BOSCH

Engine Control Unit MS 6

Manual

Version 1.1 26/09/2019

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.

NOTICE

Drive-by-wire systems

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

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.

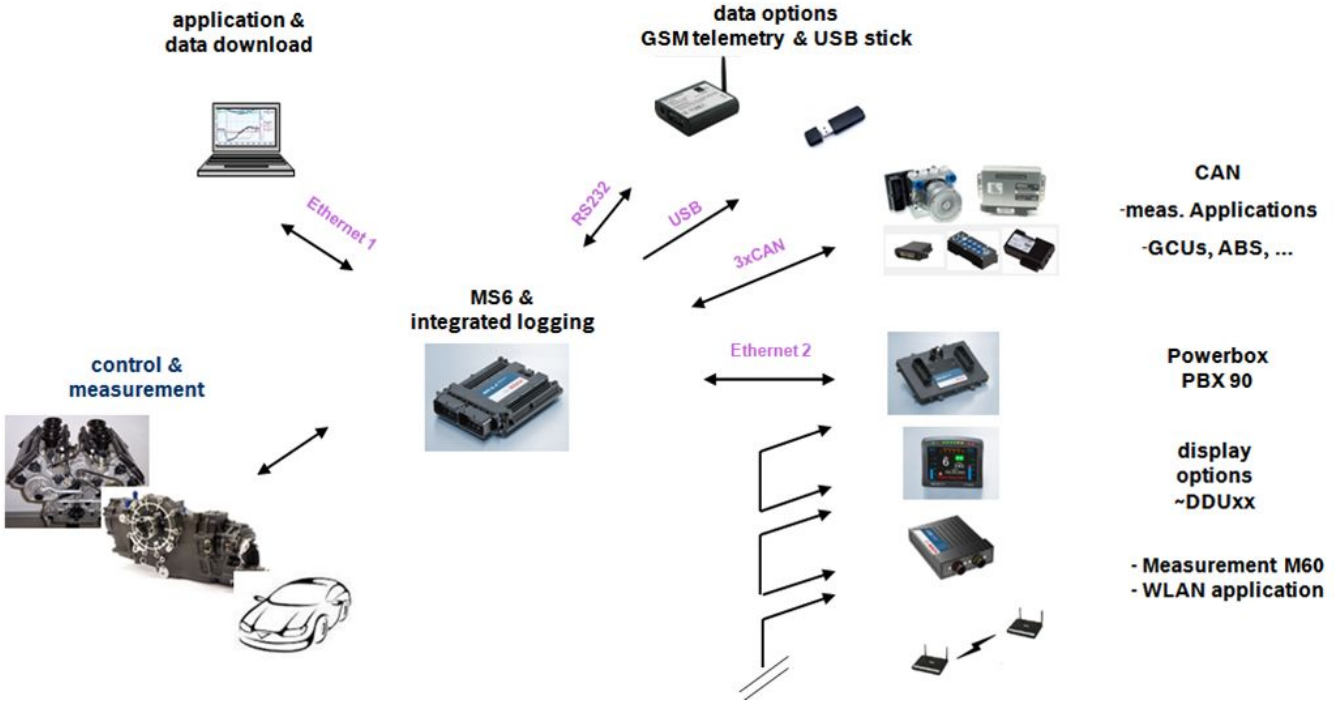
2.1 System Layout

- 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 F02UV01961-03, MS 6.2 F02UV01867-06, MS 6.3 F02UV01963-03 or MS 6.4 F02UV02019-06 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, Licenses and Order Numbers

To accommodate the wide range of different engine requirements and race track 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	F 02U V02 001-01
Engine function package II	To activate traction and launch control	F 02U V02 002-01
For MS 6.1 and MS 6.3		
Measurement package	To increase from 21 to 42 analog channel inputs	F 02U V02 000-01
For MS 6.3		
High pressure injection package	To activate 2nd engine bank and 2nd MSV controls	F 02U V01 999-01
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	F 02U V01 993-01
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	F 02U V01 998-01
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	F 02U V02 082-01
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]	F 02U V02 107-01 On request
Gear control package II	Strategy for pneumatic forced gear change control	F 02U V02 108-01
Gear control package III	Support for external GCU like Cosworth or Megaline [included for base versions	F 02U V02 109-01 On request

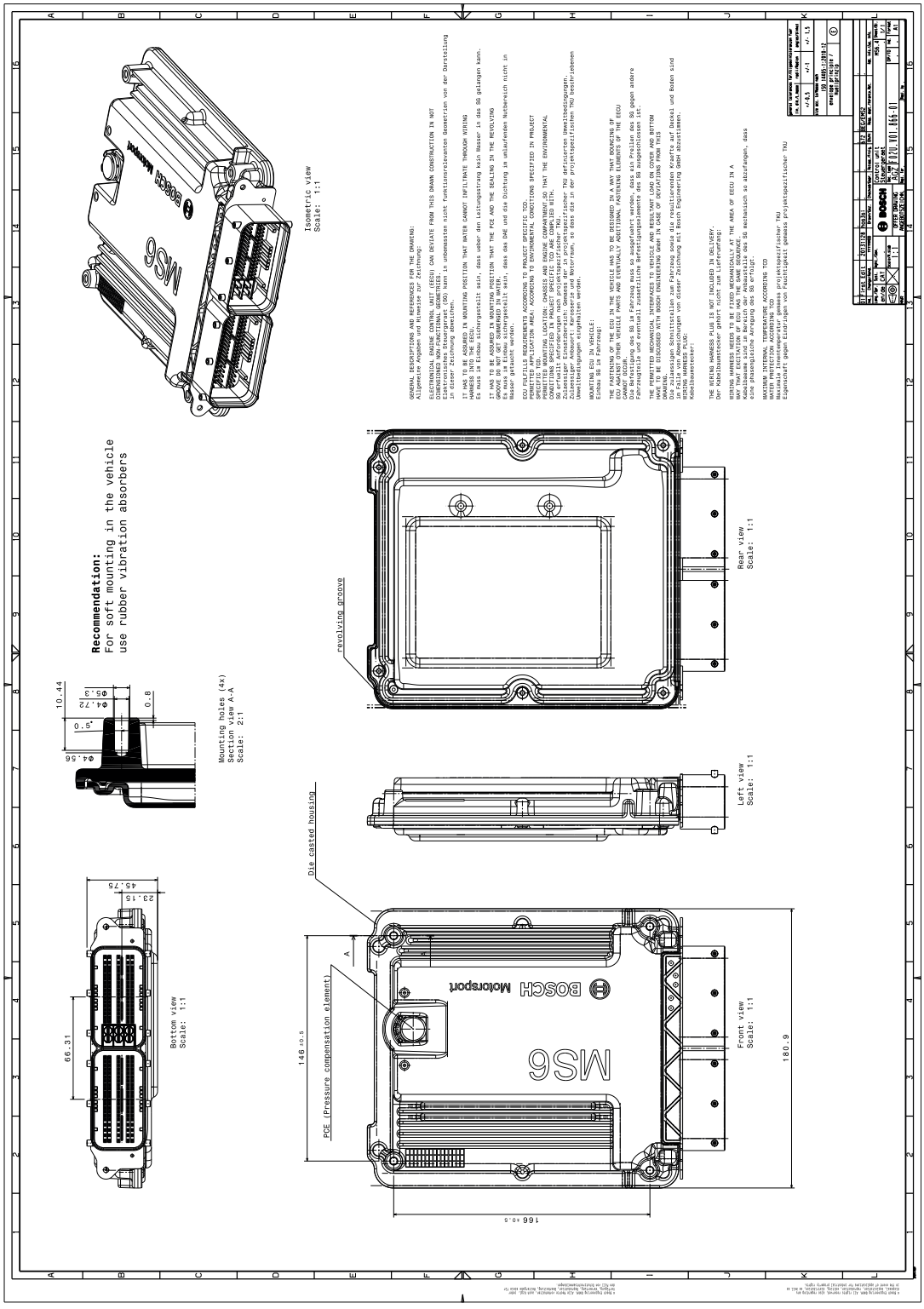
For all MS 6 Versions		
	beginning with MS6A_BASE_0600 or comparable]	
Customer Code Area	Enable Customer Code Area	F 02U V02 511-01

NOTICE

Verify the necessity of gearbox control licenses by checking the Features info window in RaceCon (see section Feature/License Activation [▶ 32]).

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	


Recommendation:
For soft mounting in the vehicle
use rubber vibration absorbers
Isometric view
Scale: 1:1
Rear view
Scale: 1:1
Left view
Scale: 1:1
Front view
Scale: 1:1
Bottom view
Scale: 1:1
Mounting holes (4x)
Section view A-A
Scale: 2:1
revolving groove
Die casted housing
PCE (Pressure compensation element)
MS6
BOSCH Motorsport
166 ±0.5
180.9
66.31
45.75
23.15
10.44
0.8
4.56
0.5
GENERAL DESCRIPTIONS AND REFERENCES FOR THE DRAWING:
Allgemeine Angaben und Hinweise zur Zeichnung:
ELECTRONICAL ENGINE CONTROL UNIT (EECU) CAN DEVIATE FROM THIS DRAWN CONSTRUCTION IN NOT
EINBEDEUTENDEN NON-FUNCTIONAL GEOMETRIES.
Elektronische Motorsteuergeräte (EMG) können in unbedeutenden nicht funktionsrelevanten Geometrien von der Darstellung
in dieser Zeichnung abweichen.
IT HAS TO BE ASSURED IN MOUNTING POSITION THAT WATER CANNOT INFILTRATE THROUGH WIRING
HARNESS INTO ECU HOUSING.
Es muss in Einbau sichergestellt sein, dass weder ein Leitungsstrang kein Wasser in das SG gelangen kann.
IT HAS TO BE ASSURED IN MOUNTING POSITION THAT THE PCE AND THE SEALING IN THE REVOLVING
GROOVE DO NOT GET SUBMERGED IN WATER.
Es muss in Einbaulage sichergestellt sein, dass das DAE und die Dichtung in umlaufenden Nutbereich nicht in
Wasser getaucht werden.
ECU FULFILLS REQUIREMENTS ACCORDING TO PROJECT SPECIFIC TOD:
ENVIRONMENTAL CLASSIFICATION AREA: ACCORDING TO ENVIRONMENTAL CONDITIONS SPECIFIED IN PROJECT
SPECIFIC TOD.
ECU ERFÜLLT ANFORDERUNGEN GEMÄß PROJEKTSPEZIFISCHER TOD:
CONDITIONAL SPECIFIED DA PROJECT-SPECIFIC TOD ARE COMPLIED WITH, THAT THE ENVIRONMENTAL
SG erfüllt Anforderungen nach projektspezifischer TOD:
Umgebungsklassifizierung: Gemäß den in projektspezifischer TOD definierten Umweltbedingungen.
Zulässiger Ambient: Karosserie und Motorraum, so dass die in der projektspezifischen TOD beschriebenen
Umweltbedingungen eingehalten werden.
MOUNTING ON THE VEHICLE:
Einbau SG im Fahrzeug:
THE FASTENING OF THE ECU IN THE VEHICLE HAS TO BE RESTORED IN A WAY THAT BOUNCING OF
ECU AGAINST OTHER VEHICLE PARTS AND EVENTUALLY ADDITIONAL FASTENING ELEMENTS OF THE ECU
CONNECTOR ARE AVOIDED.
Die Befestigung des SG im Fahrzeug muss so ausgeführt werden, dass ein Prellen des SG gegen andere
Fahrzeugteile und eventuell zusätzlichen Befestigungselemente des SG ausgeschlossen ist.
THE ECU HOUSING NEEDS TO BE CONNECTED TO VEHICLE GROUND. THE CONNECTION BETWEEN BOTTOM
HAVE TO BE DIRECTED WITH BOSCH ENGINEERING GmbH IN CASE OF DEVIATIONS FROM THIS.
DRAWING.
Das Gehäuse des SG muss mit Fahrzeugmasse verbunden sein. Die Verbindung zwischen Boden und
Deckel muss direkt mit Bosch Engineering GmbH abgestimmt werden.
MATING CONNECTORS:
Gegenstecker:
THE MATING HARNESS PLUG IS NOT INCLUDED IN DELIVERY:
Der Kabelbaumstecker gehört nicht zum Lieferumfang!
WIRING HARNESS NEEDS TO BE FIXED MECHANICALLY AT THE AREA OF ECU IN A
WAY THAT EXCITATION OF ECU HAS THE SAME SEQUENCE.
Kabelbaum muss im Bereich des SG so befestigt sein, dass SG anschwingt so abzufangen, dass
eine phasengleiche Anregung des SG erfolgt.
MAXIMUM INTERNAL TEMPERATURE ACCORDING TOD
WATER PROTECTION ACCORDING TOD:
Maximale Innentemperatur gemäß projektspezifischer TOD
Wasserschutz gemäß projektspezifischer TOD
Eigenschaft gegen Eindringen von Feuchtigkeit gemäß projektspezifischer TOD
BOSCH
Motorsport
MS6
Bosch Motorsport

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

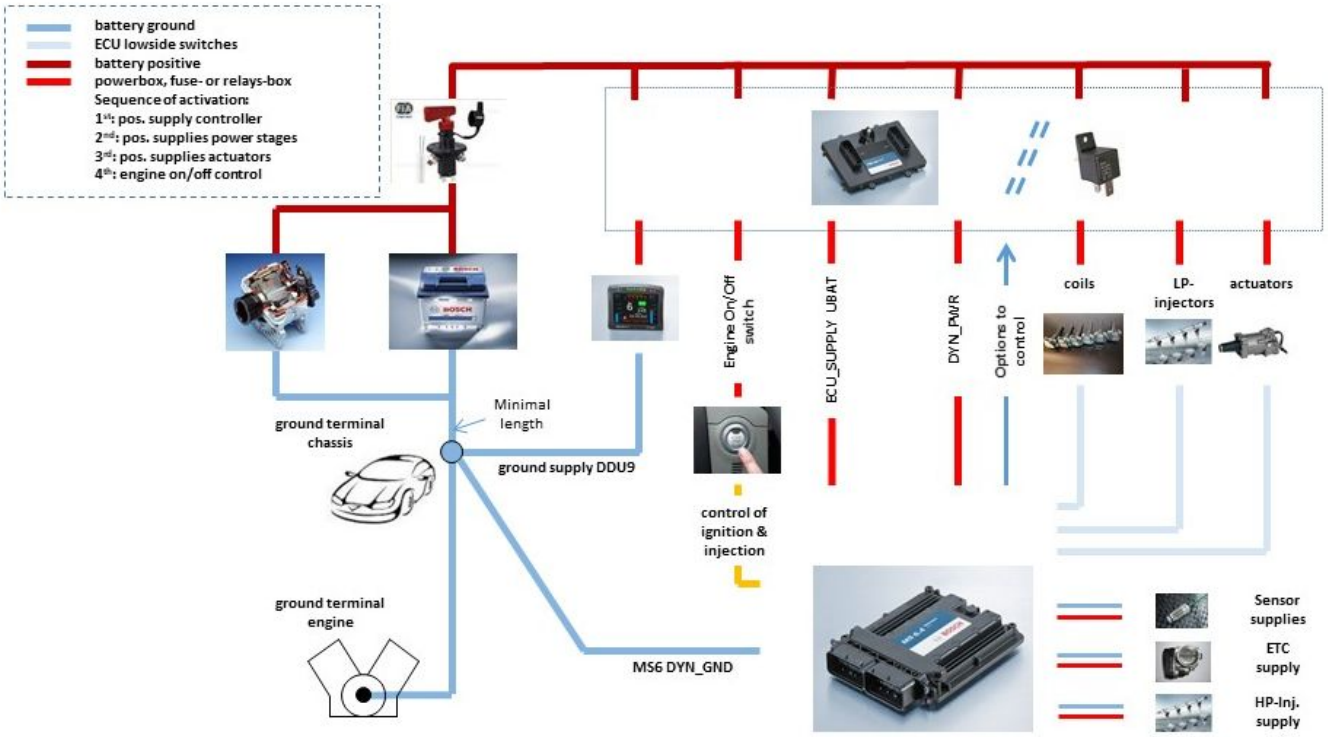
38 function related outputs
12 x ignition controls, support of coils with integrated amplifier only
12 x low pressure injection power stages for high impedance valves (max. 2.2 amps and min. 6 Ohm internal resistance of the injectors)
8 x high pressure injection power stages for magnetic valves (HDEV 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 Pin Layout

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

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

Analogue Inputs

ECU Pin connector >A<	ECU Pin connector >K<	MS6.1 MS6.3 measure package	MS6.Cup not available	I/O Type	description	pin related functions	LEAD AWG	MS6 default functionality	function to pin coordination	Measure channel
A032				analog input	pullup 3k01, 12bit		24	engine temperature	PIN_IN_UTMOT	utmot
A033				analog input	pullup 3k01, 12bit		24	oil temperature	PIN_IN_UTOIL	utoil
A034				analog input	pullup 3k01, 12bit		24	intake air temperature	PIN_IN_UTINT	utint
A035		Measure package	not available	analog input	pullup 3k01, 12bit		24	fuel temperature	PIN_IN_UTFUEL	utfuel
A079				analog input	no pullup, 12bit angle- or time related measurement		24	rail pressure	PIN_IN_UPRAIL	uprail
A080		Measure package	not available	analog input	no pullup, 12bit angle- or time related measurement		24	rail pressure, bank 2	PIN_IN_UPRAIL2	uprail2
A081				analog input	no pullup, 12bit		24	fuel pressure	PIN_IN_UPFUEL	upfuel
A082				analog input	switch.-pullup 3k01 12bit	CWPULLUP_A082	24	oil pressure	PIN_IN_UPOIL	upoil
A058				analog input	no pullup, 12bit angle- or time related measurement		24	pressure upstream throttle	PIN_IN_UP21	up21
A059		Measure package	not available	analog input	switch.-pullup 1k47 for future dvlp., 12bit angle- or time related measurement		24	pressure upstream throttle, bank 2	PIN_IN_UP21_2	up21_2
A060				analog input	no pullup, 12bit angle- or time related measurement		24	intake manifold pressure, mean value	PIN_IN_UP22M	up22m
A061		Measure package	not available	analog input	switch.-pullup 1k47 for future dvlp., 12bit angle- or time related measurement		24	intake manifold pressure, mean value, bank 2	PIN_IN_UP22M_2	up22m_2
A056				analog input	no pullup, 12bit		24	APS potentiometer a	fixed function to pin coordination	uaps_a
A054				analog input	no pullup, 12bit		24	APS potentiometer b	fixed function to pin coordination	uaps_b
A041				analog input	no pullup, 12bit		24	throttle potentiometer	fixed function to pin coordination	uthrottle
A053				analog input	no pullup, 12bit		24	backup throttle potentiometer	fixed function to pin coordination	uthrottle_b
A036			not available	analog input	no pullup, 12bit		24	throttle potentiometer, bank 2	fixed function to pin coordination	uthrottle2
A037			not available	analog input	no pullup, 12bit		24	backup throttle potentiometer, bank 2	fixed function to pin coordination	uthrottle2_b

