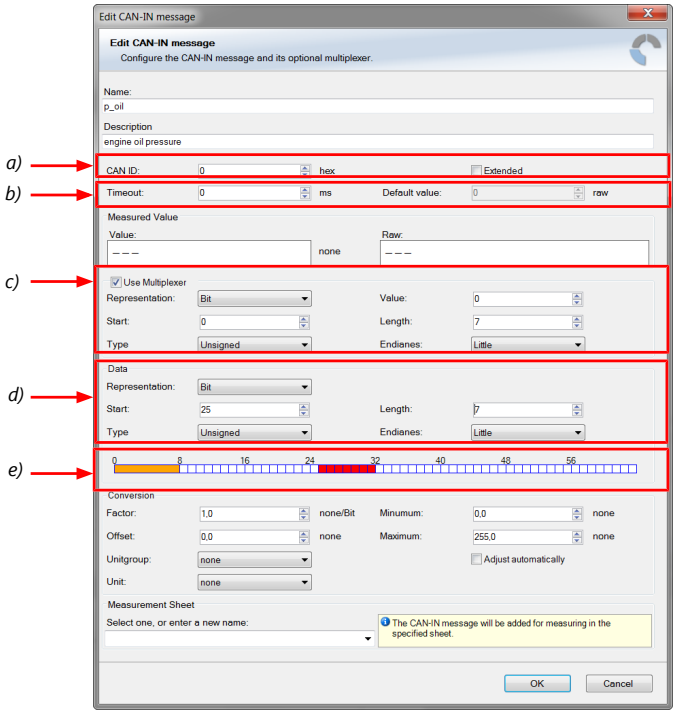
Some CAN devices need to be addressed by a byte represented CAN channel. The address can be assigned in this window and is illustrated by a bar graph.



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

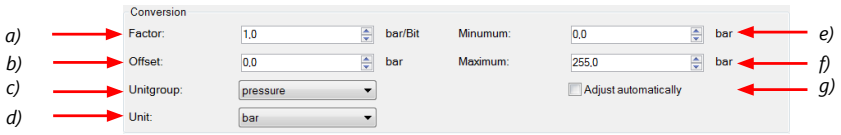
Representation: Bit

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

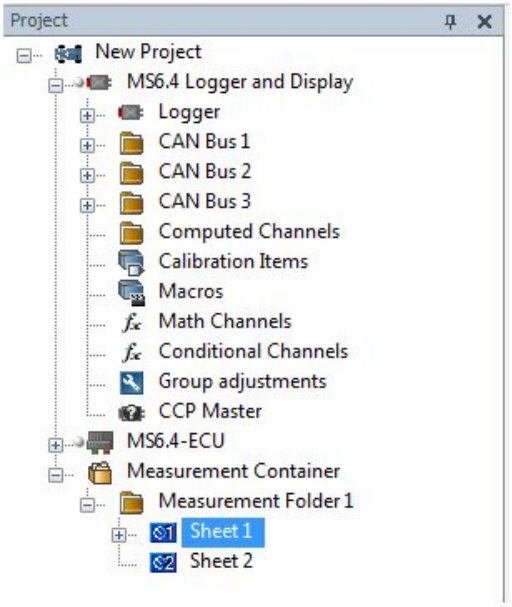


a) Enter CAN message ID. If extended IDs (29 bit) are used, check the box.
b) If replacement values are used, specify time-out period and raw value.
c) If a multiplexer (row counter) is used, check the box.
d) Enter data position, length and format.
e) The bargraph shows the assignment of the bits.
-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

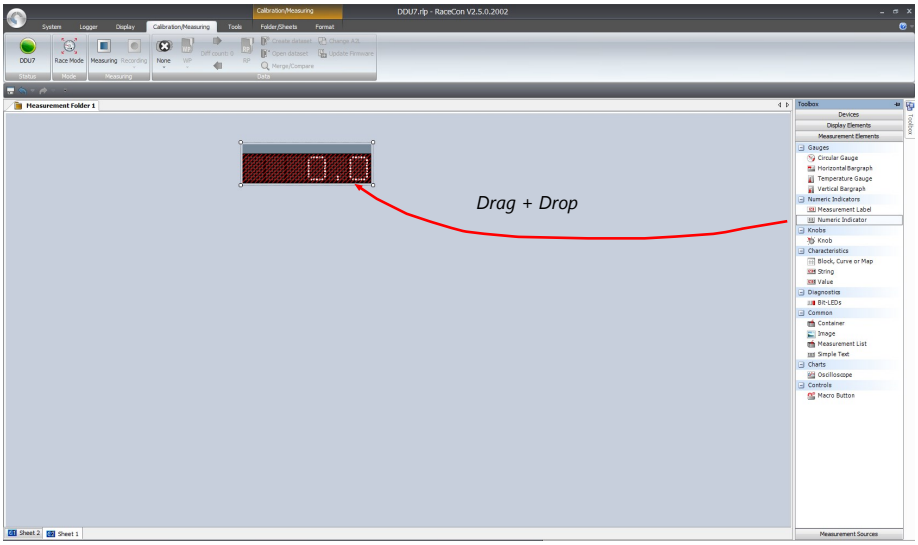
7.2.5 Conversion to physical values



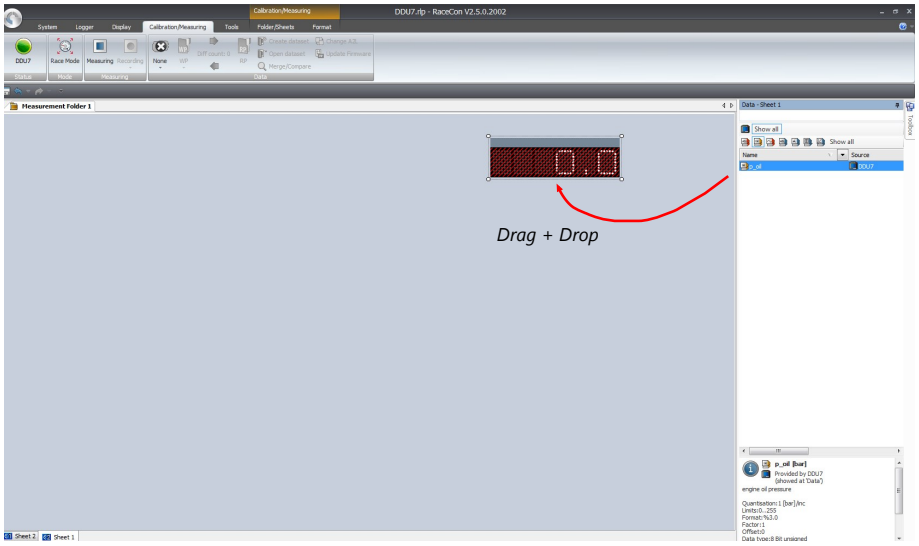
7.2.6 Online view of CAN channels in vehicle



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.

