



# Modular Sensor Interface M 60

Manual

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# 1 Preparation

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

Operation of the M 60 is only certified with the combinations and accessories that are specified in this manual. The use of variant combinations, accessories and other devices outside the scope of this manual are only permitted when they have been determined to be compliant from a performance and safety standpoint by a representative from Bosch Motorsport. Read the manual carefully and follow the application hints step by step. Don't hesitate to contact us, contact data can be found on the back page of this document.

### Disclaimer

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

Please retain this manual for your records.



# 3 Installation

### **Power Supply**

Please ensure that you have a good ground installation. That means:

- A ground that has a solid, low resistance connection to the negative battery terminal.
- Connection should be free from dirt, grease, paint, anodizing etc.
- Use large diameter wire.
- More metal-to-metal contact is better!

The following notations for power signals are used:

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



### NOTICE

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

# 4 Technical Data



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

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

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

### Application

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

### Mechanical Data

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

### **Electrical Data**

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

### Inputs

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

### Outputs

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

### Environment

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

### Connectors and Wires

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

### Communication

Configuration via RaceCon over Ethernet or MSA-Box II

2 CAN interfaces

3 Ethernet 100BaseT

The required software for this device is available on our homepage www.boschmotorsport.com

# 5 Inputs and Outputs

The following chapter introduces the Input and Output Channels.

# 5.1 Input Channels

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

### 5.1.1 Analog Inputs

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

## 5.1.2 Digital Inputs

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

# 5.2 Output Channels

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

### 5.2.1 PWM Outputs

The M 60 has 4 low side switch outputs controlled by pulse width modulation (PWM). Each switch is rated 1 A maximum current. Maximum PWM switch frequency is 1 kHz with a 0 % ... 100 % duty cycle. Each output is short circuit protected to GND and battery voltage. It is mandatory to connect the LS\_PWM pins to vehicle GND as indicated in the circuit diagram when using the PWM outputs.

## 5.2.2 Sensor Power Supply

The M 60 has three types of sensor power supply:

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

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

# 5.3 Communication Channels

This chapter describes the Communication Channels of the M 60.

# 5.3.1 CAN Bus

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

## 5.3.2 Ethernet Channels

The M 60 has three 100 Mbit full duplex Ethernet communication ports. The ports are internally connected with an Ethernet switch. The Ethernet ports have 'cable auto crossover' functionality.

## 5.3.3 RS232 Ports

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

## 5.3.4 Vehicle Diagnosis Connector

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

PIN	Name	Description	Used for M 60
1	Terminal 30	Permanent positive	+
2	Terminal 15	Switched positive	+
3	Terminal 31	GND	+
4	CAN High	Diagnostic CAN bus	
16	CAN Low	Diagnostic CAN bus	
10	K-Line	ECU diagnosis	
8	Ethernet RxD +	Ethernet interface	+
9	Ethernet RxD -	Ethernet interface	+
11	Ethernet TxD +	Ethernet interface	+
12	Ethernet TxD -	Ethernet interface	+
22	Screen	Cable screen	+

# 5.4 Pin Layout Connectors

# 5.4.1 Pin Layout Life Connector ASDD212-41PN (red)

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

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

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

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

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









Front view



# 7 Starting up

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

# 7.1 Before Starting

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

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

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

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

Minimum wiring loom of the Life connector (red):

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

# 7.1.1 Setting up the Network Interface

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

1. Switch off the PC's firewall.

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

Local Area Connection Properties	5	? ×		Internet Protocol (TCP/IP) Properties	? ×
General				General	
Connect using:	i Port C	onfigure		You can get settings assigned automatically if your netw supports this capability. Otherwise, you need to ask you administrator for the appropriate IP settings.	ork r network
This connection uses the following iter	ns:			<ul> <li>Obtain an IP adress automatically</li> </ul>	
Ele and Printer Sharing for Mi	crosoft Network	2)		C Use the following IP adress	
Network Monitor Driver			a)	IP address:	
🗹 🀨 Internet Protocol (TCP/IP) <	•	-		Subnet mask:	1
				Default gateway:	-
Instal Uninstal	Pro	operties 📥	b)		
				<ul> <li>Obtain DNS Server adress automatically</li> </ul>	
Description Transmission Control Destroyal Visitory		a data h		O Use the following DNS Server adresses —————————————————————————————————	
wide area network protocol that pro	vides communic	cation		Preferred DNS server:	1
across diverse interconnected netw	orks.			Alternate DNS server:	1
Show icon in notification area when	n connected			,	
Votify me when this connection ha	s limited or no c	onnectivity		âdva	nced
1	or	Canad			Canad
	70	Lancel		UK 🖛	

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

### 7.1.2 Starting the M 60

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

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

### 7.1.3 About RaceCon

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

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

The video tutorial is available in the 'Software Download' section of www.boschmotorsport.com.

### 7.1.4 Connecting the M 60 to RaceCon

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



#### 1. Start the RaceCon software.

RaceCon V2.4.0.13		
File Edit View Extras Help	p	
1 🔁 🗃 🗐 🗇   X 🗣 🖻 🛷   *	🗤 - 🔍 - 📜 Design mode   🕨 = 🛞   🔍 Race mode   🔄 🌉 🥥 🍵	
Welcome to RaceCon		4 Þ 🗙
RaceCon		Â
Last Projects		
	RaceCon News Tutorials Licence Information	
	No littoriale avaiable	
Ouick Start		
Open an example Configuration		
		-
Ready.		

New Project - RaceCon V2.4.0.13						
File Edit View Extras Help						
🗄 📬 🖬 🚑 🖓 🕉 🖻 🖄 🖓 19 -	- 🝽 👻 🔛 Synchronize 🕞 🏹	Design mode 🕨 😐 🕘	- 🔍 Race mode 📑 🌺 🎯 🚊			
Project # X	Welcome to RaceCon	al New Project		4 Þ 🗙	Toolbox	ά×
🕞 🛤 New Project	/				Devices	
👜 - 🎁 Measurement Container					<ul> <li>Displays</li> </ul>	*
					C60-D	
					DDU4	
					P DDU5	
					P DDU6	
					DDU7	
					E DDU8	
					<ul> <li>ECUs</li> </ul>	
					MS3 Sport	
					MS4 Sport	=
					MS4.4 Sport	
					MS15 Sport	
					III MS3.1	
					I MS4.0	
Properties - New Project # X					MS4.2	
🔠 👌 🝸 all 🔹 🍸 standard 🔹 🖃 🔹					MS4.3	
Priest emerties					MS4.4	
Background image \SystemOverviewImages					MS5.0	
Name New Project					MS5.1	
System logger 🔀					MS5.2	
Security					MS0.5	
Protection Palse					MS0.6	
					M55.8	
					MS15.1	
					MS10.2	
					M324	
					PDB PSILE1	
					Dimara ECII	
					Custom ECU	-
					Display elements	
Background image The current system overview background					Measurement elements	
image.	and Suntam averaging Da	aset manager			Measurement sources	
	Gue System Overview () 00		1. A. 100 - 1		Macro actions	
Data - New Project			4 X Into/status			4 X
snow all			Errors A warnings 1 wessages			0/0 🔨
Used T Name	V V Function	Source	Type Time Sender Message			
			•			
			The late (Protuge Of CAN Long steepend			-
			Card Into/otatus CAN rod - stopped			
Ready.			No errors detected - all cleared or state u	nknown	1 (ki) v	New Project

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

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



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

Specify M60 p	ogram archive					0
Select a progra	m archive for the M	460.			1	6
Program archive:						
<sup>2</sup> roduktreleases\/	2_SW-Releases\	M60\M60_BA	SE_0612\M6	0_BASE_061	12_vl3_DL.pst	
D Deserver and	1					
Program arc	ive is valid.					
Program arc	iive is valid.					
() Program arc	iive is valid.					
() Program arc	iive is valid.					
() Program arc	ive is valid.					
U Program arc	ive is valid.					
U Program arc	ive is valid.					

- 5. Click 'Next'.
- 6. Select location of M 60.

Specify locati Select locatio	ion of M60 in of your M60 at the o	car.		5
Location:				
Center				
Front left Front right Rear left Rear right Front Rear Contor Gearbox	_	_	_	_
	< <u>B</u> ack	Liext >	Enish	Gancel

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



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

8. Click 'OK' to proceed.

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

# 7.2 Assign the Mounting Location

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

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

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

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



All connected M 60 are listed.

Devices					x
Discovered devices					
This Dialog shows detected devices (M60	/MSI60) on	connected network.			
		d Discovered Discovered, Used Conflicts			
X Z	Туре	FNumber	SNumber	Location	
	M60	F 02U V00 882-02	#198	Rear	
	M60	F 02U V00 882-01	#102	Front	
		0	c Can	cel Apply	

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



Assign the desired mounting location (e.g. 'Front') and confirm by clicking 'Apply'. 3. Device X Dis vered devices This Dialog shows detected devices (M60/MSI60) on connected net Discovered, Us Туре FNumber M60 F 02U V00 882-02 #198 ... Ok Cancel Apply

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



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

Now the device is ready to be used.

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

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



# 7.3 Feature Activation

- If you have purchased an optional software feature package, it must be activated before it becomes operational.
- The feature activation status is stored permanently in the device and requires activating once only.
- As the activation key is device specific, a key delivered with one M 60 does not work on any other M 60.
- If you have not purchased an option package, the next steps can be skipped.
- 1. To activate a feature, double-click on 'M 60' in the Project Tree and click on the 'Features info' tab in the Main Area.

tiend	1	9 X	Aut. New Project 200	460 Center				11.	finites.	- a x
	A New D	roject	a landada a						Devices	
1	1 100	Contor							- Displays	
	110	o center					1000		20 C60-D	-
	1.1460	surement co		Contro Instance					COU4	
			-	ov constributives i			194		ODU5	
									ODU6	
				ECUID			Copy to clipboard		COU7	
									CDU8	
				Status/Unlock	ider informations				-) ECUs	
				Name	Description				I MS3 Sport	
									I MS4 Sport	
									I MS4.4 Sport	
									MS15 Sport	
									III MS3.1	
									10 MS4.0	
									di MS4.2	
									MS4.3	100
									III MS4.4	
									# MS5.0	
									MS5.1	
									MS5.2	
									MS5.5	
									MSS.G	
									AM M55.8	
									MS15.1	
									MS15.2	
									M524.3	
									M524.4	and the
									=	<u> </u>
									Display elements	100
									measurement elements	
1			Retatice & Math Ch	annela 🔏 Conditio	nal Channels 🖸 CAN messages 🚯 De	ice info 🥵 Settinge 🥪 Fi	suit into 👘 Features info		measurement sources	
-	Mar					ALC: NO.		-		A 12
- 12			CONTRACTOR OF							
	1.2	999999	Show an	-		Errors	warnings   U Message	5		-
bed	Type	Name	Punction	Source	426	Type Time	Selider Message			
		adjust_data_nv_copy	100	160 Center						
		ana01	ADC	Millio Center						
	2	ana02	ADC	Of M60 Center						
	-	anaus	ADC	ge 160 Center						
		ana04	ADC	of 160 Center						
	8	ana05	ADC	MUD Certer		and the second second				

a) Double-click on 'M 60'.

b) Click on 'Features Info'.