	K036			analog input	pullup 3k01, 12bit		24	map switch	PIN_IN_UMAPSW	umapsw
	K031			analog input	switch.-pullup 3k01 12bit	CWPULLUP_K031	24	pitspeed switch	PIN_IN_UPITSPEEDSW	upitspeedsw
	K019	Measure package		analog input	switch.-pullup 3k01 12bit	CWPULLUP_K019	24	launch control switch	PIN_IN_ULAUNCHSW	ulaunchsw
	K015			analog input	switch.-pullup 3k01 12bit	CWPULLUP_K015	24	traction control switch	PIN_IN_UTCSW	utcsw
	K016	Measure package	not available	analog input	switch.-pullup 3k01 12bit	CWPULLUP_K016	24	reset chassis channels switch	PIN_IN_UCHRESSW	uchressw
	K017	Measure package	not available	analog input	switch.-pullup 3k01 12bit	CWPULLUP_K017	24	wet track switch	PIN_IN_UWETSW	uwetsw
A039				analog input	no pullup, 12bit		24	gear position	PIN_IN_UGEARP	ugearp
A055		Measure package		analog input	switch.-pullup 3k01 12bit	CWPULLUP_A055	24	reverse shift switch	PIN_IN_UREVSW	ushiftrevsw
A057		Measure package		analog input	switch.-pullup 3k01 12bit	CWPULLUP_A057	24	downshift switch	PIN_IN_USHIFTDNSW	ushiftdnsw
A076		Measure package		analog input	switch.-pullup 3k01 12bit	CWPULLUP_A076	24	upshift switch	PIN_IN_USHIFTUPSW	ushiftupsw
A077				analog input	switch.-pullup 3k01 12bit	CWPULLUP_A077	24	gearshift	PIN_IN_UGS	ugs
A078		Measure package		analog input	switch.-pullup 3k01 12bit	CWPULLUP_A078	24	free measure channel A78		
A038		Measure package		analog input	no pullup, 12bit		24	gearbox pneumatic pressure	PIN_IN_UPGEARAIR	upgearair
	K033	Measure package		analog input	no pullup, 12bit		24	clutch pressure	PIN_IN_UPCLUTCH	upclutch
	K048	Measure package	not available	analog input	no pullup, 12bit		24	free measure channel K48		
	K047			digital input	fixed pullup to 5volts		24	laptrigger	fixed function to pin coordination	lapctr
A040				analog input	no pullup, 12bit		24	brake pressure rear	PIN_IN_UPBRAKE_R	upbrake_r
	K020			analog input	switch.-pullup 3k01 12bit	CWPULLUP_K020	24	brake pressure front	PIN_IN_UPBRAKE_F	upbrake_f
	K018	Measure package	not available	analog input	switch.-pullup 3k01 12bit	CWPULLUP_K018	24	damper sensor front/left	PIN_IN_UDAM_FL	udam_fl
	K032	Measure package	not available	analog input	no pullup, 12bit		24	damper sensor front right	PIN_IN_UDAM_FR	udam_fr
	K034	Measure package	not available	analog input	no pullup, 12bit		24	damper sensor rear left	PIN_IN_UDAM_RL	udam_rl
	K035	Measure package	not available	analog input	no pullup, 12bit		24	damper sensor rear right	PIN_IN_UDAM_RR	udam_rr
	K050	Measure package	not available	analog input	no pullup, 12bit		24	steering angle	PIN_IN_USTEER	usteer
	K077			Thermocouple input	k-type sensor		24shield thermo	exhaust gas temperature	fixed function to pin coordination	utexh
	K076									
	K079	Measure package	not available	Thermocouple input	k-type sensor		24shield thermo	exhaust gas temperature bank 2	fixed function to pin coordination	utexh2
	K078	Measure package	not available							

Digital Inputs

ECU Pin connector >A<	ECU Pin connector >K<	MS6.1 MS6.3 measure package	MS6.Cup not available	I/O Type	description	pin related functions	LEAD AWG	MS6 default functionality	function to pin coordination	Measure channel
A047				crankshaft+ (Hall/Inductive)	switchable between halleffect- and inductive sensor	CWINTF_CRANK PIN_IN_CRANK CWINTF_CRANK_K CWINTF_CRANK_TH	24shield	engine speed	fixed function to pin coordination	nmot
A048				crankshaft - (inductive)			24shield			
A074				digital input	halleffect sensor only		24shield	camshaft inlet	PIN_IN_CAM_IN	cam_pos_edges_001
A075				digital input	halleffect sensor only		24shield	camshaft outlet	PIN_IN_CAM_OUT	cam_pos_edges_out_001
A049				digital input	switchable between halleffect- or DF11 sensors	CWINTF_A049	24shield	camshaft inlet bank2 or wheelspeed front right	PIN_IN_CAM_IN2 or PIN_IN_FWEEL_FR	cam_pos_edges2_001 or fwheel_fr
A050				digital input	switchable between halleffect- or DF11 sensors	CWINTF_A050	24shield	camshaft outlet bank2 or wheelspeed front left	PIN_IN_CAM_OUT2 or PIN_IN_FWEEL_FL	cam_pos_edges_out2_001 or fwheel_fl
A051				digital input	switchable between halleffect- or DF11 sensors	CWINTF_A051	24shield	wheelspeed rear right	PIN_IN_FWHEEL_RR	fwheel_rr
A052				digital input	switchable between halleffect- or DF11 sensors	CWINTF_A052	24shield	wheel speed rear left	PIN_IN_FWHEEL_RL	fwheel_rl
	K045			digital input	switchable between halleffect- and inductive sensor	CWINTF_K045 CWINTF_K045_K CWINTF_K045_TH	24shield	turbo speed	PIN_IN_FTURBO	fturbo
	K046			digital input	switchable between halleffect- and inductive sensor	CWINTF_K046 CWINTF_K046_K CWINTF_K046_TH	24shield	turbo speed bank2	PIN_IN_FTURBO2	fturbo2
	K062			ground supply	if inductive sensos are connected to K045 or K046		24shield	ground for turbo speed and--2		
	K054			digital input	B_engon		20	Engine On/Off switch		b_engon(_in)
A013				knock input			24shield	knock sensor 1, bank1	KCSENCYL	ikcraw_n_..
A014				knock input			24shield	knock sensor 2, bank1	KCSENCYL	ikcraw_n_..
A015			not avl.	knock input			24shield	knock sensor 1, bank2	KCSENCYL	ikcraw_n_..
A016			not avl.	knock input			24shield	knock sensor 2, bank2	KCSENCYL	ikcraw_n_..
A017				knock sensor ground			24shield			
	K085			Lambda_IA	LSU4.9 probe only		24	Lambda	fixed function to pin coordination	lambda
	K086			Lambda_IP			24			
	K087			Lambda_UN			24			
	K088			Lambda_VM			24			
	K068		not avl.	Lambda_IA	LSU4.9 probe only		24	Lambda bank2	fixed function to pin coordination	lambda2
	K069		not avl.	Lambda_IP			24			

	K070		not avl.	Lambda_UN			24			
	K071		not avl.	Lambda_VM			24			

Ignition- & Injection Outputs

ECU Pin connector >A<	ECU Pin connector >K<	MS6.1 MS6.3 measure pack-age	MS6.Cup not avail-able	I/O Type	description	pin related functions	LEAD AWG	MS6 default functionality	function to pin coordination	Measure channel
A026				ignition driver	output related to mechanical cylinder number; use of coil integrated power stages only	CWIGNDRV_MODE IGNDRV_CURRENT	24	Ignition cyl.1	CYLNUMBER CYLANGLE	ign_out_n_001
A027							24	Ignition cyl.2		ign_out_n_002
A028							24	Ignition cyl.3		ign_out_n_003
A029							24	Ignition cyl.4		ign_out_n_004
A030			not avl.				24	Ignition cyl.5		ign_out_n_005
A031			not avl.				24	Ignition cyl.6		ign_out_n_006
A068			not avl.				24	Ignition cyl.7		ign_out_n_007
A069			not avl.				24	Ignition cyl.8		ign_out_n_008
A070			not avl.				24	ignition cyl.9		ign_out_n_009
A071			not avl.				24	ignition cyl.10		ign_out_n_010
A072			not avl.				24	ignition cyl.11		ign_out_n_011
A073			not avl.				24	ignition cyl.12		ign_out_n_012
A098				low pressure output for high imp. injectors	output related to mechanical cylinder number		24twist	Injection cyl.1	CYLNUMBER CYLANGLE or (PIN_OUT_LPINJ_A098 ... PIN_OUT_LPINJ_A084)	tinj_n_001
A100							24twist	Injection cyl.2		tinj_n_002
A101							24twist	Injection cyl.3		tinj_n_003
A096							24twist	Injection cyl.4		tinj_n_004
A099			not avl.				24twist	Injection cyl.5		tinj_n_005
A103			not avl.				24twist	Injection cyl.6		tinj_n_006
A042			not avl.				24twist	Injection cyl.7		tinj_n_007
A105			not avl.				24twist	Injection cyl.8		tinj_n_008
A018			not avl.				24twist	Injection cyl.9		tinj_n_009
A020			not avl.				24twist	Injection cyl.10		tinj_n_010
A063			not avl.				24twist	Injection cyl.11		tinj_n_011
A084			not avl.				24twist	Injection cyl.12		tinj_n_012

A043			high pressure outputs for magnetic injectors	INJVH1	20twist	Injection cyl.A	PIN_OUT_HPIN-J11A_A043_A064	tinj_n_(cyl.A)
A064				INJVL11	20twist			
A002		not avl.		INJVH3	20twist	Injection cyl.B	PIN_OUT_HPIN-J12E_A002_A023	tinj_n_(cyl.B)
A023		not avl.		INJVL32	20twist			
A003				INJVH2	20twist	Injection cyl.C	PIN_OUT_HPIN-J21C_A003_A024	tinj_n_(cyl.C)
A024				INJVL21	20twist			
A046		not avl.		INJVH4	20twist	Injection cyl.D	PIN_OUT_HPIN-J22G_A046_A067	tinj_n_(cyl.D)
A067		not avl.		INJVL42	20twist			
A044		not avl.		INJVH1	20twist	Injection cyl.E	PIN_OUT_HPIN-J31F_A044_A065	tinj_n_(cyl.E)
A065		not avl.		INJVL12	20twist			
A001				INJVH3	20twist	Injection cyl.F	PIN_OUT_HPIN-J32B_A001_A022	tinj_n_(cyl.F)
A022				INJVL31	20twist			
A004		not avl.		INJVH2	20twist	Injection cyl.G	PIN_OUT_HPIN-J41H_A004_A025	tinj_n_(cyl.G)
A025		not avl.		INJVL22	20twist			
A045				INJVH4	20twist	Injection cyl.H	PIN_OUT_HPIN-J42D_A045_A066	tinj_n_(cyl.H)
A066				INJVL41	20twist			

Outputs

ECU Pin connector >A<	ECU Pin connector >K<	MS6.1 MS6.3 measure package	MS6.Cup not available	I/O Type	description	pin related functions	LEAD AWG	MS6 default functionality	function to pin coordination	Measure channel
A095				lowside switch	4 amps pwm		24twist	camshaft inlet control	fixed pin to output control coordination	cam_pwm
A021			not avl.	lowside switch	4 amps pwm		24twist	camshaft inlet control bank2	fixed pin to output control coordination	cam_pwm2
A102				lowside switch	3 amps pwm		24twist	camshaft outlet control	fixed pin to output control coordination	cam_pwm_out
A094			not avl.	lowside switch	3 amps pwm		24twist	camshaft outlet control bank2	fixed pin to output control coordination	cam_pwm_out2
A019				lowside switch	3 amps pwm		24twist		PIN_OUT_A019	
A104			not avl.	lowside switch	3 amps pwm		24twist		PIN_OUT_A104	
A097				lowside switch	2,2 amps pwm		24twist	wastegate increase	PIN_OUT_A097	wgc_inc_pwm
A093			not avl.	lowside switch	2,2 amps pwm		24twist	wastegate increase bank2	PIN_OUT_A093	wgc_inc_pwm2
	K039		not avl.	lowside switch	2,2 amps pwm		24twist		PIN_OUT_K039	
	K056			lowside switch	2,2 amps pwm		24twist	air conditioning compressor	PIN_OUT_K056	comp_pwm
	K038			lowside switch	2,2 amps pwm		24twist	gearshift actuator upshift	PIN_OUT_K038	shiftup_pwm
	K040		not avl.	lowside switch	2,2 amps pwm		24twist		PIN_OUT_K040	
	K055			lowside switch	2,2 amps pwm		24twist	gearshift actuator downshift	PIN_OUT_K055	shiftdn_pwm
	K074			lowside switch	2,2 amps pwm		24twist		PIN_OUT_K074	
	K089			lowside switch	1 amps pwm		24twist	fuel pump relay	PIN_OUT_K089	fpump_pwm
	K073		not avl.	lowside switch	1 amps pwm		24twist		PIN_OUT_K073	

	K057			lowside switch	1amp pwm reset < 3,5V		24twist	control main relay	fixed pin to output control co-ordination	b_mainrelay
	K072			lowside switch	1amp pwm reset < 3,5V		24twist	Kl.50 / starter control	fixed pin to output control co-ordination	b_starter
	K022			lowside switch	4 amp pwm		24twist	heater lambda	fixed pin to output control co-ordination	lsuh_out
	K023		not avl.	lowside switch	4 amp pwm		24twist	heater lambda2	fixed pin to output control co-ordination	lsuh_out2

H-Bridges & Metering Unit

ECU Pin connector >A<	ECU Pin connector >K<	MS6.1 MS6.3 measure package	MS6.Cup not available	I/O Type	description	pin related functions	LEAD AWG	MS6 default functionality	function to pin coordination	Measure channel
A089				H-Bridge 1 pos.	8,5 amps	CWHB1_EN	24twist	electrical throttle	fixed pin to output control co-ordination	etc_pwm
A090				H-Bridge 1 neg.						
A091				H-Bridge 2 pos.	8,5 amps	CWHB2_EN	24twist	electrical throttle bank 2	fixed pin to output control co-ordination	etc_pwm2
A092				H-Bridge 2 neg.						
K090				H-Bridge 3 pos.	8,5 amps	CWHB3_EN	24twist		fixed pin to output control co-ordination	
K091				H-Bridge 3 neg.						
A085				MSV1 controller pos.	FCVH1		24twist	high press. pump MSV valve 1	fixed pin to output control co-ordination	msv_dlvy_angle
A086				MSV1 controller neg.	FCVL1					
A087			not avl.	MSV2 controller pos.	FCVH2		24twist	high press. pump MSV valve 2	fixed pin to output control co-ordination	msv_dlvy_angle2
A088			not avl.	MSV2 controller neg.	FCVL2					

Network

ECU Pin connector >A<	ECU Pin connector >K<	MS6.1 MS6.3 measure package	MS6.Cup not available	I/O Type	description	pin related functions	LEAD AWG	MS6 default functionality	function to pin coordination	Measure channel
	K029			CAN Bus1 high	uptp 1Mbit/s switchable 120Ohm terminator	CWCAN1_TERM	CAN	CAN1		E_can1
	K012			CAN Bus1 low						
	K028			CAN Bus2 high	uptp 1Mbit/s switchable 120Ohm terminator	CWCAN2_TERM	CAN	CAN2		E_can1
	K011			CAN Bus2 low						
	K027			CAN Bus3 high	uptp 1Mbit/s switchable 120Ohm terminator	CWCAN3_TERM	CAN	CAN3		E_can1
	K010			CAN Bus3 low						
	K052			Serial interface	RS232_RX		24twist	telemetry use		
	K053				RS232_TX					
	K044			Ethernet 1	ETH1RX+		CAT7	Communication PC to device		
	K043				ETH1RX-					
	K042				ETH1TX+					
	K041				ETH1TX-					
	K061			Ethernet 2	ETH2RX+		CAT7	extended communication to PBx90, DDU7, DDU8 or C60		
	K060				ETH2RX-					
	K059				ETH2TX+					
	K058				ETH2TX-					
	K025		not avl.	USB	USB_DP		USB	use for additional data stick		
	K024		not avl.		USB_DN					
	K007		not avl.		USB_GND					
	K008		not avl.		USB_VBUS					
	K014			TIMESYNC	timeline		24	data synchronising for Ethernet extension modules		
	K066			not in use						
	K067			not in use						
	K083			not in use						
	K084			not in use						
	K051			LIN-Bus		CWLINMODE	24	LIN communication		
	K030			TN digital output		TNSIG_PULSENUM TNSIG_PWM	24	rpm-signal	PIN_OUT_K030	
	K013			TN digital output			24	flywheel-signal	PIN_OUT_K013	
	K037			TN digital output			24	triggerwheel-signal	PIN_OUT_K037	