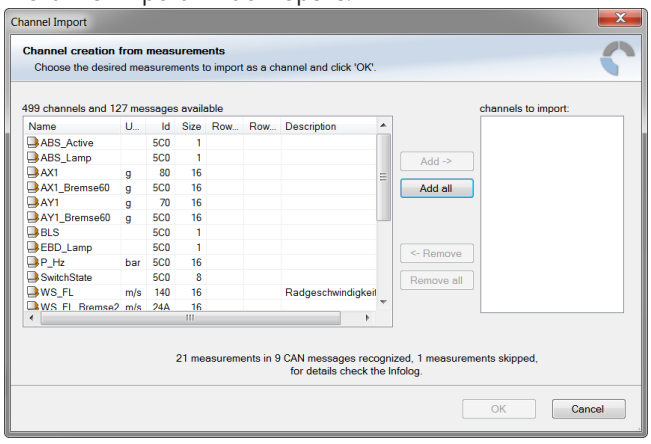


The measurement element displays the values of the assigned channel.

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

7.2.7 Import a CAN database (DBC) file

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



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

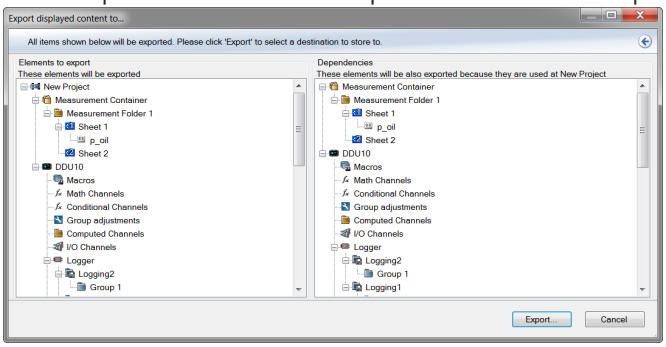
   The channels are inserted in the Data window.

7.2.8 Export in RaceCon

You can choose to export the whole project or you can export specific parts of the project.

Proceed with the following steps to perform an export:

1. Click with the right mouse button on an item in the project tree.
2. Select 'Export...' from menu. An 'Export Selection' window opens.



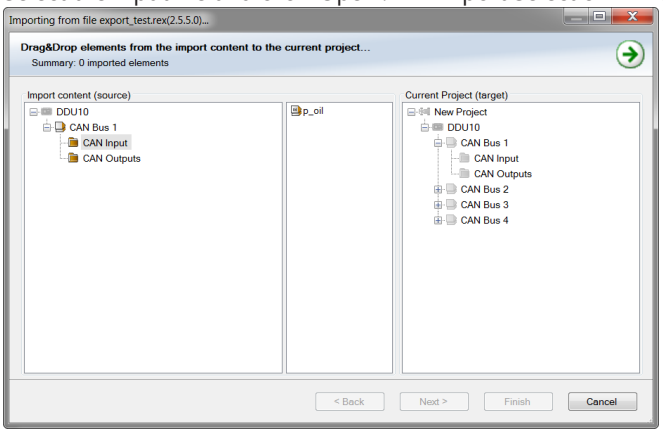
3. Click on 'Export' to select a destination to store.
4. Specify the filename.
5. Click 'Save' when done.

7.2.9 Import in RaceCon

You can choose to import the whole project or you can import specific parts of the project.

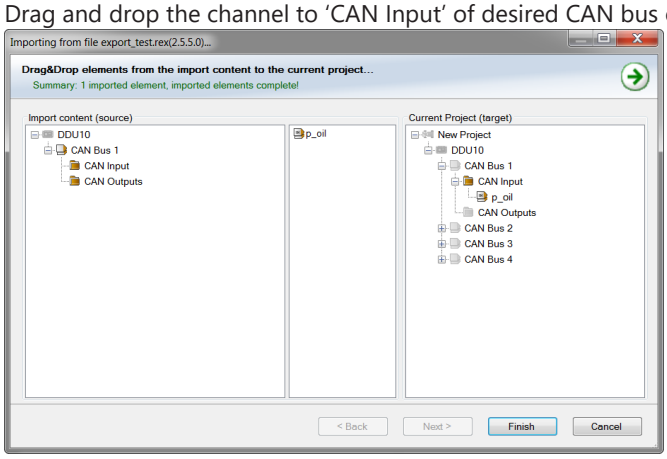
Proceed with the following steps to perform an import:

1. Click with the right mouse button on any item in the project tree.
2. Select 'Import...' from menu. A file browser opens.
3. Select the input file and click 'Open'. An 'Import Selection' window opens.

