Engine Control Unit MS 7.4

Manual

Version 1.0 12/03/2020

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 7.4 inappropriately.

Use the MS 7.4 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 7.4 with uncertified combinations and accessories

Operation of the MS 7.4 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 7.4 was developed for use by professionals and requires in depth knowledge of automobile technology and experience in motorsport. Using the system does not come without its risks.

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

2 Technical Data

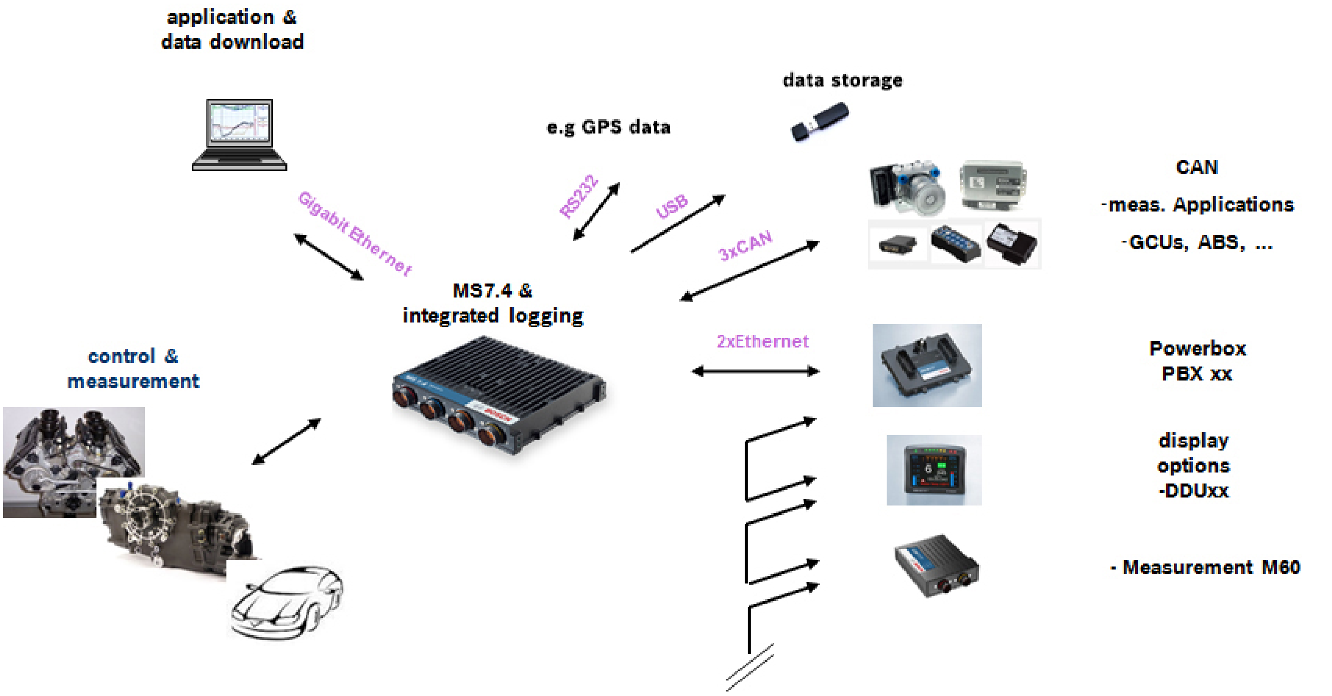
The MS 7.4 engine control unit features a powerful digital processing dual-core with floating point arithmetic and a high-end field programmable gate array FPGA for ultimate performance and flexibility.

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 7.4 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
- Determination of combustion chamber pressure
- Various networks like 1 Gigabit Ethernet for communication to application tools, 2 Ethernet, 1 USB, 1 LIN for system communication, 3 configurable CAN for external device communication and 1 RS232 for e.g. GPS data
Realtime Ethernet SERCOS is prepared for future use with compatible system devices.
- Functionalities may be linked to in- and outputs for free system design or harness adaptation.
- Internal data logger divided into 2 partitions, 4 GB each
- Option to copy all data to removable USB stick



2.1.1 Structure of Devices and Licenses

The MS 7.4 provides the possibility to operate a wide range of different engine requirements and race track operating conditions.

Additional packages may be ordered separately, all of these may be activated later. The license concept is related to the individual device and the requested upgrading.

Gear Control Package I	Gear control Mega-Line functionality, has to be used with Mega-Line components (License model via Mega-Line) [included for base versions beginning with MS7A_BASE_0500 or comparable]
Gear Control Package II	Gear control Bosch Motorsport functionality
Gear Control Package III	Gear control coordination to external GCU systems [included for base versions beginning with MS7A_BASE_0400 or comparable]
Customer Code Area	Enable Customer Code Area
Combustion chamber pressure determination	On request
Knock detection and control based on combustion chamber pressure	On request

NOTICE

Verify the necessity of gearbox control licenses by checking the Features info window in RaceCon (see section Feature / License Activation [▸ 24]).

2.2 Mechanical Data

Milled aluminum housing	
4 Motorsport connectors, 264 pins in total	
Vibration suppression via multipoint fixed circuit boards	
Size without connectors	198 x 180 x 42 mm
Weight	1,610 g
Protection Classification	IP67
Temperature range	-20 to 85°C, measured at internal sensor
Inspection services recommended after 250 h or 2 years, internal battery to be replaced during service	

2.2.1 Installation

Mounting	4 housing integrated screw sockets
Offer drawing	Available at Bosch Motorsport homepage on the MS 7.4 product page. Please find item "Special (Offer Drawing)".
3D-Model	Available at Bosch Motorsport homepage on the MS 7.4 product page. Please find item "3D data".

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 1,000 MHz; FPGA

2.3.1 Communication

3 x CAN	The MS 7.4 has 3 CAN buses configurable as input and output. Different baud rates are selectable. Please note that the MS 7.4 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.

1 x Gigabit Ethernet	For connection to calibration tools and logging data download the MS 7.4 provides a Gigabit Ethernet communication port.
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
1 x Timesync Co-ordination	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 switchable to assist passive sensor elements like NTC temperature sensors or to change to active signal inputs.

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 freely 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 diverse 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.

41 analog inputs in a mix of different hardware designs
6 x reserved for electronic throttle controls
29 x 0 to 5 V, switchable 3.01 kOhm pull-up
6 x option for time synchronous measurement, switchable 3.01 kOhm pull-up

8 fast analog inputs for cylinder pressure recognition
0 to 5 V, switchable 3.01 kOhm pull-up

8 analog / digital inputs
0 to 5 V, switchable 3.01 kOhm pull-up, frequency measurement

2 thermocouple probes
2 x thermocouple exhaust gas temperature sensors (K-type)

20 internal measurements
1 x ambient pressure
1 x triax acceleration
2 x ECU temperature
10 x ECU voltage (e.g. sensor supply)
6 x ECU current (e.g. sensor supply)

8 function related inputs
2 x Lambda interfaces for LSU 4.9 sensor types
1 x lap trigger / beacon input
4 x knock sensors (switchable to 2 inputs with symmetrical operation)
1 x digital switch for engine ON/OFF

10 digital inputs for speed and position measurements
2 x switchable Hall or inductive sensors for flywheel measurement
2 x Hall sensors for sync wheel detection (camshaft)
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 / 400 mA
1 x sensor supply ubat / 250 mA
9 x sensor grounds
2 x sensor screens

2.3.4 Outputs

19 freely configurable outputs in a mix of different hardware designs
4 x 2.2 amp pwm lowside switch
6 x 3 amp pwm lowside switch
2 x 4 amp pwm lowside switch
2 x 1 amp pwm lowside switch
1 x 8.5 amp H-bridge
4 x Moog control ±12 mA

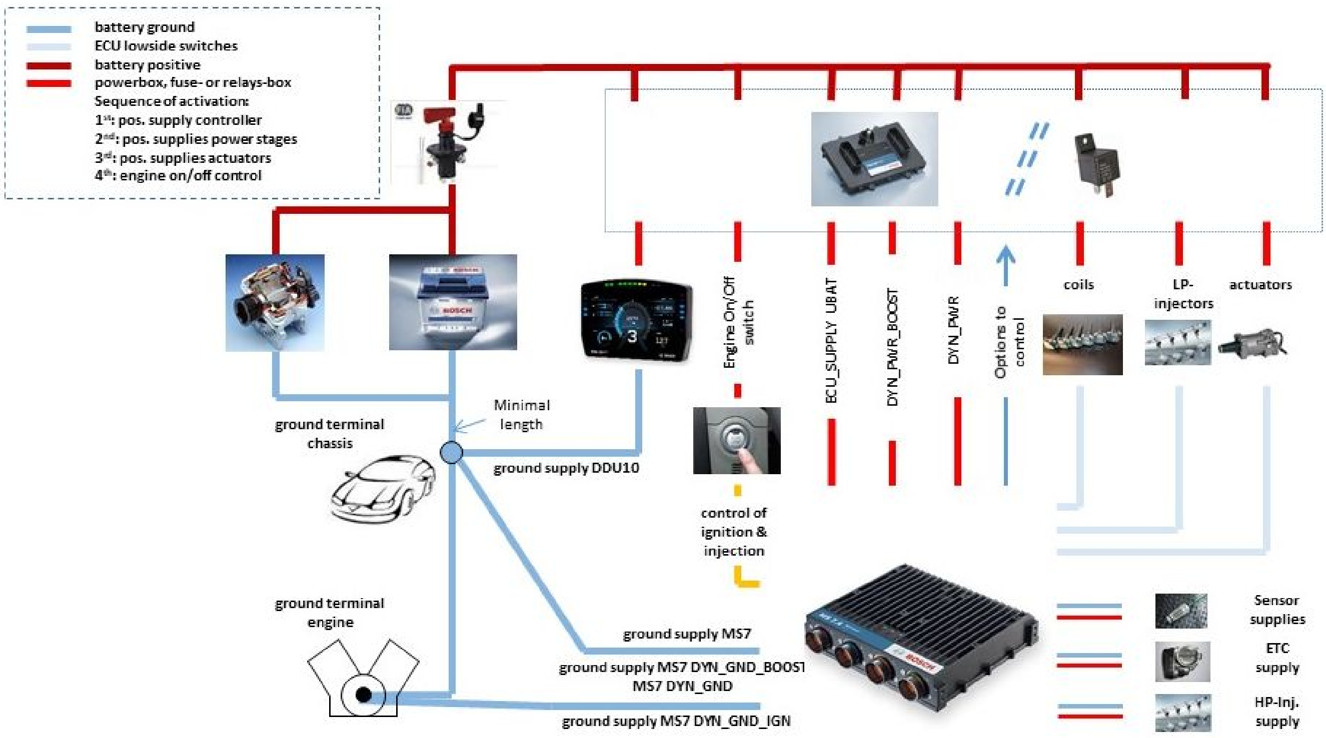
43 function related outputs
12 x ignition controls, support of coils with integrated amplifier only, 8 of them switchable to support coils without integrated amplifier and a max. current of 20 amps
12 x low pressure injection power stages for high impedance valves (max. 2.2 amps and min. 6 Ohm internal resistance of the injectors), may also be used as standard output 2.2 amps (no freewheeling, operation only during engine run) or for control of an additional HPI 5
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 3 amp pwm lowside switch for Lambda heater

5 x muxed output signals
Switchable internal signals like flywheel, trigger wheel, engine rpm, knock signals

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 7.4 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 7.4 power supply is separated into the maintenance of controller and power stages.
- Ensure controller supply UBAT is activated before the power stages.
- The MS 7.4 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 placed at Bosch Motorsport homepage on the MS 7.4 product page. Please find item "Special (Pin layout)".

Most of MS 7.4 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.

Analog Inputs								
S	**C**	**A**	**L**	I/O Type	SIG_NAME	LEAD	DESCRIPTION	FUNCTION
27				analog input	I_A_ANA01	AWG24	universal input 0-5V - pull up switchable	pedal a (fixed)
2				analog input	I_A_ANA02	AWG24	universal input 0-5V - pull up switchable	throttle 1a (fixed)
21				analog input	I_A_ANA03	AWG24	universal input 0-5V - pull up switchable	throttle 2a (fixed)
29				analog input	I_A_ANA04	AWG24	universal input 0-5V - pull up switchable	tamb
3				analog input	I_A_ANA05	AWG24	universal input 0-5V - pull up switchable	tfuel
20				analog input	I_A_ANA06	AWG24	universal input 0-5V - pull up switchable	pbrake_f
47				analog input	I_A_ANA07	AWG24	universal input 0-5V - pull up switchable	pbrake_r
46				analog input	I_A_ANA08	AWG24	universal input 0-5V - pull up switchable	poil
12				analog input	I_A_ANA09	AWG24	universal input 0-5V - pull up switchable	pwat
28				analog input	I_A_ANA10	AWG24	universal input 0-5V - pull up switchable	pclutch
53				analog input	I_A_ANA11	AWG24	universal input 0-5V - pull up switchable	utint
38				analog input	I_A_ANA12	AWG24	universal input 0-5V - pull up switchable	pfuel
45				analog input	I_A_ANA13	AWG24	universal input 0-5V - pull up switchable	toil
37				analog input	I_A_ANA14	AWG24	universal input 0-5V - pull up switchable	tmot2
7				analog input	I_A_ANA15	AWG24	universal input 0-5V - pull up switchable	tmot
8				analog input	I_A_ANA16	AWG24	universal input 0-5V - pull up switchable	prail
13				analog input	I_A_ANA17	AWG24	universal input 0-5V - pull up switchable	pedal b (fixed)
6				analog input	I_A_ANA18	AWG24	universal input 0-5V - pull up switchable	throttle 1b (fixed)
14				analog input	I_A_ANA19	AWG24	universal input 0-5V - pull up switchable	throttle 2b (fixed)
1				analog input	I_A_ANA20	AWG24	universal input 0-5V - pull up switchable	prail2
19				analog input	I_A_ANA21	AWG24	universal input 0-5V - pull up switchable	toil2
	60			analog input	I_A_ANA22	AWG24	universal input 0-5V - pull up switchable	gear
	46			analog input	I_A_ANA23	AWG24	universal input 0-5V - pull up switchable	pcrank
	28			analog input	I_A_ANA24	AWG24	universal input 0-5V - pull up switchable	pgear
	54			analog input	I_A_ANA25	AWG24	universal input 0-5V - pull up switchable	pservo
	39			analog input	I_A_ANA26	AWG24	universal input 0-5V - pull up switchable	shiftupsw
	38			analog input	I_A_ANA27	AWG24	universal input 0-5V - pull up switchable	shiftdnsw
	47			analog input	I_A_ANA28	AWG24	universal input 0-5V - pull up switchable	sdam_fl
	61			analog input	I_A_ANA29	AWG24	universal input 0-5V - pull up switchable	sdam_fr
	55			analog input	I_A_ANA30	AWG24	universal input 0-5V - pull up switchable	sdam_rl
	48			analog input	I_A_ANA31	AWG24	universal input 0-5V - pull up switchable	sdam_rr
	62			analog input	I_A_ANA32	AWG24	universal input 0-5V - pull up switchable	steer
	53			analog input	I_A_ANA33	AWG24	universal input 0-5V - pull up switchable	p1
	45			analog input	I_A_ANA34	AWG24	universal input 0-5V - pull up switchable Voltage devider switchable to 0-26V	tgear
	37			analog input	I_A_ANA35	AWG24	universal input 0-5V - pull up switchable Voltage devider switchable to 0-26V	tservo
5				analog input	I_A_ANA36_PCYL	AWG24	fast analog input 0-5V - pull up switchable	cylinder pressure recognition 1
10				analog input	I_A_ANA37_PCYL	AWG24	fast analog input 0-5V - pull up switchable	cylinder pressure recognition 2
11				analog input	I_A_ANA38_PCYL	AWG24	fast analog input 0-5V - pull up switchable	cylinder pressure recognition 3
17				analog input	I_A_ANA39_PCYL	AWG24	fast analog input 0-5V - pull up switchable	cylinder pressure recognition 4
25				analog input	I_A_ANA40_PCYL	AWG24	fast analog input 0-5V - pull up switchable	cylinder pressure recognition 5
26				analog input	I_A_ANA41_PCYL	AWG24	fast analog input 0-5V - pull up switchable	cylinder pressure recognition 6
34				analog input	I_A_ANA42_PCYL	AWG24	fast analog input 0-5V - pull up switchable	cylinder pressure recognition 7
4				analog input	I_A_ANA43_PCYL	AWG24	fast analog input 0-5V - pull up switchable	cylinder pressure recognition 8
44				analog input	I_A_ANA44_FADC	AWG24	analog input 0-5V, pull up switch., time or angular synchronism measurement	up21
64				analog input	I_A_ANA45_FADC	AWG24	analog input 0-5V, pull up switch., time or angular synchronism measurement	up21_2
43				analog input	I_A_ANA46_FADC	AWG24	analog input 0-5V, pull up switch., time or angular synchronism measurement	up22
59				analog input	I_A_ANA47_FADC	AWG24	analog input 0-5V, pull up switch., time or angular synchronism measurement	up22_2
52				analog input	I_A_ANA48_FADC	AWG24	analog input 0-5V, pull up switch., time or angular synchronism measurement	reserve
36				analog input	I_A_ANA49_FADC	AWG24	analog input 0-5V, pull up switch., time or angular synchronism measurement	reserve
51				thermocouple	I_A_TEXH1P	twisted pair (AWG24)	Thermocouple 1 +	utexh
58					I_A_TEXH1N	shielded	Thermocouple 1 -	
65				thermocouple	I_A_TEXH2P	twisted pair (AWG24)	Thermocouple 2 +	utexh2
60					I_A_TEXH2N	shielded	Thermocouple 2 -	

Combined Analog / Digital Inputs								
S	**C**	**A**	**L**	I/O Type	SIG_NAME	LEAD	DESCRIPTION	FUNCTION
	21			analog / dig input	I_AD_ANADIG01	AWG24	selectable universal input 0-5V / digital input 0-12V - pull up switchable	mapsw
	22			analog / dig input	I_AD_ANADIG02	AWG24	selectable universal input 0-5V / digital input 0-12V - pull up switchable	pitspeedsw
	29			analog / dig input	I_AD_ANADIG03	AWG24	selectable universal input 0-5V / digital input 0-12V - pull up switchable	launchsw
	30			analog / dig input	I_AD_ANADIG04	AWG24	selectable universal input 0-5V / digital input 0-12V - pull up switchable	tcsw
	31			analog / dig input	I_AD_ANADIG05	AWG24	selectable universal input 0-5V / digital input 0-12V - pull up switchable	wetsw
	40			analog / dig input	I_AD_ANADIG06	AWG24	selectable universal input 0-5V / digital input 0-12V - pull up switchable	chressw
	49			analog / dig input	I_AD_ANADIG07	AWG24	selectable universal input 0-5V / digital input 0-12V / SENT - pull up switchable	reserve
	56			analog / dig input	I_AD_ANADIG08	AWG24	selectable universal input 0-5V / digital input 0-12V / SENT - pull up switchable	reserve