MSI-60 Rear right features info	
ECU ID 3e000009:4e41202d	Copy to clipboard
Status/Unlock Order informations	
* Name Description	
UPGRADE1 F02U.V01.012-01 - MSI60 UPGRADE	1, CCP MASTER, MEASURE 3.RD PARTY ECU
L	

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

A feature unlo	ock window appears.	
MSI-60 Rear right fe	features info	
ECU ID 3e00	00009:4e41202d Copy to clipboard	]
Status/Unlock	Order informations	
Name	Description	
	IDE1 F02U.V01.012-01 - MSI60 UPGRADE 1, CCP MASTER, MEASURE 3.RD PARTY ECU	
	ECU Protection	

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

The featu	ure's stat	us changes to 'unlocked'.		
MSI-60 Rea	ar right feature	es info		
ECU ID	3e000009	4e41202d		Copy to clipboard
Status/	Unlock Ord	er informations		
	Name	Description		
of L	JPGRADE1	F02U.V01.012-01 - MSI60 UPGRADE 1, CCP MASTER, MEASURE 3	BRD PART	( ECU
L				

4. Perform these steps to activate other features you purchased. Switch the car's ignition off and on again to cycle the power of the M 60.

# 8 Math and Condition Channels

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

# 8.1 Math Channels

#### Math channel

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

#### **Conditional function**

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

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

## 8.1.1 Creating a new Math Channel

Follow the steps shown in the screenshots.



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

The 'create/edit math channel' window appears.

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

C	reate/edit math channel		
	Define the math channel's general properties and $\ensuremath{\mathbb{R}}$ 's calculation in	le. fx	
a) b)	Name: Description: Formula:		
<u>c)</u>		Constants:	
d)	not and or xor		f)
		Define Remove	
e)	Channels (use F3 to search):	Functions:	<b>g</b> )
	Image: state       Image: state	boo      acco      ac	h)
	🕌 📄 ana02	•	
		< Back Next > Finish Cancel	4

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



### NOTICE

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

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

## 8.1.2 Creating a new Conditional Function

Follow the steps shown in the screenshots.

New Project.rlp - RaceCon V2.4.1.8				• ×
File Edit View Extras Help				
1 🐴 💕 🖬 🚑 1 X 🗈 🖻 🛷 🖬	🔹 🗠 - 🔁 Synchronize - 🖤 WP - 🐌 Design model 🕨 . 💌 🔍 🔍			
Project 4 x	(and New Project ) MSL60 Ervet left	d b ¥	Toobox	a x
B- Re New Project			Devices	
			<ul> <li>Displays</li> </ul>	
🔤 🦏 Calibration Items	MSI-60 Front left math channel configuration	tr	200 C60-D	
🔒 📄 CAN Bus 1	& Add channel	-	DDU4	
🚊 🛅 CAN Bus 2			DDU5	
📄 Computed Channels	Z wath channels a C)	-	DDU6	
	Jo Conditional function		DDU7	
Group adjustments			E DDU8	
Macros			<ul> <li>ECUs</li> </ul>	
a) Math Channels			MS3 Sport	
CCP Master			MS4 Sport	E
MSI-60 Rear right			MS4.4 Sport	
- Measurement Container			MS15 Sport	
			III MS3.1	
			I MS4.0	
			MS4.2	
			MS4.3	
			MS4.4	
			MS5.0	
			MS5.1	
			MISS.2	
			MISS.S	
			MISS 8	
			MS15.1	
			MS15.2	
			MS24	
			PDB	
			PSU-F1	
			Bypass ECU	
			Custom FCU	-
			Display elements	
			Measurement elements	
	🍯 Statistics 🏂 Math Channels 🥂 Conditional Channels 🛄 CAN messages 🕕 Device info 🕌 Settings 🥡 Fault info 🔒 Features info		Macro actions	
Data - Math Channels	a 🗙 Info/Status			
Show all	😮 Errors 🔥 Warnings 🕦 Messages			0/0 🗙
Used T Name	V V Function V Source V Type Time Sender Message			
	🖶 info/Status 👼 CAN Log - stopped 🗟 SYS Log - stoppe	d		
Ready.	No errors detected - all cleared or state unknown	MSI-60 Fro	nt left/Math Channels 🖷	online 🔹 .

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

c) Choose 'Conditional Function'.

The 'create/edit conditional function' window appears.

- picture above. fx Define the co a) p\_br\_front\_mx n hr front (p\_br\_front, p\_br\_front\_mx 1 b) d) Otherwise: p\_br\_front\_mail e) Reg 10 C) (i) If (p\_br\_front > 20) is TRUE, then return (max (p\_br\_front, p\_br\_front\_mx)), else return (p\_br\_front\_mx) Reset value is used: ecomes TRUE for the first time after power-up changes state from FALSE to TRUE. <Back Next > Finish Cancel
- 1. Define the conditional function using the following configuration possibilities in the picture above.

*a)* Enter the name of the conditional function.

*b)* Enter the If-condition. Click on the pencil symbol to open an editor to enter expressions.

c) Enter the Then-condition. Click on the pencil symbol to open an editor to enter expressions.

*d)* Enter the Otherwise-condition. Click on the pencil symbol to open an editor to enter expressions.

- e) Enter the reset value (must be a number).
- 2. Click 'Finish' when done.

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



### NOTICE

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

The conditional function works in the following way:

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

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

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

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

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

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



Example: Setting up a condition for maximum front brake pressure. "Brake pressure front 'p\_br\_front'"

- At power-up, the reset value (10) is used for 'p\_br\_front\_mx'.

 'p\_br\_front' rises to 30. As 'p\_br\_front' is > 20 (condition is TRUE), the condition 'max (p\_br\_front, p\_br\_front\_mx)' in the THEN window is triggered. The condition sets the bigger value as new value for 'p\_br\_front\_mx'. As 'p\_br\_front' (30) is bigger than 'p\_br\_front\_mx' (10), the new value for 'p\_br\_front\_mx' is set to 30.

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

# 8.2 Condition Channels

### **Condition channel**

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

#### **Condition combination**

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

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

### 8.2.1 Creating a new Condition Channel

Follow the steps shown in the screenshot.



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

The 'create/edit condition' window appears.

Define the condition channel using the following configuration possibilities:

	Create/edit condition	X
	Define the conditions general properties and the condition itself. Select between single channel/value or multiple constant comparison by selecting the comparing mode.	fx.
<u>a)</u>	Name:	
ь)	Comparing mode © Constant  © Channel  © Range  © Multiple (constant list)	
c)	Input channel: Operator: Constant value:	
d) e)	General settings     Output settings       Debounce time:     0 ÷ ms       Turn off delay:     0 ÷ ms	• • f)
	Ok C	uncel

a) Enter the name of the condition channel.

b) Select the comparing mode:

- Constant: Compare a measurement channel with a constant value.
- Channel: Compare a measurement channel with a measurement channel.
- Range: Compare a measurement channel with a defined value range.

• *Multiple: Compare a measurement channel with up to 5 constant values. c) Depending on the chosen comparing mode, you can enter the following values:* 

• Constant: Choose the measurement channel or condition, the operator and enter the value of the constant.

• Channel: Choose the measurement channel or condition, the operator and the measurement channel or condition to becompared.

• *Range*: Choose the measurement channel or condition, the operator and define the minimum and maximum value.

• Multiple: Choose the measurement channel or condition, the operator and enter the value of up to 5 constants.

*d)* Enter the minimal time to detect the signal of the measurement channel to avoid high-frequent switchovers.

e) Enter the time the signal of the measurement channel is delayed after its ending.

f) Choose the output setting of the result.

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

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

## 8.2.2 Creating a new Condition Combination

Follow the steps shown in the screenshot.

New Project.rlp - RaceCon V2.4.1.8				×
<u>File Edit View Extras H</u> elp				
i 🞦 😂 属 🎯 i 🕉 🗈 🛍 🕩 🔊	🔹 🖓 - 🖓 Synchronize 🔹 🐏 WP 🔹 🐌 Design mode 🕨 🔹 🥥 😦 🔍 🔍 🔍 🔍 Race mode   🗄 🏭 🚳 🖕			
Project A X	/ Sul New Project / 🔛 MSI-60 Front left	4 Þ 🗙	Toobax	άX
B- Sa New Project			Devices	
⊨-→ 🔛 MSI-60 Front left		£	<ul> <li>Displays</li> </ul>	*
🔤 🕞 Calibration Items	MSI-60 Front left condition channel configuration	Jx	🗱 C60-D	
🔒 🛅 CAN Bus 1	f. Add condition to dit to hition f. Delete condition(s)		DDU4	
😥 🛅 CAN Bus 2			DDU5	
a) Computed Channels	Jo Condition	Value	DDU6	
Conditional Channels	Jo Condition combination		DDU7	
Group adjustments			DDU8	
B- 2 1/0 Channels			ECUs	
Macros			MS3 Sport	
J <sub>x</sub> Math Channels			MS4 Sport	-
Mat CCP Master			MS4.4 Sport	1
HISI-OU Kear right			MS15 Sport	
I Measulement Container			MS3.1	
			MS4.0	
			MS4.2	
			MS4.3	
			MS4.4	
			MS5.0	
I			MS5.1	
			MS5.2	
			MS5.5	
			MS5.6	
I			MS5.8	
			MS15.1	
			MS15.2	
			MS24	
			PDB	
			PSILE1	
			Burner FCII	
i			Custon ECU	-
i			Display elements	
í II			Measurement elements	
1			Measurement sources	
I	Statistics   Jx Math Channels   Jx Conditional Channels 🛄 CAN messages   1) Device into   🎆 Settings   🥑 Fault into   🔬 Feat	ures info	Macro actions	
Data - Conditional Channels	a 🗙 Info/Status			άX
Show all	😮 Errors 🔥 Warnings 🕕 Messages			0/0 ×
Used T Name	V  v Function v Source v Type Time Sender Messa	age		
	🛃 Info/Status 🗟 CAN Log - stopped 🛃 S'i	/S Log - stopped		
Ready.	No errors detected - all cleared or state unknown • fx New P	roject/MSI-60 Front left	/Conditional Channels 🖷 onl	ine 👻 🚲

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

c) Choose 'Conditional combination'.