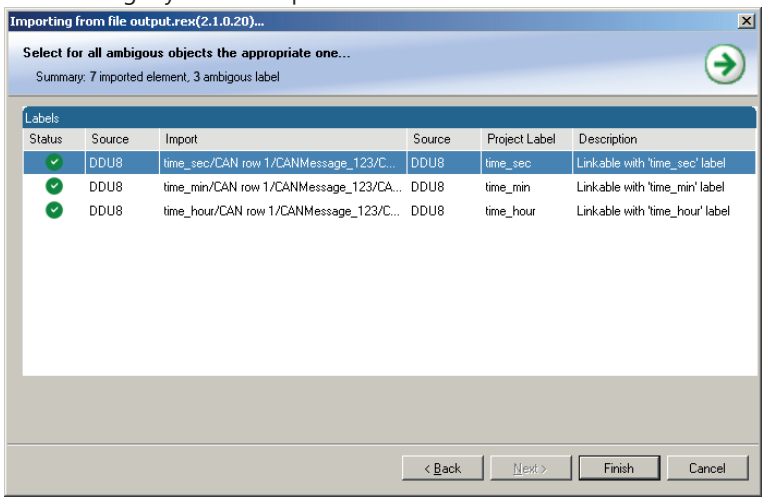


4. Select channels to import.

5. Drag and drop the channel to ‘CAN Input‘ of desired CAN bus on right hand side.



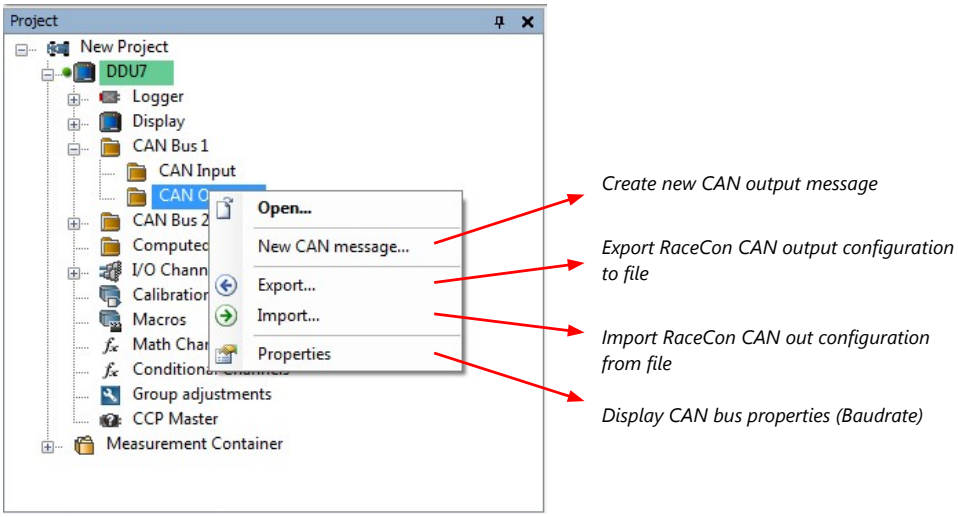
6. Click ‘Finish‘. If a measurement channel belongs to more than one source, the ‘Solve Label Ambiguity‘ window opens.



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

7.3 CAN Output

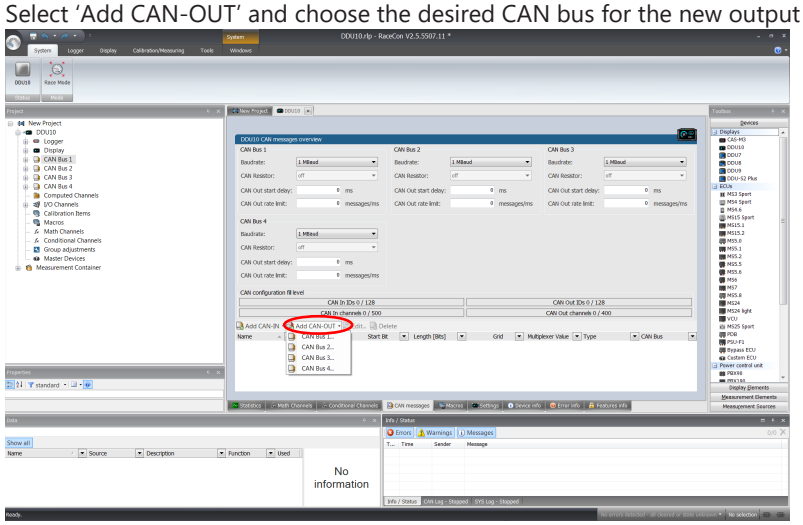
7.3.1 Output configuration



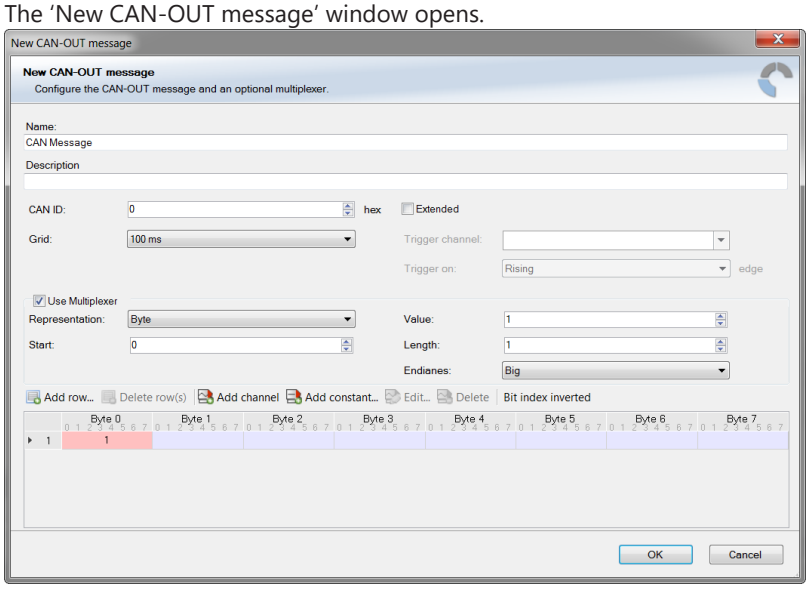
7.3.2 Create new CAN output message channel

Double-click on any CAN bus item, to open the "CAN messages overview".

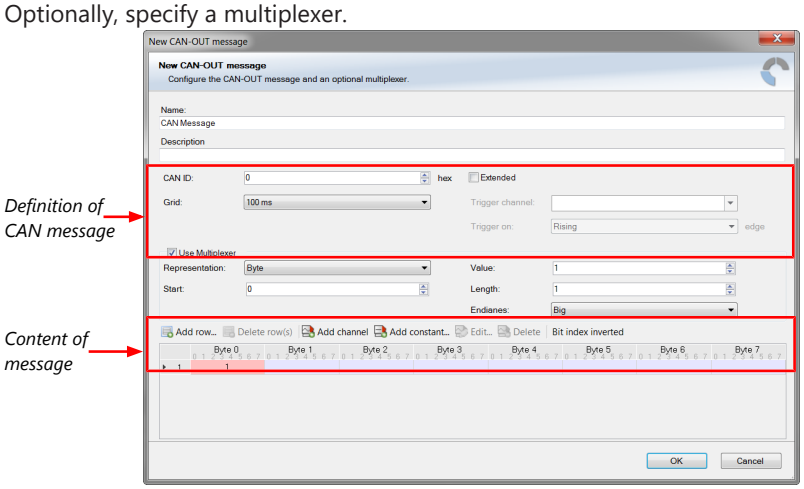
1. Select 'Add CAN-OUT' and choose the desired CAN bus for the new output channel.



The ‘New CAN-OUT message’ window opens.