Digital Inputs								
S	**C**	**A**	**L**	I/O Type	SIG_NAME	LEAD	DESCRIPTION	FUNCTION
			43	digital input	I_F_DIG01P_HALL_IND	twisted pair (AWG24)	Hall or inductive sensor selectable	CRANK_1+
			44		I_F_DIG01N_HALL_IND	shielded		CRANK_1-
			10	digital input	I_F_DIG02P_HALL_IND	twisted pair (AWG24)	Hall or inductive sensor selectable	CRANK_2+
			19		I_F_DIG02N_HALL_IND	shielded		CRANK_2-
			37	digital input	I_F_DIG03_HALL	AWG24	Hall sensor	CAM_1
			3	digital input	I_F_DIG04_HALL	AWG24	Hall sensor	CAM_2
			11	digital input	I_F_DIG05_HALL_DF11	AWG24	Hall or DF11 sensor selectable	speed1 / CAM3
			1	digital input	I_F_DIG06_HALL_DF11	AWG24	Hall or DF11 sensor selectable	speed2 / CAM4
			2	digital input	I_F_DIG07_HALL_DF11	AWG24	Hall or DF11 sensor selectable	speed3
			6	digital input	I_F_DIG08_HALL_DF11	AWG24	Hall or DF11 sensor selectable	speed4
			47	digital input	I_F_DIG09P_HALL_IND	twisted pair (AWG24)	Hall or inductive sensor circuit selectable	TURBO_1+
			46		I_F_DIG09N_HALL_IND	shielded		TURBO_1-
			8	digital input	I_F_DIG10P_HALL_IND	twisted pair (AWG24)	Hall or inductive sensor circuit selectable	TURBO_2+
			7		I_F_DIG10N_HALL_IND	shielded		TURBO_2-
			21	digital input	I_S_LAPTRIG	AWG24	laptrigger input	LAPTRIGGER
			57	digital input	I_S_ENGRUN	AWG24	digital input, pull down	Engine Switch

Further Inputs								
S	**C**	**A**	**L**	I/O Type	SIG_NAME	LEAD	DESCRIPTION	FUNCTION
61				knock sensor 1A	I_A_KS1A	AWG24, twisted pair (10), shielded	fast I/O / DIGITAL KNOCK CONTROL Core 1	knock_1A
54				knock sensor 1B	I_A_KS1B	AWG24, twisted pair (10), shielded	fast I/O / DIGITAL KNOCK CONTROL Core 1, in case of symm. use reference for sensor 1	knock_1B
62				knock sensor 2A	I_A_KS2A	AWG24, twisted pair (10), shielded	fast I/O / DIGITAL KNOCK CONTROL Core 2	knock_2A
55				knock sensor 2B	I_A_KS2B	AWG24, twisted pair (10), shielded	fast I/O / DIGITAL KNOCK CONTROL Core 2 in case of symm. use reference for sensor 2	knock_2B
66				knock GND	G_R_KS	xx	COMMON GND for knocksensors	
40				LAMBDA	I_A_LSU1UN	4 x AWG24		LAM_1_UN
39					I_A_LSU1VM			LAM_1_VM
31					I_A_LSU1IP			LAM_1_IP
32					I_A_LSU1IA			LAM_1_IA
30				LAMBDA	I_A_LSU2UN	4 x AWG24		LAM_2_UN
22					I_A_LSU2VM			LAM_2_VM
23					I_A_LSU2IP			LAM_2_IP
33					I_A_LSU2IA			LAM_2_IA

Outputs

S	C	A	L	I/O Type	SIG_NAME	LEAD	DESCRIPTION	FUNCTION
		12		lowside switch 4A	O_S_LS01	AWG20		SHIFT_UP
		34		lowside switch 4A	O_S_LS02	AWG20		SHIFT_DN
		17		lowside switch 3A	O_S_LS03	AWG20		WGC_INC
		59		lowside switch 3A	O_S_LS04	AWG20		WGC_DEC
		6		lowside switch 3A	O_S_LS05	AWG20		CAMCTRL_IN
		51		lowside switch 3A	O_S_LS06	AWG20		CAMCTRL_IN2
		43		lowside switch 3A	O_S_LS07	AWG20		CAMCTRL_OUT
		65		lowside switch 3A	O_S_LS08	AWG20		CAMCTRL_OUT2
		19		lowside switch 2.2A or INJ1	O_S_LS09	AWG20	to be used as low side switch or high imp. Injectors, no freewheeling, runs only with engine speed	
		52		lowside switch 2.2A or INJ2	O_S_LS10	AWG20	to be used as low side switch or high imp. Injectors, no freewheeling, runs only with engine speed	
		18		lowside switch 2.2A or INJ3	O_S_LS11	AWG20	to be used as low side switch or high imp. Injectors, no freewheeling, runs only with engine speed	
		60		lowside switch 2.2A or INJ4	O_S_LS12	AWG20	to be used as low side switch or high imp. Injectors, no freewheeling, runs only with engine speed	
		10		lowside switch 2.2A or INJ5	O_S_LS13	AWG20	to be used as low side switch or high imp. Injectors, no freewheeling, runs only with engine speed	
		53		lowside switch 2.2A or INJ6	O_S_LS14	AWG20	to be used as low side switch or high imp. Injectors, no freewheeling, runs only with engine speed	
		27		lowside switch 2.2A or INJ7	O_S_LS15	AWG20	to be used as low side switch or high imp. Injectors, no freewheeling, runs only with engine speed	
		61		lowside switch 2.2A or INJ8	O_S_LS16	AWG20	to be used as low side switch or high imp. Injectors, no freewheeling, runs only with engine speed	
		5		lowside switch 2.2A or INJ9	O_S_LS17	AWG20	to be used as low side switch or high imp. injectors or control of external HDEV 9-12, no freewheeling, runs only with engine speed	
		44		lowside switch 2.2A or INJ10	O_S_LS18	AWG20	to be used as low side switch or high imp. injectors or control of external HDEV 9-12, no freewheeling, runs only with engine speed	
		25		lowside switch 2.2A or INJ11	O_S_LS19	AWG20	to be used as low side switch or high imp. injectors or control of external HDEV 9-12, no freewheeling, runs only with engine speed	
		45		lowside switch 2.2A or INJ12	O_S_LS20	AWG20	to be used as low side switch or high imp. injectors or control of external HDEV 9-12, no freewheeling, runs only with engine speed	
		11		lowside switch 2.2A	O_S_LS21	AWG20		MIL
		36		lowside switch 2.2A	O_S_LS22	AWG20		FUELPUMP
		35		lowside switch 2.2A	O_S_LS23	AWG20		WGC_INC2
		64		lowside switch 2.2A	O_S_LS24	AWG20		WGC_DEC2
		26		lowside switch 1A	O_S_LS25	AWG20		MAINRELAY
			14	lowside switch 1A	O_S_LS26	AWG20		STARTER
		4		lowside switch 3A	O_S_LSH1	AWG20	Lambda Heater Output	LAM_1_HEATER
		58		lowside switch 3A	O_S_LSH2	AWG20	Lambda Heater Output	LAM_2_HEATER
	26			MSV controller	O_P_MSV1P	AWG20		MSV_1P
	35				O_P_MSV1N	AWG20		MSV_1N
	18			MSV controller	O_P_MSV2P	AWG20		MSV_2P
	11				O_P_MSV2N	AWG20		MSV_2N
		66		H-Bridge 8.5A	O_S_HBR1P	AWG20	for EGAS	EGAS_1P
		62			O_S_HBR1N	AWG20		EGAS_1N
		63		H-Bridge 8.5A	O_S_HBR2P	AWG20	for EGAS	EGAS_2P
		57			O_S_HBR2N	AWG20		EGAS_2N
		2		H-Bridge 8.5A	O_S_HBR3P	AWG20		HBRIDGE_1P
		1			O_S_HBR3N	AWG20		HBRIDGE_1N
	34			High Pressure Injection	O_P_INJ1P	AWG20	High Pressure Injection +	INJ_1P
	25				O_P_INJ1N	AWG20	High Pressure Injection -	INJ_1N
	58			High Pressure Injection	O_P_INJ2P	AWG20	High Pressure Injection +	INJ_2P
	59				O_P_INJ2N	AWG20	High Pressure Injection -	INJ_2N
	52			High Pressure Injection	O_P_INJ3P	AWG20	High Pressure Injection +	INJ_3P
	44				O_P_INJ3N	AWG20	High Pressure Injection -	INJ_3N
	5			High Pressure Injection	O_P_INJ4P	AWG20	High Pressure Injection +	INJ_4P
	4				O_P_INJ4N	AWG20	High Pressure Injection -	INJ_4N
	10			High Pressure Injection	O_P_INJ5P	AWG20	High Pressure Injection +	INJ_5P
	17				O_P_INJ5N	AWG20	High Pressure Injection -	INJ_5N
	51			High Pressure Injection	O_P_INJ6P	AWG20	High Pressure Injection +	INJ_6P
	43				O_P_INJ6N	AWG20	High Pressure Injection -	INJ_6N
	6			High Pressure Injection	O_P_INJ7P	AWG20	High Pressure Injection +	INJ_7P
	27				O_P_INJ7N	AWG20	High Pressure Injection -	INJ_7N
	2			High Pressure Injection	O_P_INJ8P	AWG20	High Pressure Injection +	INJ_8P
	1				O_P_INJ8N	AWG20	High Pressure Injection -	INJ_8N
		50		Ignition	O_P_IGN01	AWG20/AWG24	selectable int. ignition power stage or ignition driver	IGN_1
		3		Ignition	O_P_IGN02	AWG20/AWG24	selectable int. ignition power stage or ignition driver	IGN_2
		33		Ignition	O_P_IGN03	AWG20/AWG24	selectable int. ignition power stage or ignition driver	IGN_3
		9		Ignition	O_P_IGN04	AWG20/AWG24	selectable int. ignition power stage or ignition driver	IGN_4
		24		Ignition	O_P_IGN05	AWG20/AWG24	selectable int. ignition power stage or ignition driver	IGN_5
		8		Ignition	O_P_IGN06	AWG20/AWG24	selectable int. ignition power stage or ignition driver	IGN_6
		42		Ignition	O_P_IGN07	AWG20/AWG24	selectable int. ignition power stage or ignition driver	IGN_7
		16		Ignition	O_P_IGN08	AWG20/AWG24	selectable int. ignition power stage or ignition driver	IGN_8
		7		Ignition	O_P_IGN09	AWG24	ignition driver cyl 9-12	IGN_9
		20		Ignition	O_P_IGN10	AWG24	ignition driver cyl 9-12	IGN_10
		13		Ignition	O_P_IGN11	AWG24	ignition driver cyl 9-12	IGN_11
		14		Ignition	O_P_IGN12	AWG24	ignition driver cyl 9-12	IGN_12
		46		MOOG Control	O_A_MOOG1P	AWG24	H-Bridge 12mA +	
		38			O_A_MOOG1N	AWG24	H-Bridge 12mA -	
		54		MOOG Control	O_A_MOOG2P	AWG24	H-Bridge 12mA +	
		47			O_A_MOOG2N	AWG24	H-Bridge 12mA -	
		39		MOOG Control	O_A_MOOG3P	AWG24	H-Bridge 12mA +	
		48			O_A_MOOG3N	AWG24	H-Bridge 12mA -	
		40		MOOG Control	O_A_MOOG4P	AWG24	H-Bridge 12mA +	
		31			O_A_MOOG4N	AWG24	H-Bridge 12mA -	
			29	DIAG_MUX	O_A_MUX1	AWG24 shielded	PushPull driver Diagnosis Multiplexer (KS1A, eng. speed, int. Signals)	MUXCTRL_CH1
			30		O_A_MUX2	AWG24 shielded	PushPull driver Diagnosis Multiplexer (KS1B, cam speed, int. Signals)	MUXCTRL_CH2
			38		O_A_MUX3	AWG24 shielded	PushPull driver Diagnosis Multiplexer (KS2A, cam speed, int. Signals)	MUXCTRL_CH3
			39		O_A_MUX4	AWG24 shielded	PushPull driver Diagnosis Multiplexer (KS2B, cam speed, int. Signals)	MUXCTRL_CH4
			31		O_A_MUX5	AWG24 shielded	PushPull driver Diagnosis Multiplexer (MF1, MF2, MF combined, cam speed, int. Signals)	MUXCTRL_CH5

Communication

S	C	A	L	I/O Type	SIG_NAME	LEAD	DESCRIPTION	FUNCTION
			48	CAN Bus 1	BI_CAN1_H	CAN-Ltg	up to 1Mbit/s, switchable Terminator	CAN_1_H, use for Motronic, Powerbox, HPI and ABS control functions
			56		BI_CAN1_L			CAN_1_L
			62	CAN Bus 2	BI_CAN2_H	CAN-Ltg	up to 1Mbit/s, switchable Terminator	CAN_2_H, use for external ECU / gearbox control
			55		BI_CAN2_L			CAN_2_L
			12	CAN Bus 3	BI_CAN3_H	CAN-Ltg	up to 1Mbit/s, switchable Terminator	CAN_3_H, use for measurement purposes
			13		BI_CAN3_L			CAN_3_L
			66	Gigabit Ethernet	BI_GETH_D1+_TX+	Ethernet Ltg. (CAT6), shielded to G_C_COMSCR	1000 Mbit/s	GETH_0P (Application Interface)
			61		BI_GETH_D1-_TX-			GETH_0N (Application Interface)
			65		BI_GETH_D2+_RX+			GETH_1P (Application Interface)
			54		BI_GETH_D2-_RX-			GETH_1N (Application Interface)
			64		BI_GETH_D3+			GETH_2P (Application Interface)
			60		BI_GETH_D3-			GETH_2N (Application Interface)
			59		BI_GETH_D4+			GETH_3P (Application Interface)
			53		BI_GETH_D4-			GETH_3N (Application Interface)
			26	100 Mbit Ethernet	BI_ETH1_RX+	Ethernet Ltg. (CAT5), shielded to G_C_COMSCR	100 Mbit/s	ETH1RX+
			25		BI_ETH1_RX-			ETH1RX-
			18		BI_ETH1_TX+			ETH1TX+
			17		BI_ETH1_TX-			ETH1TX-
			35	100 Mbit Ethernet	BI_ETH2_RX+	Ethernet Ltg. (CAT5), shielded to G_C_COMSCR	100 Mbit/s	ETH2RX+
			34		BI_ETH2_RX-			ETH2RX-
			36		BI_ETH2_TX+			ETH2TX+
			27		BI_ETH2_TX-			ETH2TX-
			42	Realtime Network SERCOS	BI_RETH1_RX+	Ethernet Ltg. (CAT5), shielded to G_C_COMSCR	100MBit/s Ring Output 1	RETH1RX+
			41		BI_RETH1_RX-			RETH1RX-
			50		BI_RETH1_TX+			RETH1TX+
			49		BI_RETH1_TX-			RETH1TX-
			24		BI_RETH2_RX+	Ethernet Ltg. (CAT5), shielded to G_C_COMSCR	100MBit/s Ring Output 2	RETH2RX+
			23		BI_RETH2_RX-			RETH2RX-
			33		BI_RETH2_TX+			RETH2TX+
			32		BI_RETH2_TX-			RETH2TX-
			15	RS232	BI_RS232_RX	AWG24	Serial interface	RS232_RX
			16		BI_RS232_TX	AWG24		RS232_TX
			51	USB	BI_USB_DP	USB Ltg.	USB interface, supply 5V/500mA	USB_DP
			45		BI_USB_DN			USB_DN
			58		G_R_USBGND			USB_GND
			52		O_V_USB5V			USB_5V
			9	LIN Bus	BI_LIN	AWG24, shielded	LIN interface	LIN
			22	TIMEBASE	BI_TIMESYNC	AWG24	Timesync line between Bosch devices	SYNC