The 'create/edit condition combination' window appears.

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



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

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

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

# 9 CAN Bus

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

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

## 9.1 CAN Bus Trivia

### CAN message

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

#### CAN bus

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

Configuration of M 60 bus data rate in 'Properties' menu.



#### Row counter concept

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

	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x100	0	💁 p_oil		💁 t_oil				
0x100	1	💁 s_dam_fl		💁 s_dam_fr				
0x100	2	Ns_dam_rl		National States 🔁				

Message, Id / Row, Counter / Payload Area

# 9.2 CAN Input

## 9.2.1 Input Configuration



a) Open CAN messages overview window.

b) Create new channel to read from CAN bus.

c) Import Vector CAN database (DBC) channel configuration.

d) Export channel configuration to vector CAN database (DBC).

e) Export RaceCon CAN input configuration to file.

f) Import RaceCon CAN input configuration from file.

g) Display CAN bus properties (baudrate).

## 9.2.2 Create new CAN Channel

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

3. Insert name and description of channel.

Create Channel	
Set the unique name for the	e channel and add an optional description.
Name:	
p_oil	
Description:	
engine oil pressure	
	Ok Cancel

4. Click 'OK' when done.

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

Data - CAN Bus 1								д	×			
			Show all									
Used	T	Name		$\nabla$	•	Function	•	Source	Ŧ			
	<b>B</b>	p_oil						SI-60 Front left				

## 9.2.3 CAN Channel Configuration

	CAN channel p_oil configuration	Measurement value	
a)	General	Value 8, 8, 8, 8, 8, 8, 8, 8, 9, 00	
	CAN Id		<mark>≺ c)</mark>
	Imeout         0 ⊕         ms         Default value         0 ⊕         raw           Use multiplexer         Image: Show         Show         Image: Show	Raw Value 8. 8. 8. 8. 8. 8.	
	Multiplexer	Measurement Sheet	
	Data		
	Representation () Byte () Bit		d)
	Start 0 🚖 Length 1 🚖		
	Type Unsigned V Endian @ Little O Big		
			,
	Conversion		
h)	<u>F</u> actor 1.0 ♀ none/Bit Minimum 0.0 ♀ none		
$\rightarrow$	Offset 0,0 - none Maximum 255,0 - none		
	Unitgroup: none		
	Unit: none 💌		
	a) Extractions of data thomas CAN bus		

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

### 9.2.4 Extracting Data from CAN Bus Representation: Byte
Some CAN devices need to be addressed by a byte represented CAN channel. The address can be assigned in this window and is illustrated by a bargraph.

	CAN channel p_oil	configuration		
	General			
$\frac{a}{}$	L <u>a</u> bel	p_oil		
(a	<u>C</u> AN Id	0 🚖 hex	Extended	
c)	Timeout	0 🚔 ms	<u>D</u> efault value	0 🔶 raw
a) >	Use multiplexer	I 🔥 Hide	Multiplexer value	0 🜩
	Multiplexer			
	Representation	Byte		
	Start	0	Length	1 🚔
	Туре	Unsigned -	Endian	Little ○ Big
e)	Data			
	Papersontation	B.4. O B.		
	Ctart	0 PMie 0 pi	Length	1
	Type		Endian	
	1)00	onagrica -		
f)	0 1	2 3	4 5	6 7
g)	Conversion	· ·		
	Eactor	10 none/Bit	Minimum	0.0
	Offset		Maximum	255 0 none
	Unitaroup:		maginam	Adjust automatically
	Unit:			

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

#### **Representation: Bit**

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

	CAN channel p_oil configuration
	General
$\frac{a}{b}$	Label p_oil
	CAN Id 0 hex Extended
$\frac{c}{d}$	<u>T</u> imeout 0 → ms <u>D</u> efault value 0 → raw
<u>u</u>	Use multiplexer 🗹 🔿 Hide Multiplexer value 0
	Multiplexer
	Representation 💿 Byte 🔘 Bit
	Start 0 🔶 Length 1 🖕
	Type Unsigned 🔻 Endian 💿 Little 🔿 Big
e)	Data
1	Representation  Byte  Bit
	Start 25 Length 7
	Type Unsigned  Type Endian
	→ Hide image
f)	7     6     5     4     3     2     1     0       0     mab

a) Enter name of the CAN-channel.

b) Enter CAN message ID. Check the box, if extended IDs (29 bit) are used.

c) If replacement values are used, specify time-out period and raw value.

d) Check the box, if a multiplexer (row counter) is used.

e) Enter data position, length and format.

f) The matrix table shows the assignment of the bits.

• Red colored fields show the assignment of the data bits.

• Orange colored fields show the assignment of the multiplexer bits.

### 9.2.5 Conversion to Physical Values



a) Enter factor (gain) for conversion to physical value.

b) Enter offset for conversion to physical value.

c) Select type of physical value.

d) Select unit of physical value.

e) Enter minimum physical limit of the channel (for manual setup).

f) Enter maximum physical limit of the channel (for manual setup).

g) Check the box to automatically adjust the limits of the channel.

### 9.2.6 Special Features

#### **CAN** analyzer functionality

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

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

Measurement	value	
Value	8. 8. 8. 8. 8. 8. 8.	none
Raw Value	8, 8, 8, 8, 8,	

#### Automatic creation of online measurement sheets

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

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

Meas	urement	Sheet			
	_				
				•	

### 9.2.7 Online View of CAN Channels in Vehicle

1. Double-click on 'Sheet 1' in Project Tree.

Measurement Sheet 1 is displayed in Main Area.



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

not 0 × 04 New Project	# M60 Center 1 Measurement Folder 1	4 b x Toolog
M New Project		Devices
P M60 Center		Display elements
Calibration Itams		Measurement elements
CAN Due 1		🔄 Gauges
E CAN DUS 1		Sy Circular Gauge
- 🛅 CAN Input		Horizontel Bargraph
<ul> <li>CAN Outputs</li> </ul>		Temperature Gauge
a CAN Bus 2		Vertical Bargraph
Tomputed Channels		Numeric Indicators
Compared Charlies	KANADARA AND AND AND AND AND AND AND AND AND AN	III Measurement Label
- A Conditional Channels		15 Numeric Indicator
I/O Channels		S Krobs
- Macros	VIOLAND VI	D Knob
- & Math Channels		G Daracteristics
CCD Master		Block. Curve or Mep
th Manurament Container		💷 String
e measurement container		USS Value
B Measurement Folder 1		Disprostice
- M Sheet 1		III BI-LEDA
- March Sheet 2		Common
		Container
		t image
Show all		m Measurement List
d T. Name A		au Simple Text
Channel		Charts
2 a di		HI Deciloscope
		- Controls
		Control In Name

ad A A	New Project 20 M60 Center 2 Measurement Folder 1	41.8	
ed New Project e J∰ M60 Center			Devices Display elements Measurement elements
Calibration Items Calibration Items Calibration Items Calibration Items Calibration Calib			Gauges     Constant Gauge     Monicontal Bargraph     Horizontal Bargraph     Verical Bargraph     Verical Bargraph     Normeric Indicators     Sold Measurement Label     Shormeric Indicator     Norde     Orantedirentiato     Dearsetingtion     Sing     Sing     Walve     Dearsetingtion
Sheet 1     Sheet 2	Channel - none		III Bit-LEDs
ed T. Name Function Source			Measurement List
			Charts
			- Costrola
			S Macro Button

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

- Drag desired measurement channel and drop it on the measurement element.
   The measurement element displays the values of the assigned channel.
- 6. Connect PC to the vehicle and switch to 'Race Mode' by clicking 'F11' on the keyboard to display online data.

### 9.2.8 Import a CAN Database (DBC) File

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

A file browser opens.

3. Select DBC file to import and click 'OK' when done.

#### A channel import window opens.

0 channels a	nd 64 r	nessages	s availab	le				c	channels to import:
Name	U	Id	Size	RowCtr	RowVal	D	*		
accx_f	g	778	16						
accy_f	g	778	16					Add ->	
accz_f	g	778	16						
B_asr		772	1	0	0			Add all	
B_ekp		772	1	0	1				
B_gs		772	1	0	1				
B_laptrg		772	1						
B_lca		772	1	0	1			<- Remove	
B_lcsw		772	1	0	1			Pannun all	
B_Irs		772	1	0	0			nemove all	
B_Irs2		772	1	0	0				
R memoar		770	1	n	2		*	1	

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

The channels are inserted in the Data window.

### 9.2.9 Export RaceCon CAN Configuration

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

#### An 'Export Selection' window opens.

Exp	port displayed content to	_ 0	x
	All items shown below will be exported. Please click 'Export' to select a destination to s	store to.	۲
	CAN Input		
	Export	<u>C</u> ance	el

- 3. Specify the filename.
- 4. Click 'OK' when done.

# 9.2.10 Import RaceCon CAN Configuration

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

A file browser opens.

3. Select the input file and click 'OK'.

An 'Import Selection' window opens.