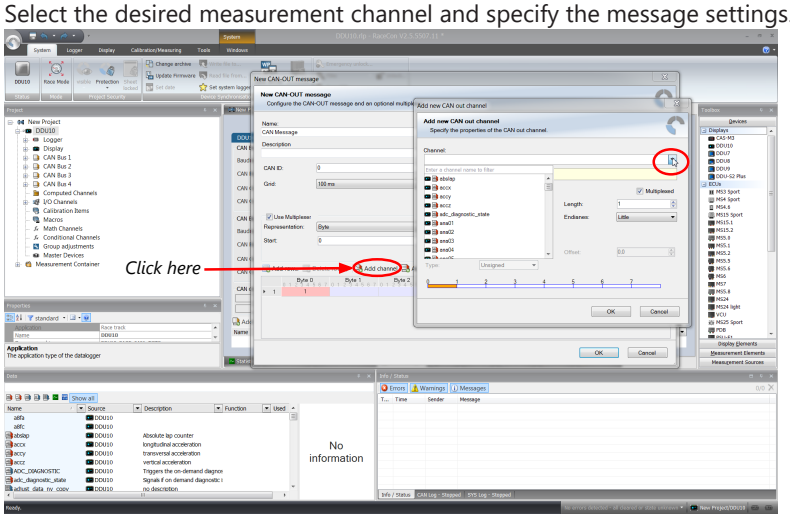


2. Enter name of message, description, CAN-Id and Grid (output interval). Optionally, specify a multiplexer.



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

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



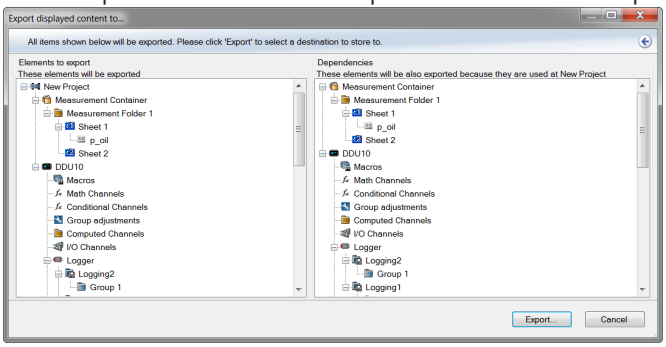
The measurement channel is now assigned to the CAN message.

7.3.3 Export in RaceCon

You can choose to export the whole project or you can export specific parts of the project.

Proceed with the following steps to perform an export:

1. Click with the right mouse button on an item in the project tree.
2. Select 'Export...' from menu. An 'Export Selection' window opens.



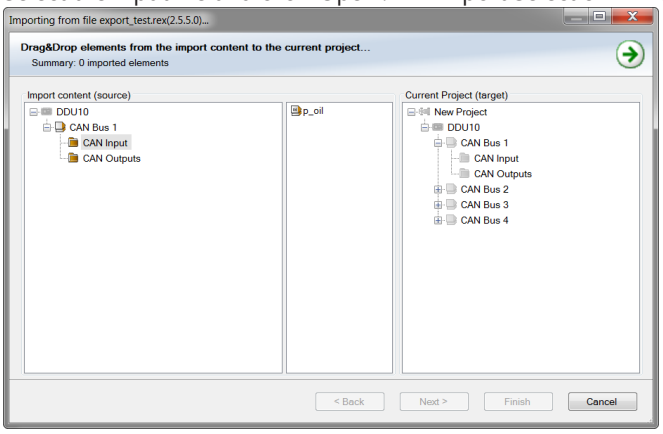
3. Click on 'Export' to select a destination to store.
4. Specify the filename.
5. Click 'Save' when done.

7.3.4 Import in RaceCon

You can choose to import the whole project or you can import specific parts of the project.

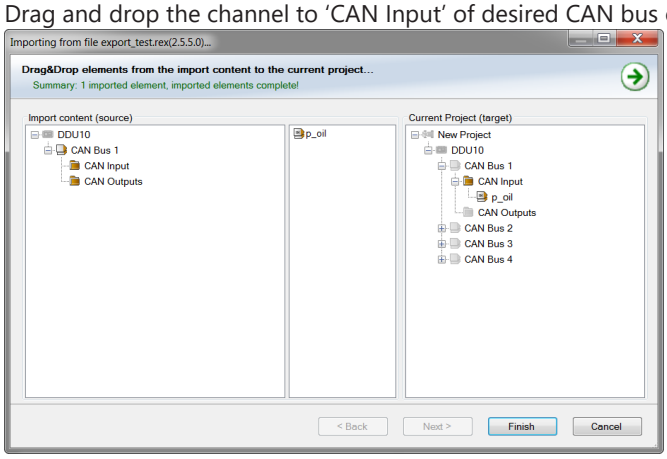
Proceed with the following steps to perform an import:

1. Click with the right mouse button on any item in the project tree.
2. Select 'Import...' from menu. A file browser opens.
3. Select the input file and click 'Open'. An 'Import Selection' window opens.

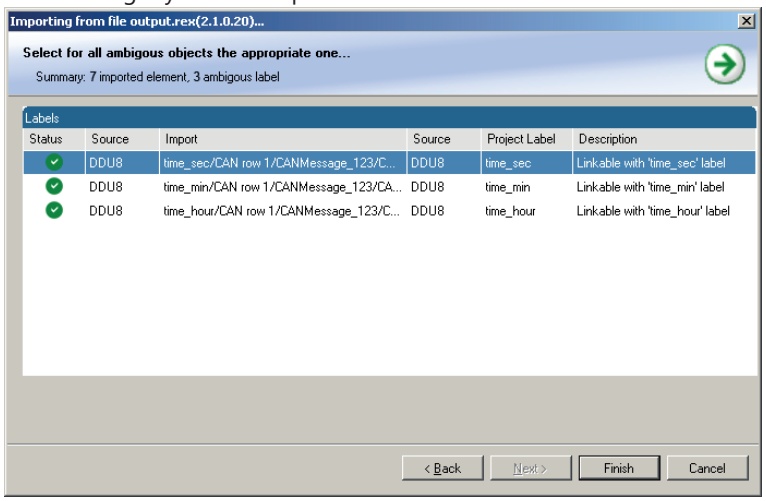


4. Select channels to import.

5. Drag and drop the channel to ‘CAN Input‘ of desired CAN bus on right hand side.



6. Click ‘Finish‘. If a measurement channel belongs to more than one source, the ‘Solve Label Ambiguity‘ window opens.



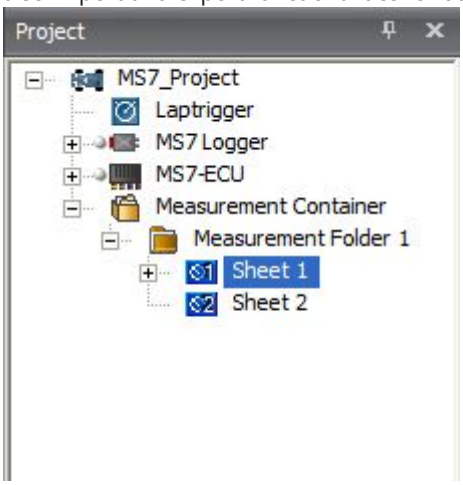
7. Assign the ambiguous channels to the desired source.
8. Click ‘Finish‘.