Supply

S	C	A	L	I/O Type	SIG_NAME	LEAD	DESCRIPTION	FUNCTION
			63	Supply In	V_UBAT	AWG20	ECU Processor Supply	
			5	Supply In	V_DYNPWR	AWG20	ECU Supply	
		28		Supply In	V_DYNPWR	AWG20	ECU Supply	
		30		Supply In	V_DYNPWR	AWG20	ECU Supply	
	13			Supply In	V_DYNPWR_BOOST	AWG20	ECU Booster Supply	
	15			Supply In	V_DYNPWR_BOOST	AWG20	ECU Booster Supply	
	32			Supply In	V_DYNPWR_BOOST	AWG20	ECU Booster Supply	
	33			Supply In	V_DYNPWR_BOOST	AWG20	ECU Booster Supply	
	36			Supply In	V_DYNPWR_BOOST	AWG20	ECU Booster Supply	
	41			Supply In	V_DYNPWR_BOOST	AWG20	ECU Booster Supply	
	42			Supply In	V_DYNPWR_BOOST	AWG20	ECU Booster Supply	
	50			Supply In	V_DYNPWR_BOOST	AWG20	ECU Booster Supply	
	64			Supply In	V_DYNPWR_BOOST	AWG20	ECU Booster Supply	
			4	Ground In	G_DYNGND	AWG20	DYN Ground	
	3			Ground In	G_DYNGND	AWG20	DYN Ground	
		22		Ground In	G_DYNGND	AWG20	DYN Ground	
		29		Ground In	G_DYNGND	AWG20	DYN Ground	
		32		Ground In	G_DYNGND	AWG20	DYN Ground	
		56		Ground In	G_DYNGND	AWG20	DYN Ground	
	7			Ground In	G_DYNGND_BOOST	AWG20	ECU Booster Ground	
	8			Ground In	G_DYNGND_BOOST	AWG20	ECU Booster Ground	
	9			Ground In	G_DYNGND_BOOST	AWG20	ECU Booster Ground	
	12			Ground In	G_DYNGND_BOOST	AWG20	ECU Booster Ground	
	14			Ground In	G_DYNGND_BOOST	AWG20	ECU Booster Ground	
	16			Ground In	G_DYNGND_BOOST	AWG20	ECU Booster Ground	
	20			Ground In	G_DYNGND_BOOST	AWG20	ECU Booster Ground	
	23			Ground In	G_DYNGND_BOOST	AWG20	ECU Booster Ground	
	24			Ground In	G_DYNGND_BOOST	AWG20	ECU Booster Ground	
		15		Ground In	V_DYNGND_IGN	AWG20	ECU Ignition Ground	
		21		Ground In	V_DYNGND_IGN	AWG20	ECU Ignition Ground	
		23		Ground In	V_DYNGND_IGN	AWG20	ECU Ignition Ground	
		41		Ground In	V_DYNGND_IGN	AWG20	ECU Ignition Ground	
		49		Ground In	V_DYNGND_IGN	AWG20	ECU Ignition Ground	
		55		Ground In	V_DYNGND_IGN	AWG20	ECU Ignition Ground	
			20	Ground In	G_ECUGND	AWG20	ECU Ground	
			40	Ground Out	G_C_COMSCR	AWG24	connection for communication screen	
			28	Ground Out	G_C_USBSCR	AWG24	connection for USB screen	
35				Ground Out	G_C_SENSSCR	AWG24	connection for signal screens	
	19			Ground Out	G_C_SENSSCR	AWG24	connection for signal screens	
		37		Ground Out	G_C_ACTSCR	AWG24	connection for actuator screens	
42				Supply Out	O_V_SENS5_APS1	AWG24	sensor supply 5V, ca. 50mA, for aps a	
50				Supply Out	O_V_SENS5_APS2	AWG24	sensor supply 5V, ca. 50mA, for aps b	
56				Supply Out	O_V_SENS5_THR1	AWG24	sensor supply 5V, ca. 50mA, for throttle poti(s) a	
48				Supply Out	O_V_SENS5_THR2	AWG24	sensor supply 5V, ca. 50mA, for throttle poti(s) b	
24				Supply Out	O_V_SENS5_1	AWG24	sensor supply 5V, ca. 400mA	
9				Supply Out	O_V_SENS5_2	AWG24	sensor supply 5V, ca. 400mA	
	66			Supply Out	O_V_SENS5_3	AWG24	sensor supply 5V, ca. 400mA	
	63			Supply Out	O_V_SENS_BAT	AWG24	sensor supply ubat, ca. 250mA	
41				Ground Out	G_R_SENS5_APS1	AWG24	sensor ground for aps a	
49				Ground Out	G_R_SENS5_APS2	AWG24	sensor ground for aps b	
63				Ground Out	G_R_SENS5_THR1	AWG24	sensor ground for throttle poti(s) a	
57				Ground Out	G_R_SENS5_THR2	AWG24	sensor ground for throttle poti(s) b	
16				Ground Out	G_R_SENS5_1	AWG24	sensor ground	
15				Ground Out	G_R_SENS5_2	AWG24	sensor ground	
	65			Ground Out	G_R_SENS5_3	AWG24	sensor ground	
	57			Ground Out	G_R_SENS_BAT	AWG24	sensor ground	
18				Ground Out	G_R_PCYL	AWG24	sensor ground for cylinder pressure sensors	

2.3.7 Harness / Wiring

The wiring diagram is available at Bosch Motorsport website on the MS 7.4 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

The MS 7.4 is equipped with Motorsport connectors. On the harness side the following types apply:

LIFE	AS6-18-35SN (red ring)
ACTUATOR	AS6-18-35SB (blue ring)
COMBINED	AS6-18-35SC (orange ring)
SENSOR	AS6-18-35SA (yellow ring)

Wiring

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

For Ethernet and USB connection CAT5 specified material is recommended. For Gigabit Ethernet CAT6E specified material is recommended. 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.

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 7.4 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.

Office harness

Reduced layout to realize communication between PC, MS 7.4 device and Display DDU, recommended for flash configuration, display configuration and installation tasks. Bosch Motorsport part number: F 02U V02 289

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)**.

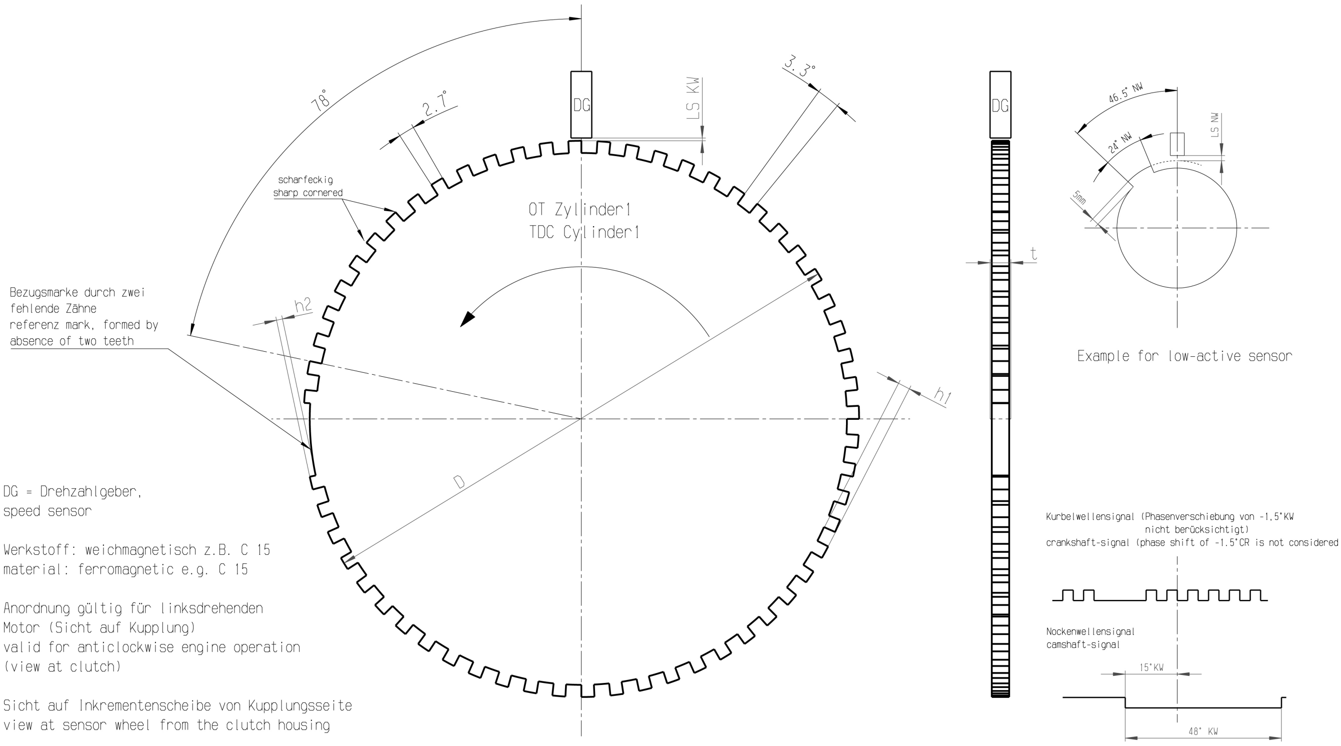
NOTICE

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

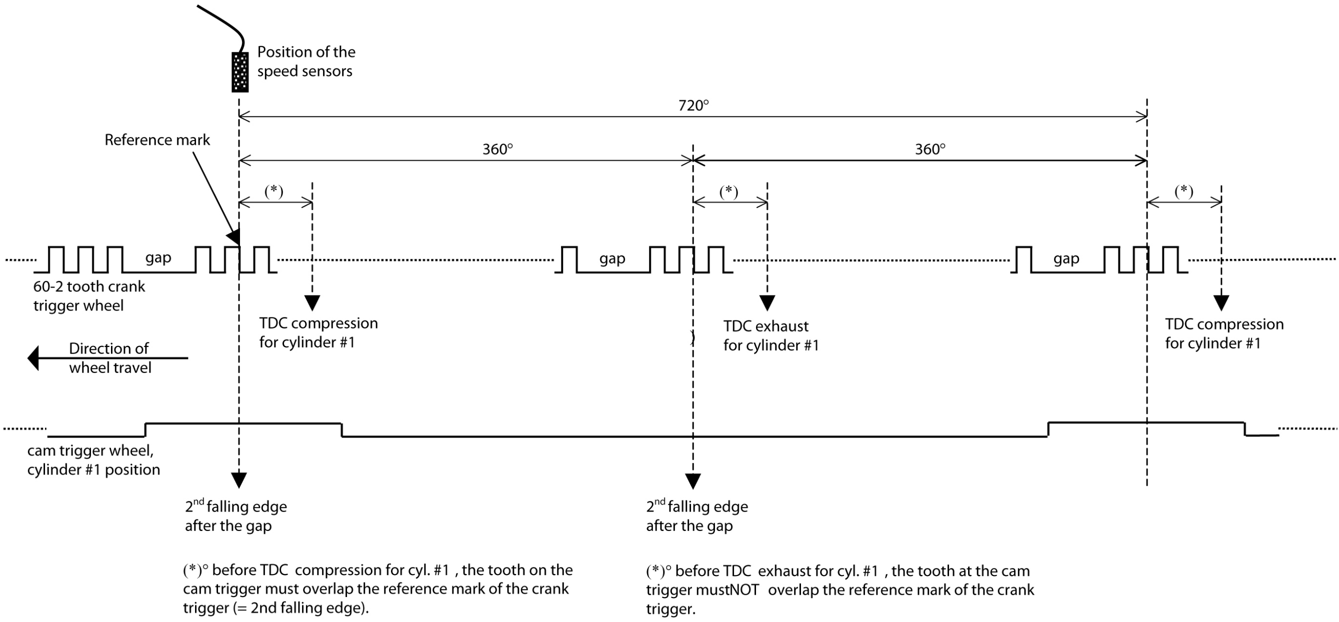
Not usable are flywheels with 4-1 or 6-1 teeth. Please follow the description below as recommendation for the mechanical dimensions.

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.

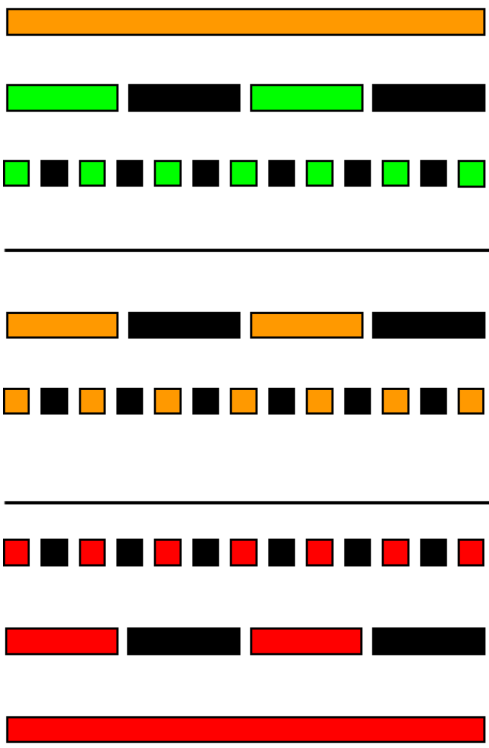
The width of the cam trigger tooth is not important, however it is recommended to use at least 48 crankshaft degrees (24 cam degrees).

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 Description of ECU Status LEDs

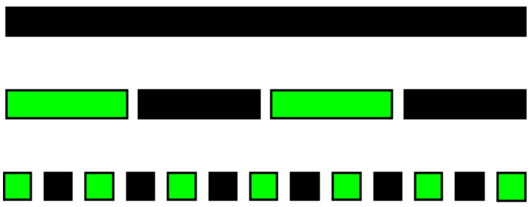
The MS 7.4 provides state LEDs showing various operation states by means of color / blinking frequency. In detail, there exits three LEDs: "LOG" (Data logger), "RUN" (Motronic Run) and "POW" (Motronic Power). Indications are as follows:

LOG



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

RUN



Black constant
• Motronic Processor Boot in progress

Blinking green slow (5 Hz)
• Motronic Processor Boot finished, ECU is operating

Blinking green fast (10 Hz)
• ECU is in emergency state, engine start not possible.
• Flashed firmware is not running properly. Please flash new firmware.

POW

Black constant
• One or more internal Power Supplies missing, ECU is not operating

Green constant
• All internal Power Supplies of the Motronic available

2.5 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 7.4 system are available at Bosch Motorsport homepage for free download.

RaceCon V2.5.1.1102 or higher	Mainly used for system configuration
Modas Sport V1.08.018 or higher	Data application and online measurement
WinDarab V7	Data analysis tool, Light version as shareware or Expert version if license available
MS 7.4 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 7.4 provides Gigabit Ethernet to communicate between tool and ECU. Please ensure that all components comply with this standard to take advantage of the increased data rate.

MS 7.4 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 7.4 is shown as green marked connection in the top left corner of RaceCon.

3.2 Configuration of the system

Bosch MS 7.4 devices are delivered in a not engine executable mode. The customer has to include the correct programs, data applications and licenses.

The MS 7.4 offers two mainly different configuration areas, related to the two core areas of the controller.

MS 7.4 ECU

1st core area for the functional part of the MS 7.4 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 7.4 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.

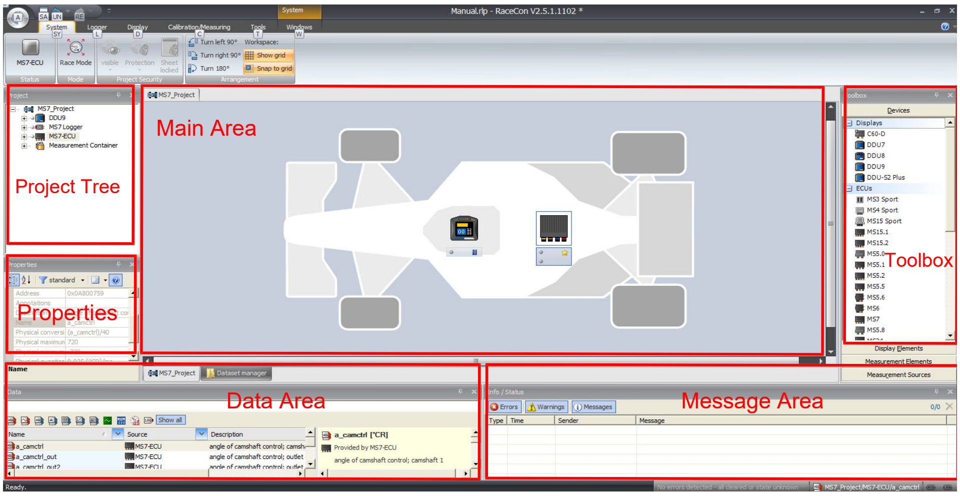
MS 7.4 Programming

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

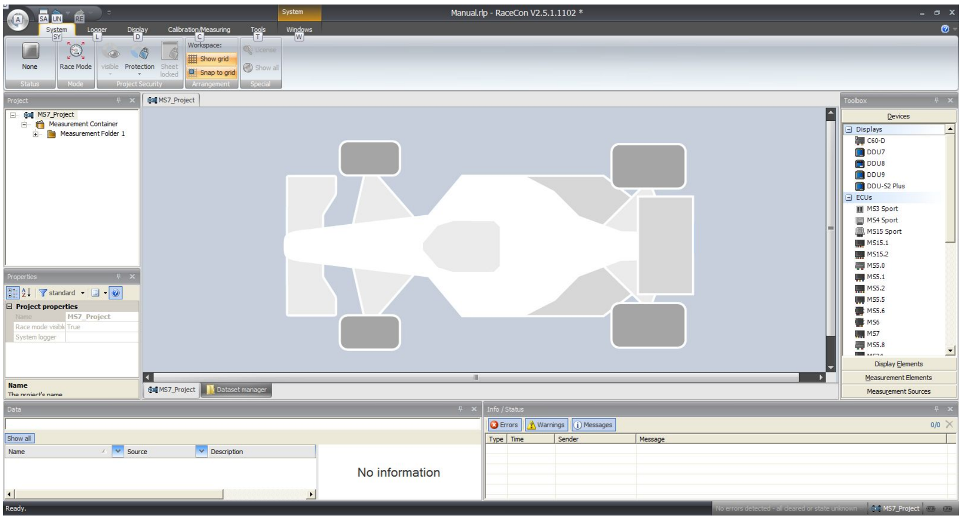
File / New / RaceCon Project opens a new project in RaceCon.



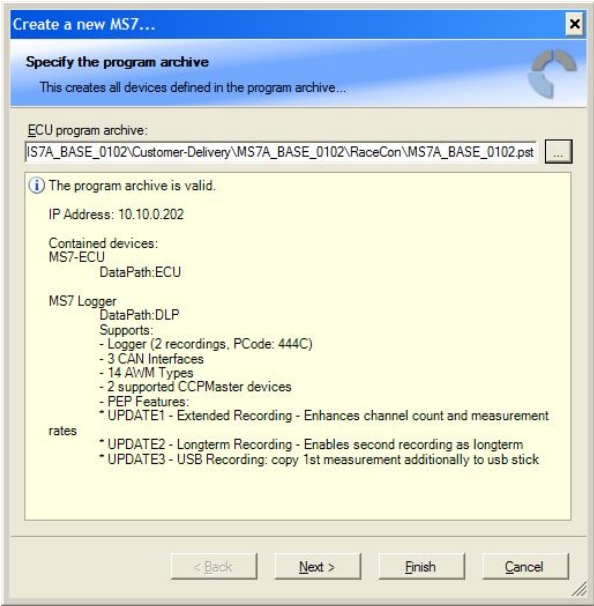
To create a new vehicle configuration, the devices can be pushed via drag & drop from the toolbox to the vehicle. Then they are part of the project and can be configured.

Select an ECU model MS 7.4 from the Toolbox / Devices / ECUs.