Power Supplies

ECU Pin connector >A<	ECU Pin connector >K<	MS6.1 MS6.3 measure package	MS6.Cup not available	I/O Type	description	pin related functions	LEAD AWG	MS6 default functionality	function to pin coordination	Measure channel
	K003			battery plus	UDYNPOWER		14	dynamic power supply		
	K005			battery plus	UDYNPOWER		14	dynamic power supply		
	K006			battery plus	UDYNPOWER		14	dynamic power supply		
	K075			battery plus	UBAT		20	digital power supply		
	K001			battery minus			14			
	K002			battery minus			14			
	K004			battery minus			14			
A009				sensor supply 5V/50mamp	recommended supply for: aps_a, etc		24	ETC sensor supply 1		
A011				sensor supply 5V/50mamp	recommended supply for: aps_b, etc2		24	ETC sensor supply 2		
	K065			sensor supply 5V/150mamp		CW5VOUT3_EN	24	5 V sensor supply 4		
A007				sensor supply 5V/50mamp			24	5 V sensor supply 5		
A005				sensor supply 5V/150mamp		CW5VOUT1_EN	24	5 V sensor supply 1		
	K064			sensor supply 5V/150mamp		CW5VOUT2_EN	24	5 V sensor supply 2		
	K063			sensor supply 5V/50mamp			24	5 V sensor supply 3		
	K080			sensor ground 1			20	ground sensor supply		
	K081			sensor ground 2			20	ground sensor supply		
	K082			sensor ground 3			20	ground sensor supply		
A006				sensor ground 4			20	ground sensor supply		
A008				sensor ground 5			20	ground sensor supply		
A010				sensor ground 6	recommended ground for: aps_a, etc		20	ground sensor supply		
A012				sensor ground 7	recommended ground for: aps_b, etc2		20	ground sensor supply		
A062				shield ground			24	sensor shields		
	K021			shield ground			24	sensor shields		
	K026			shield ground			24	Ethernet and LIN shields		
	K049			not used						
	K009			shield ground			24	USB shield		
A083				not in use						

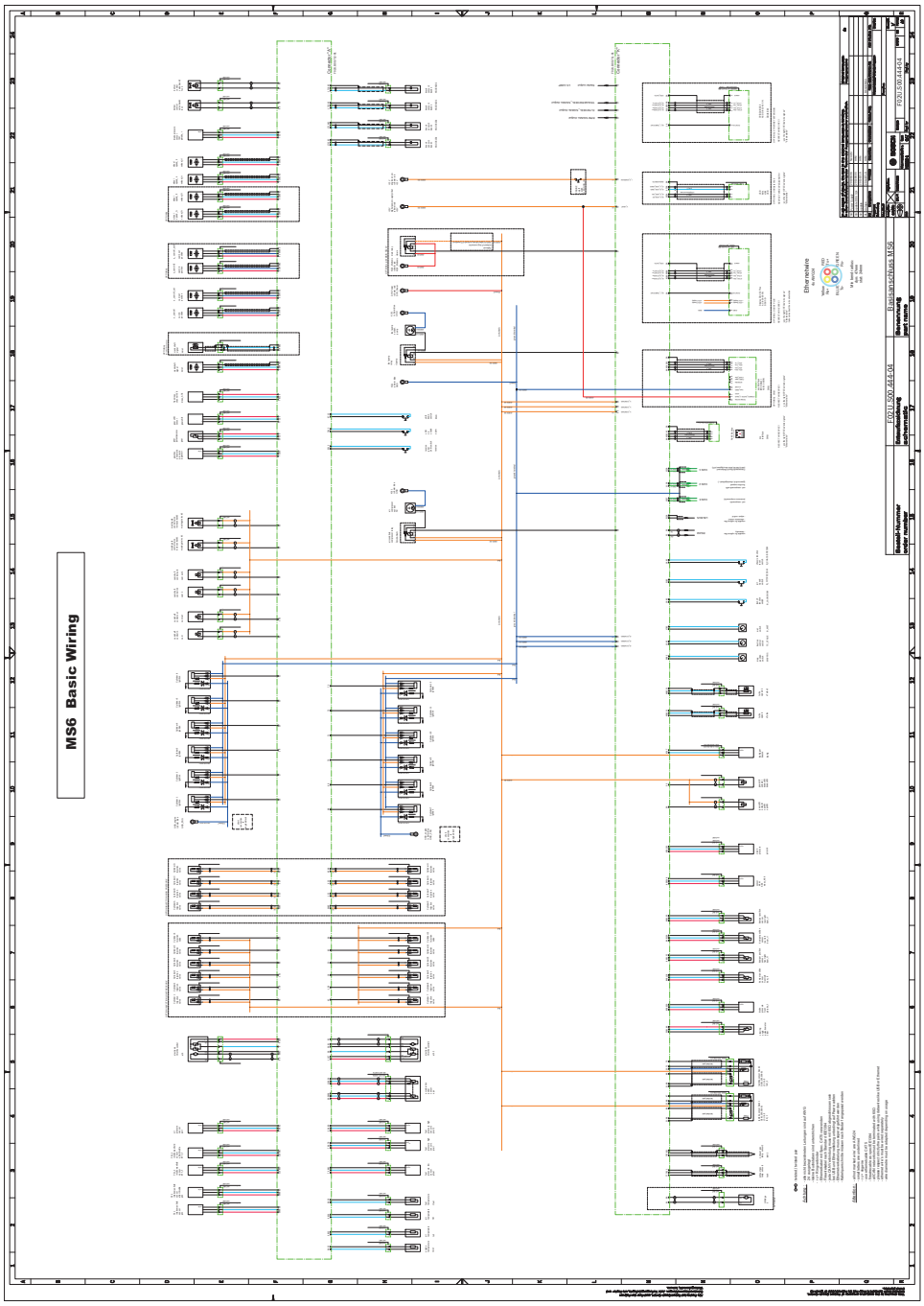
2.3.7 Harness / Wiring

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



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

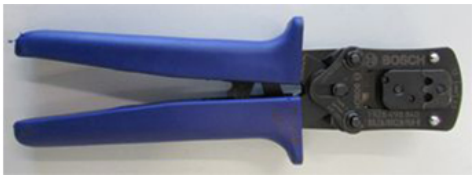
MS 6 harness connector type A (105 contacts), coding variant 1	F 02U B00 712-01
MS 6 harness connector type K (91 contacts), coding variant 1	F 02U B00 711-01
Protection Classification	IP X6K, X8, X9K
Temperature range	-40 to 120°C
Shakeproofed	Max. 3.4 g
Wiring diameter	0.35 to 2.5 mm^2
Pinsize	1.2 mm; 2.8 mm

Dummy Plug

Dummy plug 1 928 405 459 for unused connections	Matrix 1.2 / CB / 0.75 to 1.0 mm^2
Dummy plug 1 928 405 460 for unused connections	Matrix 1.2 / CB / 1.0 - 1.5 mm^2
Dummy plug 1 928 301 207	BTL 2.8

Tools and Contacts

Tool	Matrix	Contact	Wire size
1928498212	Matrix 1.2	Clean Body 1928.498.991	0.35 to 0.5 mm^2
1928498213	Matrix 1.2	Clean Body 1928.498.992	0.75 to 1.0 mm^2
1928498837	1928498840	BTL 2.8 1928.498.651	1.5 to 2.5 mm^2



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: F 02U V01 809

2.3.8 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)**.

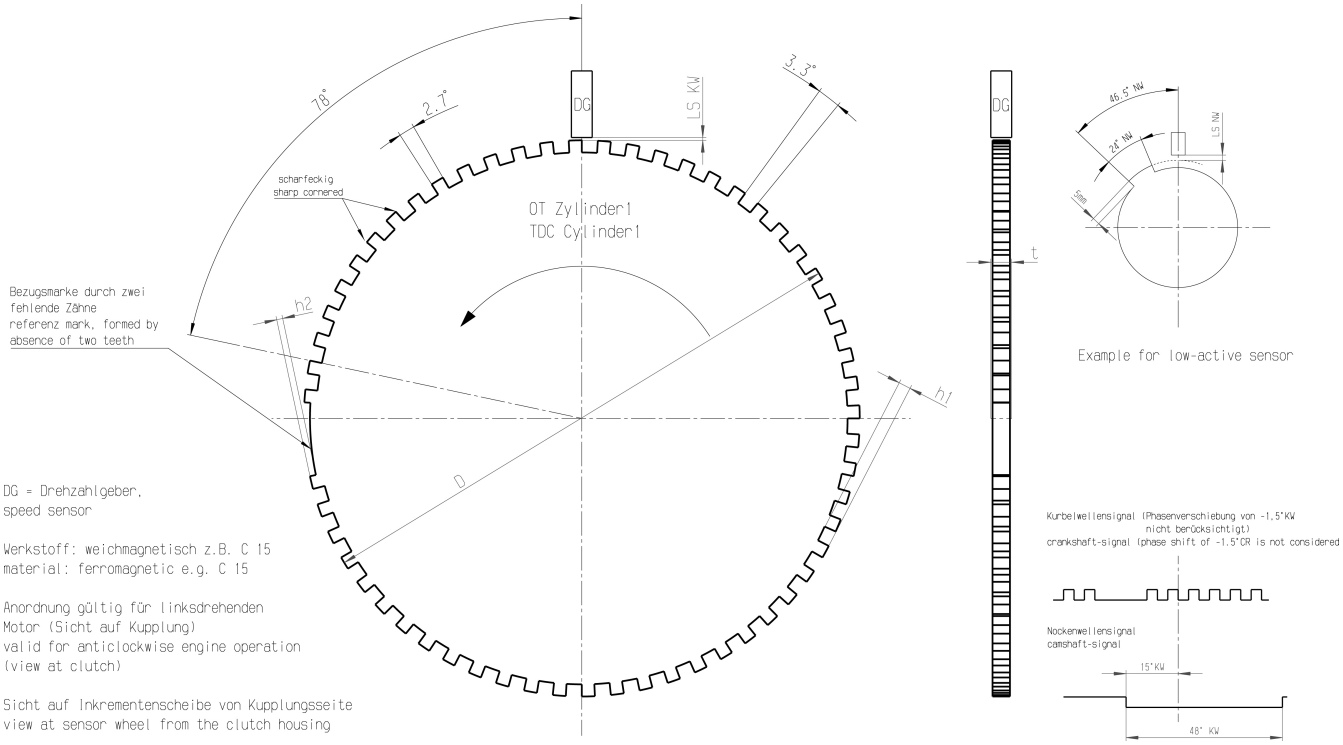
NOTICE

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

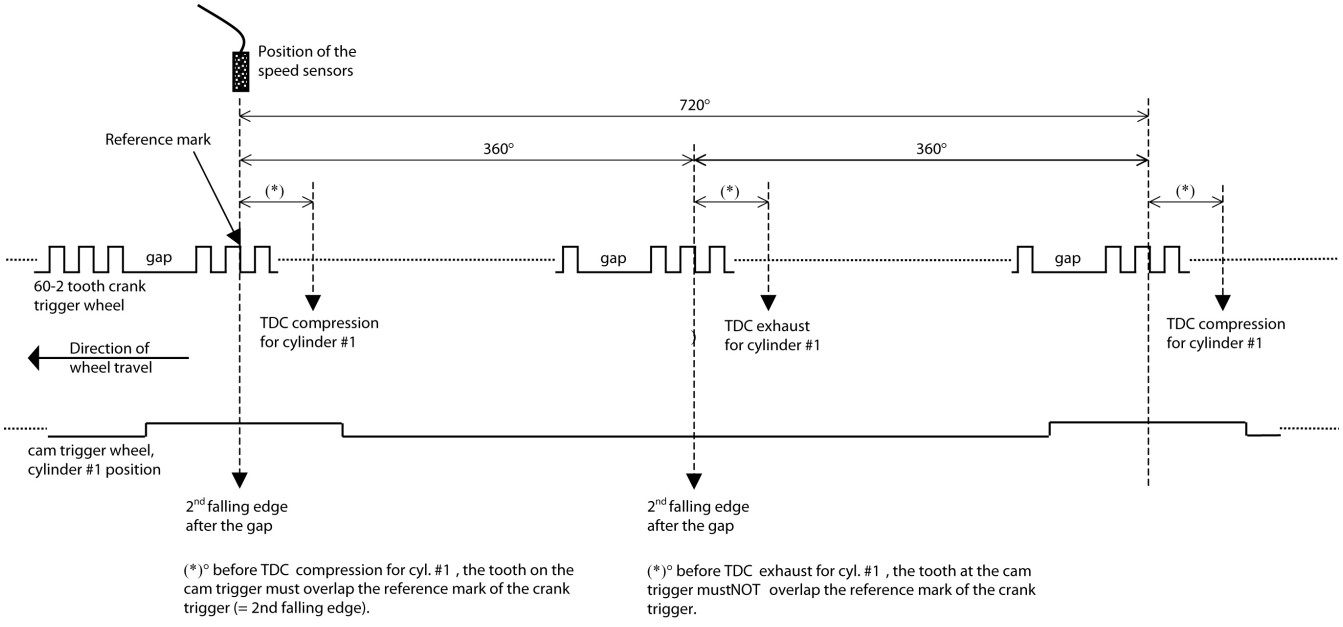
Not usable are flywheels with 4-1 or 6-1 teeth. Please follow the description below as recommendation for the mechanical dimensions.

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



The procedure for correct adjustment of the trigger wheel



Procedure to find the right position for the crank and cam trigger:

1. Rotate the engine to the precise position of TDC compression for cylinder #1.
2. Rotate the engine 78 crankshaft degrees backwards.
3. Adjust the position of the crank trigger wheel in reference to its inductive speed sensor: the longitudinal axis of the sensor must point exactly towards the reference mark (2nd falling edge after the gap).
4. Rotate the engine further 15 crankshaft degrees backwards.
5. Adjust the position of the cam trigger in reference to its Hall effect speed sensor: the sensor must be at the begin of the tooth.
6. Turn the engine by 345 crankshaft degrees to reach the position of 78° before TDC exhaust for cylinder #1.

7. Verify that the crank trigger reference is in alignment with the longitudinal axis of the sensor (same as step 3) and that the cam trigger tooth is at the opposite side of its speed sensor.

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

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	Mainly used for system configuration
Modas Sport V1.08.012 or higher	Data application and online measurement
WinDarab V7	Data analysis tool, Light version as share-ware or Expert version if license available
MS 6 customer_delivery	ECU programs and function description

All tools are delivered as self-installing executable files.

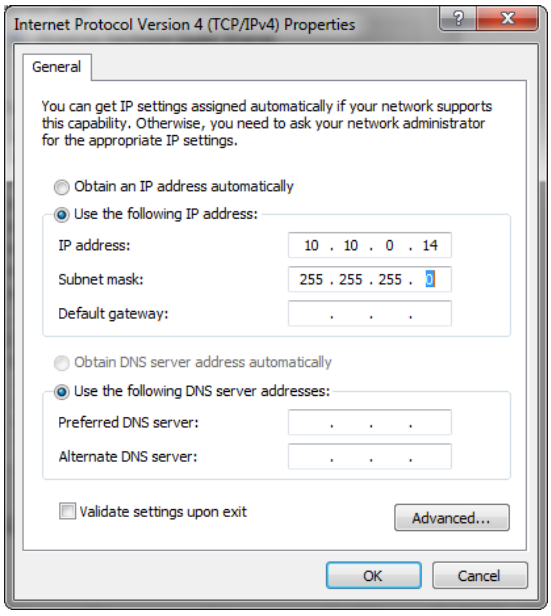
Select your personal installation folder.

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, Modas Sport 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.

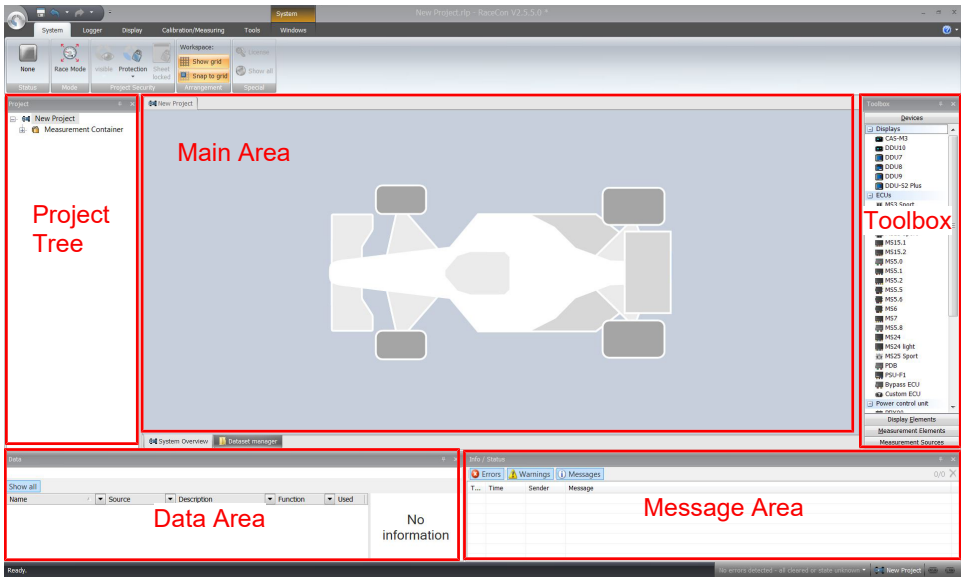
MS 6 Programming

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

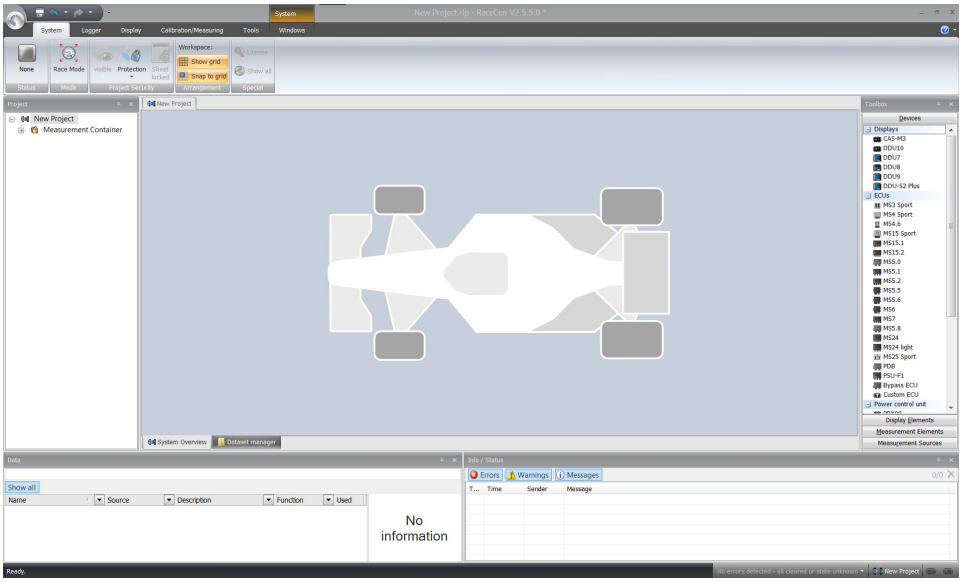
File / New / RaceCon Project opens a new project in RaceCon.