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

6. Click 'Next'.

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

Import	ting	from file N	ISI60.rex(2.4.1.2)				_ <b>D</b> X
Sele Su	ect f	or all amb ary: 1 import	<b>igous objects tl</b> ed element, 3 resto	ne appropriate one. ored label links, importe	 d elements complete!		•
So	olve I	abel ambigu	uity				
Stat	tus	Label	Source	Assigned Source	Assigned Label	Project Label	
G	0	time_hour	MSI-60 Front left	MSI-60 Front left	time_hour	In target project - time_hour/Calibratic	n Items/M 🔻
6		time_min	MSI-60 Front left	MSI-60 Front left	time_min	In target project - time_min/Calibration	n Items/MS ▼
	۵	time_sec	MSI-60 Front left	MSI-60 Front left	time_sec	In target project - time_sec/Calibration	n Items/MS 💌
					< Back	Next > Finish	Cancel

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

## 9.3 CAN Output

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

### 9.3.1 Output Configuration



- d) Import RaceCon CAN output configuration from file.
- e) Display CAN bus properties (Baudrate).

### 9.3.2 Create new CAN Output Message Channel

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

2. Select 'New CAN Message' from menu.

The 'Create new CAN message' window opens.

Create new CANOut	message			×
Configure the CAN	N Out message and an	optional multiplex	er.	C
Name CAN ld (hex) Grid	CANMessage	Extended		
Multipleyer	Use multiplexer			
Representation Start Number of rows	Byte ○ Bit     D ◆     1 ◆	Endianness Length	◯ Little ⊚	Big
		Ok	Cano	cel

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

A CAN message configuration window opens in the Main Area.

	Ad New Point	Ma MGD Center	4 F x Tobac
a de New Project			Devices
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a) Output messages on CAN bus1.b) Definition of CAN message.c) Content of message.

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

- Scheduler
   Scheduler
- 7. Select the desired measurement channel and drop it on message's bytes.

The measurement channel is assigned to the CAN message.

# 9.3.3 Set up of Word Length, Byte Order and Quantization

1 2 2 3 4 4 5 5 7 9 • 0 • 12 Syndronize • 12 Design model > • 2 18 6 • 3 Race model 2 2 9 5	1. 10
Elle Edit Yiew Extras Help	
	The second se
4 P Star Star Star Star Star Star Star Star	×
How Project     How Proje	Image: Section of the sectio

Set byte order of channel on CAN bus

Word length and quantization of channel can be adapted if necessary. Byte Order can only be changed if a channel allocates more than one byte.

# 9.3.4 Export RaceCon CAN Configuration

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

The 'Export Selection' window opens.

3. Specify the filename.



4. Click 'OK' when done.

### 9.3.5 Import RaceCon CAN Configuration

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

A file browser opens.

3. Select the input file and click 'OK'.

#### An 'Import Selection' window opens. Importing from file importfile.rex(2.2.2.0).. \_ 🗆 X Drag&Drop elements from the import content to the current project. € rt content (source) Current Project (targ 🖃 👭 M60 Center age\_123 age\_234 E 64 New Project - CAN Bus 1 B- M60 Center CAN Outputs CAN Bus 1 - CAN Outputs E CANMessage\_123 CAN Bus 2 < Back Next > Brish Qancel

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

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

Impor	mporting from file MSI60.rex(2.4.1.2)						
<b>Sel</b>	ect for all	l ambigou	<b>is objects ti</b> ement, 3 resto	he appropriate one pred label links, import	ed elements complete!		•
S	olve label a	ambiguity					
Sta	atus Labe	Sou	urce	Assigned Source	Assigned Label	Project Label	
	🗿 time_	hour MSI	-60 Front left	MSI-60 Front left	time_hour	In target project - time_hour/Cali	bration Items/M 🔻
	🖉 time_	min MSI	-60 Front left	MSI-60 Front left	time_min	In target project - time_min/Calib	oration Items/MS
	🖉 time_	sec MSI	-60 Front left	MSI-60 Front left	time_sec	In target project - time_sec/Calib	oration Items/MS 🔻
					< Back	Next > Finish	Cancel

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

# 10 Analog and Frequency Inputs

This chapter describes the analog and frequency inputs.

# 10.1 Features

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

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

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

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

4 PWM outputs

- Low-side switch
- Up to 2 A each
- Output frequency selectable

# 10.2 Measurement Channels

For each analog channel, several 'subchannels' are available.

Data - f_wheel_fl #						
	Show a	11				
Used Type	Name V 🗣	Source	•	Description		
	f_wheel_fl	👭 M60 Center		Wheel force front left		
	f_wheel_fl_fi	👭 M60 Center		Wheel force front left		
<b></b>	raw_f_wheel_fl	🙀 M60 Center		Wheel force front left		
<b></b>	raw_f_wheel_fl_fi	🙀 M60 Center		Wheel force front left		

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

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

Filtered channels are routed through digital low pass filters:

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

- Latency compensation - no filter delay in recorded data.

# 10.3 Configuring Inputs

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

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



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

	Select Sensor					
	Select a sensor, base	d on the order number.				
,	Sensor category	EMPERATURE SENSORS	▼ Calibra	ation data		
	Sensor group	1]	• 🗸	Pullup		
			_	Ohm	°C -	-
	Order number		•	89	130	
7	0 280 130 026 0 280 130 039		<u>^</u>	113	120	
	0 281 002 170 B 261 209 155			144	110	
	B 261 209 160			186	100	
	B 261 209 166 01			322	80	
	B 261 209 167 01 B 261 209 168		-	435	70	
		Sensor category	_	834	50	
		TEMPERATURE SENSORS	_   _	1175	40	
		Conversion of		1707	30	
		NTC M12	_   _	2500	20	
	(h		_   _	3792	10	
	<u>u</u> )	Open datasheet		5896	0	

The 'Bosch Sensor Wizard' opens.

- a) Choose the sensor's category.
- b) Narrow your choice by choosing a type.
- c) Select the exact type.
- d) Opens sensor's datasheet.
- e) These calibration values will be used.
- 4. Click 'Finish' when done.
- 5. The 'Create channel on M 60' window opens.
- 6. Enter channel name and description.

eate Channel	
Set the unique name for the channe	l and add an optional description. 🥄
me: rad.out	
scription:	
itiet temperature of radiator	
	<u>O</u> k <u>C</u> ancel

7. Click 'Ok' when done.



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

- a) Channel is linked to ANA03.
- b) Available measurements for channel.
- c) Input pin pull-up resistor is activated.
- d) Calculation of physical value with characteristic curve.

#### Available measurements for channel

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

### 10.3.2 Configuring a generic linear sensor

#### Example: Acceleration sensor 5 g

- From sensor data sheet - operating characteristics:

Output Signal					
Zero g (T <sub>A</sub> = 25°C, V <sub>DD</sub> = 5.0 V) <sup>(4)</sup>	VOFF	2.25	2.5	2.75	v
Zero g (V <sub>DD</sub> = 5.0 V)	VOFF	2.0	2.5	3.0	v
Sensitivity (T <sub>A</sub> = 25°C, V <sub>DD</sub> = 5.0 V) <sup>(5)</sup>	s	380	400	420	mV/g
Sensitivity (V <sub>DD</sub> = 5.0 V)	s	370	400	430.1	mV/g
Bandwidth Response	f <sub>-3dB</sub>	42.5	50	57.5	Hz
Nonlinearity	NLOUT	-1.0	-	+1.0	% FSO

- Sensitivity 400 mV/g, Offset 2,500 mV
- The sensor has a linear output signal with sensitivity and offset.
- 1. Click on 'Measurement Sources' in the Toolbox.
- 2. Expand the list of 'I/O Channels' by clicking on '+' in the M 60 Project Tree.
- Drag the 'Sensitivity/Offset' analog signal source from the Toolbox and drop it on the desired analog input channel in the M 60 Project Tree.
   A 'Sensitivity/Offset Wizard' opens.
- 4. To activate the internal M 60 pull-up resistor, check the box.

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

Pin Properties			
Configure the and	log pin properties.		
Use pullup:	9		
Pullup <u>x</u> alue	3010		 글 0

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

5. Click 'Next' when done.

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



a) Physical (channel) value.

- b) Electrical (pin) value.
- c) Choose unit group and unit of physical value.
- d) Enter values from sensor datasheet.
- 6. Click 'Next' when done.



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

a) Physical limits of channel.

- b) Enter physical limits of the sensor.
- c) Choose datatype of the measurement variable.
- d) Checkbox to enable online calibration of offset and enter desired physical offset value.
- e) Enter name to automatically create a new measurement sheet.
- 7. Click 'Finish' when done.
- 8. Enter channel name and description.
- 9. Click 'OK' when done.



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

The channel is inserted into the M 60 Project Tree.

#### Available measurements for channel

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

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

# 10.3.3 Configuring a generic nonlinear sensor

Toper

[^C]

0

10

20

25

30 35

#### Example: Thermistor 5 kOhm

From sensor data sheet: resistance values over temperature
 PART NR.: 2381 640 502



[Ω]	
16 277	
12 669	
9 936	
7 849	
8 244	
5 000	
4 030	
3 267	

RT

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

Toper [°C]	<b>R</b> τ [Ω]
80	628
85	535
90	457
95	399
100	338
105	292
110	251
115	221

- The sensor has a nonlinear behavior.

- Use characteristic curve for linearization.

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



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

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

It allows you to use a push-button.

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



5. Click 'Next' when done.

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



a) Physical (channel) value.

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

6. Click 'Next' when done.

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



a) Physical limits of channel.

- b) Enter physical limits of the channel.
- c) Choose data type of the measurement.
- d) This sensor does not need offset calibration.
- e) Enter name to automatically create a new measurement sheet.
- 7. Click 'Finish' when done.
- 8. Enter channel name and description.
- 9. Click 'OK' when done.

The channel is inserted into the M 60 Project Tree.



a) Channel is linked to ANA05.

- b) Available measurements for channel.
- c) Input pin pull-up resistor is activated.
- d) Characteristic curve for sensor.

e) Adjustment is disabled.

#### Available measurements for channel

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

# 10.3.4 Configuring a Multipoint Adjustment

#### Example: Measurement of wheel force

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



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

A 'Multipoint Adjustment Wizard' opens.

4. To activate the internal M 60 pull-up resistor, check the box.

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

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



5. Click 'Next' when done.



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

a) Physical (channel) value.

b) Electrical (pin) value.