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

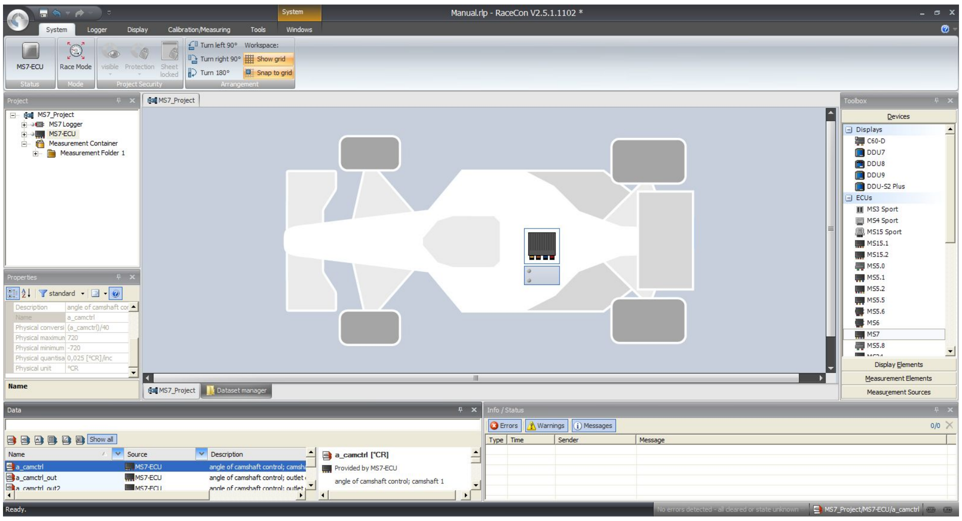


Now the ECU program archive PST files must be selected. These archives are delivered by Bosch. Specify the MS 7.4 program archive: MS 7.4_XXX_xxx.pst.



Access to all configurable data is now available.

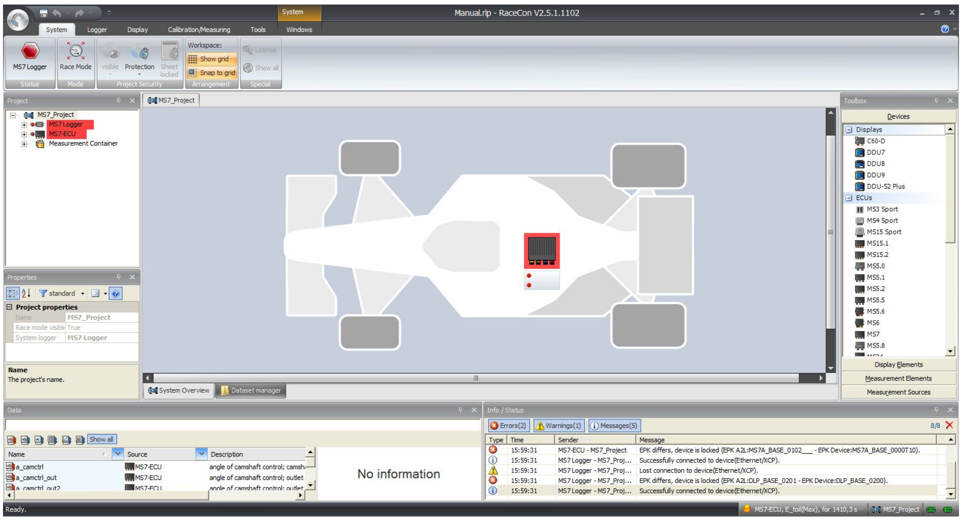
Installation may now be saved as customer project for further data application.



3.2.2 Programs Installation

Going Online for program and license configuration

In the project tree both parts of the MS 7.4 core are shown as >red<, that means MS 7.4 device and RaceCon project differ in the used program version.

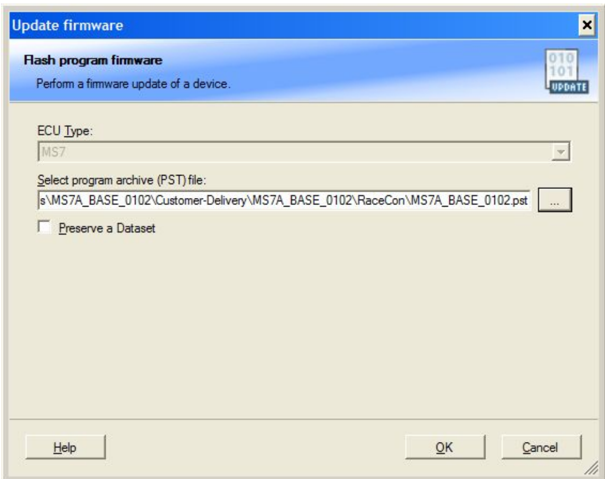


Synchronize MS 7.4 and RaceCon program version / update the firmware of the device:

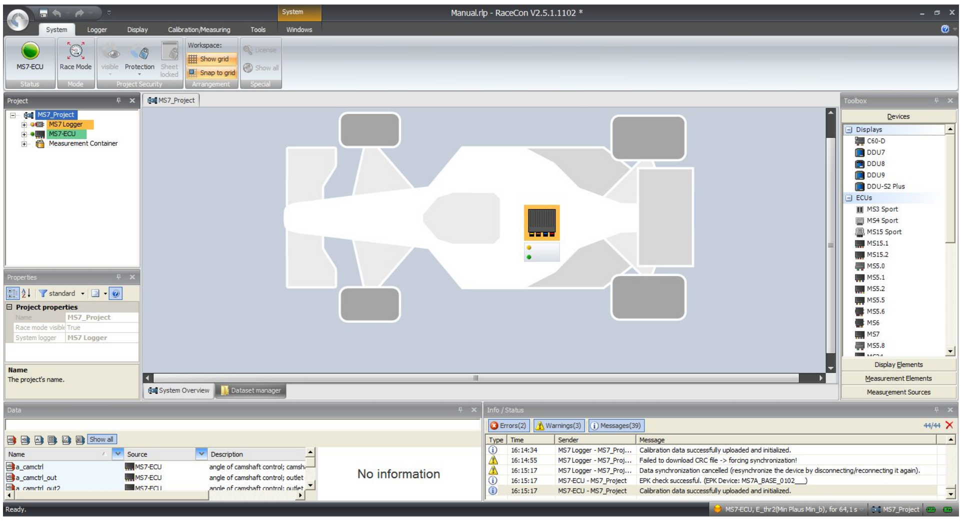
Project-tree / right mouse button to one of the red MS 7 core / synchronize / update firmware >select customer software of the MS 7.4 (file with extension: -.pst)

NOTICE

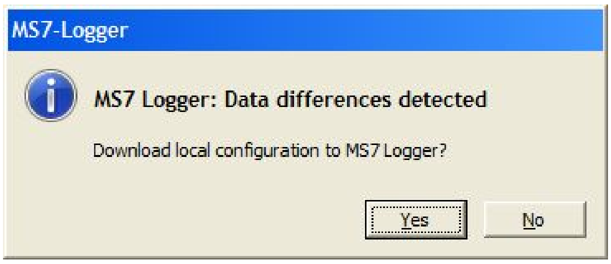
Do not interrupt flash process.



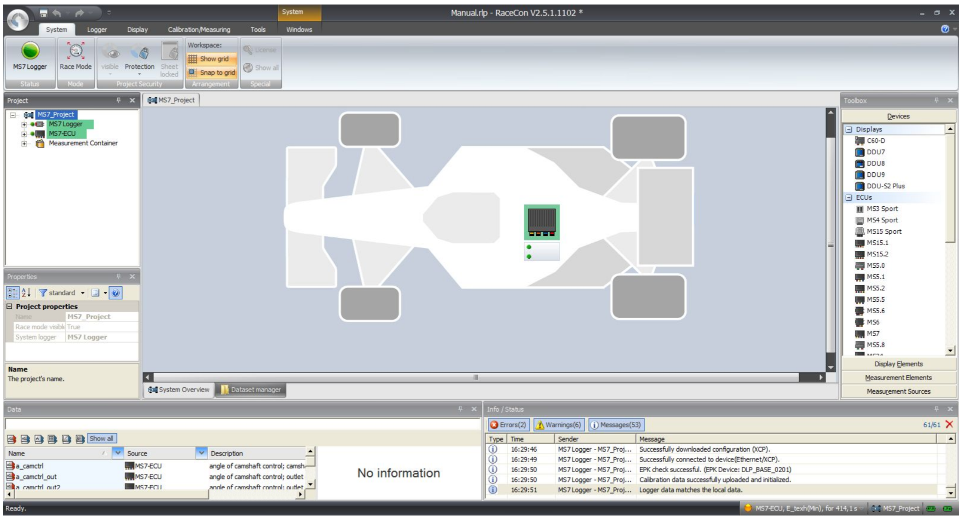
In the project tree, the MS 7 logger core is shown as >yellow<, means the firmware of MS 7 device and project are identical, but the data differs.



The offline preconfigured data have to be sent to the MS 7.4. Option one, select: Project tree / right mouse button to the yellow MS 7 core / synchronize / or follow the RaceCon menu:

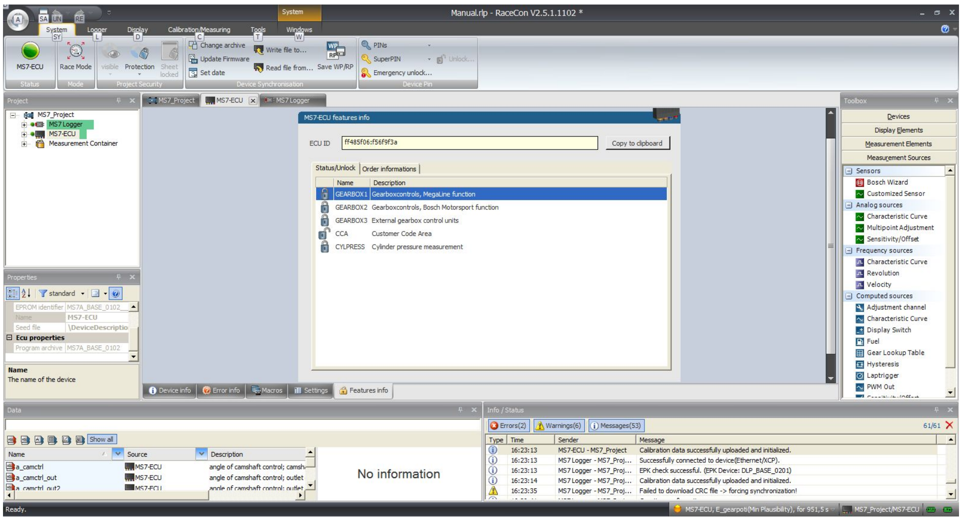


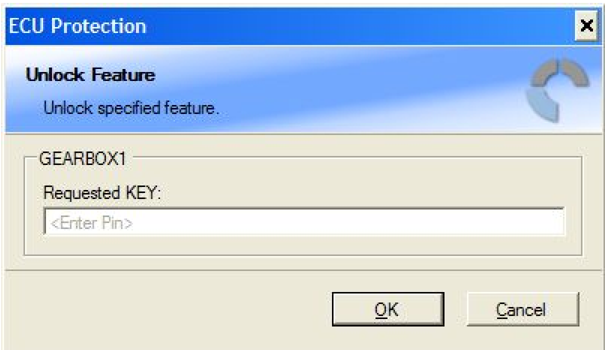
Both MS 7 cores are shown as green, means firmware and data of device and project are now identical.



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 7 licenses are related to one specific device and the delivered code is only to activate for this ECU. Both cores, MS 7 ECU and MS 7 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 7 ECU core. The licenses for logger related packages like Ethernet telemetry are handled in the MS 7 logger core. MS 7.4 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 7.4 programs MS7a_xxxx_yyyy_data.s19 and MS7a_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 7.4 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 [▶ 15].

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)**
PIN_IN_CRANK	Selection of used crankshaft input pin
CWINTF_L43_L44	Selection of used crankshaft sensor type (Hall or inductive type), example for used pins L43/L44
CRANK_GAP_TOOTH_CNT	Number of missing teeth on the flywheel
PIN_IN_CAM_x	Selection of used camshaft input pin
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

Main Data Labels to configure for crank- and camshaft wheel	
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 7.4 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 system	
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.

Main Data Labels for Load Calculation	
MP_RLP1 ...P4	Relative load depending on throttle position 1-4
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 Main Data Labels for Ignition

The MS 7.4 provides two alternatives to drive the ignition coils: For engines up to 8 cylinders the internal powerstages may be used. Alternatively or for engines up to 12 cylinders external powerstages may be used.	
IGNDRV_TYPE	For ignition coils with integrated powerstage set IGNDRV_TYPE to 0 („External PS (CK200)“). To use the ECU’s internal powerstages (for ignition coils without integrated powerstage), set IGNDRV_TYPE to 1 (“Internal PS”) The ECU must be restarted for changes to take effect.

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.

Main Data Labels for ignition	
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.

4.1.9 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.

4.1.10 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_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

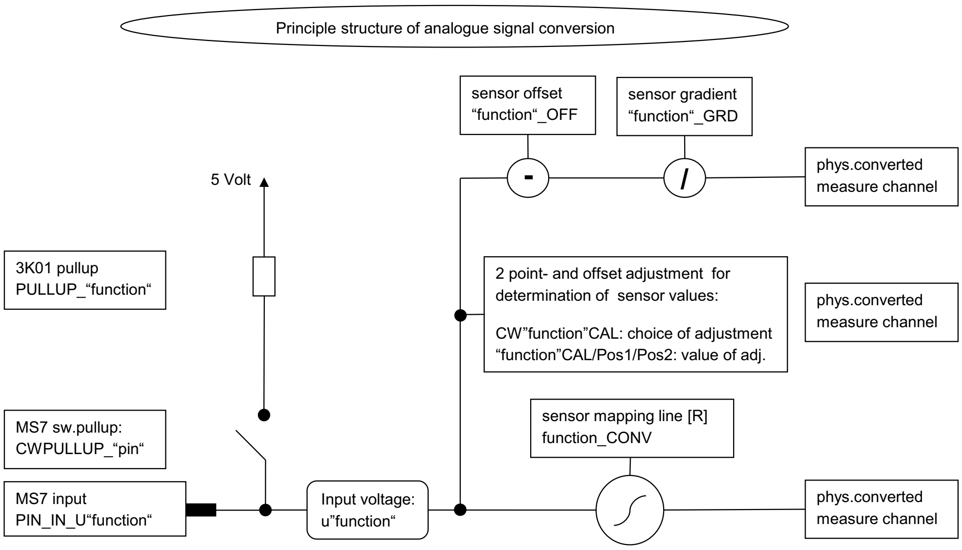
Make sure the battery is connected properly, all sensors are connected and ground wiring is fixed before powering up the system. Check all sensors for errors (E_...) and reliable measure values before starting the engine.

Sensor configuration

The MS 7.4 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.

Analogue sensor inputs

The physical way of conversion from sensor signal voltage to physical values follows the same structures. Usually inputs provide switchable 3.01 kOhm pull-ups. The pull-up resistor itself is not modifiable. 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. Failures 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.
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

Most of the MS 7.4 digital sensor inputs used for frequency measurements are possible to configure to different sensor types.

CWINTF_L43_L44 / CWINTF_L10_L19	Selection between Hall effect or inductive sensor for flywheel measurement, related to the appropriate contacts of MS 7.4. (Use ECU ground L20 if Hall type is selected.)
CWINTF_L01 / CWINTF_L02 / CWINTF_L06 / CWINTF_L11 /	Selection between Hall effect or DF11 sensors for frequency measurements like cam- or wheel speeds, related to the appropriate contacts of MS 7.4. (Use ECU ground L20 for reference.)
CWINTF_L47_L46 / CWINTF_L08_L07	Selection between Hall effect or inductive sensors for frequency measurement like turbo speed, related to the appropriate contacts of MS 7.4. (Use ECU ground L20 if Hall type is selected.)

The contacts L37 and L03 are usually (but not necessarily) used for cam signal. They are fixed as Hall effect inputs.

4.3 Throttle Control

The system supports mechanic and electronic throttle controls.

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.

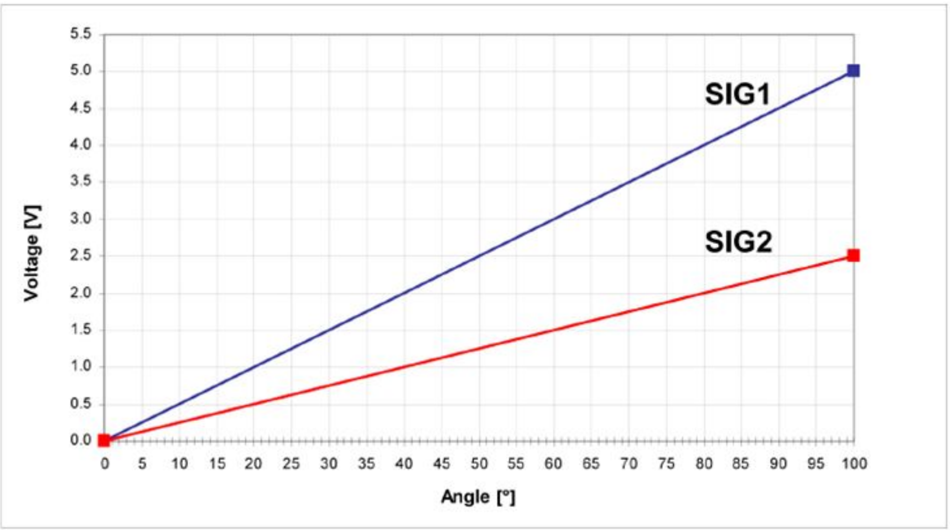
Notice: For detailed information see function description ETC.

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".

The signal sequences of an acceleration pedal sensor:



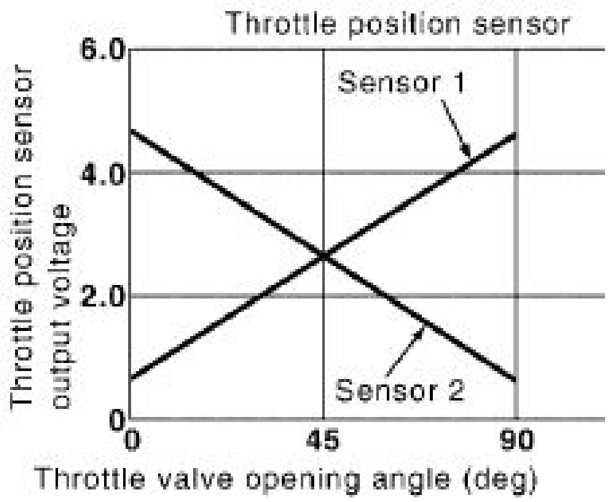
uaps_a	Voltage APS potentiometer a
uaps_b	Voltage APS potentiometer b
aps	Acceleration pedal position
UAPS_MIN, UAPS_MAX:	Minimum and maximum accepted sensor voltage. Set to approx. 200 mV/4,800 mV. Check if the uaps(x) outputs are changing when the pedal is moved.