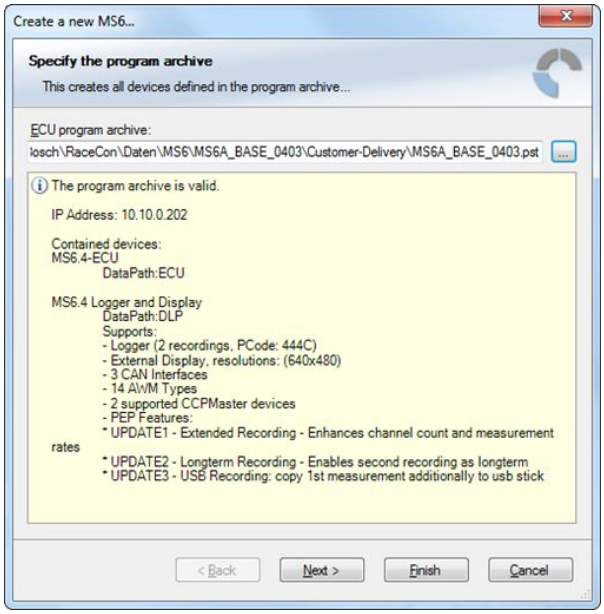
To create a new vehicle configuration, the devices can be pushed via drag & drop from the toolbox to the vehicle. Then they are part of the project and can be configured.

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.

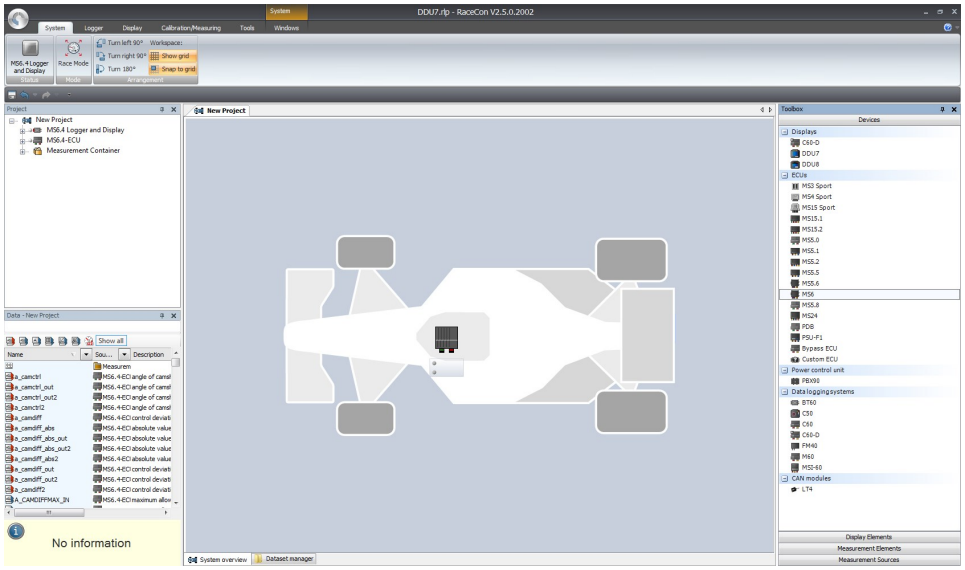


Now the ECU program archive PST files must be selected. These archives are delivered by Bosch or are available at Bosch Motorsport homepage. Specify the MS 6 program archive: MS6A_XXX_xxx.pst.



Access to all configurable data is now available.

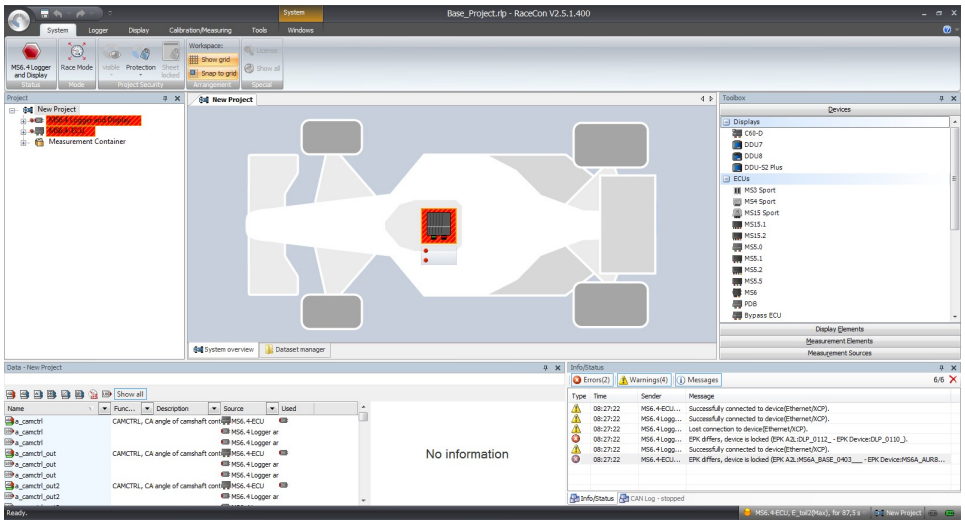
Installation may now be saved as customer project for further data application.



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.

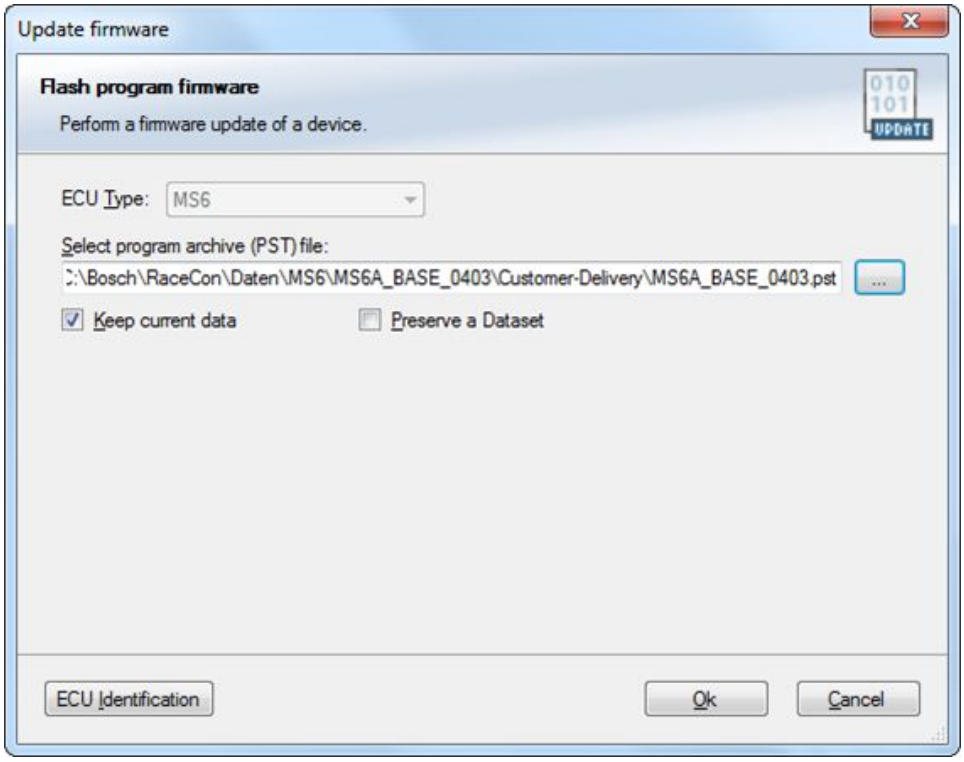


Synchronize MS 6 and RaceCon program version / update the firmware of the device:

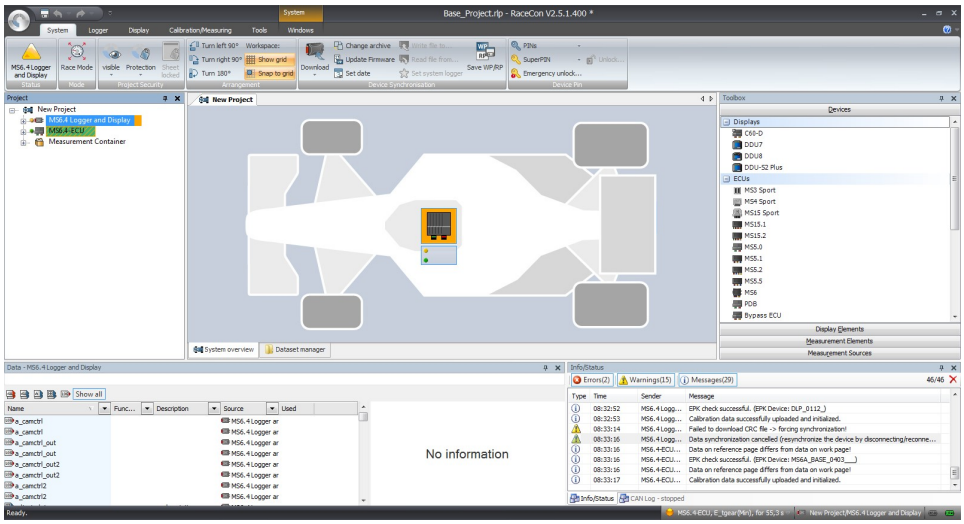
Project-tree / right mouse button to one of the red MS 6 core / synchronize / update firmware >select customer software of the MS 6 (file with extension: -.pst)

NOTICE

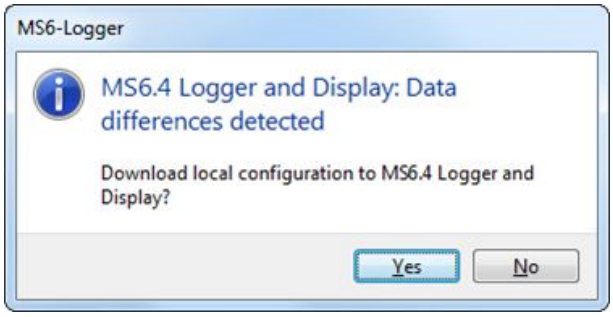
Do not interrupt flash process.



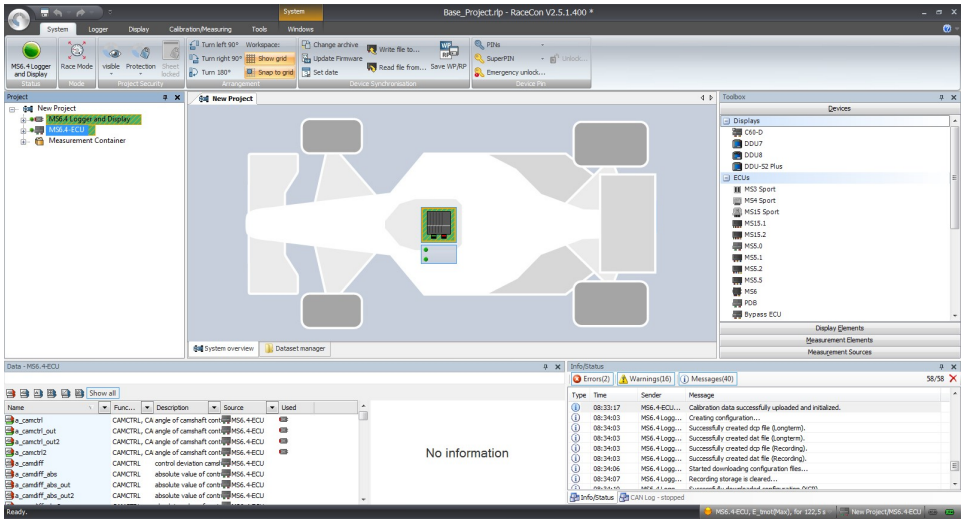
In the project tree, the MS 6 logger core is shown as >yellow<, means the firmware of MS 6 device and project are identical, but the data differs.



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:

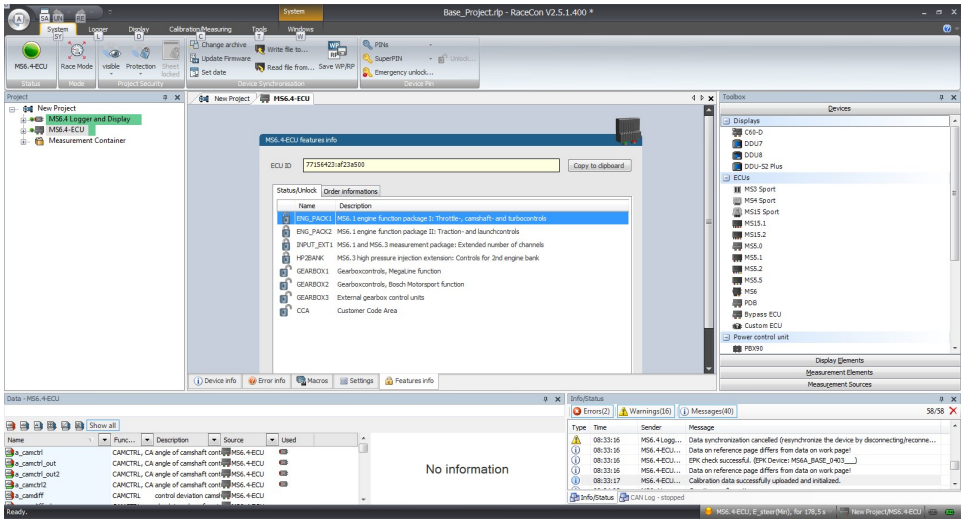


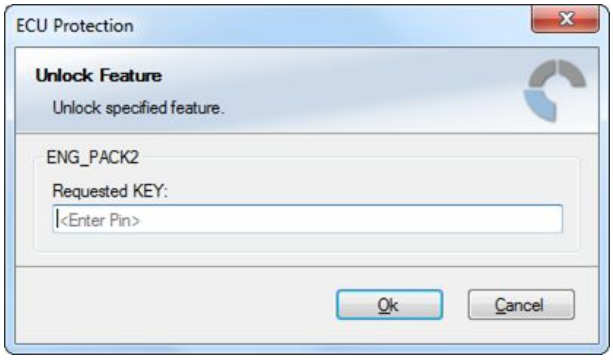
Both MS 6 cores are shown as green, means firmware and data of device and project are now identical.



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.

ModasSport uses the two MS 6 programs MS6a_xxxx_yyyy_data.s19 and MS6a_xxxx_yyyy_ms_a2l for work folder generation.

For help, please follow the Modas Sport manual instructions.

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 [▷ 23].

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_CRANK	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

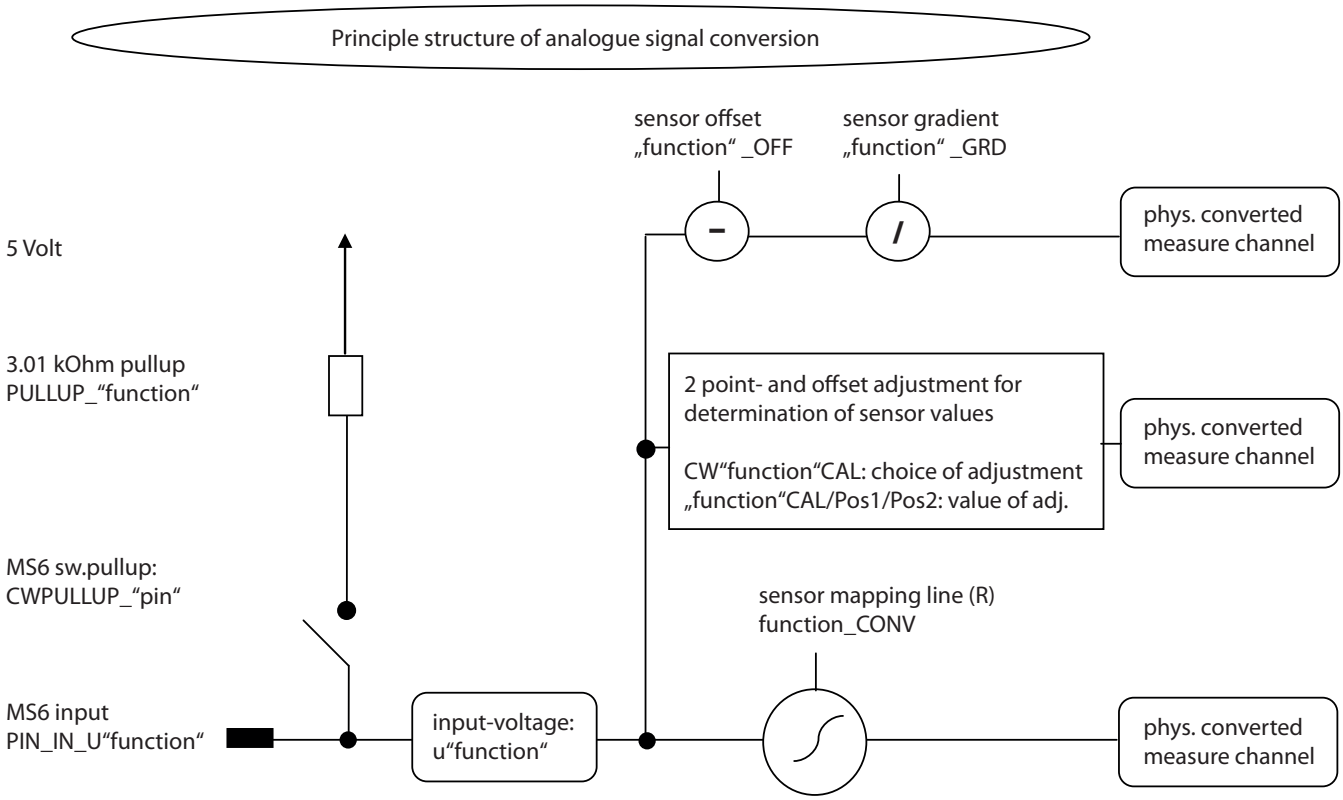
Make sure the battery is connected properly, all sensors are connected and ground wiring is fixed before powering up the system. Check all sensors for errors (E_...) and reliable measure values before starting the engine.

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 “SWITCHMATRIX_ENABLED_PIN_IN_ADC” 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 a lot of 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 a lot of 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_CRANK	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 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.

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.