- c) Choose unit group and unit of physical value.
- d) Select type of curve.
- e) Enter physical adjustment values here (can still be edited later).
- 6. Click 'Next' when done.

int Adjust nent Wizard - Add New × Analog Source Properties Adjust the analog source properties Limit m ÷ N b) 50 Limit ma ÷ N 50000.0 ar Output of c) • 16 Bit (Evg) N d) ÷ N 20 e) 10 C Point No Write protected <u>Einish</u> < <u>B</u>ack

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

- a) Physical limits of channel.
- b) Enter physical limits of the sensor.
- c) Choose data type of the measurement variable. d) Enable additonal online calibration.
- e) Enter name to automatically create a new measurement sheet.
- 7. Click 'Finish' when done.
- 8. Enter channel name and description.

9. Click 'OK' when done.

The channel is inserted into the M 60 Project Tree.



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

e) Adjustment is enabled.

#### Available measurements for channel

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

Online definition of the curve is covered in the chapter 'Online Calibration of Measurement Channels [> 76]'.

# 10.3.5 Digital Filter Details

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



Digital filters eliminate 'out-of-band' noise



Cut-off frequency automatically adjusted to recording rate



Linear phase – no signal distortion

#### Example:

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



Latency compensation – no filter delay in recorded data

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

### 10.3.6 Configuring a Frequency Input

This function requires the installation of Software Upgrade 2.

#### Example: Measurement of wheel speed

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



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

Velocity Wizard - Add New	0	1000	and the		
Velocity Properties	nit to measure a linear valority			л	
conligure a frequency in	Jul to measure a imeal velocity.				
Number of increments:			44	. 🔸	a)
Wheel eize inference :			2000		b)
Whee circumeterice.			2000		
Output data type:	16 Bit		•	] 🔸	c)
Limit minimum:			0	km/h 🔫	d)
					e)
Limit maximum:			400 🚔	km/h 🔫	
					Ð
Measurement sheet:			<b>.</b>		
	< Back	Next >	Finish	Cancel	

a) Number of teeth on the pulse wheel.

b) Circumference of wheel for speed calculation.

c) Choose data type of the measurement variable.

d) Choose Limit minimum speed.

e) Choose Limit minimum speed.

f) Enter name to automatically create a new measurement sheet.

4. Click 'Finish' when done.

5. Enter channel name and description.

6. Click 'OK' when done. The channel is inserted into the M 60 Project Tree.



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

#### Available measurements for channel

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



#### NOTICE

Measurement of ,Revolution' is similar.

# 10.4 Configuring computed Source

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

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

#### Example: Sensitivity/Offset calculation on input channel

- 1. Click 'Measurement Sources' in the Toolbox.
- Drag the 'Sensitivity/Offset' computed source from the Toolbox and drop it on 'Computed Channels' in the M 60 Project Tree.
   A 'Computed Sensitivity / Offset Wizard' opens.

3. Click 'Next' when done.

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

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



a) Physical limits of channel.

b) Enter physical limits of the sensor.

c) Choose data type of the measurement variable.

d) Enable additonal online calibration.

e) Enter name to automatically create a new measurement sheet.

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

The channel is inserted into the M 60 Project Tree.

# 10.5 Hysteresis

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

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



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

The second part of the 'Hysteresis Wizard' opens.



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

The channel is inserted into the M 60 Project Tree.

![](_page_63_Figure_1.jpeg)

c) Calculation of hysteresis channel.

# 10.5.1 Special Functionality: Vehicle speed

This functionality allows:

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

#### Vehicle speed calculation function

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

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

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

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

Calculated speed is speed of 2nd fastest wheel.

### 10.5.2 Setting up calculated Speed

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

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

![](_page_64_Figure_2.jpeg)

#### A 'Calculated Speed Wizard' opens.

Calculated Speed Con Select speed inputs for	figuration alculating a reference speed.	۹	
Configure on device	M60 Center	•	
nput source:	Wheel speeds		-
Drive shaft s <u>wi</u> tch:	Four wheel drive		
Speed input front left:	🚑 🔁 v_wheel_fi	• /	
Speed input front right:	😫 💁 v_wheel_fr		
Speed input rear left:	🚑 🔁 v_wheel_rl	• 2	
Speed input rear right:	🙀 🔁 v_wheel_rr	• /	
Speed difference:	5		

a) Choose device.

b) Choose input source (internal/external).

c) Choose driven axle.

d) Choose individual wheel speed channels.

e) Set limit for speed difference for calculation.

4. Click 'Finish' when done.

The speed calculation is inserted into the M 60 Project Tree.

- 😗 Calibration Items	Speed configuration			MS24.3 MS24.4 PDB
CAN Bus 1	Configure on device	59 M60 Center		Bypass ECU
CAN Outputs	input gourde	Wheel speed	×	Custom ECU
E Computed Channels	Drive shaft sigtch	Rear wheel drive		BT55 BT50
_ & nmot_hyst _ & Conditional Channels	Speed input front left	A av_wheel_f	•/	C40
Data - Soood # ×	Speed input front right	4 av_wheel_t	2/	C55
Show all	Speed input rear left	Max_wheel_d	2/	State C60-D
Speed_dist_dis	Speed input rear right	Star owheel or	812	AN MED
File Steet"ut5"up	Speed gifference		5 <u>-</u> %	MSI-60
				CAN modules
				• LT4
•				Display elements Measurement elements
Properties - Speed In Data - Speed	Configuration			Macro actions
D Errore D Warnings D Marcages				4
Type Time Sender Message				

a) Speed calculation in M 60 Project Tree.

b) Measurement channels calculated speed and calculated distance.

c) Configuration window.

# 10.6 Configuring PWM Outputs

#### PWM

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

![](_page_65_Figure_12.jpeg)

M 60 has 4 PWM outputs:

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

![](_page_66_Figure_1.jpeg)

#### Configuring a PWM Output

- 1. Click on 'Measurement Sources' in the Toolbox.
- 2. Drag the 'PWM Out' computed source from the Toolbox and drop it on the desired 'PWM\_OUT' channel in the M 60 Project Tree.

A 'PWM Out Wizard' opens.

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

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

![](_page_66_Figure_8.jpeg)

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

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

5. Click 'OK' when done.

The channel is inserted into the M 60 Project Tree.

				~
New Project.rlp - RaceCon V2.4.	.1.8	the P last last like		
: File Edit View Extras	Help			
i 🞦 🚅 🔒 🎒 👗 🛍 🛝	🌮 🖃 👻 🌍 Synch	onize + 🔃 RP + 🐌 Design mode 🕨 😐 🥘 🔍 🚽 🔍 Race mode 📑 🏭 🥹 🖕		
Project	4 ×	New Project MSI-60 Front left	x Toolbox #	×
ANA_DIFF27	*		Devices	
		PWM_OUT01 Yelp3 PWM_1	Display elements	
🐗 ANA_DIFF29			Measurement elements	
ALS ANA_DIFF30			Measurement sources	
			<ul> <li>Sensors</li> </ul>	_ 1
ANA_DIFF32			Bosch Wizard	
👜 🛁 ANA01		u) Output frequency:	Customized Sensor	
		1000 Hz	<ul> <li>Analog sources</li> </ul>	_ 1
			Characteristic Curve	
			Multipoint Adjustment	
SUL ANAUS			Sensitivity/Offset	_ 1
			<ul> <li>Frequency sources</li> </ul>	_ 1
			Characteristic Curve	
VDT01			Revolution	
ILVDT02			Velocity	_ 1
-48 LVDT03			<ul> <li>Digital sources</li> </ul>	_ 1
			Digital Channel	. I
			Group Adjustment Channe	4
🐗 LVDT06			- Computed sources	_ 1
📲 LVDT07			Adjustment channel	
- ALE LVDTOB	-		Characteristic Curve	
a) a wm_outo1			Constants Table	
N PWM_1	E		Jx Gear Lookup Table	
at DWA OUT02			J2 Hysteresis	
			Capuigger	_
all REV01			Sensitivity/Offect	-1
			Constanti, Onder	
- Macros			S Speed	
fx Math Channels				
CCP Master	*	🖍 Conditional Channels 🛄 CAN messages 👔 Device info 🔛 Settings 🔞 Fault info 🔒 Features info 📲 PWM OUT01 💽	Macro actions	_
Data - PWM_OUT01		do/Satur		
		Prors A Warning D Messages		Ŷ
			0/0	
Used Type Name		Type Time Sender Message		
b) PWM_1				
				- 1
				- 1
				- P
<	F			
Ready.		No errors detected - all cleared or state unknown	ft/I/O Channels/PWM OUT01/PWM	(1 . d)

### Diagnostic channels

Measurement label	Function
pwm_err_ls_out_01_OL	PWM output 1 error open load
pwm_err_ls_out_01_OT	PWM output 1 error over temperature
pwm_err_ls_out_01_SCB	PWM output 1 error short circuit to battery
pwm_err_ls_out_01_SCG	PWM output 1 error short circuit to GND

![](_page_67_Picture_6.jpeg)

#### NOTICE

The diagnosis of PWM output 2 to 4 is similar.

# 11 Online Measurement

#### M 60 configuration

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

#### Online measurement and calibration

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

# 11.1 Achieving an online Connection

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

### 11.1.1 Set up the PC for Access

- 1. Switch off local firewall on the PC.
- Set IP Configuration for the Ethernet interface to 'automatic configuration' (DHCP). See chapter Setting up the Network Interface [▶ 15] for details.
- 3. Start RaceCon.
- 4. Establish the Ethernet connection to the vehicle.
- 5. Power on the vehicle.
- 6. Click 'OK' to download RaceCon configuration to device.