8 Online Measurement and Calibration

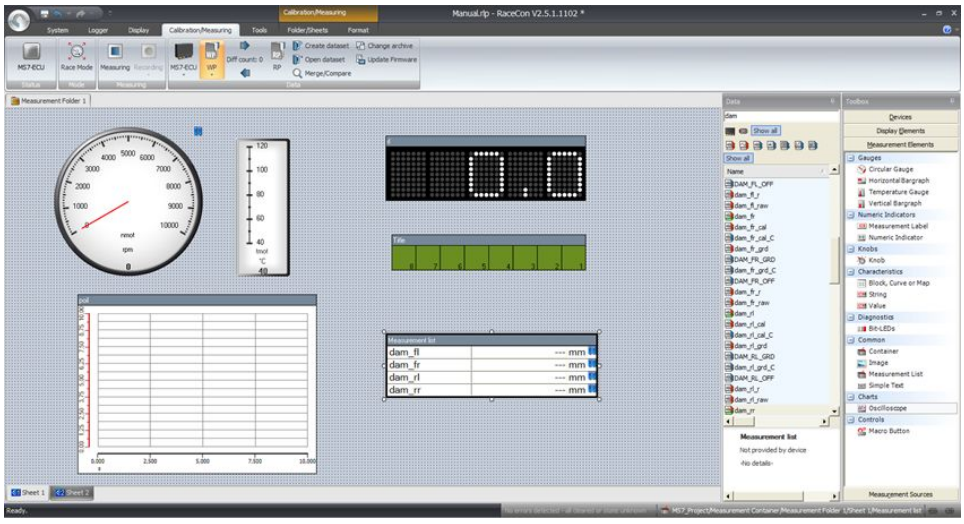
- Verify system status and diagnosis.
- Check and calibrate sensors of the system.
- Data application in online mode.
- PC and device are connected.
- Local PC data match to MS 6 configuration (devices are indicated as green).
- From the context menu of the project, new measurement pages can be created.

8.1 Setting up an Online Measurement

- Expand measurement container and measurement folder in the project tree.
- Double click on Sheet 1 opens the main area.
- The context menus offer a lot of options, like add, delete and rename folder or sheets, also import and export functionalities for data storage are available.



- The main area opens additional window data sheet and toolbox.
- Drag and drop the measure channels and select the graphic rendition or select first toolbox offers and place the channel to the element.



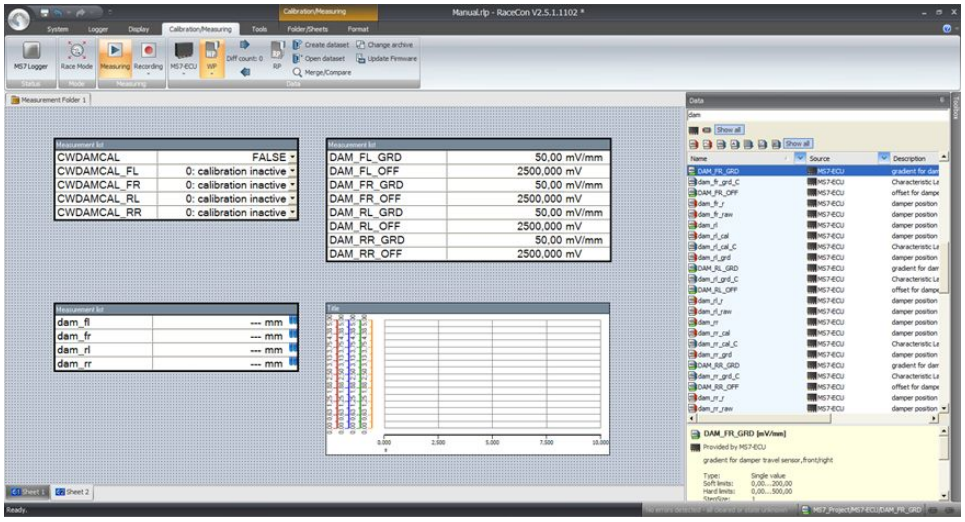
Measure and calibration:

(Example: damper position measurement)

Base of the data list are the function- and measure labels, described in details in the function description.

- To assist the discovery of relevant labels, data list may be graduated.
- Description and label symbol explain the task of the data label.
- Structure of Bosch Motorsport Labels shall communicate recognition values.

CWxxx	Code-Word starts an action for the function
CWDAMCAL	Code-Word damper travel adjustment "True" sets the actual measure values of all dampers to 0
CWDAMCAL_FL	Code-Word damper front left adjustment,2-point sensor calibration added by offset adjustment for each single damper
dam_xx	measure values are always typed in small letters
dam_fl	damper position front left
udam_xx	voltage values starts always with "u", the value represents the sensor signal
DAM_XX_YY	Data Label are always typed in big letters
DAM_FL_GRD	Gradient for damper travel sensor, front left, values are available from sensor manufacturer



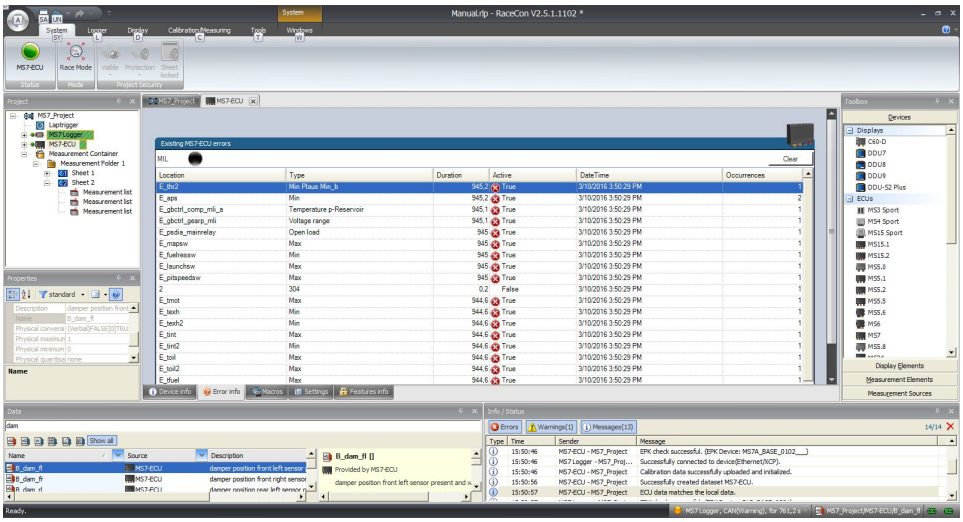
8.2 Using the Measurement Sheets

- When RaceCon is online, press "F11" key to switch from Design Mode into Race Mode.
- The measurement sheet is extended to full screen.
- Switch between different sheets using the tabs at the bottom of the page or the keyboard shortcuts associated with the sheets.
- Press ESC key to return to Design Mode.

9 Error Memory

9.1 Error Memory representing in RaceCon

- Bosch Motorsport devices feature an error memory. Information on detected errors can be visualized via RaceCon (online measurement) or can be transmitted via telemetry.
- Select any configured device of the system and inspect the “error info” folder.