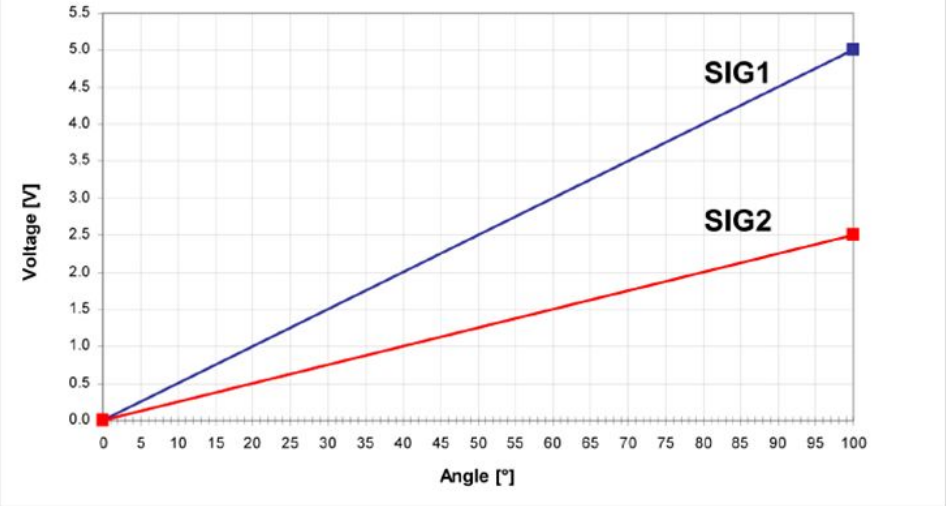
Notice: For detailed information see function description ETC

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:



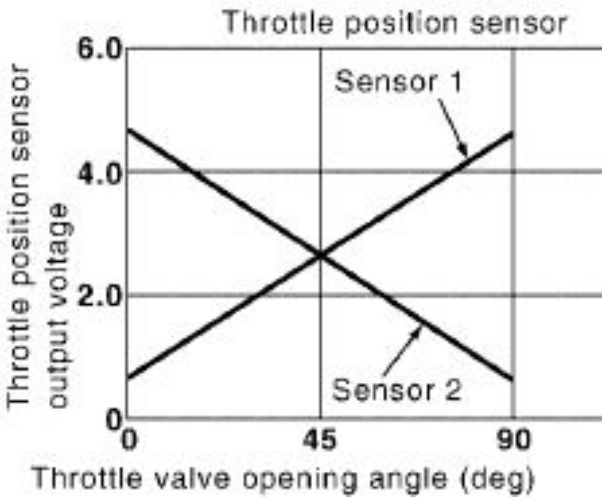
uaps_a	Voltage APS potentiometer a
uaps_b	Voltage APS potentiometer b
aps	Acceleration pedal position
UAPS_MIN, UAPS_MAX:	Minimum and maximum accepted sensor voltage. Set to approx. 200 mV/4,800 mV. Check if the uaps(x) outputs are changing when the pedal is moved.
CWAPSADJ	Codeword to adjust acceleration 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:

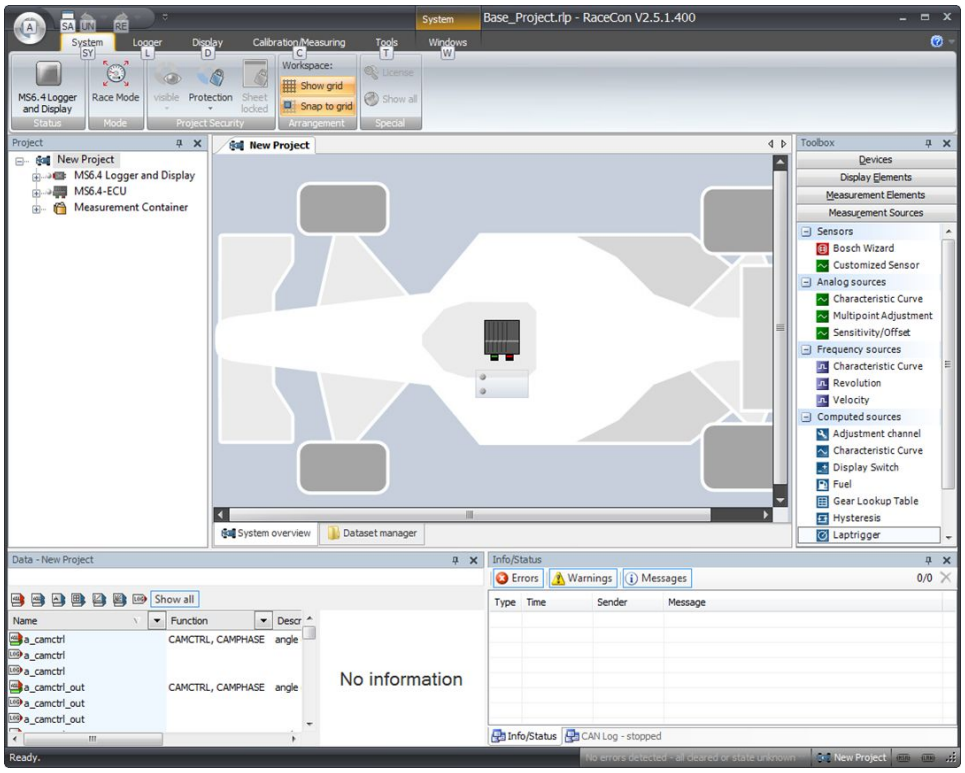
- Close throttle and set CWTHRADJ to 2.
- Open throttle fully and set CWTHRADJ to 3.
- Adjust the throttle to idle point.
- Do not forget to set CWTHRADJ back to 0. Check calibration by moving throttle.

4.4 Vehicle Test

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

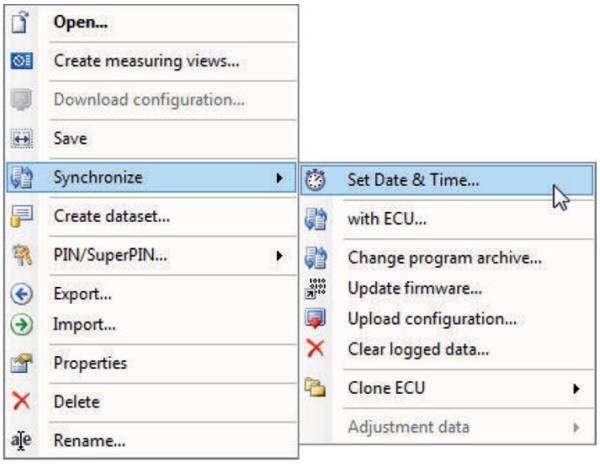
Speed & distance measurements	The signals for speed calculation may be available from different sources, like MS 6 own measurement, GPS data or via CAN received information from ABS calculation. For MS 6 own calculation, mechanical influenced data like number of available sensors, front wheel drive, 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 informa-tion will be created.
Laptrigger_xxxx_yy	Results and measure channels of lap-func-tionalities
Consumption-calculation	Is designed in the same way as lap-inform-ation, 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.

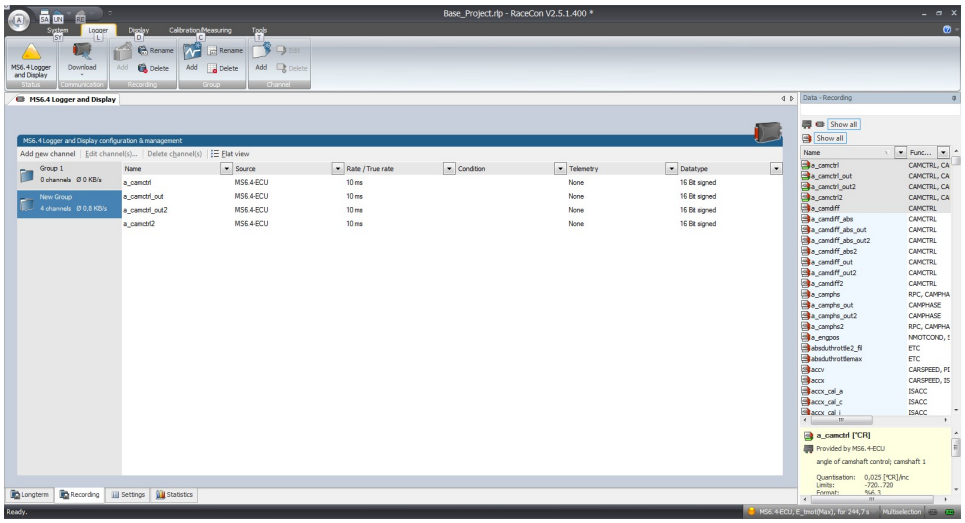
The MS 6 data recording is separated in two partitions. Both are completely independent. The free of license storable channels have to be selected into the >Recording< folder. Data logging extensions for more than 100 channels or the 2nd partitioning have to be activated in front of the configuration.

Select topic >Logger< in the menu bar

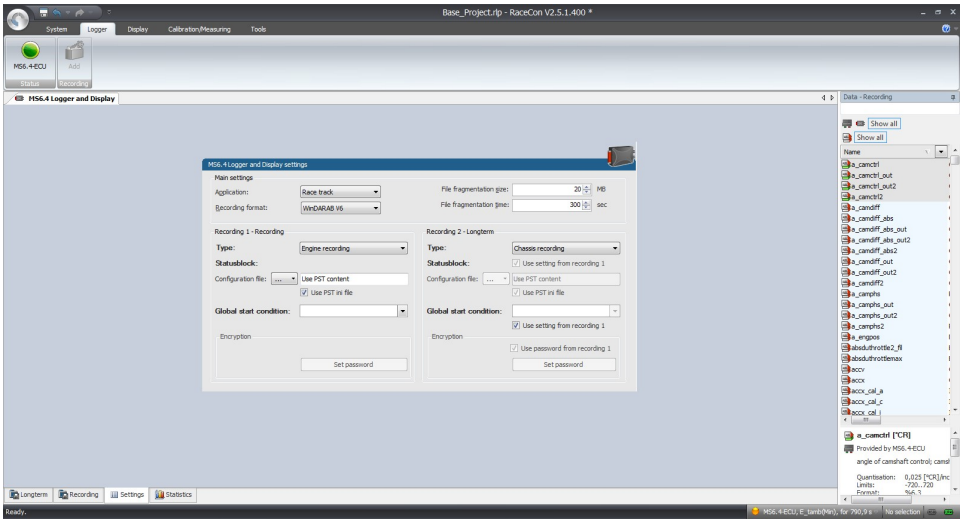
>Recording< selects data logging package I or the free area for data logging

>Longterm< selects data logging package II

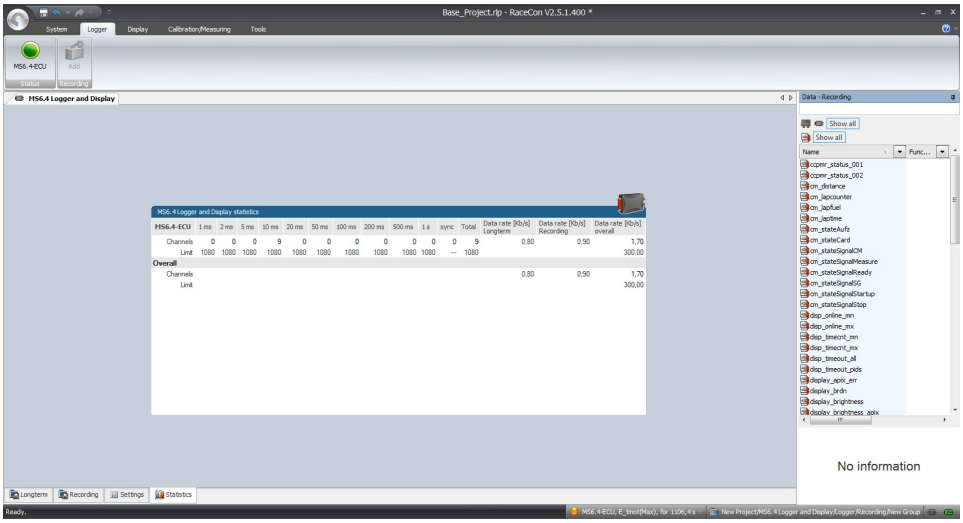
Drag and Drop the channels of your selection.



>settings< For limited recording, please follow the wizard

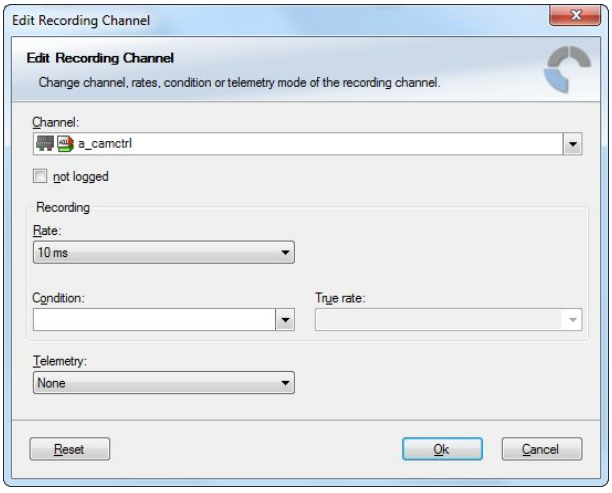


>statistics< check the selection to ensure the system limits are respected.



>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



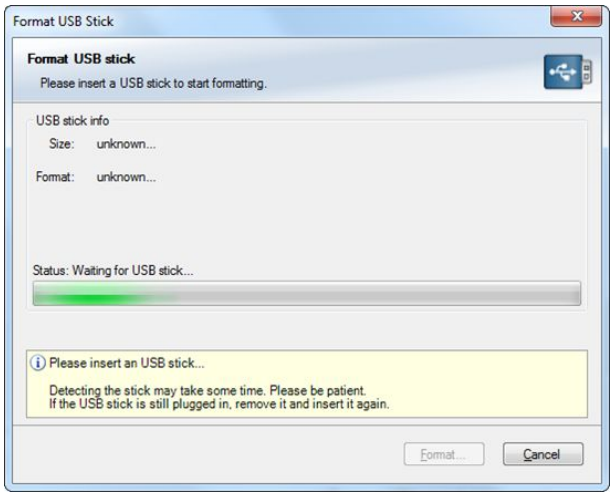
>Project Window / MS 6 Logger / right mouse button / download configuration

>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.



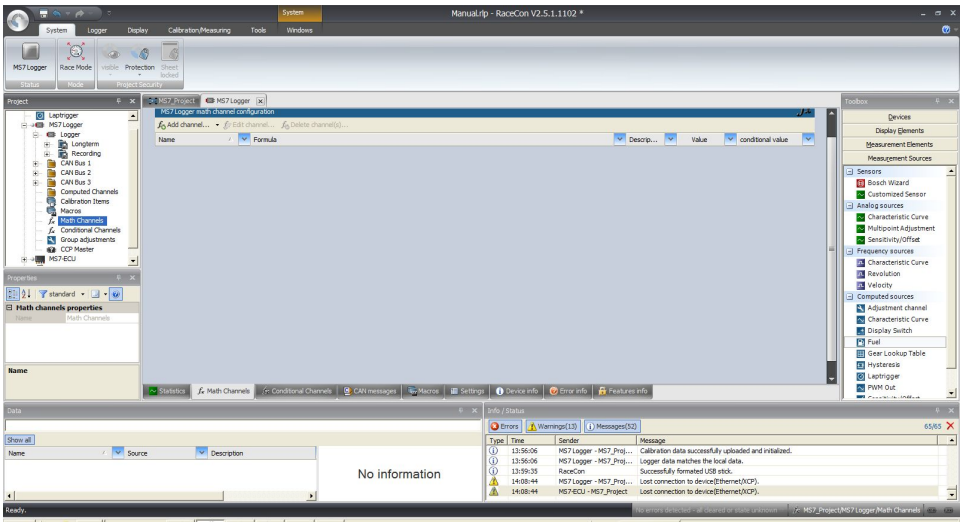
Measure channels to verify USB data recording	
usb_mediastate	0: not found
	1: stick detected
	2: stick installed
	3: stick unplugged
	4: (access)
	5: error
	6: corrupted
meas_cnt_forked	counter of recorded data blocks

6 Project Configuration

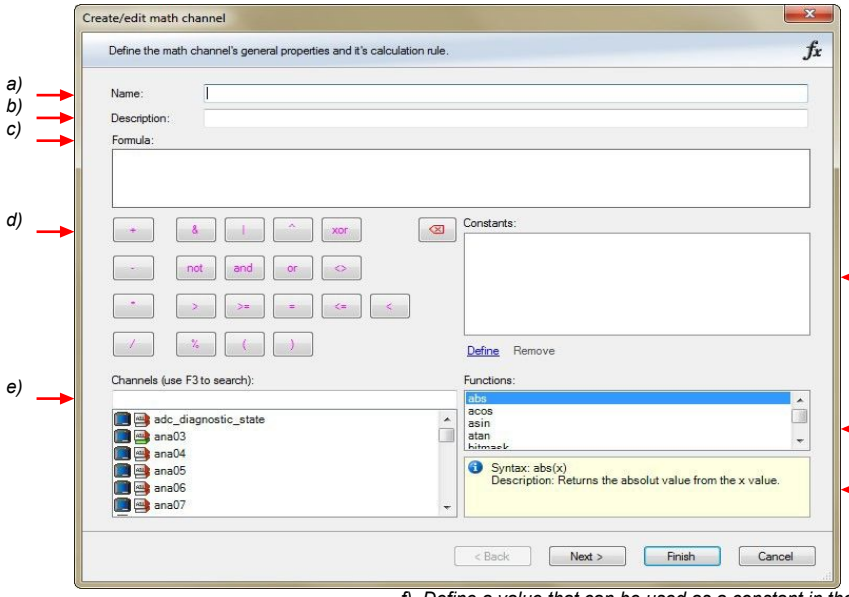
6.1 Math Channels

- Arithmetic and logical operations on up to 4 measurement channels
- Numerical results
- Result can be used as input source for various calculations in the whole project

Double click “Math Channels” in MS 6 logger and display project tree.