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 addition of voltage throttle signal 1 (uthrottle) and voltage throttle signal 2 (uthrottle_b) results in 5 V due to inverted lines. Hence the added signal minus 5 V has to be below the value of “UDTHRCM_MAX” (recommended 0.2 V) to be plausible.

Signal principle 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/4,800 mV. Check if the uthrottle(xx) outputs are changing when throttles are moved.
uthrottle uthrottle_b uthrottle2 uthrottle2_b	2 sensor output values and their redundant signals (_b). The system expects a rising up voltage for the main signals and a falling voltage for the redundant one.
UDTHRCM_MAX	max. allowed difference between sensor output and redundant signal

	abs (uthrottle(x)+uthrottle(x)_b)-5 V < UD-THRCM_MAX

Calibration:

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

Manual procedure:

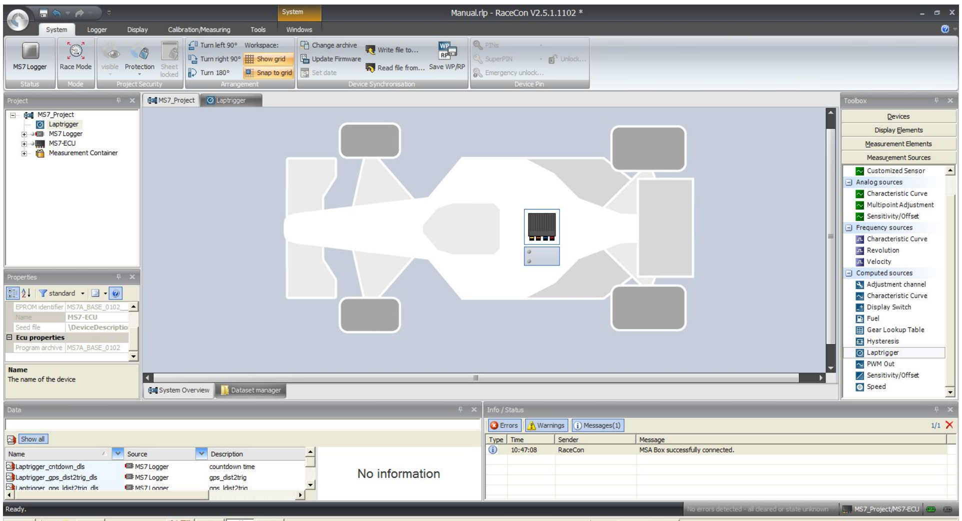
- Close throttle and set CWTHRADJ to 2.
- Open throttle fully and set CWTHRADJ to 3.
- Adjust the throttle to idle point.
- Do not forget to set CWTHRADJ back to 0. Check calibration by moving throttle.

4.4 Vehicle Test

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

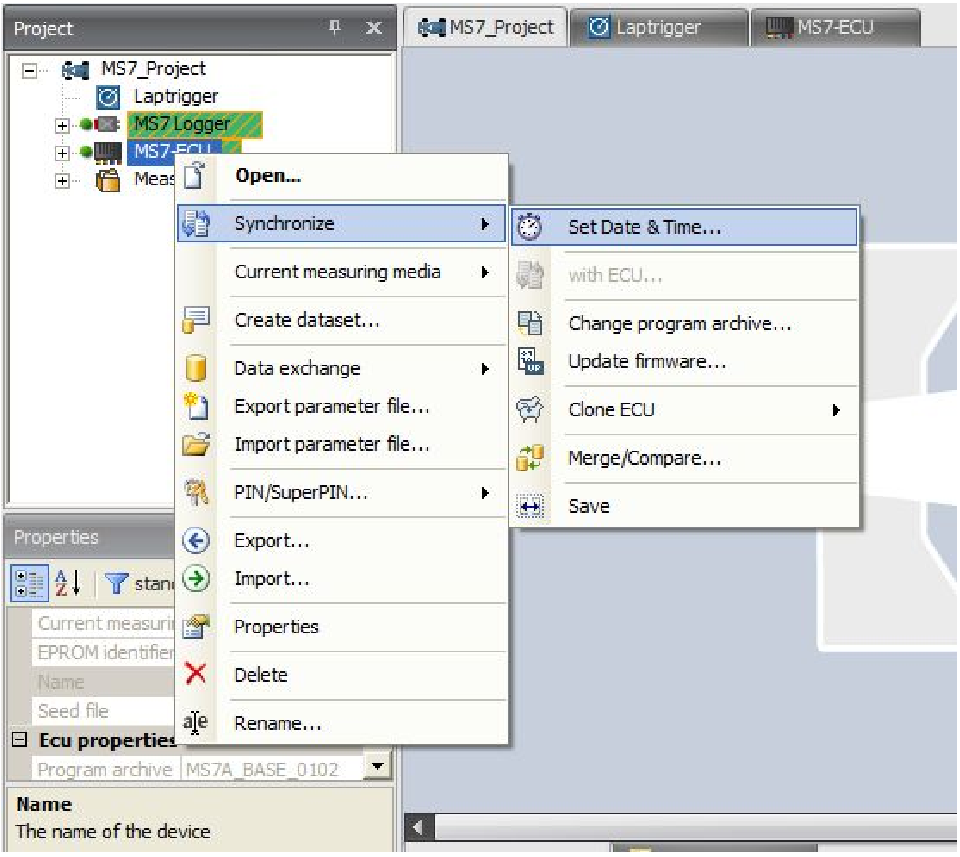
Speed & distance measurements	The signals for speed calculation may be available from different sources, like MS 7.4 own measurement, GPS data or via CAN received information from ABS calculation. For MS 7.4 own calculation, mechanical influenced data like number of available sensors, front wheel drive, 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 longitudinal 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 measurement sources into the project and follow the wizard.



	Depending to the configuration, values for lap- and outing counter, lap time, segment times and differential lap- or segment times for data analysis and driver information will be created.
Laptrigger_xxxx_yy	Results and measure channels of lap-functionalities. Drag and drop the subfolder "Laptrigger" to the project and follow the wizard.
Consumption-calculation	Designed in the same way as lap-information, subfolder is called "fuel". Drag and drop the subfolder to the project and follow the wizard.
Set time & date	MS 7.4 device is equipped with a real time clock which is permanently supplied by a battery. In order to set time and date, please connect the ECU to the PC and click on "SET DATE & TIME" in the context menu of the MS 7.4.

time_xx	The measure channels of the real time clock



5 ECU plus Data Logger

The MS 7.4 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 re-cording
	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 Win-Darab. For this tutorial we assume, that you have a MS 7.4 connected to your computer via an Ethernet line.

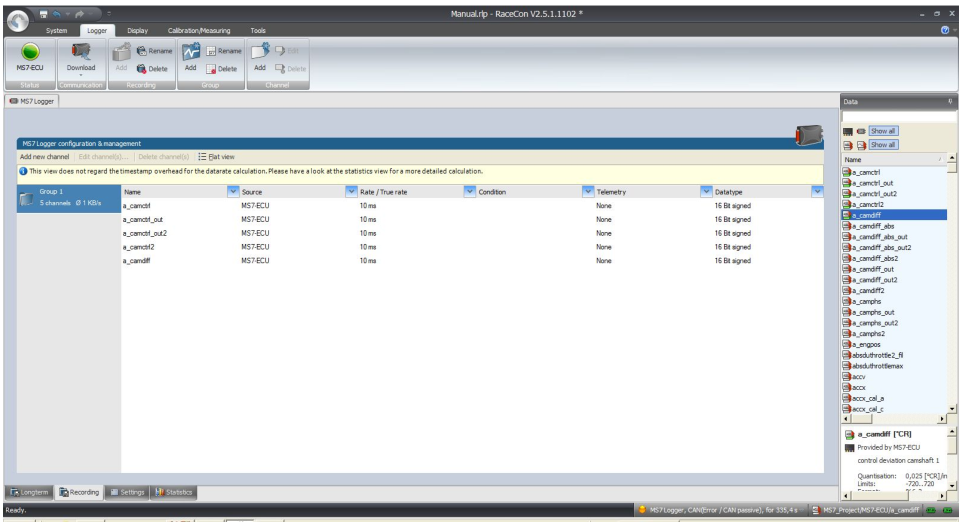
The MS 7.4 data recording is separated in two partitions. Both are completely independ-ent. Storable channels may be selected into the >Recording< folder (partition 1) or >Longterm< folder (partition 2) of the logger.

Select topic >Logger< in the menu bar.

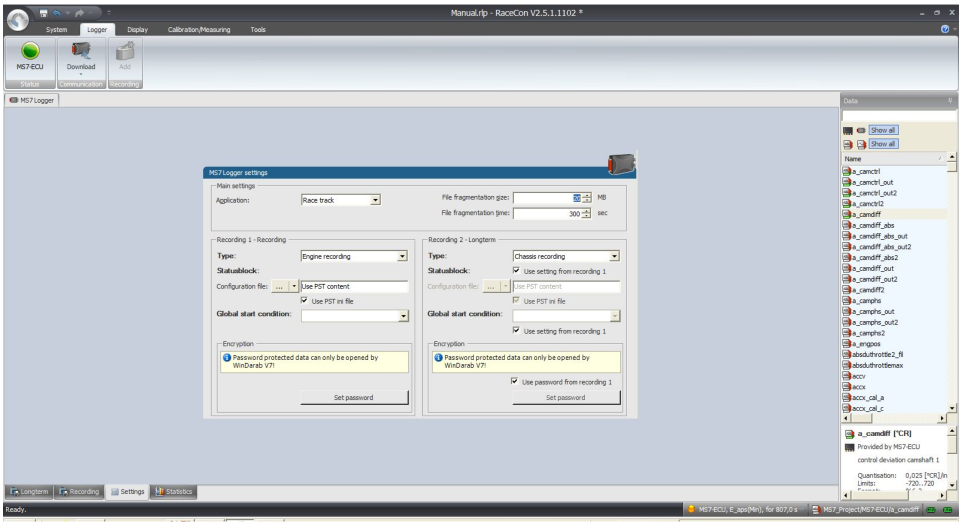
>Recording< selects data logging of partition 1.

>Longterm< selects data logging of partition 2.

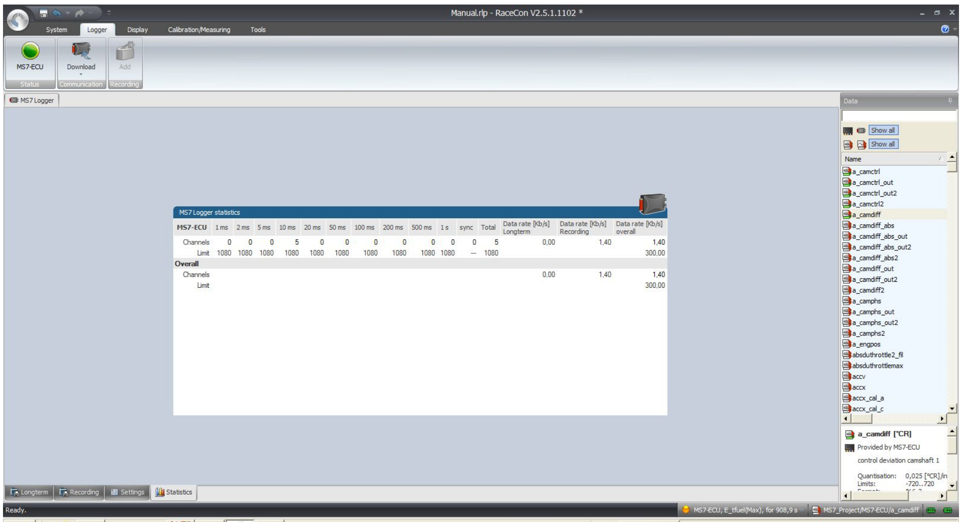
Drag and Drop the channels of your selection.



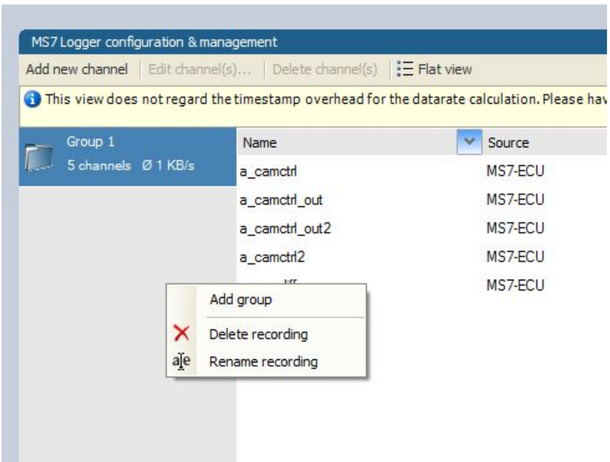
>settings< for limited recording, please follow the wizard.



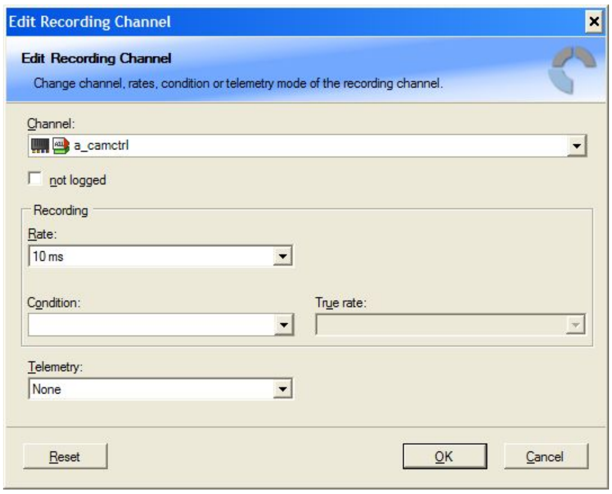
>statistics< check the selection to ensure the system limits are respected.



>group< to separate measure channels into different groups, referring to customer- or functional structures. Right mouse button will open the menu.



>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.



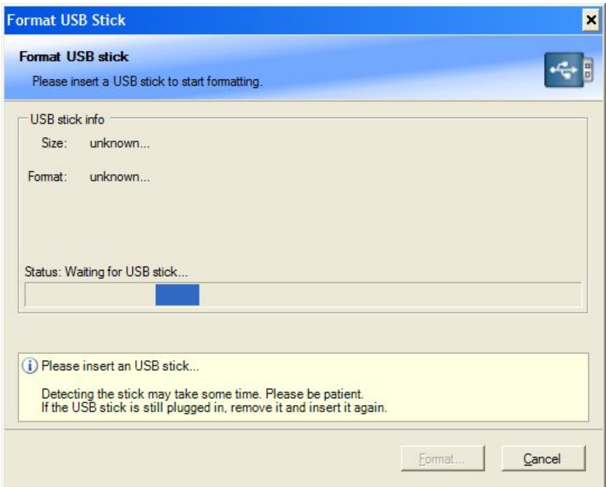
>Project Window / MS 7.4 Logger / right mouse button / download configuration

>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 7.4 data recording contents the feature to send a copy of the recorded data to an USB stick. All you need 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 the use of 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.



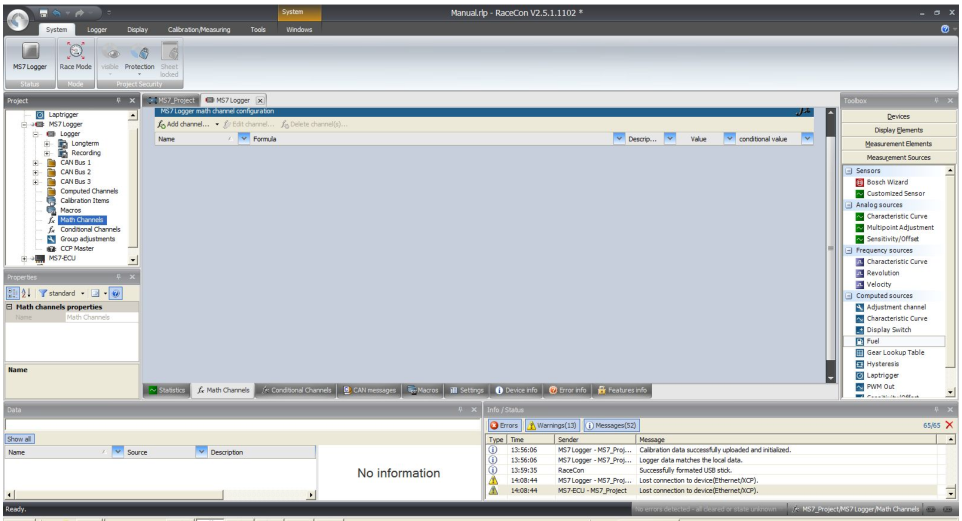
Measure channels to verify USB data recording	
usb_mediastate	0: not found 1: stick detected 2: stick installed 3: stick unplugged 4: (access) 5: error 6: corrupted
meas_cnt_forked	counter of recorded data blocks

6 Project Configuration

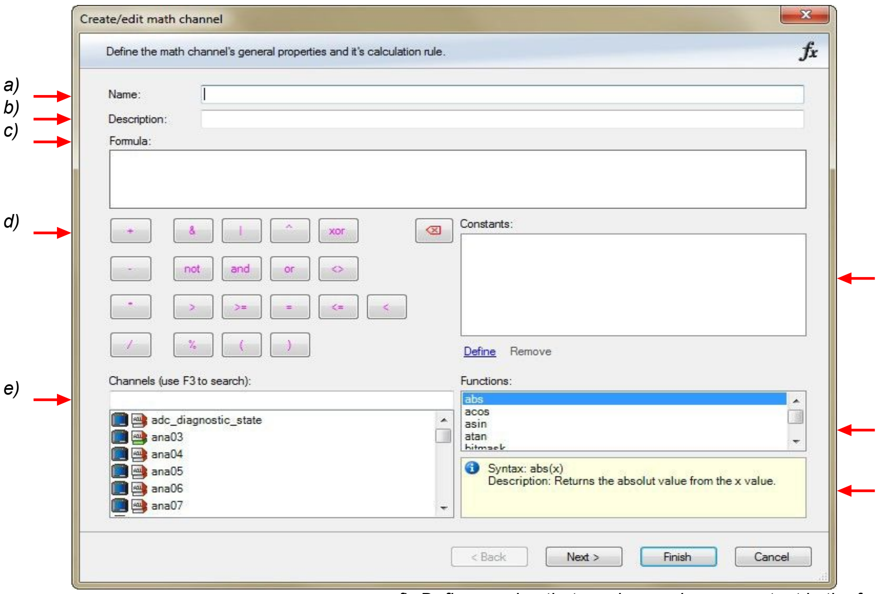
6.1 Math Channels

- 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 7 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 7 math channel window.