- Adapt the messages to the configured hardware. In general, properties of the error memory and properties of an individual error need to be distinguished.
- The memory is situated inside the device and 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.
- Clearing the error memory
  - in the top right corner of the error monitor,
  - alternatively at the bottom of the menu bar,
  - alternatively reset the error monitor in the measurement folder >CLRERRMON< = TRUE.

9.2 Writing an Error

For the functional part of the MS 6 system (MS 6-ECU) the error bits are related to the function and have to be distinguished if the function is activated. If an error is detected, the information may be shown as part of the error monitor in RaceCon, as display information and as measure channel. To support driver visibility, an activated error may activate also an output to enable the MIL-light (B_mildiag will be enabled).

CW_EM_xxx	Individual error related to a function
0	Error will not be stored in the monitor
1	Error is stored in the monitor
2	Not valid
3	Error is stored in the monitor and the MIL condition is switched on

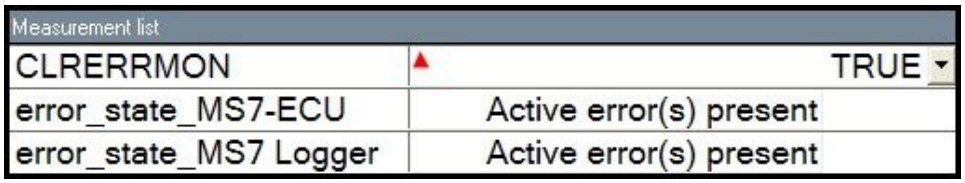
The single error bits may be collected in the error monitor.

9.3 Error Memory Properties

The following property is available for the error memory itself.

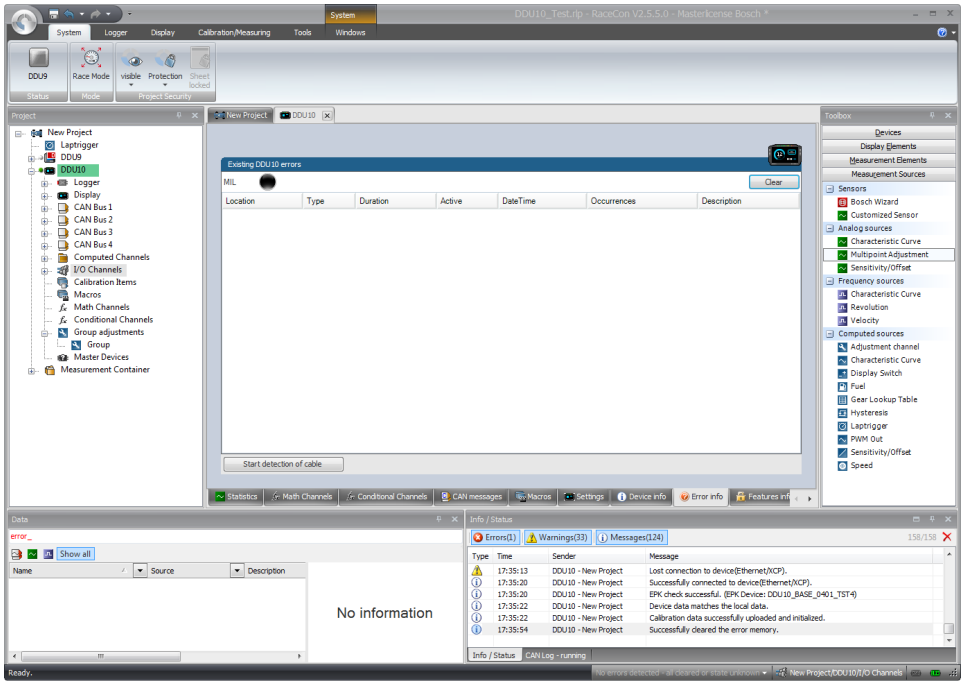
CLRERRMON	Reset of the error monitor
Error Status /device measurement label error_state	
0	No error present in the memory
1	At least one inactive error present in memory, no active errors
2	At least one active error present in memory

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

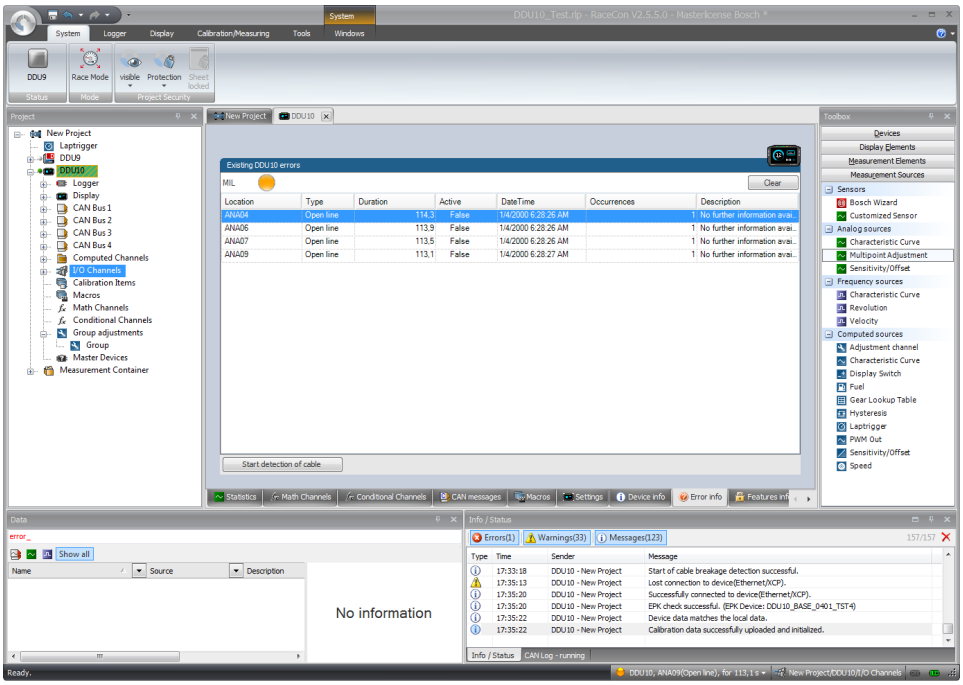


It is also represented by a color scheme within RaceCon (provided RaceCon is online with the system):