![](_page_68_Figure_23.jpeg)

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

Info/St	tatus			<b>ч х</b>		
🔕 Er	3 Errors 🔥 Warnings(4) 👔 Messages(14)					
Туре	Time	Sender	Message	*		
<b>(i)</b>	15:16:07	M60 Center	UNLOCK - ECU already unlocked			
<b>(i)</b>	15:16:07	M60 Center	EPK check successful. (EPK Device: M60_BASE_0718 )			
<b>(i)</b>	15:17:53	M60 Center	Successfully downloaded configuration (XCP).			
<b>(i)</b>	15:17:55	M60 Center	Successfully connected to device(Ethemet/XCP).			
<b>i</b>	15:17:55	M60 Center	UNLOCK - ECU already unlocked	=		
()	15:17:55	M60 Center	EPK check successful. (EPK Device: M60_BASE_0718 )	-		
				-		

Status message window

# 11.1.2 Going online

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

#### The download starts.

![](_page_69_Figure_7.jpeg)

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

	New Project		Irfo/Status				
		Type Time Sender Message		Message			
	Calibration Items	<b>(i)</b>	15:24:54	M60 Center	Successfully downloaded configuration (XCP).		
		<b>(i)</b>	15:24:56	M60 Center	Successfully connected to device(Ethemet/XCP).		
	📩 👝 CAN Bus 1	<b>(i)</b>	15:24:56	M60 Center	UNLOCK - ECU already unlocked		
• (6)		1	15:24:56	M60 Center	EPK check successful. (EPK Device: M60_BASE_0718 )		

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

![](_page_69_Figure_11.jpeg)

# 11.1.3 Configuration Download

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

Project		
🖃 🚛 New Project		
	Open	
	Create measuring views	
	Download configuration	
- <i>f</i> _ +	Save •	
	Synchronize	
	Create dataset	
	PIN/SuperPIN	
🦺 🖷 🌀 Mea 📀	Export	
۲	Import	
<b>1</b>	Properties	
X	Delete	
aje	Rename	
Used T Name	V 💌 F	un

2. Select 'Download configuration'.

The configuration download starts.

A green dot and background indicate a successful download.

![](_page_70_Figure_5.jpeg)

# 11.2 Setting up an online Measurement

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

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

New Project.rlp - RaceCon V2.4.1.8	Local Division in the local division of the		×					
Eile Edit View Extras Help								
		100% · C   Macennone   🖂 📲 🖉 🖹: [12] 🗐 📲 🚾 🗛 👘	1, 22 (m) E II (m) E					
Project 4 X	Measurement Folder 1	4 P × 1000c	× 4 ×					
B- Ball New Project		Device	88 ny elements					
Misi-ou Pront left		Displa	ivement elements					
- Measurement Folder 1			20205					
Stal Sheet 1			Circular Gauge					
Sheet 2			i Horizontal Bargraph					
		13	Temperature Gauge					
			Vertical Bargraph					
			umeric Indicators					
			1 Measurement Label					
			Numeric Indicator					
			nobs					
			í Knob					
		- 0	haracteristics					
			Block, Curve or Map					
			String					
		121	l Value					
		- Di	iagnostics					
			BisLEDs					
			ommon					
		4	Container					
			Image					
			Measurement List					
			n Simple Text					
			harts					
			- Oscilloscope					
			ontrols					
		0 w	Macro Button					
		- Measu	urement sources					
	Sheet 1 Sheet 2	Macro	actions					
Data - Sheet 1 📮 🗙	/Status		4 ×					
Show all	Errors 🔥 Warnings(6) 👔 Messages		0/6 🗙					
Iked Type Name V	n Terr Sender Mercene							
Coold Type Halle	je nine Jendel Message							
<								
Ready	No errorr detected - all cleared or ri	The upknown	easurement Folder 1/Sheet 1					
incong.	ivo errors detected - all cleared or si	. Man were respect measurement container/me	association routerly sheet 1					

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

Project	🕂 🗙 🚛 New Project
🖃 🚛 New Project	
H60 Center	
📋 👘 Measurement	
📄 💼 Measurem 📙	Add measurement rolder
Sheet 1	Export
🐼 Sheet 2	➔ Import
3	Properties
a	ije Rename

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

Project		д	×		New Project
🖃 🗤 🚛 New Project				Ĺ	
🗄 🛶 👭 M60 Center					
🗄 🖷 🎁 Measurement Co	ontair	ner			
🚊 🔤 Measuremen	-2	0			
🛐 Sheet 1		Open			
👧 Sheet 2	01	Add mea	sure	ment page	
	Ж	Cut			
		Сору			
	۲	Export			
	۲	Import			
	1	Propertie	s		
	×	Delete			
	aĵe	Rename	,		

From the context menu of a measurement page, the page can be renamed and deleted.
Project		A 🗙 🖉 New P				
🖃 🚛 New Project						
🗄 🛶 🙀 M60 Center						
🚊 🖷 🎁 Measuremen	t Con	tainer				
🚊 🛅 Measurer	nent	Folder 1				
🛐 Sheet 🐼 Sheet	ß	Open				
_	01	Add measurement page				
	Ж	Cut				
		Сору				
	€ E					
	۲	Import				
	1	Properties				
	×	Delete				
	$\Psi$	Move down				
Data - Sheet 1	aje	Rename				

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

•		
🔯 Sheet 1	🔯 Sheet 2	

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

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



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

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



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



RaceCon offers different types of measurement elements:





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

d) Horizontal Bar

time sec 23,51 s
------------------

Measurement label

time_sec		<b>i</b>
*******	*******	
	******	
	*******	





Oscilloscope (Chart)

#### 11.2.1 Automatic Creation of Measurement Sheets

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

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



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

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



a) Click to create measurement sheets.

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



a) Access to sheet.

b) Raw and physical channel values.

c) Characteristic values.

d) Button for online offset calibration.

#### 11.2.2 Using the Measurement Sheets

1. When RaceCon is online, press the 'F11' key to switch from 'Design Mode' into 'Race Mode'.

The measurement sheet is extended to full screen.

The button for offset calibration is active.

- 2. Switch between different sheets using the tabs at the bottom of the page or the keyboard shortcuts associated with the sheets.
- 3. Press the 'Esc' key to return to 'Design Mode'.

phys	<b>0,0000</b> G	SENSITI	400,000		Perspectrum de la composition
raw	2490,0 mV	OFFSET	2500,000	mV	
		MIN	-5,000	G	
		MAX	5,000	G	
		ADJ_VAL	0,000		
				,	

### 11.3 Online Calibration of Measurement Channels

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



11.3.1 Enable online offset Calibration for Measurement Channel



During creation of the measurement channel

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

#### In the channel view



a) Activate switch to enable online calibration.

### 11.3.2 Performing the online offset Calibration

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

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



The sensor's offset is now calibrated.

#### 11.4 Group Adjustment

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

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



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

a)		Group adjustment Group	e Risin		]	b)		
		Channel	N	Adjust value	Unit	Adjust		c)
		∼ acc_lat		0,000	g		-	•,
		✓ f_wheel_fl		0,000	Ν			
		✓ f_wheel_fr		0,000	Ν			
		✓ f_wheel_rl		0,000	Ν			
		f_wheel_π		0,000	Ν			
d)								
<u>/</u>		Execute adjustment manually						
	ų.	Group						

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

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

Group adjustment	Group						
Trigger channel	🥵 🙆 adj_wheelload	-	Trigger edge	Rising	•		
Channel	-			N	Adjust value	Unit	Adjus
∼ acc_lat	Add condition	<u> </u>			0,000	g	
f_wheel_fl	and contract combination				0,000	N	1
✓ f_wheel_fr	Section adj_accelerations	E			0,000	N	1
✓ f_wheel_rl	B err tecu core				0,000	N	1
f_wheel_rr	B_pwr_good				0,000	N	<b>V</b>
	<ul> <li>error_active</li> <li>pm_trigger_wdog</li> <li>pwm_err_ls_out_01_OL</li> <li>pwm_err_ls_out_01_OT</li> <li>pwm_err_ls_out_01_S</li> <li>pwm_err_ls_out_01_S</li> </ul>	-					
		aau da a diu	atmost manually				

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



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

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

Group adjustment	Group_1						_ <b>_</b> .
Trigger channel	👭 🙆 adj_accelerations	◄ 🥖	Trigger edge	Falling	•		
hannel				N	Adjust value	Unit	Adjust
acc_lat					0,000	) g	<b>V</b>
f_wheel_fl					0,000	N	
f_wheel_fr					0,000	N	
f_wheel_rl					0,000	N	
f_wheel_m					0,000	N	

#### 11.5 Online Calibration of Multipoint Adjustment Channels

#### Example: Measurement of wheel force

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



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

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



a) Click to open measurement channels in data view.

- b) Double-click to open online view.
- c) Click to open calibration window.

d) Analog and physical value.

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

Point	Value	Unit	Calibration
1	745	Ν	Calibrate
2	12548	Ν	Calibrate
3	34075	Ν	Calibrate
4	45050	Ν	Calibrate

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

M60_Manual.rlp - RaceCon V2.3.5.12 - Masterlicense Bosch		
Elle Edit View Extras Help		
📄 🎦 🚔 🛃 🎒   👗 🗈 🛝 🛷 🔊 • (** -   🖓 Synchronize - 🌚 WP - 🜷 Design mode   🕨	🔹 👰 🔍 100% - 🔍 Race mode 🖻 🌺 🤣 🖕	
Project 9 X / Sal New Project 19 M60 Center	445	Toolbox a x
E- Sat New Project		Devices
De 🏭 M60 Center		Display elements
- 🧠 Calibration Items	~	Measurement elements
8- 🚞 CAN Bus 1 f_wheel_fr		Measurement sources
8- CAN Bus 2	Anton shot	<ul> <li>Sensors</li> </ul>
- Computed Channels	Office Chart	Bosch Wizard
- fe Conditional Channels		Customized Sensor
Group adjustments Raw 6.6.5.3 0.0 0 IIIV	50000	<ul> <li>Analog sources</li> </ul>
- s Group	-	Characteristic Curve
Phys. 88.9015.00 N		Multipoint Adjustment
and ANAM		Sensitivity/Offset
Adustment value	40000	<ul> <li>Frequency sources</li> </ul>
all ANA02	+0000	Characteristic Curve
-alt ANA03 Calbrate		Revolution
41 ANA04 Calibrate advatment points		J Velocity
🖵 🔤 f wheel fl		<ul> <li>Digital sources</li> </ul>
Pin settings	3000	Digital Channel
f_wheel_fr		Group Adjustment Channel
Pullup 3,01 k0hm	2	<ul> <li>Computed sources</li> </ul>
🗆 🔤 f_wheel_ri 🔹		Adjustment channel
Data - f wheel fr 0 x	20000	Characteristic Curve
Show all	1	E Fuel
		∫⊈ Gear Lookup Table
Used Type Name 🛆 💌 Function	- Y	∫r Hysteresis
aw_f_wheel_fr_fi	10000	Laptrigger
araw_f_wheel_fr	- /	PWM Out
f_wheel_f_fi	1/	Sensitivity/Offset
f_wheel_fr	]/	Speed Speed
	0 2000 4000	
	mV	
🗧 💷 , 🕺 🕺 🖓 CAN r	ressages 🕕 Device info   👹 Settings   🥹 Fault info   🙆 Features info   🗐 ANA01   🗐 ANA05   💁 f_wheel_fr   📢	Macro actions
🔁 InfolStatus		
Ready.	No errors detected - all cleared or state unknown 🔹 🔤 New Project/M60 Center.	/I/O Channels/ANA05/f_wheel_fr 🖷 online 👻 🚲

The calibration curve is displayed in the online view.