The ‘Create/edit math channel’ window appears. Define the math channel using the following configuration possibilities:



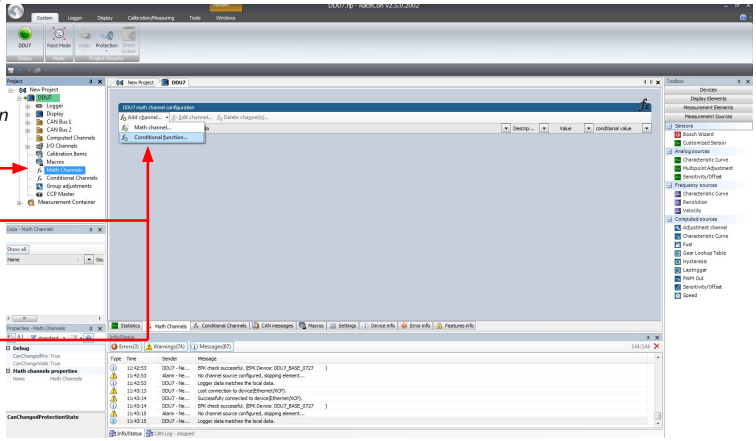
a) Enter the name of the math channel.
b) Enter a description of the math channel.
c) Enter the formula.
d) Select the logical operator.
e) Choose a measurement channel.
f) Define a value that can be used as a constant in the formula.
g) Choose a function.
h) Describes the function selected above.

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

6.2 Conditional Function

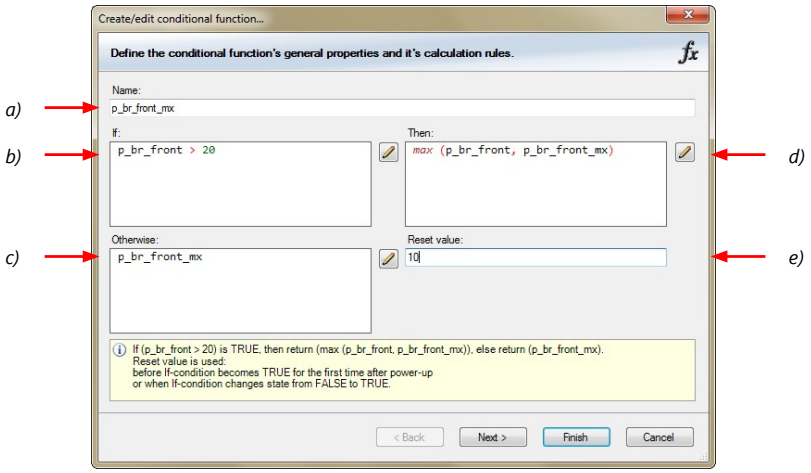
- Arithmetic and logical operations on one or more measurement channels
- If - Else structure with reset
- Numerical result
- Result can be used as input source for further calculations in the whole project

1. Follow the steps shown in the screenshot.



The “Create/edit conditional function” window appears.

2. Define the conditional function, using the following configuration possibilities:



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

3. 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”).

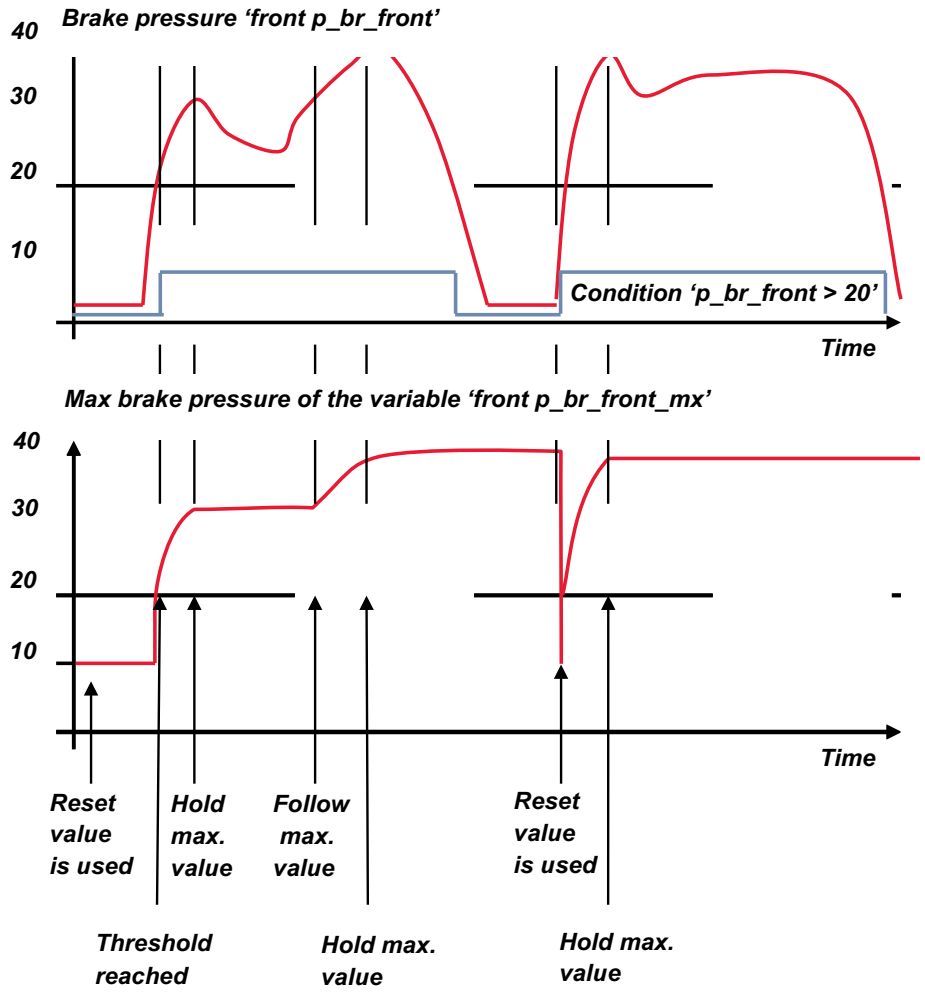
The reset value is always set for the new variable (entered in “Name”):

- 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.
- Because 40 is bigger than 10 the new value of ‘p_br_front_mx’ is 40.

6.3 Condition Channels

- Logical operations on measurement channels
- If – Else structure with reset
- Logical result
- Result can be used as input source for further calculations in the whole project

6.3.1 Condition Combination

- Combination of up to 16 condition channels for more complex calculations
- Logical result
- All conditions can be used globally in the whole project

6.4 CPU Load

Number and recording rate of logged variables have a severe influence on the processor utilization, as well as generating math and conditional channels have. Also the configuration of CAN network use capacity of the MS 6`s processor. Please ensure to keep the processor load below 85 % (average value for each processor core).

Measure channels: “cpu_load_001” and “cpu_load_002”.

7 CAN Configuration

MS 6 has 3 fully configurable CAN buses

- Baudrate (125 kbit ... 1 Mbit)
- 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

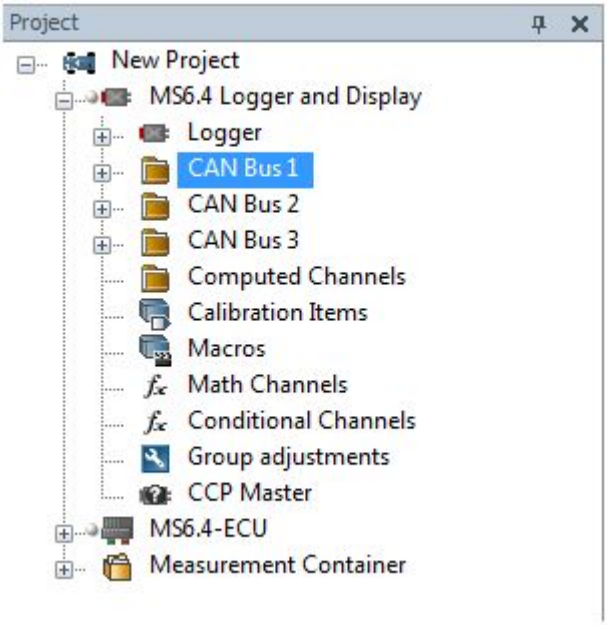
- 11 Bit (standard) or 29 Bit (extended) identifier
- Up to 8 bytes of data payload

CAN bus

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

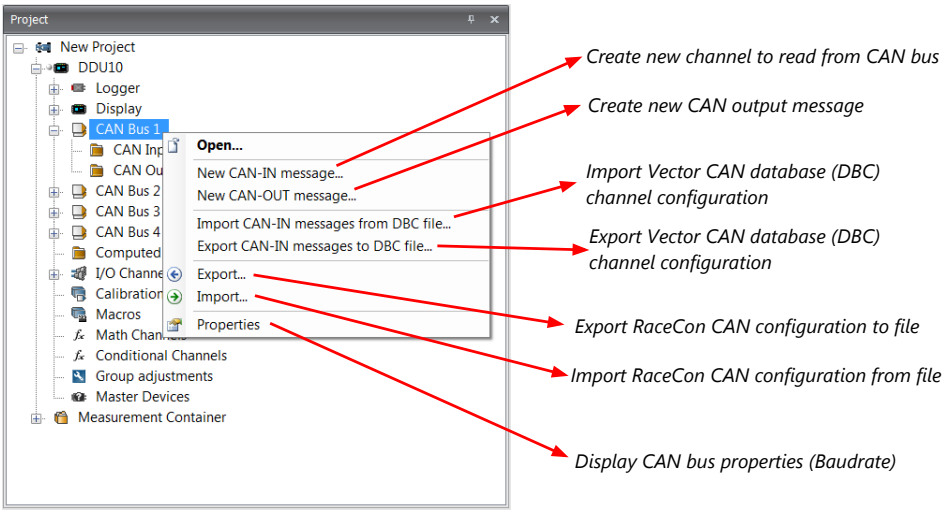
Configuration of MS 6 data rate in 'Properties' menu

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



7.2 CAN Input

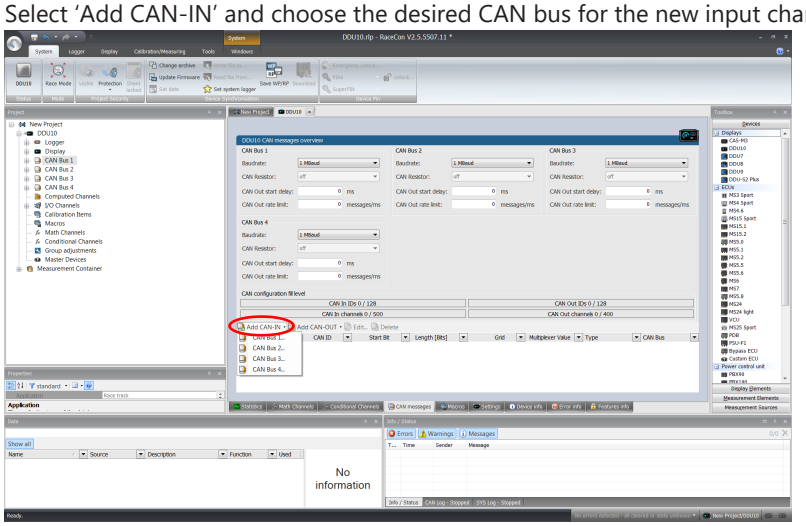
7.2.1 Input configuration



7.2.2 Create a new CAN channel

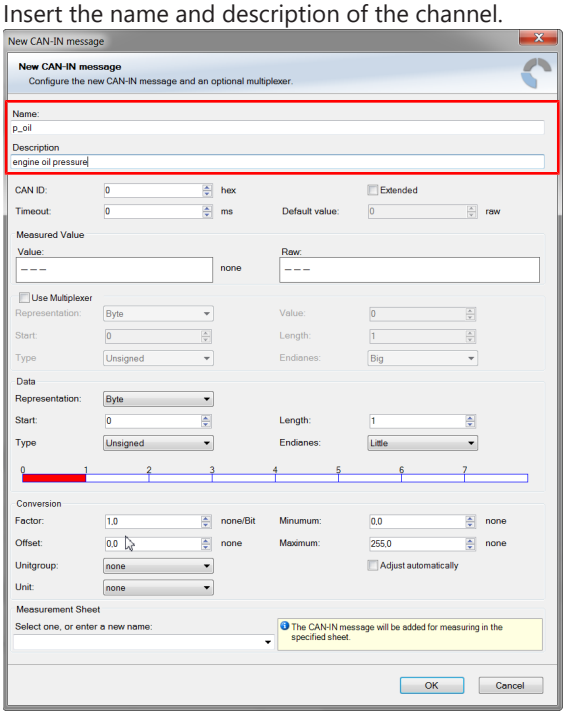
Double-click on any CAN bus item, to open the "CAN messages overview".

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



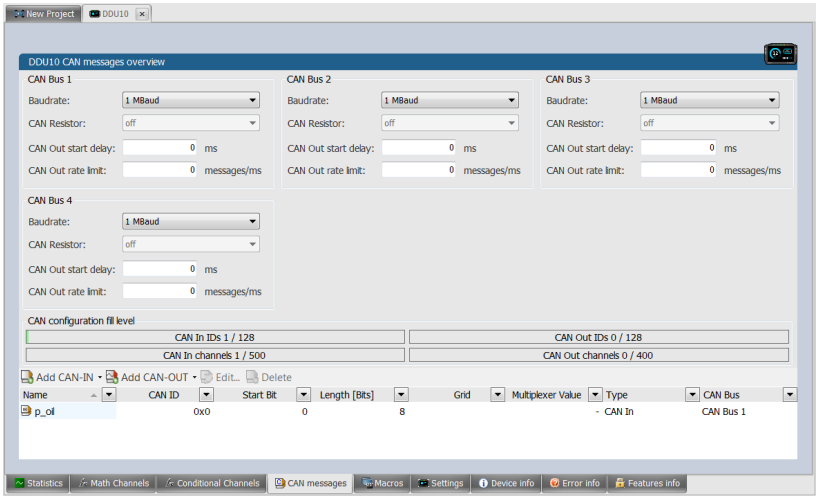
A CAN channel configuration window opens.

Insert the name and description of the channel.

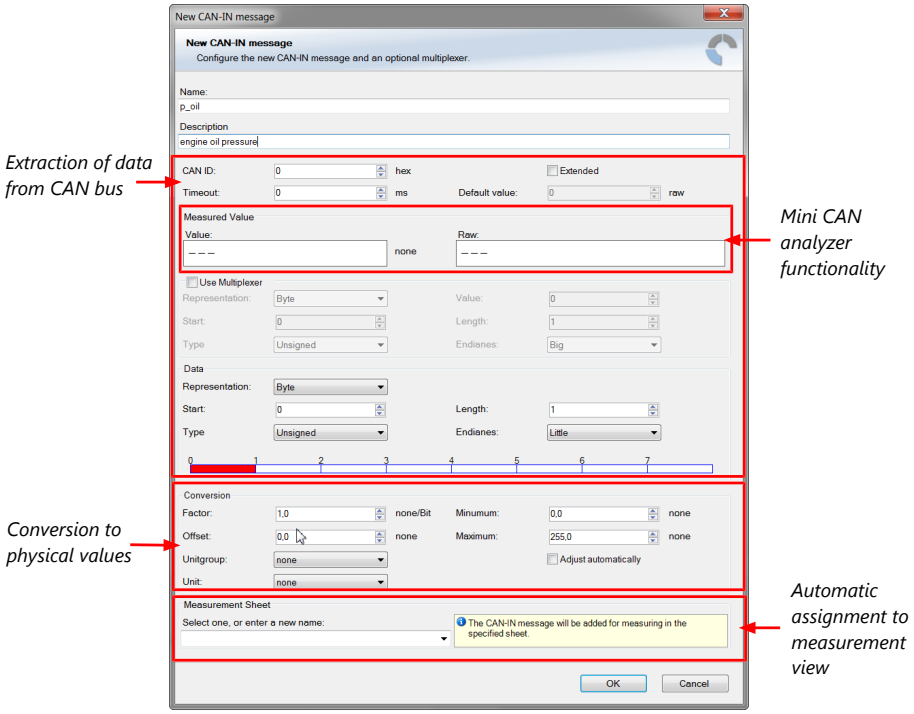


Click ‘OK’ when done.

The channel is listed in the Data window.



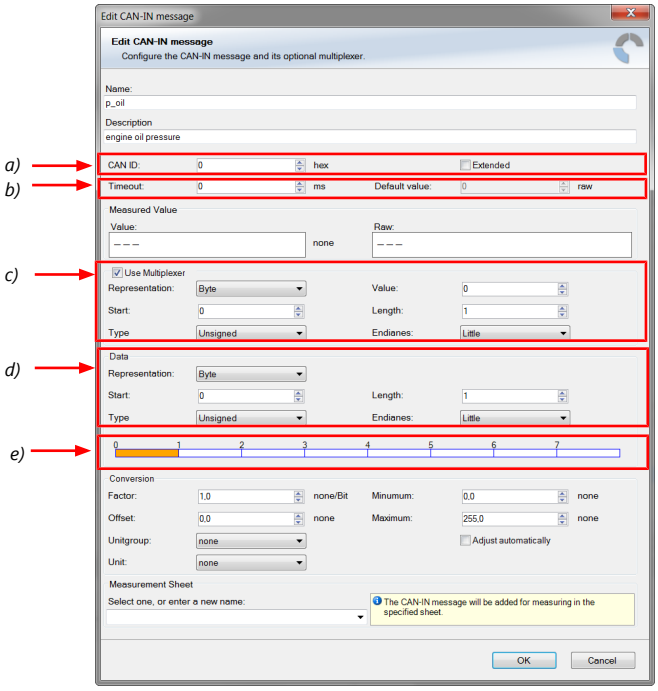
7.2.3 CAN channel configuration



7.2.4 Extracting data from CAN bus

Representation: Byte

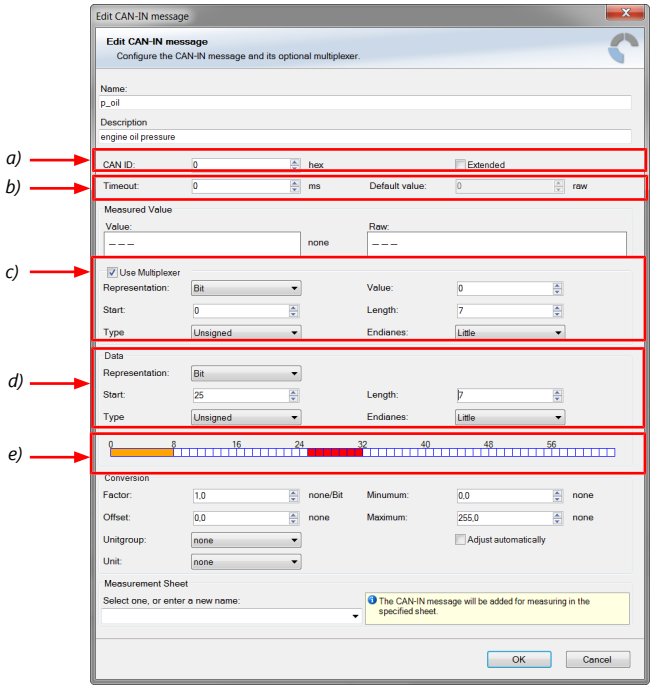
Some CAN devices need to be addressed by a byte represented CAN channel. The address can be assigned in this window and is illustrated by a bar graph.