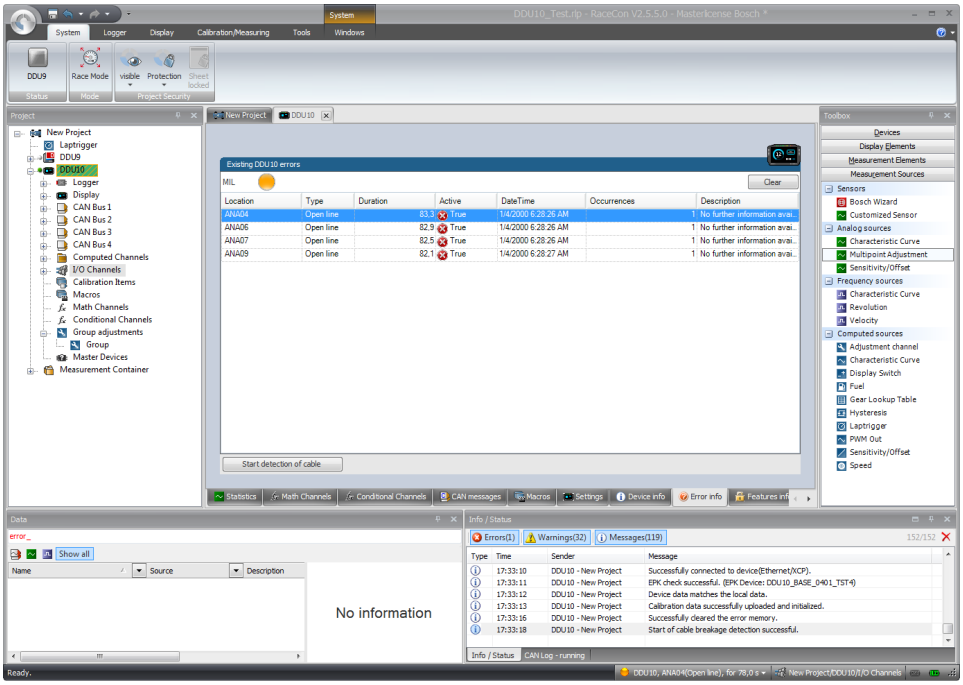
0 (no error present in memory)



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



2 (at least one active error present in memory)



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The primary ANTLR guy:

Terence Parr

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10.2.2 antlr311runtime.jar License

ANTLR-3.1.1

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/

10.2.5 Sensor Driver for BMI160 Sensor

Applies to BMI160

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xml_io_tools

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SVHC Substance	CAS Number
Lead monoxide (lead oxide)	1317-36-8
Lead	7439-92-1

11 Pin Layout

The pin layout is available at Bosch Motorsport website on MS 6 product page.

Most of MS 6 functions to pin relations may be modified to project demands.

Please see details in the function description SWITCHMATRIX.

Bosch Motorsport tests check the defined connections of the pin layout.

Using a MS 6.1 or MS 6.3 version, ensure not using analogue inputs of the measurement package without enabled license.

For MS 6.1 and MS 6.3, these hardware-options are only available if MS 6 measurement package is in use.

12 Harness

Harness connectors

Bosch automotive connectors are not available as complete set of components, so Bosch Motorsport itself offers such a package. For more technical details please check Bosch-connector homepage, 196 pins
http://www.bosch-connectors.com/bogscoca/category/142

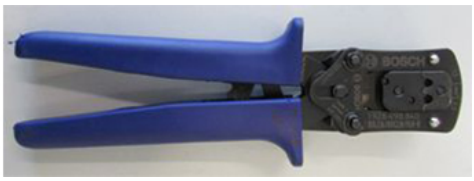
MS 6 harness connector type A (105 contacts), coding variant 1	F02U.B00.712-01
MS 6 harness connector type K (91 contacts), coding variant 1	F02U.B00.711-01
Protection Classification	IP X6K, X8, X9K
Temperature range	-40 to 120°C
Shakeproofed	Max. 3.4 g
Wiring diameter	0.35 to 2.5 mm²
Pinsize	1.2 mm; 2.8 mm

Dummy Plug

Dummy plug 1928.405.459 for unused connections	Matrix 1.2 / CB / 0.75 to 1.0 mm²
Dummy plug 1928.405.460 for unused connections	Matrix 1.2 / CB / 1.0 - 1.5 mm²
Dummy plug 1928.301.207	BTL 2.8

Tools and Contacts

Tool	Matrix	Contact	Wire size
1928.498.212	Matrix 1.2	Clean Body 1928.498.991	0.35 to 0.5 mm²
1928.498.213	Matrix 1.2	Clean Body 1928.498.992	0.75 to 1.0 mm²
1928.498.837	1928.498.840	BTL 2.8 1928.498.651	1.5 to 2.5 mm²



Wiring

Bosch Motorsport recommends using the specified cable material and harness layout for automotive connectors and wiring applications.

For Ethernet and USB connection CAT5 specified material is recommended and the pairs and shield connections have to be strictly respected as shown in the wiring diagram.

For USB, the maximum wiring length is limited to 3 m and it is not allowed to be included into a common harness and also there is no interruption allowed.

Due to installation condition, the length may have to be reduced.

Keep network wiring in distance to main sources of electrical noise like coils, coil- and HP-injector wirings and also in distance to any telemetry transmitter.

CAN-networks need a 120 Ohm termination at 2 ends of the wiring.

The MS 6 is able to switch on an internal 120 Ohm termination, set CWCANx_TERM true to enable the termination.

For wiring layout, respect the common rules of failure reduction like separated sensor power supply between important system sensors (e.g. camshaft detection) and measure options (e.g. damper position).

Be ensure HP-injectors, electronic throttles and other high frequently switched actuators are connected within the wiring limits of 2.5 m and all wires are manufactured as twisted pairs.