#### Adjustment points vs. offset adjustment



# 12 Error Memory

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

### 12.1 Error memory representation in RaceCon

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



#### 12.1.1 Accessing the memory

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





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

An error is deleted from the list when

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

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

#### 12.1.2 Clearing the error memory

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

System Logger Display ( DDU32 Race Mode velike Potention Shi Ddu32 Node Projection Shi Ddu32 Node Projection Shi	Calibration, Measuring	System Tools Windows	-	DDU10_Test.rl	p - RaceCon V2.5.	5.0 - Mastericense Bosch *	_ = > @
oject 0 x	New Project	00010 x					Teobox 0 X
- da New Project							Qevices
E Laptrigger						-	Display Clements
B -> C DDU9	Existing DDU10 e	11978					Measurement Bements
e.•m 00010	-						Measurgement Sources
Dirplay	MIL U						<ul> <li>Sensors</li> </ul>
- CAN Bus 1	Location	Type Duratio	e Active	DateTime	Occurrences	Description	Bosch Wizard
🚊 🛄 CAN Bus 2	ANADA	Open line	30.2 🙆 True	14/2000 6 28 26 AM		<ol> <li>No further information avai</li> </ol>	Customized Sensor
🚡 🛄 CAN Bus 3	ANA06	Open line	29,8 😋 True	1/4/2000 6 28 26 AM		1 No further information avai.	<ul> <li>Analog sources</li> </ul>
😑 📑 CAN Bus 4	ANAD/	Upen line	25,4 😳 True	14/2000 6 28 26 AM		1 No further information avail.	Characteristic Curve
Computed Channels     Computed Chann	AAH.2	Open line	22 🔯 1108	14/2000 6 20 27 AM		I NO TUTOLE INCOMISION AVAIL	Mutipoint Adjustment
							E Sensitivity/offset
- Grantation sens							Characteristic Curve
6 Math Channels							Revolution
& Conditional Channels							Velocity
Group adjustments							El Computed sources
Group							Adjustment channel
Master Devices							Characteristic Curve
👜 👩 Measurement Container							Display Switch
							Fuel
							Gear Lookup Table
							Hysteresis
							C Laptrigger
							NM Out
							Sensitivity/Offset
	Start detect	ion of cable					Speed
	Statistics 🥢	Kath Channels 🛛 🊈 Conditio	nal Channels 🛛 🤮 CAN mes	sages 🗟 Marros 📼	Settings 👔 🚺 Device i	nfo 🛛 🥹 Error info 🛛 📅 Features inf 🧃 🖡	
ta			€ x 1:6	/Stehn			
×_			0	Errors(1) Wernings(	32) Messages(1)	9)	152/152 🗙
Show all			Te	e Tree Sender	N N	ettace	
ene / • Source	Descriptor		0	17:33:10 DDU 10	- New Project St	accessfully connected to device ("themet/NCP).	
			ŭ	17:33:11 DOU 10	- New Project El	W check successful. (EPK Device: DDU 10_BASE	0401_TST4)
			Ŭ	17:33:12 000.10	- New Project D	evice data matches the local data.	
		No info	rmation 0	17:33:13 DOU 10	- New Project C	albration data successfully uploaded and initial	zed.
		NOTITIO		17:33:16 DDU 10	- New Project Si	accessfully cleared the error memory.	
			0	1/100110	- New Project S	tert of cable breakage detection successful.	
			Tel.	States Chilles and	60 L		
			0	a same pasto front	101		



# 12.2 Information on errors available from the error memory

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

#### 12.2.1 Error Memory Properties

The following property is available for the error memory itself:

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

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



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

0 (no error present in memory):



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

			System			DDU10_Test.ri	p - RaceCon V2.5	5.5.0 - Masterlicense Bosch *	- = X
	System Looper Lo	or stoor, we say in ng	loos whooks				-		
	Project 0 ×	🖬 New Project 💷 D	X 01100						Toobox 0 X
Constantly orange border	Laptrigger							(C)	Display Benents
	E BLoger	Easting 000 to eno	¥8					Cear	Measurement Sources
	Display	Location	Type D	uration	Active	DateTime	Occurrences	Description	Bosch Wizard
MIL constantly orange —	🖶 🛄 CAN Bus 2	ANA04 ANA06	Open line Open line	114,3	False	1/4/2000 6:28:26 AM		1 No further information avai.	Customized Sensor
	CAN Bus 3     CAN Bus 4	ANAD7	Open line	113,5	False	1/4/2000 6:28:26 AM		1 No further information avai.	Characteristic Curve
	E Computed Channels	ANA09	Open line	113,1	False	1/4/2000 6:28:27 AM		1 No further information avai	Multipoint Adjustment
	⊕- 📲 1/0 Channels								Sensitivity/Offset
	- Glibration Items - Macros								Characteristic Curve
	- fr Math Channels								Revolution
	fx Conditional Channels								Velocity
	Coop     Coop     More deuterets     Coop     Mater Devices     Massuement Container	Start detection	of cable						Charpeted Sources Adjustment chanel Charpeter charel Charpeter charel Charpeter charpeter Garancology Table Garancology Table Charpeter
		Statistics 🖇 Mat	th Channels 🥼 Co	and tional Channels	CAN mess	ages 📑 Macros 🛤 S	Settings 🚺 🕦 Device	e info 🧕 😧 Error info 🔒 Features inf 🧃	<u>۲</u>
	Deta				V X Info,	Status			= 0 ×
	error_				0	Errors(1) 🔥 Warnings(3	33) 🕕 Messages(1	123)	157/157 🗙
	😫 🖬 🔄 Show all	_			Type	Time Sender		Message	*
	Name / Source	<ul> <li>Description</li> </ul>				17:33:18 DDU10 - 17:35:13 DDU10 -	- New Project	Start of cable breakage detection successful. Lost connection to device(Ethernet/NCP).	
					Ū.	17:35:20 DDU10	New Project	Successfully connected to device(Ethernet/NDP	).
info cycling through			No ii	nformation	0	17:35:20 DDU10 - 17:35:22 DDU10 -	- New Project	EPK check successful, (EPK Device: DDU 30_BA3 Device data matches the local data.	8E_0401_TST4)
errors present in					Ũ	17:35:22 DDU10	New Project	Calibration data successfully uploaded and inite	slæd.
enois, present un					Info	/Status CAN Log - runni	ng		
error memory	Ready.					·		0, ANAD9(Open line), for 113,15 + 🖉 New	Project/DOU10/1/O Channels 🖷 🖷 🕂



	System Logoer Display Co	albration,Measuring	System Tools Windows	_	DDU10_Test.r	ip - RaceCon V2.5.5.0 -	Masterlicense Bosch *	- = ×
	DDU9 Status Mode Status Mode Mode Froget Security							
	Project 0 X	Ren New Project 🔳	DOU10 💌					Toobox 0 X
Blinking orange border	Gal New Project     GL Laptrigger     GLAPTIGGER						<b>6-</b>	Devices Display Bernents
	COULO	Existing DDU 10 erro	rs					Measurement Sources
	⊕- 📾 Logger	MI 🦰					Clear	Sersors
MIL blinking orange	e Display	Location	Type Dura	ion Active	DateTime	Occurrences	Description	Bosch Wizard
MIL buriking orange	B- CAN Bus 1	A1404	Open line	83,3 👸 True	1/4/2000 6/28/26 AM		1 No further information avai	Customized Sensor
	CAN Bus 3	AN406	Open line	82,9 👸 True	1/4/2000 6:28:26 AM		1 No further information avai	<ul> <li>Analog sources</li> </ul>
	🚊 🛄 CAN Bus 4	ANA07	Open line	82.5 😵 True	1/4/2000 6:28:26 AM		1 No further information avai	Characteristic Curve
	B- 🗎 Computed Channels	AN409	Open line	82,1 🔂 True	14/2000 6:28:27 AM		1 No further information avai.	Multipoint Adjustment
	B- 10 Channels							Sensitivity/Umset
	- Galeration items							Characteristic Ource
	fr Math Channels							Revolution
	f_c Conditional Channels							Velocity
	😑 🌂 Group adjustments							<ul> <li>Computed sources</li> </ul>
	Group							Adjustment channel
	Measurement Container							Characteristic Curve
								Display Switch
								Gearl cokun Table
								Hysteresis
								<ul> <li>Laptrigger</li> </ul>
								PWM Out
								Sensitivity/Offset
		Start detection	of cable					Speed
		Statistics 🌾 Mai	th Channels 🍐 Cond	tonal Channels 🛛 🤮 CAN	nessages 🔄 Nacros 🛤	Settings () Device info	😢 Error Info 🔒 Features Inf	×
	Data			0 X	Info / Status			= + x
	error_				C Errors(1) 🔥 Warnings	32) () Messages(119)		152/152 🗙
	🔂 🖬 🖾 Show all				Tune Time Sender	Messar		*
	Name / Source	Description			(i) 17:33:10 DDU10	New Project Success	- sfully connected to device/Ethernet/XCP	<b>N</b>
					17:33:11 DOU10	-New Project BPK che	eck successful. (BPK Device: DDU 10_BAS	8E_0401_TST4)
Info cycling through	1				17:33:12 DDU10	- New Project Device	data matches the local data.	
ingo cycung infough			No inf	ormation	(i) 17:33:13 D0U10 (i) 17:33:14 D0U10	- New Project Calibrat	ton data successfully uploaded and inits	slaed.
errors present in					<ol> <li>17:33:18 00010</li> <li>17:33:18 00010</li> </ol>	- New Project Start of	rury ceares one error memory. Ecable breakage detection successful.	
								•
error memory	<				Info / Status CAN Log - runn			
	Ready.					💛 DOU10, AN	404(Open line), for 78,0 s + 🗐 New	hroject/20U11/2/0 Channels 🐽 💼 📩

#### 12.2.2 Error Properties

The following channels are recognized and memorized inside the devices:

Data			
err			
🖷 🖻 🥶 🍳 🖷 🗛	л 🎹 🚥	Show all	
Name 🗸 💽	Source 🔻	Description	•
<pre>error_active_rotate error_location_rotate error_state error_state error_type_rotate</pre>	DDU9 DDU9 DDU9 DDU9	error active rotation. signals if error is present or not error location rotation signals global state of error manager error type rotation	

Error type (device label "error\_type\_rotate"):
 e.g. "below\_threshold" for a violation of the minimum voltage range defined in the configuration, "shortcut\_Batt" for a shortcut to battery voltage etc.