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.

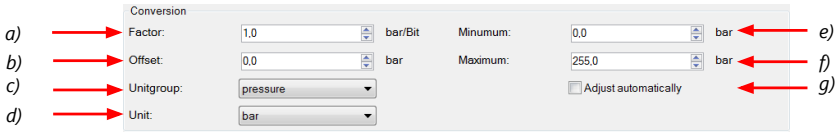
Representation: Bit

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.



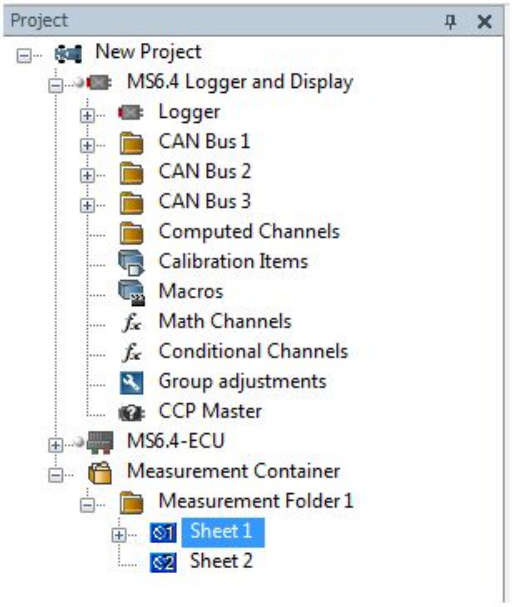
a) Enter CAN message ID. If extended IDs (29 bit) are used, check the box.
b) If replacement values are used, specify time-out period and raw value.
c) If a multiplexer (row counter) is used, check the box.
d) Enter data position, length and format.
e) The bargraph shows the assignment of the bits.
-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

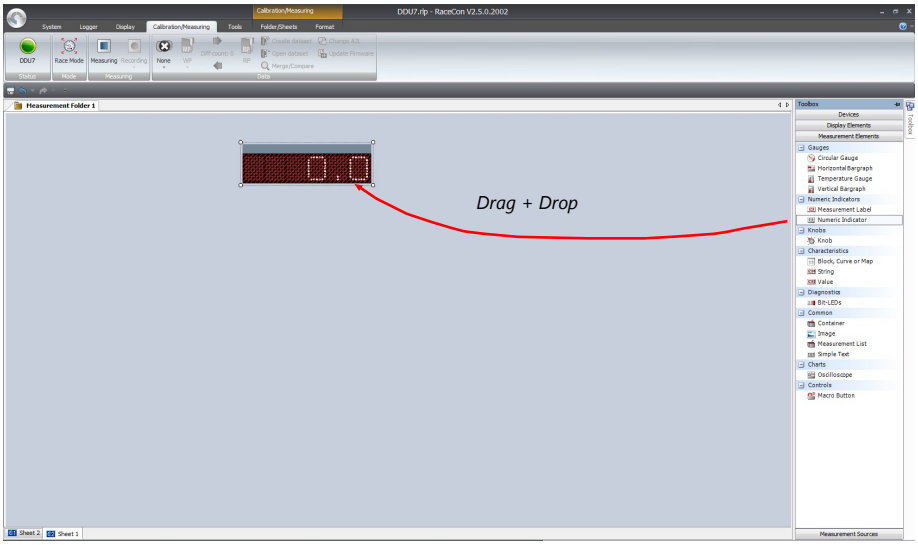


a) Enter factor (gain) for conversion to physical value.
b) Enter offset for conversion to physical value.
c) Select type of physical value.
d) Select unit of physical value.
e) Enter minimum physical limit of the channel. (for manual setup)
f) Enter maximum physical limit of the channel. (for manual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

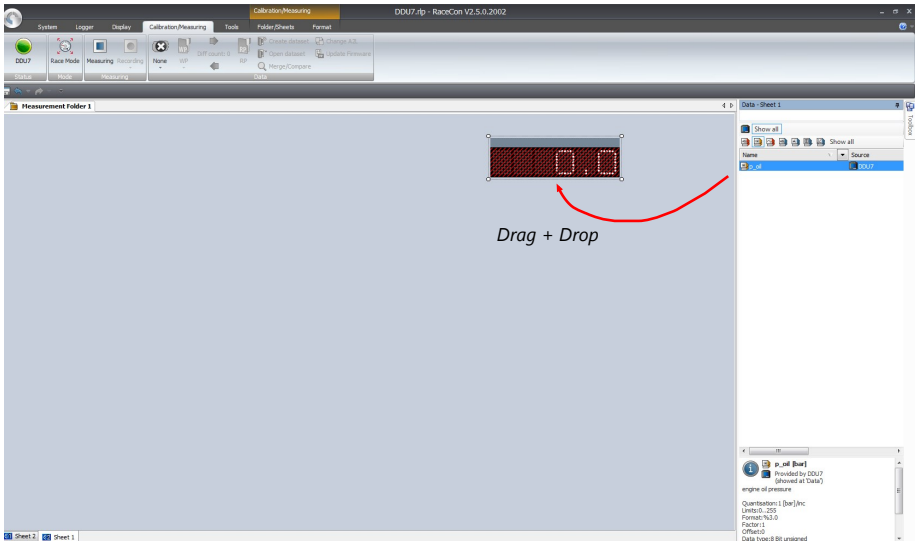
7.2.6 Online view of CAN channels in vehicle



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.

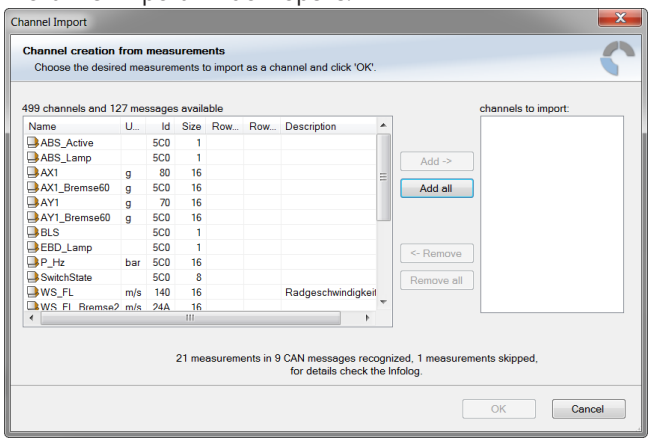


The measurement element displays the values of the assigned channel.

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.

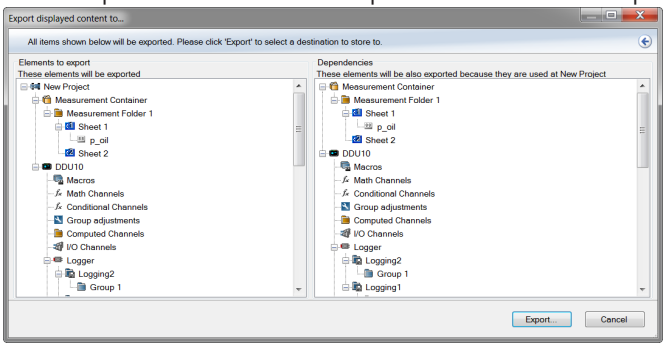
   The channels are inserted in the Data window.

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.



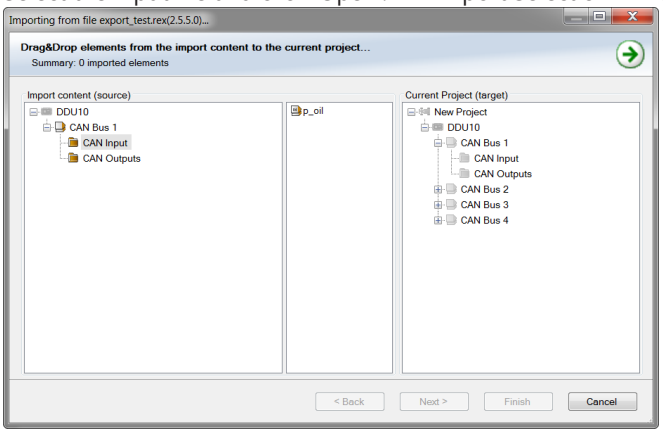
3. Click on 'Export' to select a destination to store.
4. Specify the filename.
5. Click 'Save' when done.

7.2.9 Import in RaceCon

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

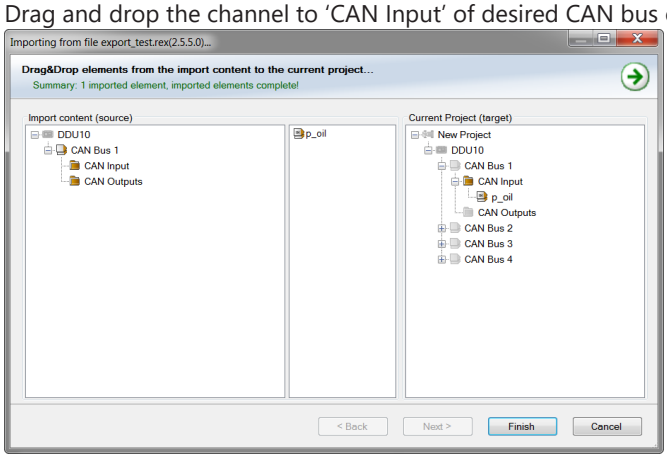
Proceed with the following steps to perform an import:

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.

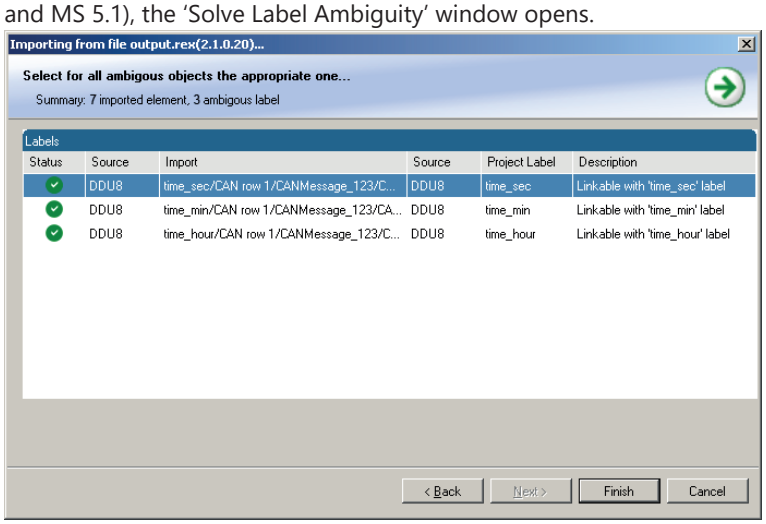


4. Select channels to import.

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



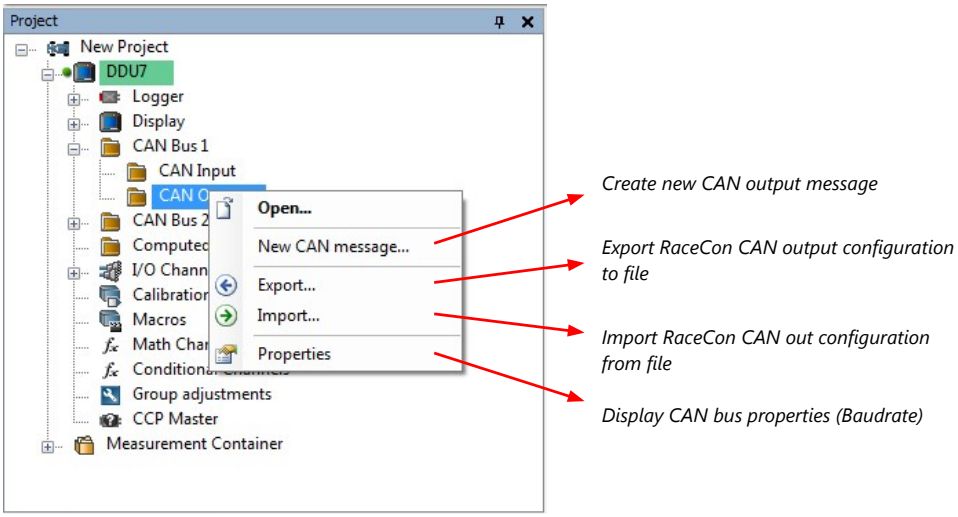
6. Click ‘Finish‘. If a measurement channel belongs to more than one source (e.g. MS 6 and MS 5.1), the ‘Solve Label Ambiguity‘ window opens.



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

7.3 CAN Output

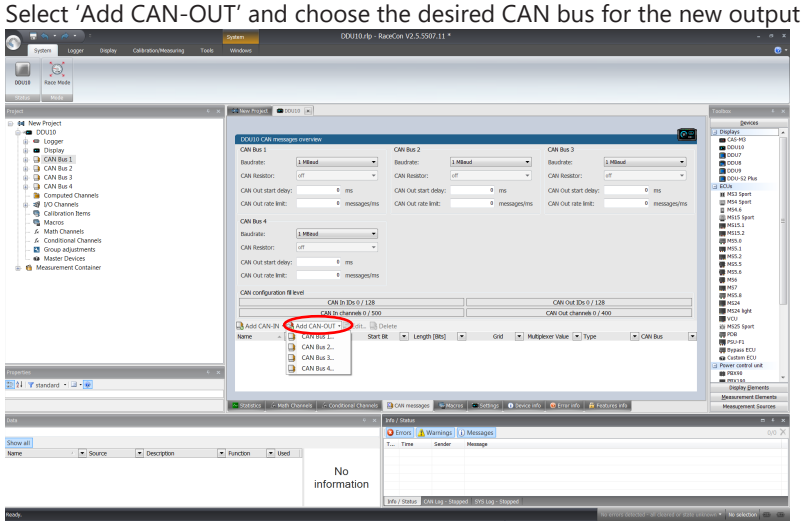
7.3.1 Output configuration



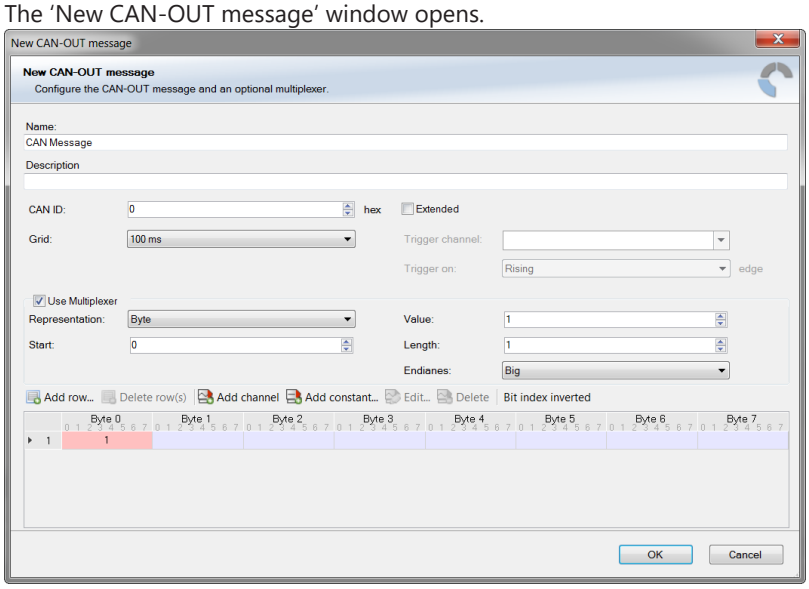
7.3.2 Create new CAN output message channel

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

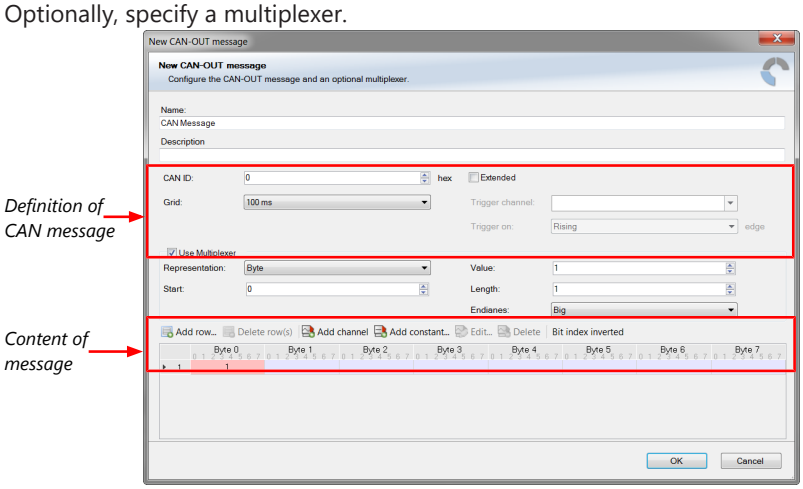
1. Select 'Add CAN-OUT' and choose the desired CAN bus for the new output channel.



The ‘New CAN-OUT message’ window opens.

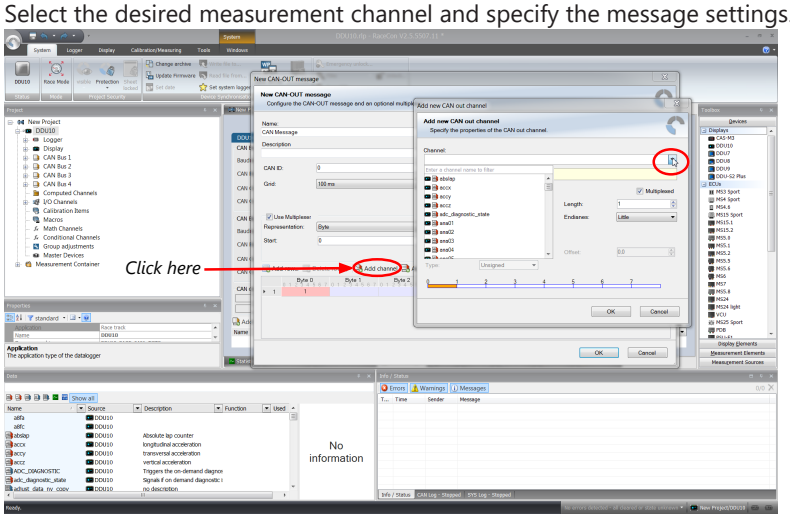


2. Enter name of message, description, CAN-Id and Grid (output interval). Optionally, specify a multiplexer.



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.