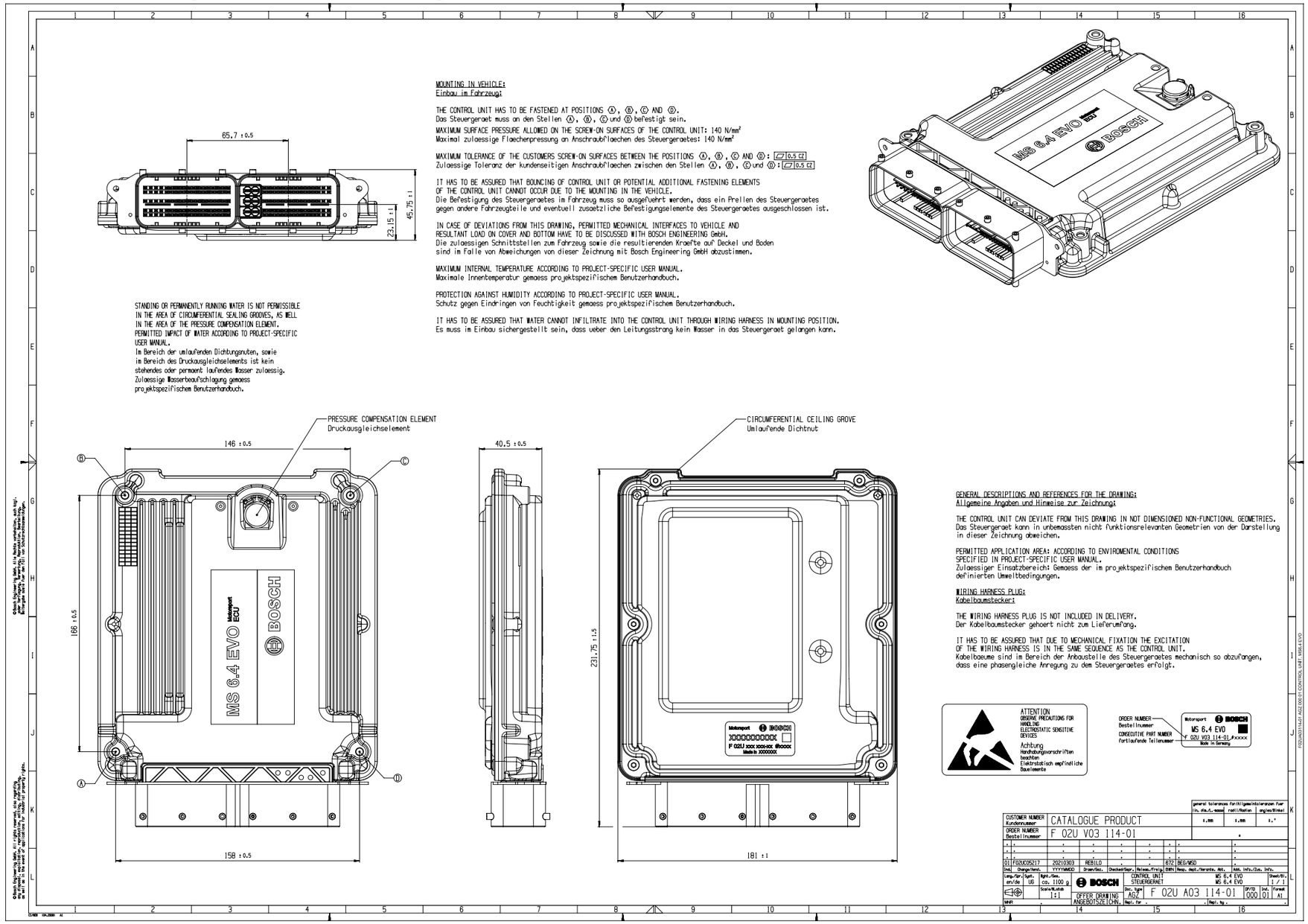
If using a preinstalled production harness, first verify the way of sensor- and actuator controls.

Often production parts have to be connected to 12 V power supply and actuators are controlled in different ways. The production harness may need to be modified.

Office harness

Reduced layout to realize communication between PC, MS 6 device and Display DDU, recommended for flash configuration, display configuration and installation tasks. Bosch Motorsport part number: F02U.V01.809

13 Offer Drawing and Basic Wiring

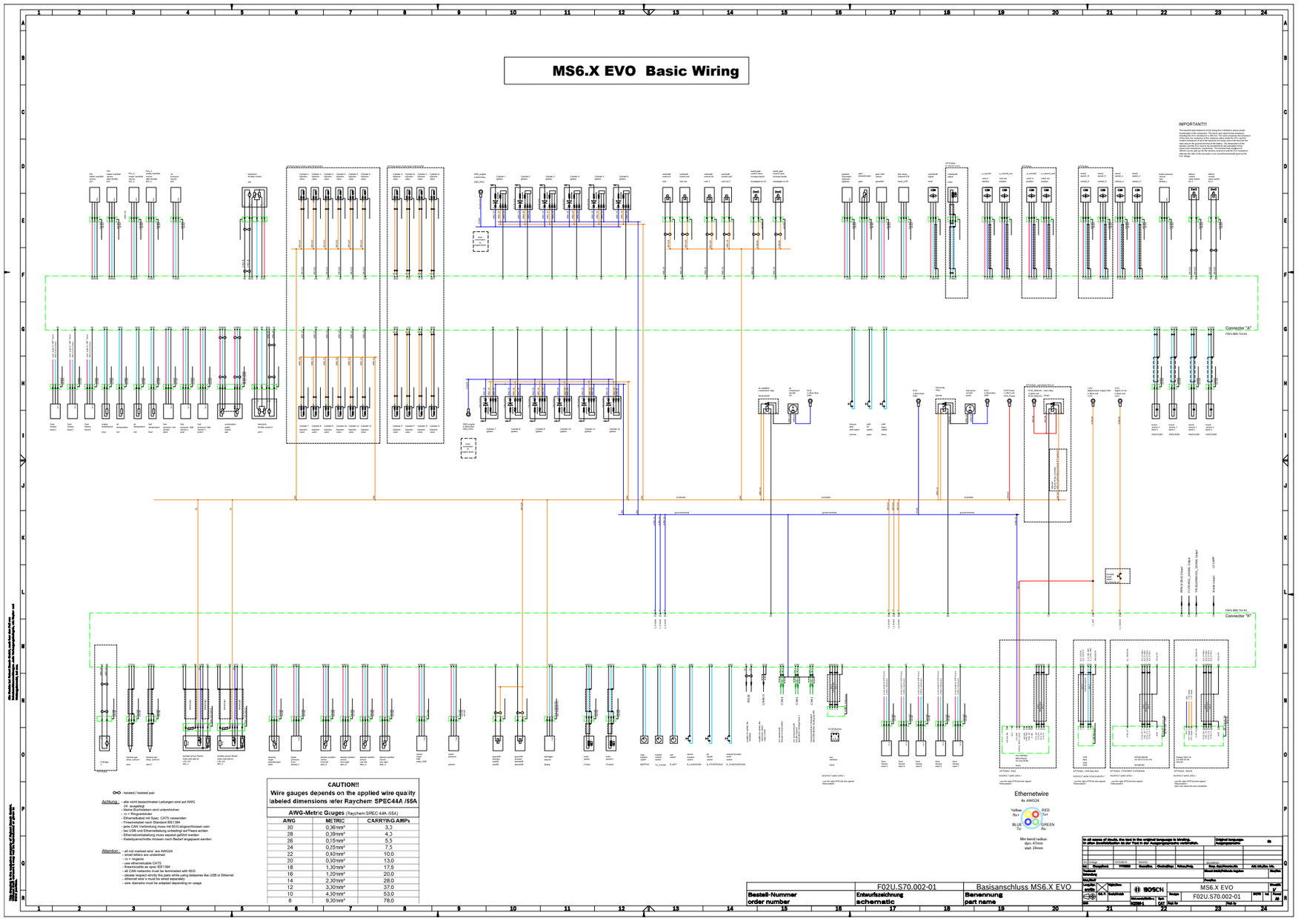


The wiring diagram is available at Bosch Motorsport website on the MS 6 EVO product page.

NOTICE

The wiring diagram shows a principle of wiring and connection options.

ECU pin relation may change to customer data application and program layout. Sensor-, actuator- and power supplies may also change to the request of the project.



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