6.2 Conditional Function

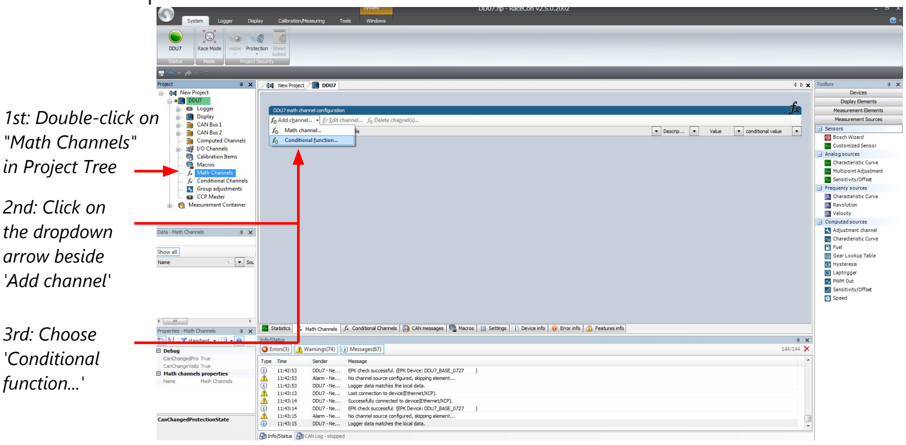
– Arithmetic and logical operations on one or more measurement channels

– If - Else structure with reset

– Numerical result

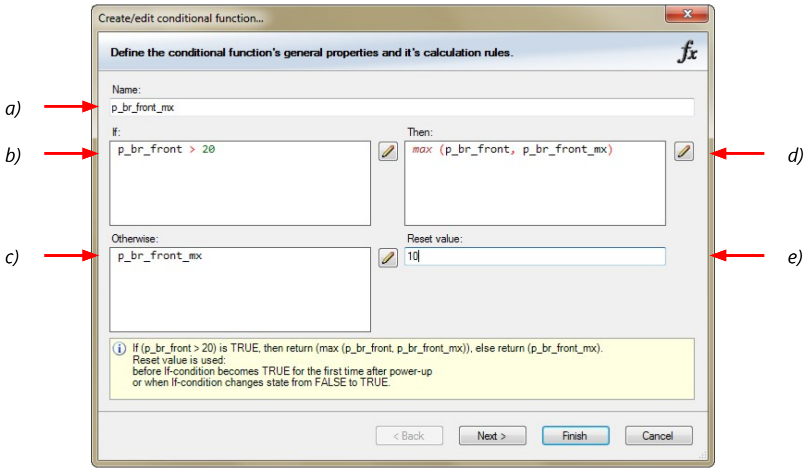
– Result can be used as input source for further calculations in the whole project

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").

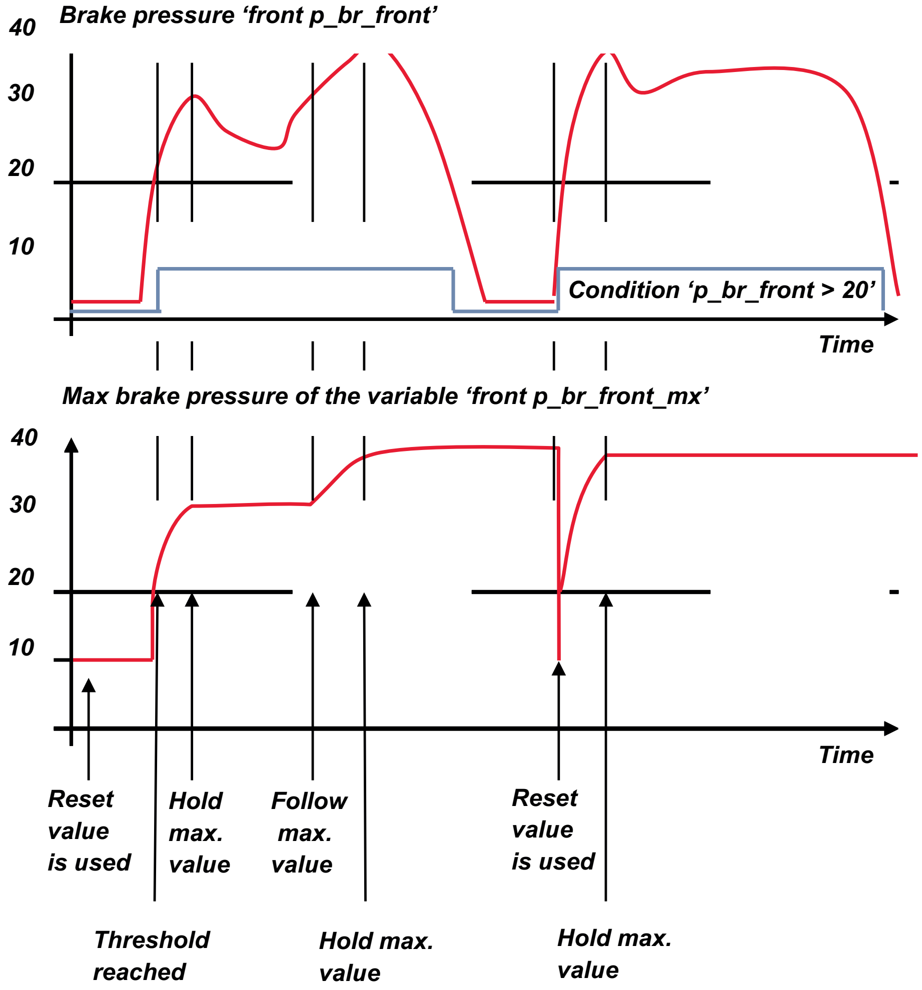
The reset value is always set for the new variable (entered in "Name"):

- 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 7.4 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 7.4`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 7.4 has 3 fully configurable CAN buses.

- Baudrate (125 kBaud to 1 MBaud)
- Input configuration: read messages from CAN bus and convert to MS 7 measurement variables
- CAN bus supports row counter configuration
- Output configuration: write MS 7 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

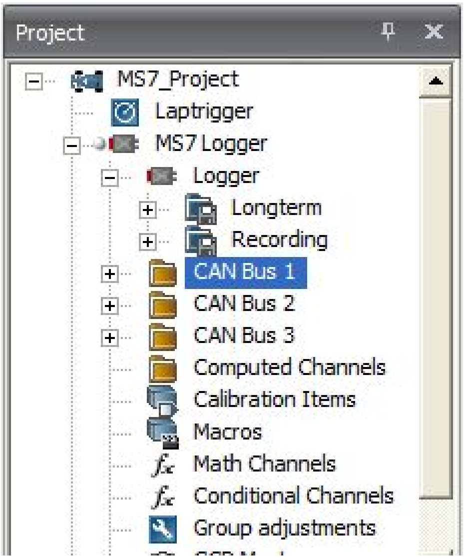
7.1 CAN Bus Trivia

CAN message

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

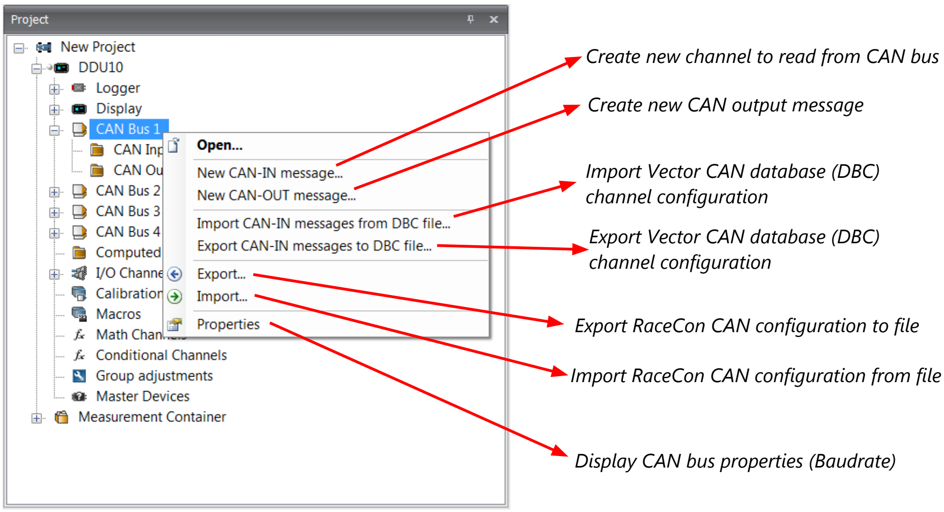
CAN bus

- Needs termination resistors (120 Ohm) in wiring harness (at MS 7.4 side there is a switchable resistor available)
- All devices connected to the bus must use identical data rate
- Configuration of MS 7.4 bus data rate in 'Properties' menu by double click on the CAN bus in project tree (1 MBaud, 500 kBaud, 250 kBaud, 125 kBaud)



7.2 CAN Input

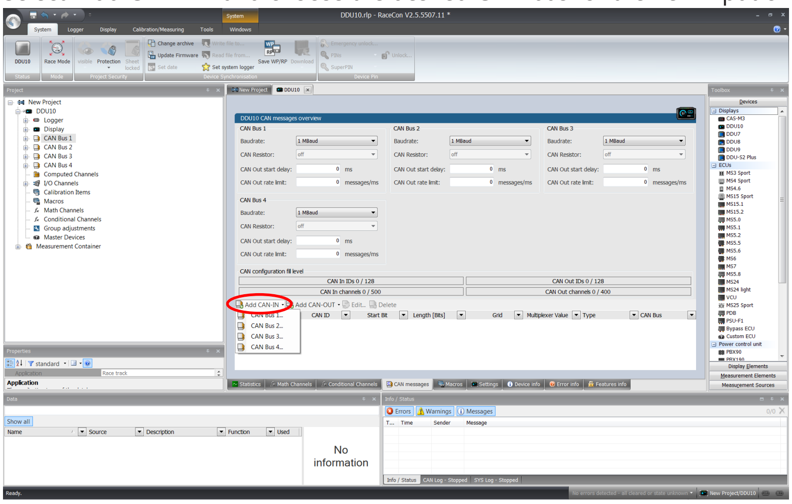
7.2.1 Input configuration



7.2.2 Create a new CAN channel

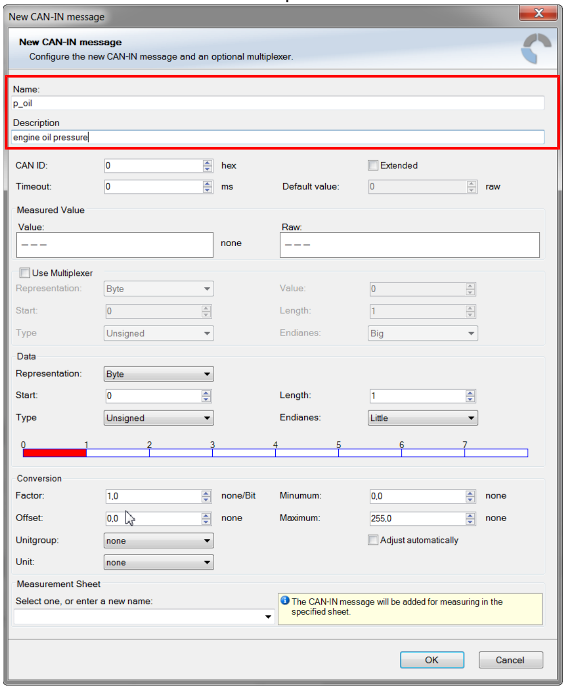
Double-click on any CAN bus item, to open the "CAN messages overview".

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



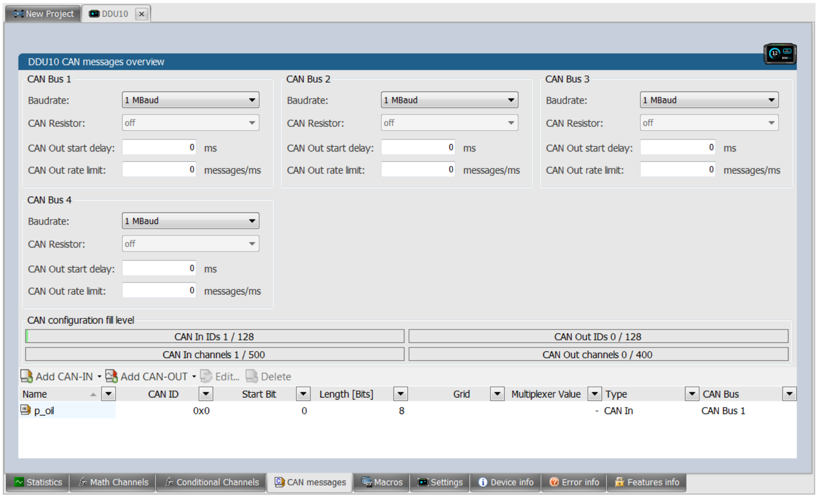
A CAN channel configuration window opens.

Insert the name and description of the channel.

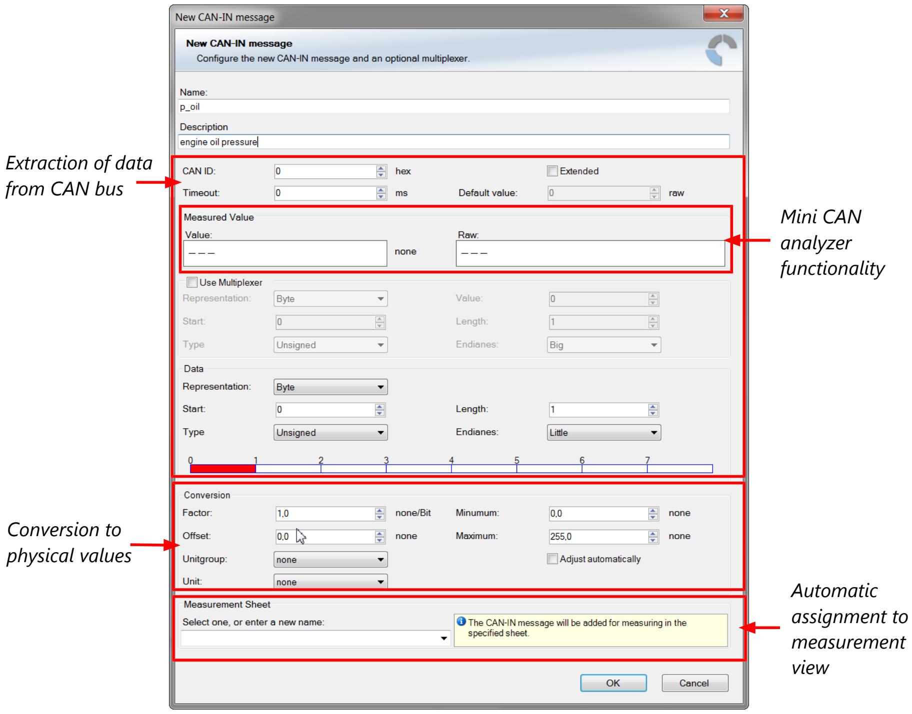


Click ‘OK’ when done.

The channel is listed in the Data window.



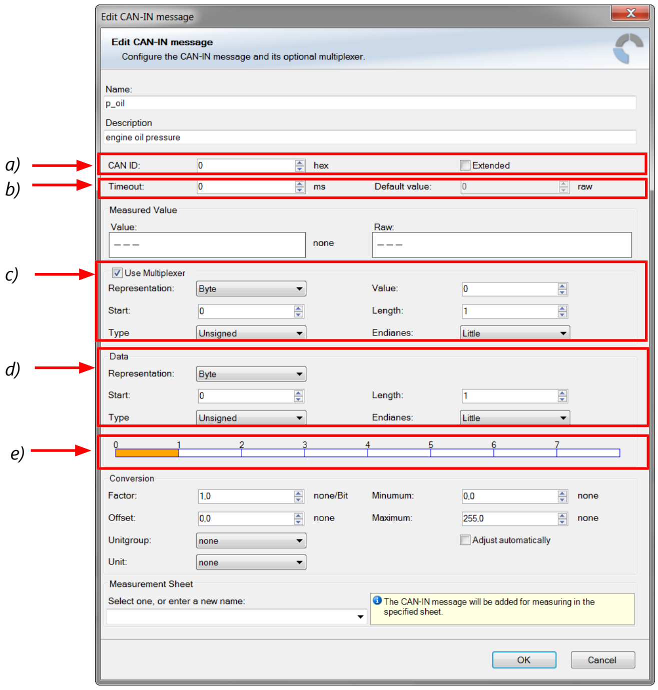
7.2.3 CAN channel configuration



7.2.4 Extracting data from CAN bus

Representation: Byte

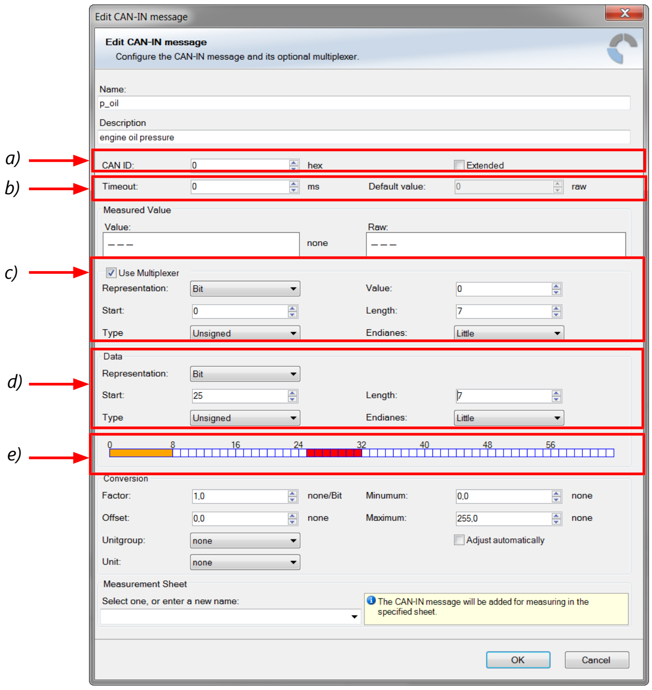
Some CAN devices need to be addressed by a byte represented CAN channel. The address can be assigned in this window and is illustrated by a bar graph.