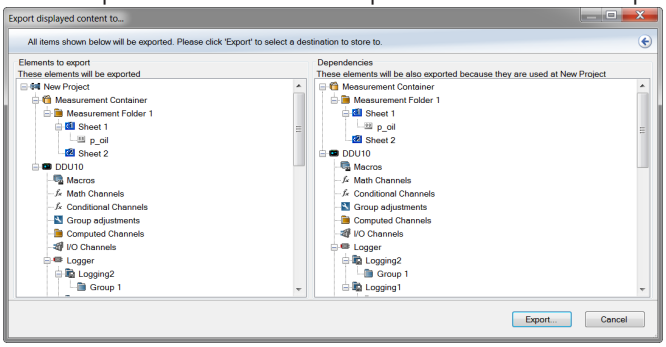
The measurement channel is now assigned to the CAN message.

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.



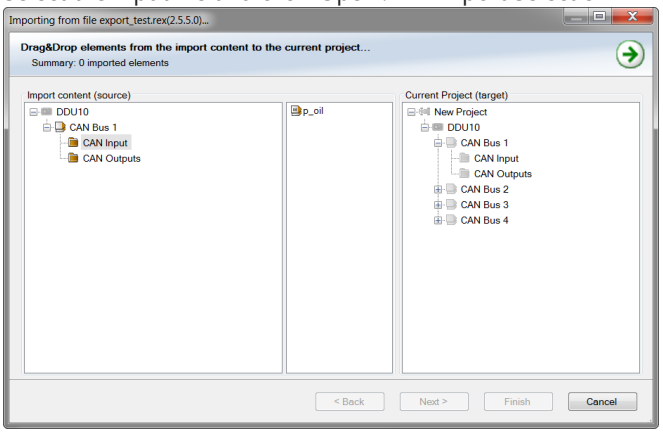
3. Click on 'Export' to select a destination to store.
4. Specify the filename.
5. Click 'Save' when done.

7.3.4 Import in RaceCon

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

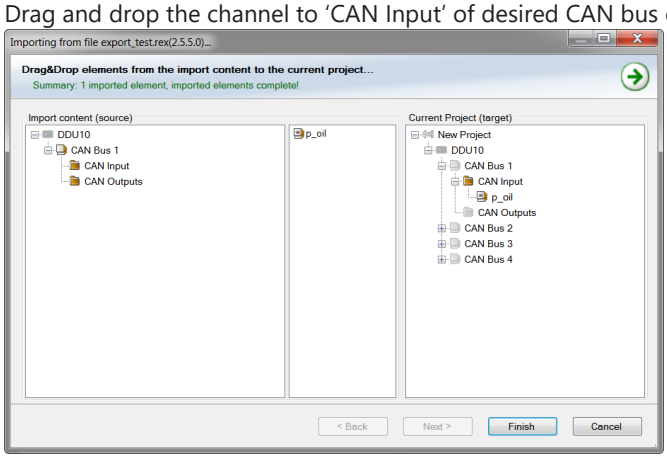
Proceed with the following steps to perform an import:

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.

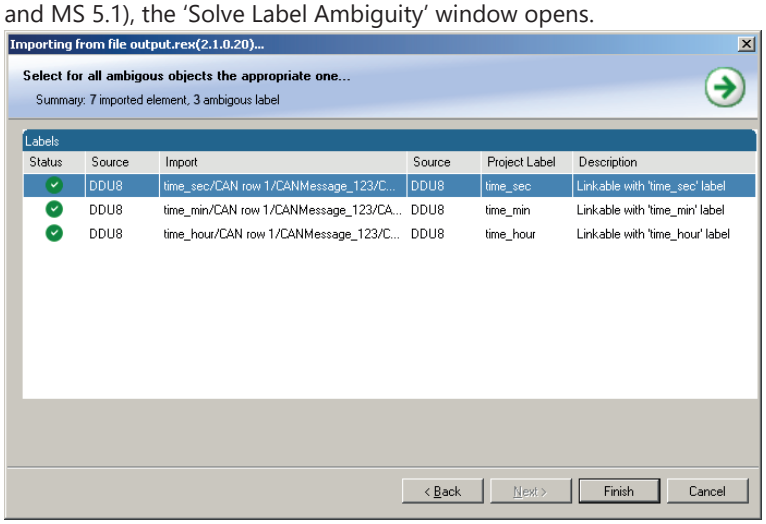


4. Select channels to import.

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 (e.g. MS 6 and MS 5.1), the ‘Solve Label Ambiguity‘ window opens.



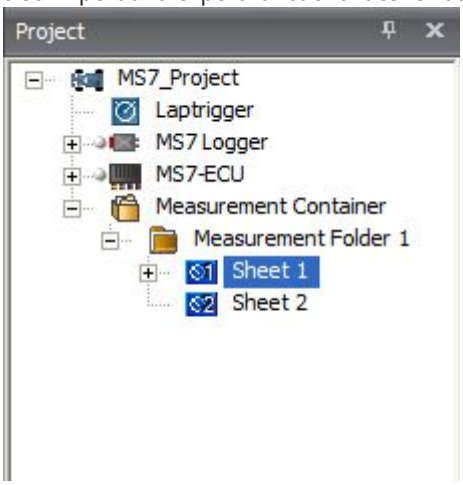
7. Assign the ambiguous channels to the desired source.
8. Click ‘Finish‘.

8 Online Measurement and Calibration

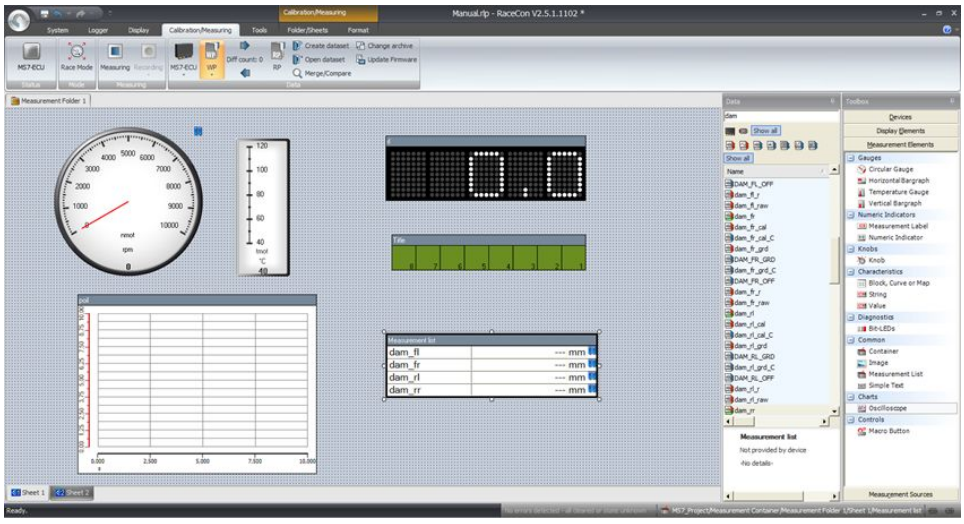
- Verify system status and diagnosis.
- Check and calibrate sensors of the system.
- Data application in online mode.
- PC and device are connected.
- Local PC data match to MS 6 configuration (devices are indicated as green).
- From the context menu of the project, new measurement pages can be created.

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.



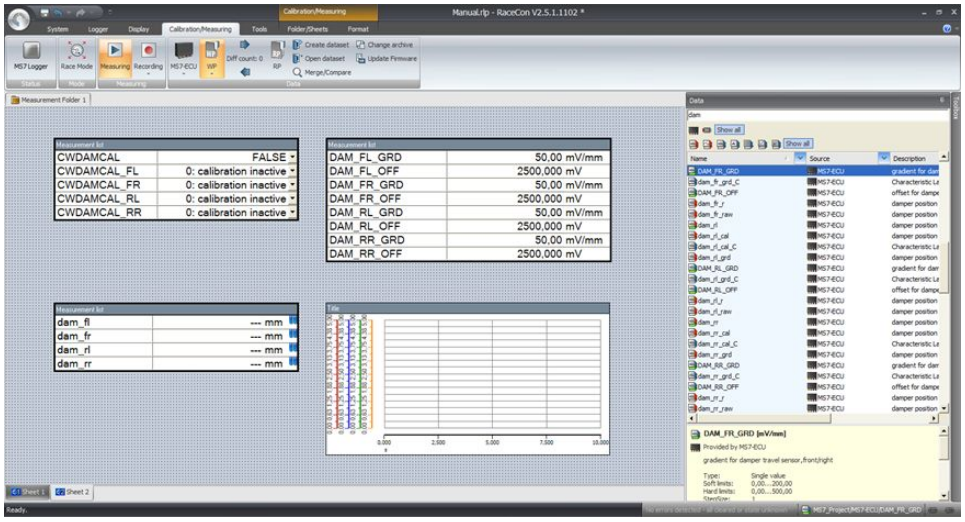
Measure and calibration:

(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



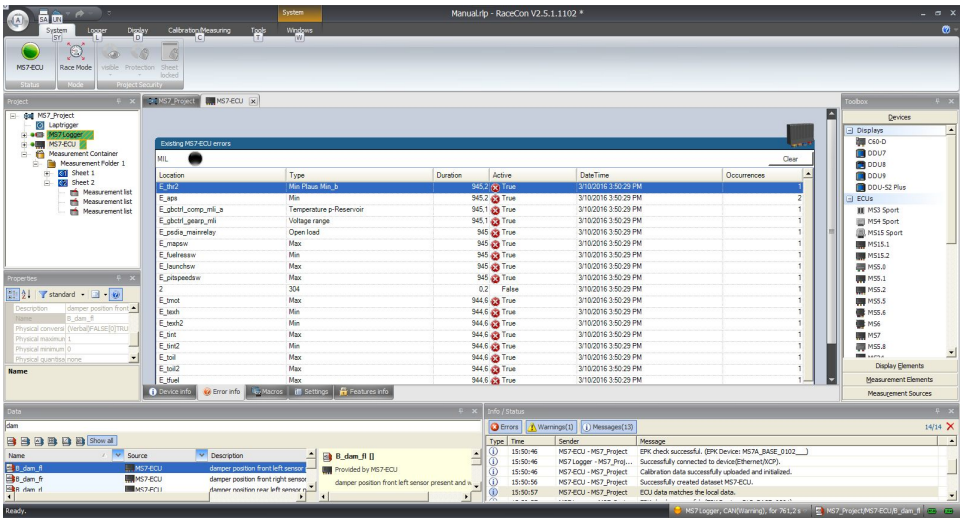
8.2 Using the Measurement Sheets

- 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

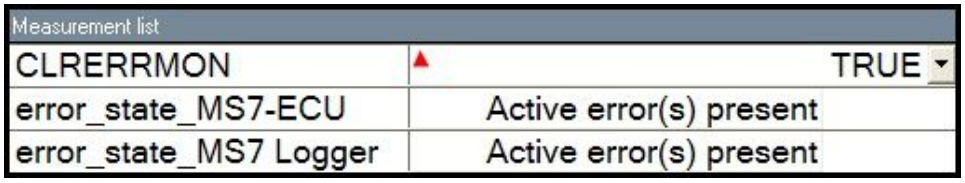
The single error bits may be collected in the error monitor.

9.3 Error Memory Properties

The following property is available for the error memory itself.

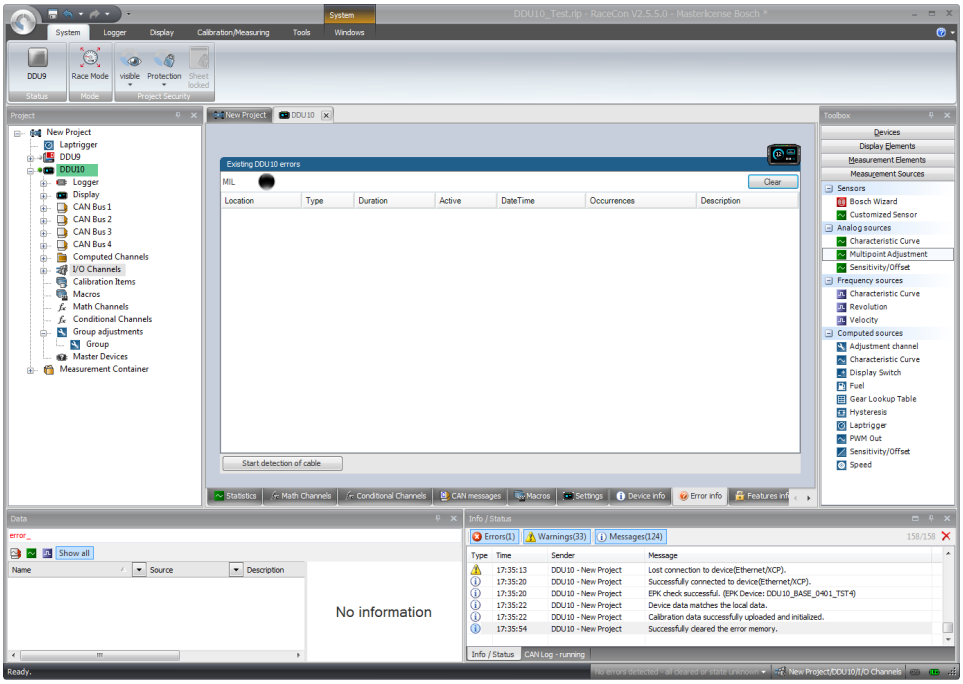
CLRERRMON	Reset of the error monitor
Error Status /device measurement label error_state	
0	No error present in the memory
1	At least one inactive error present in memory, no active errors
2	At least one active error present in memory

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

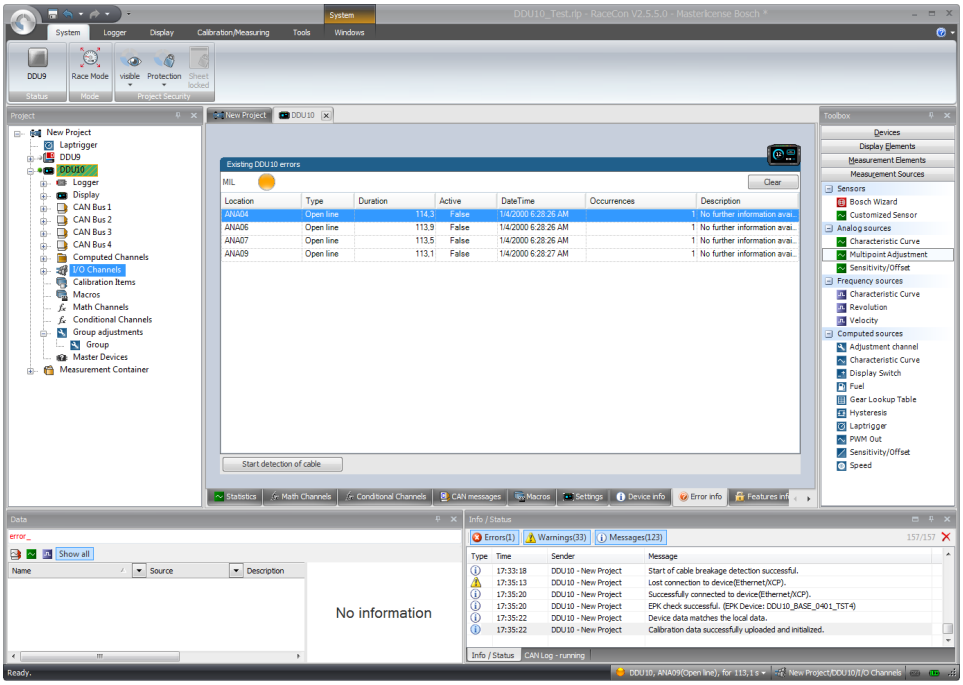


It is also represented by a color scheme within RaceCon (provided RaceCon is online with the system):

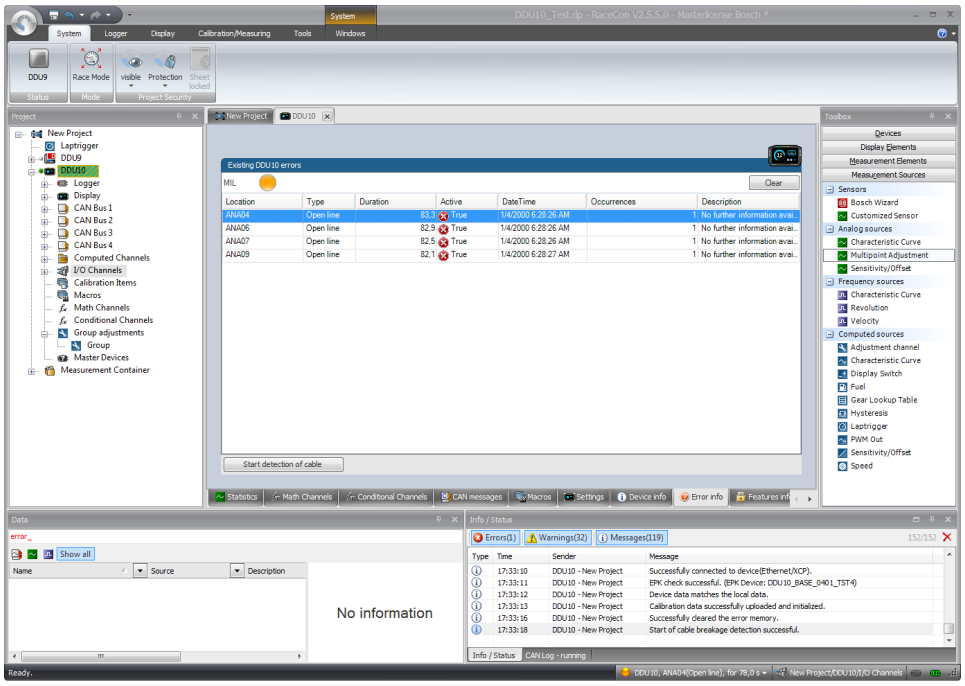
0 (no error present in memory)



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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