- Error locations (device label "error\_location\_rotate"):
   e.g. "ANA01" for an error concerning the first ANA channel
- Error durations

How long has the error been active? If an error encounters a non-active period before being cleared from the memory and is then detected again, the error duration keeps on accumulating. The number of active periods can be seen from the "number of occurrences".

- Number of occurrences
   How many times has the error been detected since the last time the error memory was cleared.
- Error active state (device label "error\_active\_rotate")
   All failure modes are continuously diagnosed; any error detected will be written to the error memory. Once an error is detected, it is qualified as "active".
  - 1 (TRUE) Error was detected in most recent diagnose run (active)

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

The aforementioned channels (error\_active\_rotate, error\_location\_rotate, error\_type\_rotate) are device specific properties (e.g. C 60) and are not related to the complete Race-Con project (e.g. "error no. 3 from the error memory"). Therefore, only one property label is available in each device. The errors from the error memory (possibly more than one error possible per device) share these three labels. The labels cycle through the errors currently present in the memory and represent the respective property of each error periodically.

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



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

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

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

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

Z I Y standard -		
Channel Measurement		
Actual measurement rate	100 ms - time synchronous event channel	
Default measurement rate	100 ms - time synchronous event channel	
Channel properties		
Address	0x25040B95	
Annotations		
Description	signals global state of error manager	
Name	error_state	
Physical conversion	(Verbal)No error present[0]Passive error(s) present[1]Active error(s) present[2]	
Physical maximum	2	
Physical minimum	0	
Physical quantisation	none	
Physical unit		

# 12.3 Analog Input Diagnosis

# 12.3.1 Monitoring limits / Shortcut Detection / Cable Breakage

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

Pin Properties Configure the analo	g pin properties.
Pullup value:	3.01 kOhm -
	Pin Diagnosis & montoring limits V Enabled Minimum: 1000 (2) Maximum: 4000 (2) mV
	< Back Next > Finith Cancel
5V	Name: Page_Switch_ANA_1
Pullup	Description:
>	
	5000         0         0         158
	5000         0         15 Bit
In Diagnosis	5000         Organ         Pege, Switch, ANA, 1           5000         6         Bit            5000         6         Bit            7000         7000         Bit            7000         7000         Bit            7000         7000         Switch, ANA, 1            7000         Fige, Switch, ANA, 1            7000         Switch, ANA, 1            7000         Switch, ANA, 1            7000         Switch, ANA, 1

### 12.3.2 Open Line Detection

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

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

System Lagger Display C DOUID Race Mode visible Protection Stre	albraton/Measuring Took	s Windows	-	DDU10_Test.rl	p - RaceCon V2	2.5.5.0 - Masterloense Bosch *	- 0
Image     Image     Image     Image       Image     Image     Image	Cashing SOLUD enter Mit, Location 7 ANAGE7 ( ANAGE7 ( ANAGE7 ( ANAGE7 ( Cashing SOLUD enter ANAGE7 ( ANAGE7	ing no	Active 312 @ Tree 234 @ Tree 29 @ Tree 29 @ Tree	DesTrue 14/2000 42 00 04 Min 14/2000 42 02 04 Min 14/2000 42 02 07 Min 14/2000 42 02 7 Min 14/2000 42 02 Min	Courrences	Level and an and a second	Anter and a second
Data			0 × brfo	Status	2 Messaw		-)
😧 🔟 Show all Name / 💌 Source	• Description	No informat	ion	Time         Sender           17:35:10         D0130           17:33:11         D0130           17:33:12         D0130           17:33:13         D0130           17:33:16         D0130           17:33:18         D0130	New Project New Project New Project New Project New Project New Project	Message Successful, GPM Cercler (DUIL) BAG BM check accessful, GPM Cercler DOULD BAG Device data casthes the local data. Calibration data successful, deviced and initial successful, device the error memory. Start of cable breakage detection successful.	_0+01_757-4) zeci.

# 13 Firmware

### 13.1 Firmware and Configuration

M 60 holds 3 types of data:

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



### 13.2 Firmware Update

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



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

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

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

Project	🕂 🗙 🕅 New	Project
New Project		
Calibra	Öpen	
🚊 📄 CAN BI	Create measuring views	
🔤 Compu [	Download configuration	
<i>f</i> <sub>x</sub> Conditi ⊕ jj. Group	Save •	
д 🖉 I/O Cha	🖞 Synchronize 🕨 🕨	👸 Set Date & Time
	Create dataset	Change program archive
🔞 CCP M 💈	PIN/SuperPIN	📲 Update firmware
🗄 🖷 🎁 Measurem	Export	Upload configuration
Data Naw Project	Import	Clone ECU +
	Properties	Adjustment data 🕨
Used Type Name	C Delete	
∼ acc_lat a	e Rename	

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

Update firmware	×
<b>Flash program firmware</b> Perform a firmware update of a device. The project content is not changed.	
ECU Type: MSI-60	
Select program archive (PST) file:	
Update (current project) Use a new A2I file:	
<use archive="" content="" of="" program=""></use>	
ECU Identification Ok Car	ncel

3. Click 'OK' when done.

The firmware update starts. The M 60 displays the message 'Updating firmware'. When the firmware update is complete, the M 60 displays the message 'Updating firmware finished. Do a power cycle.'



#### NOTICE

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

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

Update firmware		X
Hash program firmware Perform a firmware update of	f a device. The project content is not changed.	0
	Loading configuration Connecting to <b>M60</b> Center Downloading content to <b>M60</b> Center <b>Hashing controllers on M60 Center</b> Cleaning up	
		Flash completion 55%
		Cancel

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

Update firmware	×
Flash program firmware	
Perform a firmware update of a device. The project content is not changed.	
<u>D</u> k	11

## 14 Clone the Unit

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

#### Creating a clone file

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

A 2 9 1 / / 1 / 1	DD010.rtp - RaceCon V2.5.5807.11	
System Lagger Display Calibration/Meesurin		0.
Date         Oppo         Oppo <th< td=""><td></td><td></td></th<>		
		■ 64 (2007) ■ 64
Store infor		general     g
Baco matio		Oisplay Bements
n e4 System Over	iew 🛼 Dataset manager	Measurement Sources
y fa / 5180,0		
Errors A Warnings () Messages		0,0 X
T Time Sender Message		
Me / Stores CAN Log - Stronged SVS Log - Stronged		
2444 - 244 Carl Carl Carl Carl Carl Carl Carl Carl		
KAREY.	14	errors desected - an General or state utbrisser • Dra Mear Project • •

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

lone ECU	
Clone extract ecu Clone extract the ecu and upload the data to the selected file.	5
ECU Type: DDU8	Select Device
Select clone file (bmsclone):	
C:\Test\DDU8_Bosch_Motorsport bmsclone	
protocol.	x devices using the FTP/Telnet

5. Click 'OK' to start procedure.

#### Applying a clone file to a device

1. Click <u>'Clone apply' in Extras menu.</u>



- 2. Choose clone file.
- 3. Click 'Ok'.

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

- Lifetime of device
- Serial number
- Upgrade features

# 15 GPS Sensor

# 15.1 GPS (Global Positioning System)

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

Two types of GPS receivers:

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

#### Serial Interface Characterization

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

#### 15.2 Protocol

M 60 expects NMEA Protocol (ASCII).

The following messages are decoded:

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

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

#### 15.3 Sensor Recommendation

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

### 15.4 Measurement Labels

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

Measurement label	Function
gps_PDOP	Position Dilution Of Precision
gps_HDOP	Horizontal Dilution Of Precision
gps_VDOP	Vertical Dilution Of Precision
gps_lat	Latitude in NDEG - +/-[degree][min]. [sec/60]
gps_long	Longitude in NDEG - +/-[degree][min]. [sec/60]
gps_elv	Antenna altitude above/below mean sea level (geoid) in meters
gps_speed	Speed over the ground in kilometers/hour
gps_direction	Track angle in degrees
gps_declination	Magnetic variation degrees (Easterly var. subtracts from true course)
gps_year	Years since 1900
gps_mon	Months since January - [0,11]
gps_day	Day of the month - [1,31]
gps_hour	Hours since midnight - [0,23]
gps_min	Minutes after the hour - [0,59]
gps_sec	Seconds after the minute - [0,59]
gps_hsec	Hundredth part of second - [0,99]
gps_smask	Mask specifying types of packages from which data has been obtained
gps_sig	GPS quality indicator (0 = Invalid; 1 = Fix; 2 = Differential, 3 = Sensitive)
gps_fix	Operating mode, used for navigation $(1 = Fix not available; 2 = 2D; 3 = 3D)$

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

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

### 15.5 GPS Troubleshooting

#### Electrical

- Is the transmitter signal of the GPS sensor connected to the receiver pin of the serial interface of the M 60?
- Is the GPS sensor powered up?
- Does the GPS sensor deliver RS232 signal levels?

#### Interface

- Do the baudrates of the GPS sensor and the device match?
- Is the GPS sensor set up for 8N1 transmission parameters?
- Is the GPS sensor set up for NMEA messages?
- Are the GGA, VTG, RMC messages activated?
- With a correctly wired and powered GPS sensor the changing GPS time information (gps\_sec) can be immediately observed.

#### **GPS** sensor start-up

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

# 16 Disposal

Hardware, accessories and packaging should be sorted for recycling in an environmentfriendly manner.

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

Bosch Engineering GmbH

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