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.

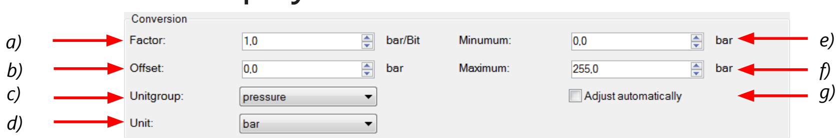
Representation: Bit

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.



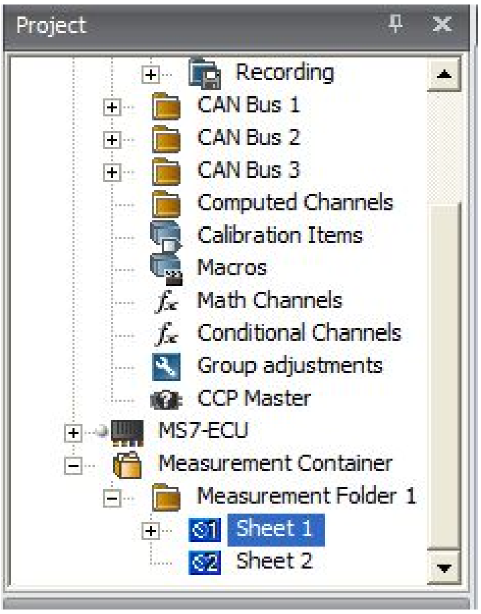
a) Enter CAN message ID. If extended IDs (29 bit) are used, check the box.
b) If replacement values are used, specify time-out period and raw value.
c) If a multiplexer (row counter) is used, check the box.
d) Enter data position, length and format.
e) The bargraph shows the assignment of the bits.
-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

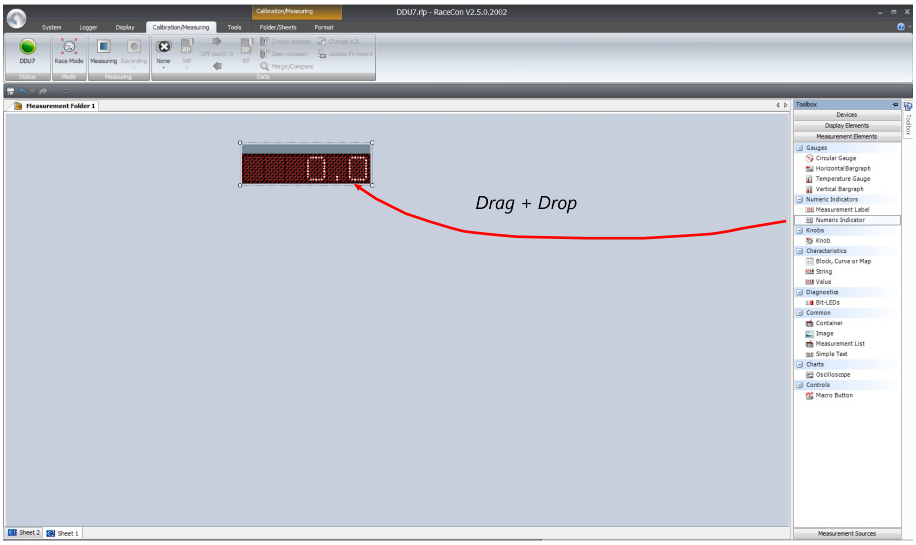


a) Enter factor (gain) for conversion to physical value.
b) Enter offset for conversion to physical value.
c) Select type of physical value.
d) Select unit of physical value.
e) Enter minimum physical limit of the channel. (for manual setup)
f) Enter maximum physical limit of the channel. (for manual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

7.2.6 Online view of CAN channels in vehicle

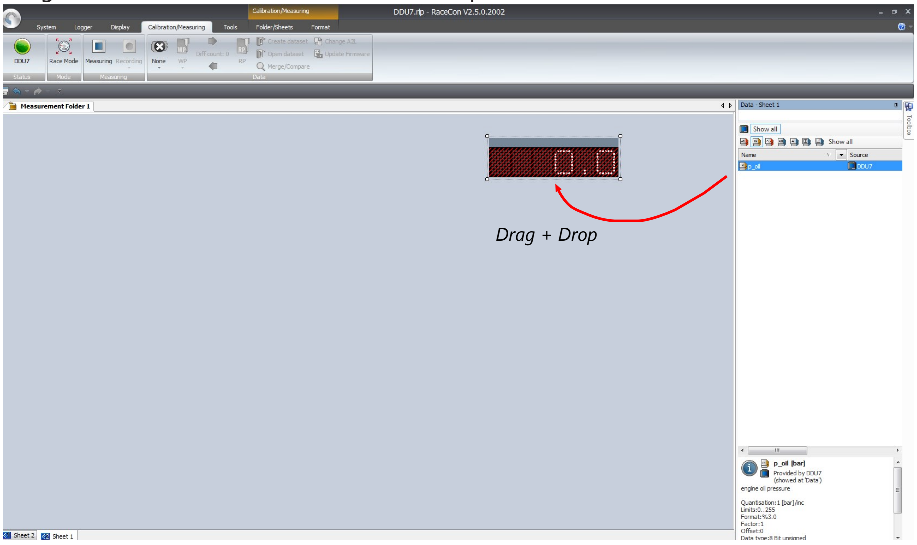


1. Double-click on ‘Sheet 1’ in Project Tree. Measurement Sheet 1 is displayed in main area.
2. Click on ‘Measurement elements’ in the toolbox.
3. Drag the desired measurement element (e.g. Numeric Indicator) and drop it on the measurement sheet.



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.

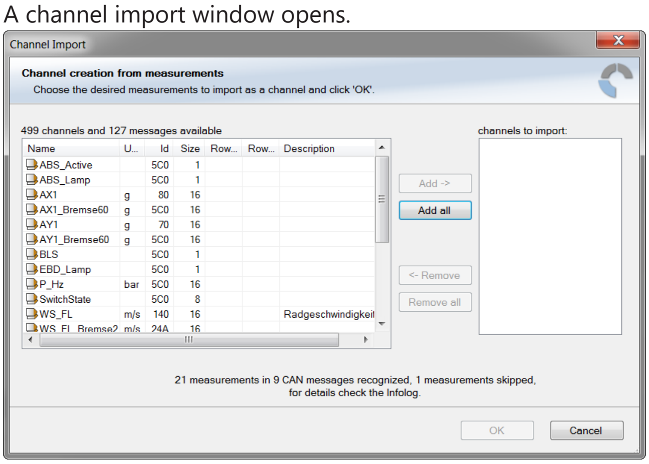
6. Connect PC to the vehicle and switch to 'Race Mode' by clicking 'F11' on the keyboard to display online data.

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.

   A file browser opens.
3. Select the DBC file to import and click 'Open' when done.

   A channel import window opens.



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

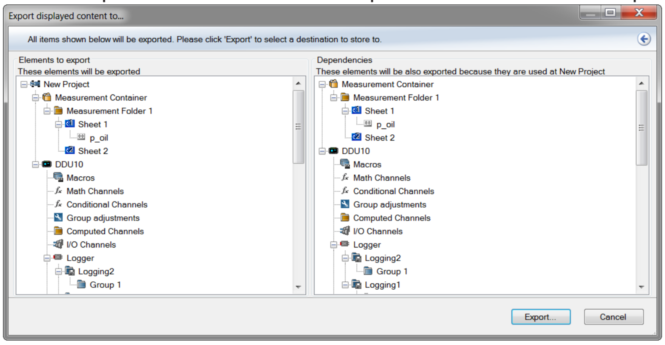
   The channels are inserted in the Data window.

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.



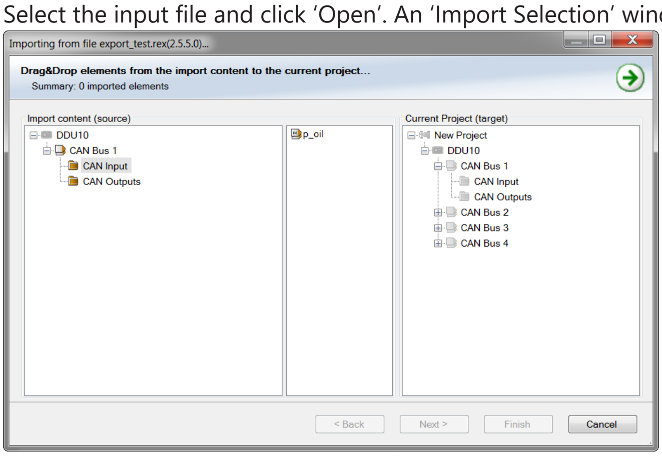
3. Click on ‘Export’ to select a destination to store.
4. Specify the filename.
5. Click ‘Save’ when done.

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.

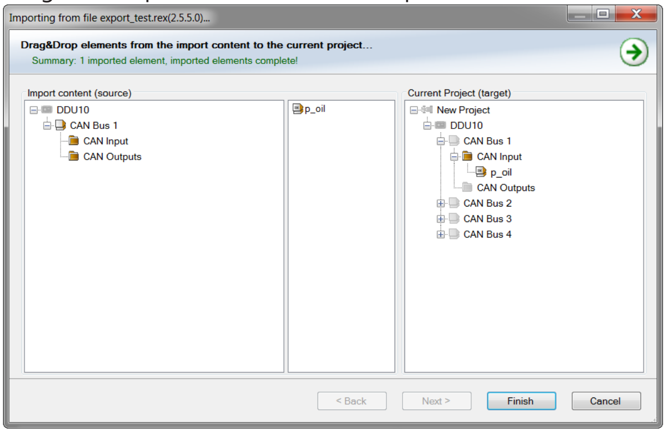
Proceed with the following steps to perform an import:

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.

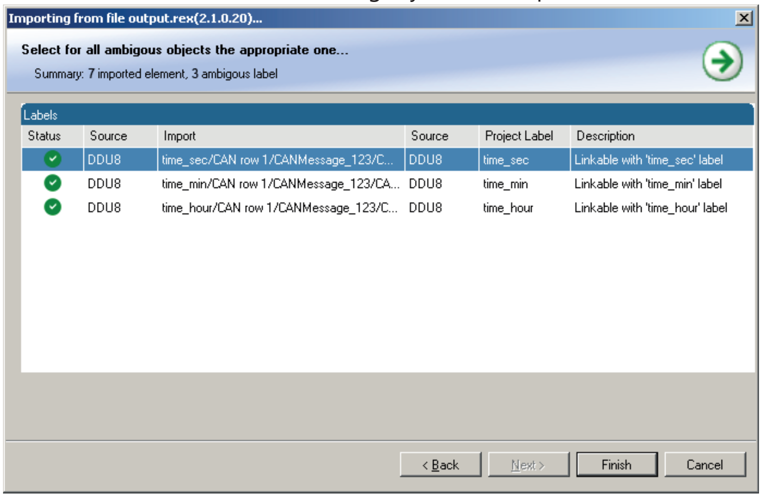


4. Select channels to import.

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



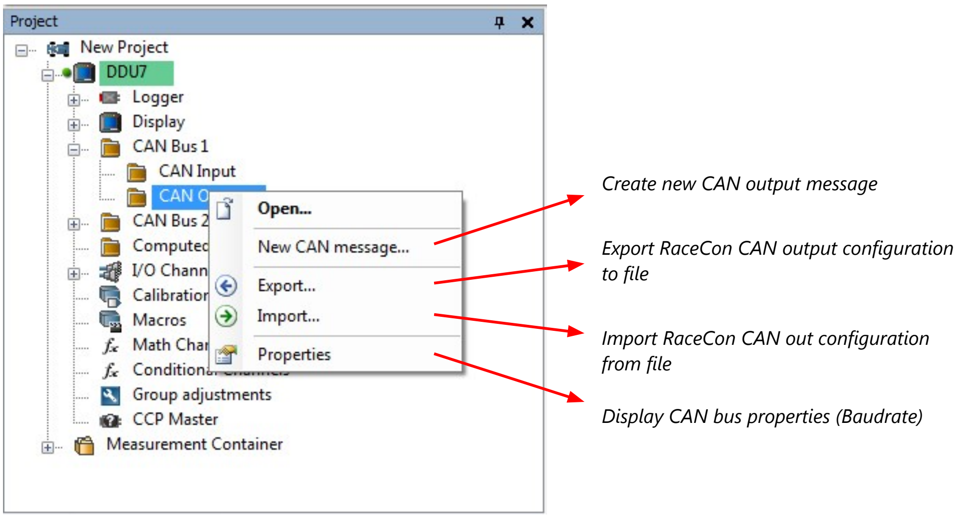
6. Click 'Finish'. If a measurement channel belongs to more than one source (e.g. MS 7.4 and MS 5.1), the 'Solve Label Ambiguity' window opens.



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

7.3 CAN Output

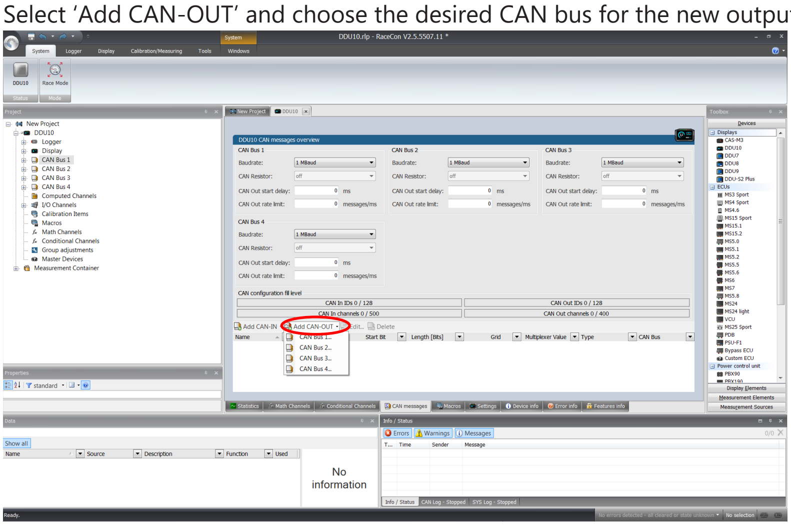
7.3.1 Output configuration



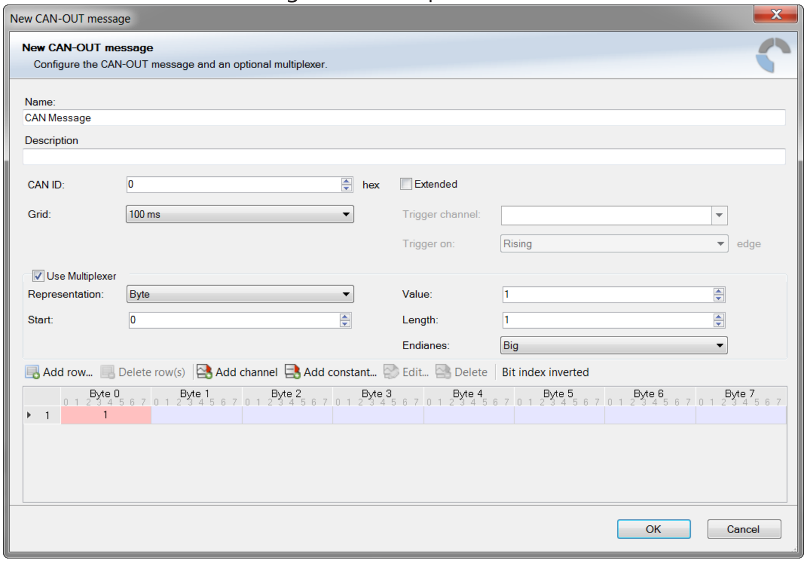
7.3.2 Create new CAN output message channel

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

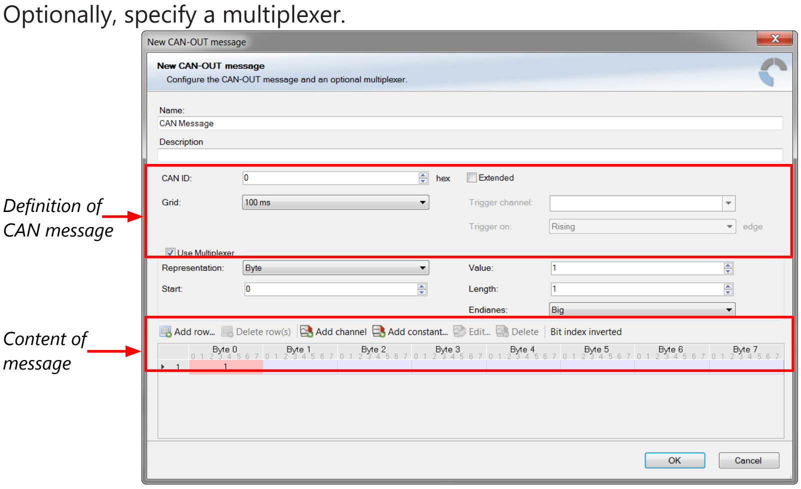
1. Select 'Add CAN-OUT' and choose the desired CAN bus for the new output channel.



The ‘New CAN-OUT message’ window opens.

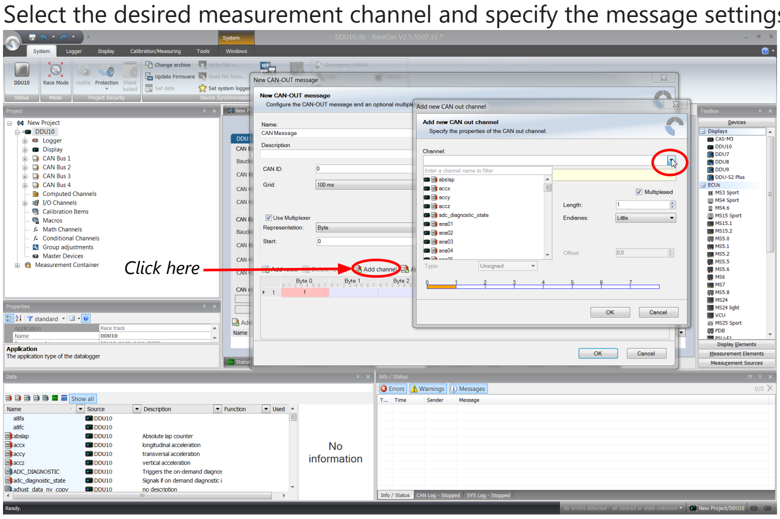


2. Enter name of message, description, CAN-Id and Grid (output interval). Optionally, specify a multiplexer.



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.



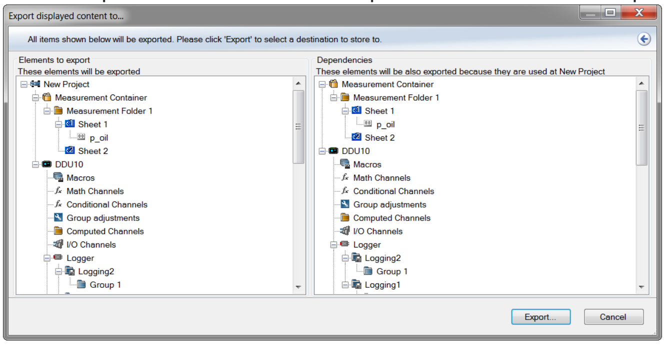
The measurement channel is now assigned to the CAN message.

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.



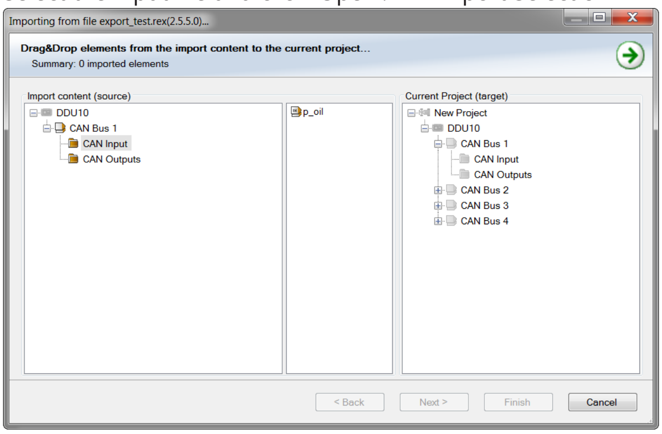
3. Click on ‘Export’ to select a destination to store.
4. Specify the filename.
5. Click ‘Save’ when done.

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.

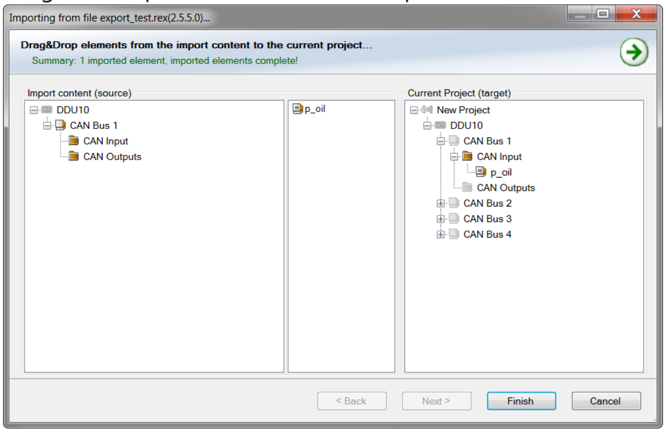
Proceed with the following steps to perform an import:

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.

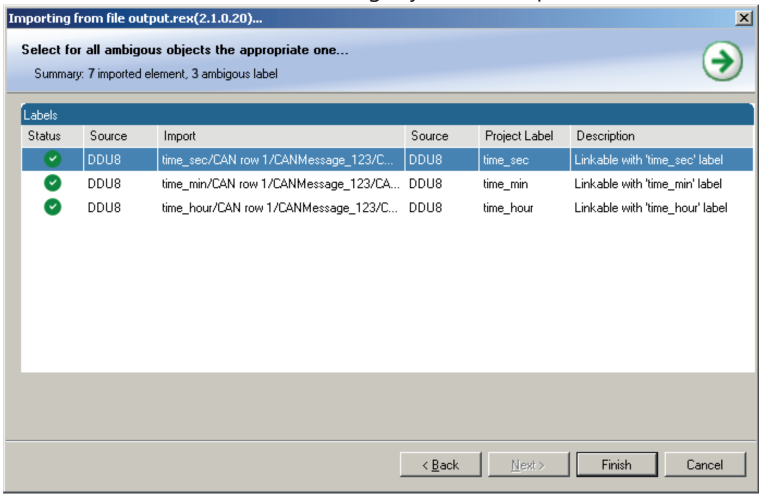


4. Select channels to import.

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 7.4 and MS 5.1), the 'Solve Label Ambiguity' window opens.



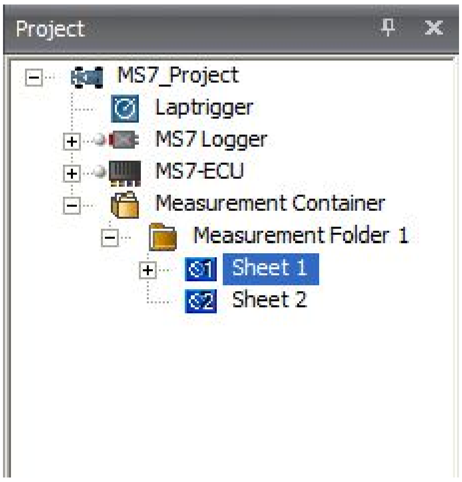
7. Assign the ambiguous channels to the desired source.
8. Click 'Finish'.

8 Online Measurement and Calibration

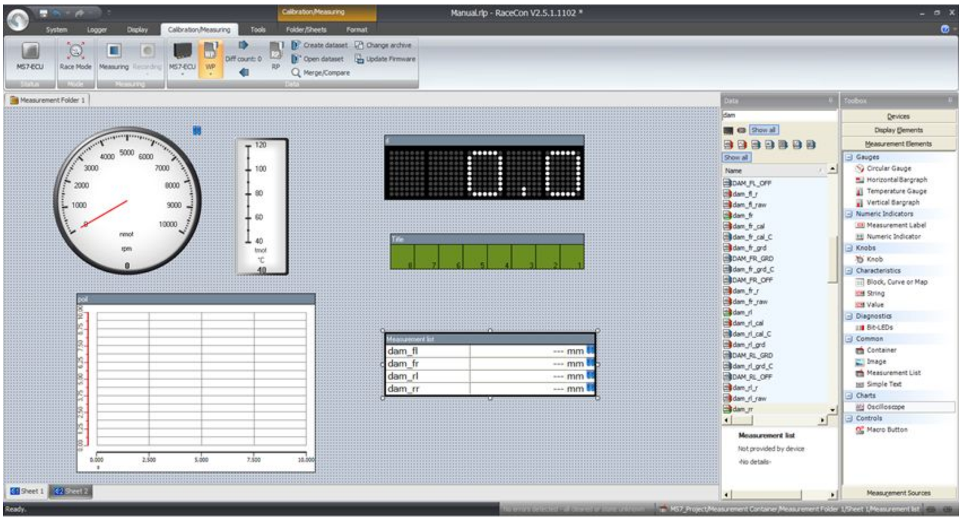
- Verify system status and diagnosis.
- Check and calibrate sensors of the system.
- Data application in online mode.
- PC and device are connected.
- Local PC data match to MS 7.4 configuration (devices are indicated as green).
- From the context menu of the project, new measurement pages can be created.

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

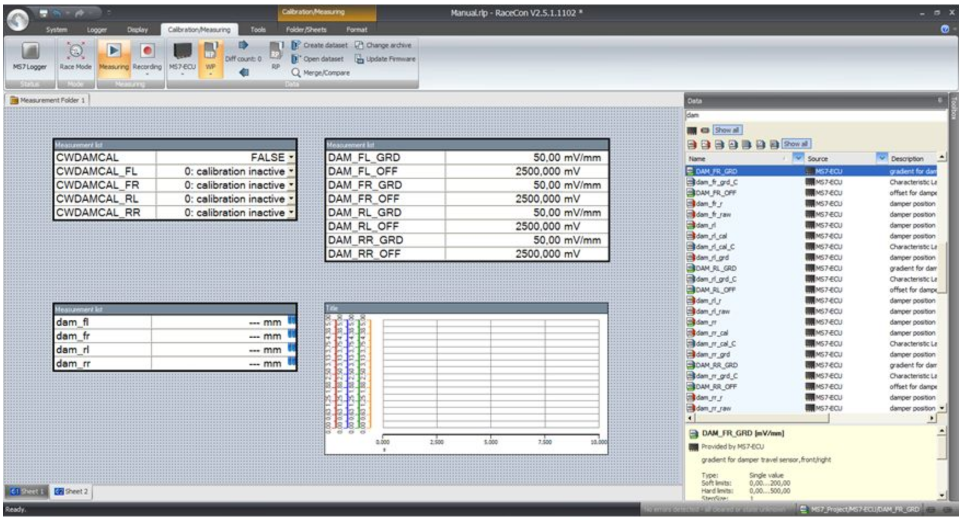
Base of the data list are the function- and measure labels, described in detail in the function description.

– To assist the discovery of relevant labels, data list may be graduated.

– Description and label symbol explain the task of the data labels.

– 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 manufac-turer



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 key-board shortcuts associated with the sheets.

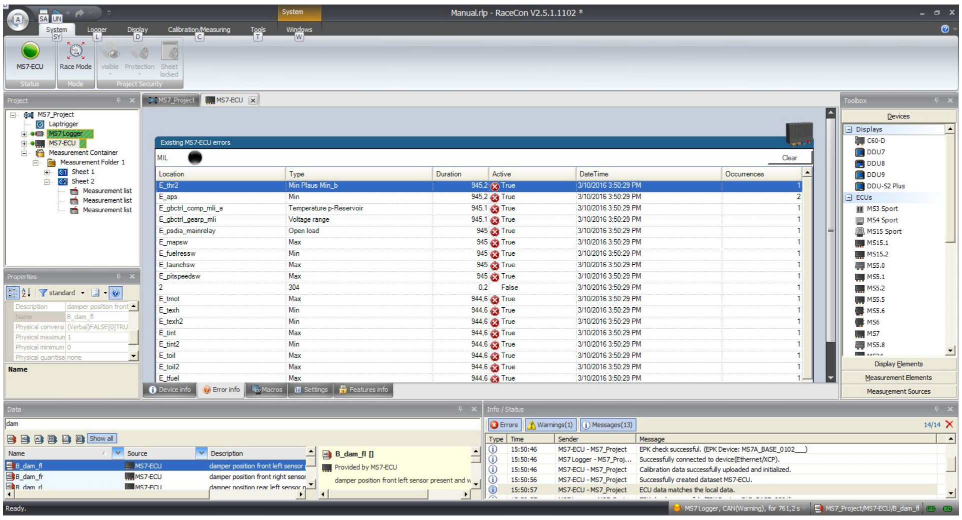
– Press ESC key to return to Design Mode.

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 7.4 system (MS 7.4-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

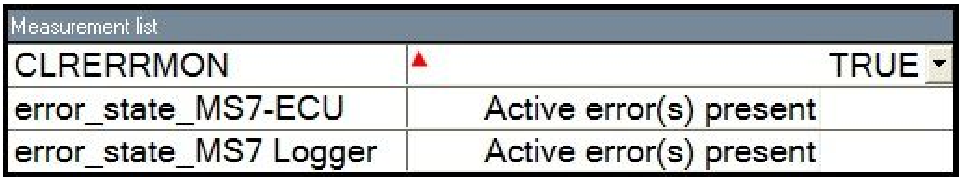
The single error bits may be collected in the error monitor.

9.3 Error Memory Properties

The following property is available for the error memory itself.

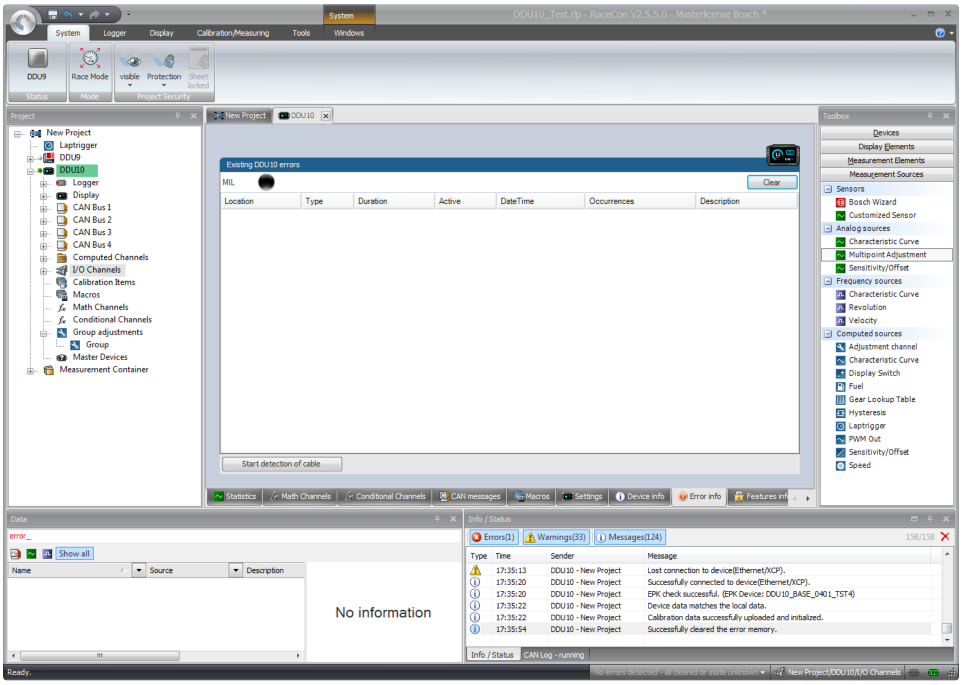
CLRERRMON	Reset of the error monitor
Error Status /device measurement label error_state	
0	No error present in the memory
1	At least one inactive error present in memory, no active errors
2	At least one active error present in memory

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

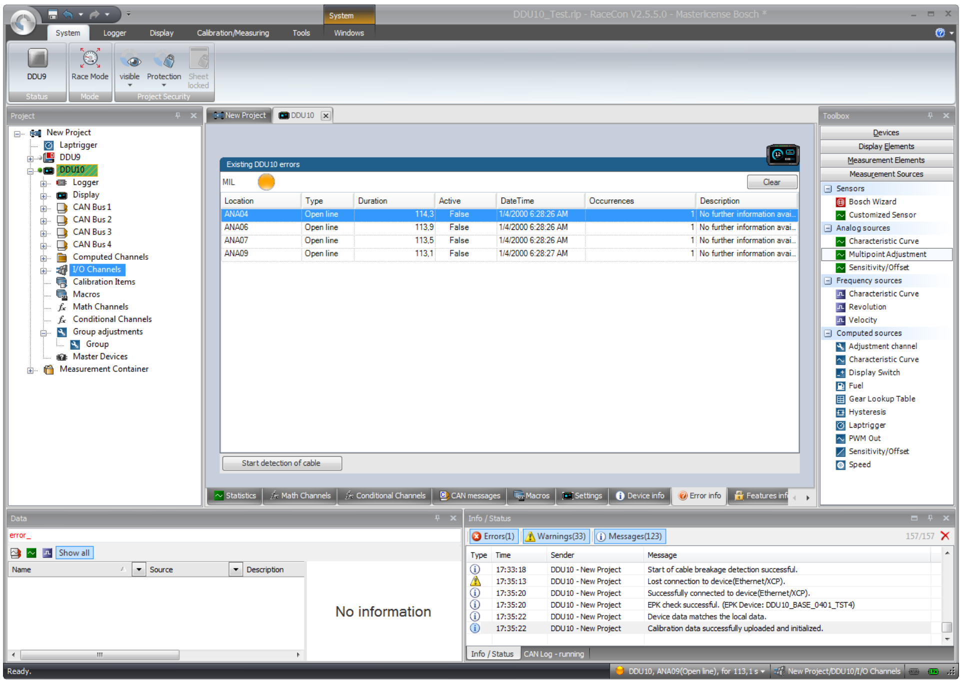


It is also represented by a color scheme within RaceCon (provided RaceCon is online with the system):

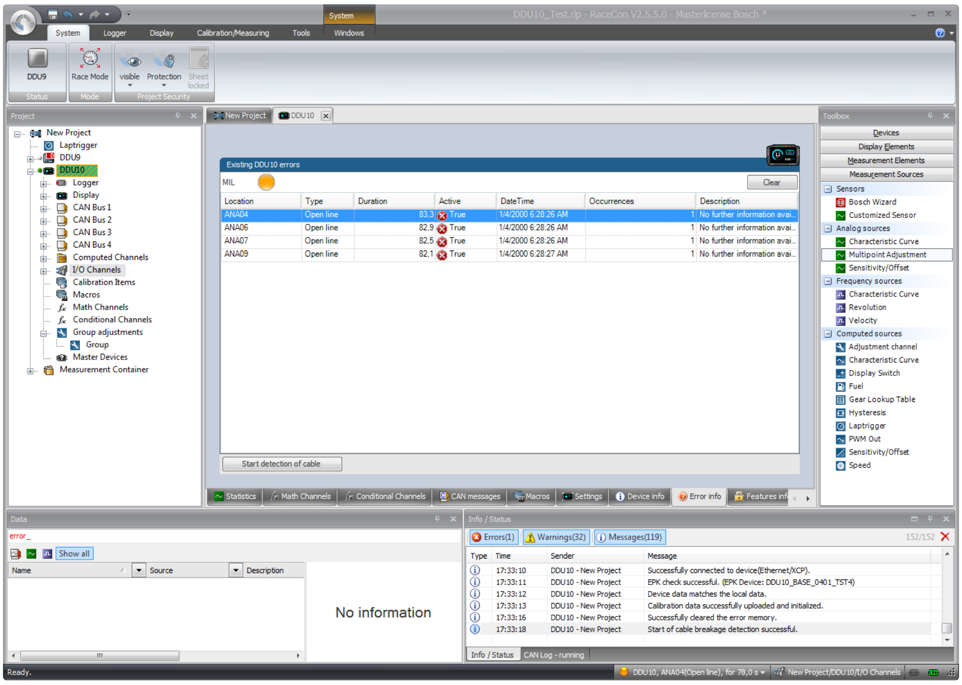
0 (no error present in memory)



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



2 (at least one active error present in memory)



10 Open Source Software (OSS) declaration

Sensor Driver for BMI160 Sensor

Applies to BMI160

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