BOSCH

Electronic Brake System EBS

Manual

Version 1.5 17/04/2024

Content

1 Warnings and Safety Instructions

The classification of the warnings and safety instructions is carried out by the respective signal word (Danger, Warning, Caution) next to the warning symbol.

Danger

⚠ DANGER

Nature and source of danger

Consequences

Warning of death or serious physical injury, which are sure to occur if ignored.

Warning

⚠ WARNING

Nature and source of danger

Consequences

Warning of death or serious injury, which can occur if this is not observed.

Caution

⚠ CAUTION

Nature and source of danger

Consequences

Warning of slight bodily injury in case of Disregard.

Notice

NOTICE

Nature and source of danger

Consequences

Warning of damage to equipment in case of ignoring.

2 Before Use

Read these instructions carefully and follow the recommendations for use step by step. We are happy to give you additional notes and explanations. Our contact information is on the back cover of this manual.

2.1 Safety Information

The EBS Kit was developed for use by professionals and requires in-depth knowledge of automobile technology and experience in motorsport. Using the system does not come without its risks.

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

The EBS system is not active in standstill. Use EBS Diagnosis Software (RaceABS) for diagnostics.

We recommend working on the system with power off and EBS system depressurized.

⚠ DANGER

Depressurize the EBS System of your vehicle before transporting it by airplane.

With EBS Diagnosis Software (RaceABS), you can depressurize the EBS system in a few moments. Reactivate the system before the next use.

It is essential that the predefined Bosch Motorsport assembly guidelines are complied with the system to run properly, see section Assembling the Parts [▷ 12]. This applies above all for installing the MIL (malfunction indication lamp) within the driver's range of visibility.

Safety concept

Two pressure sensors (one internal, one PWM input) to monitor the system pressure ensure high safety standard. Due to system monitoring, the risk of unintended braking is significantly reduced.

If the pump motor fails, a warning is set and the EBS-system is able to perform the next following driver brake request due to the 160 bar pre-filled reservoir.

If there is an EBS failure during the race, a backup mode automatically takes effect. From this moment on, only hydraulic braking takes place. This enables the driver to brake reliably at all times.

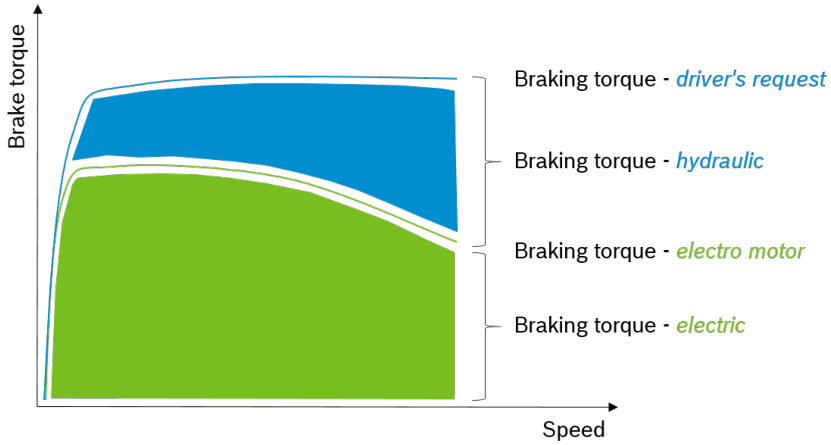
2.2 Why Electronic Brake System EBS?

Features:

- Braking system for one axle
- Supplement to the hydraulic brake
- Braking energy is recovered (recuperation)
- Recuperation share should always be maximum
- The hydraulic brake takes over individual wheel decelerations
- In case of system failure the hydraulic brake takes over

To maximize the efficiency of electric or hybrid vehicles, the electro motor shall recuperate the maximum possible amount of energy while braking. The brake torque from the electro motor varies over speed. Therefore, the hydraulic brake torque at the electrically driven axle must be controlled “by wire” to compensate the varying brake torque from the electro motor.

The aim of the system is to keep the brake balance between the front and rear axle constant.

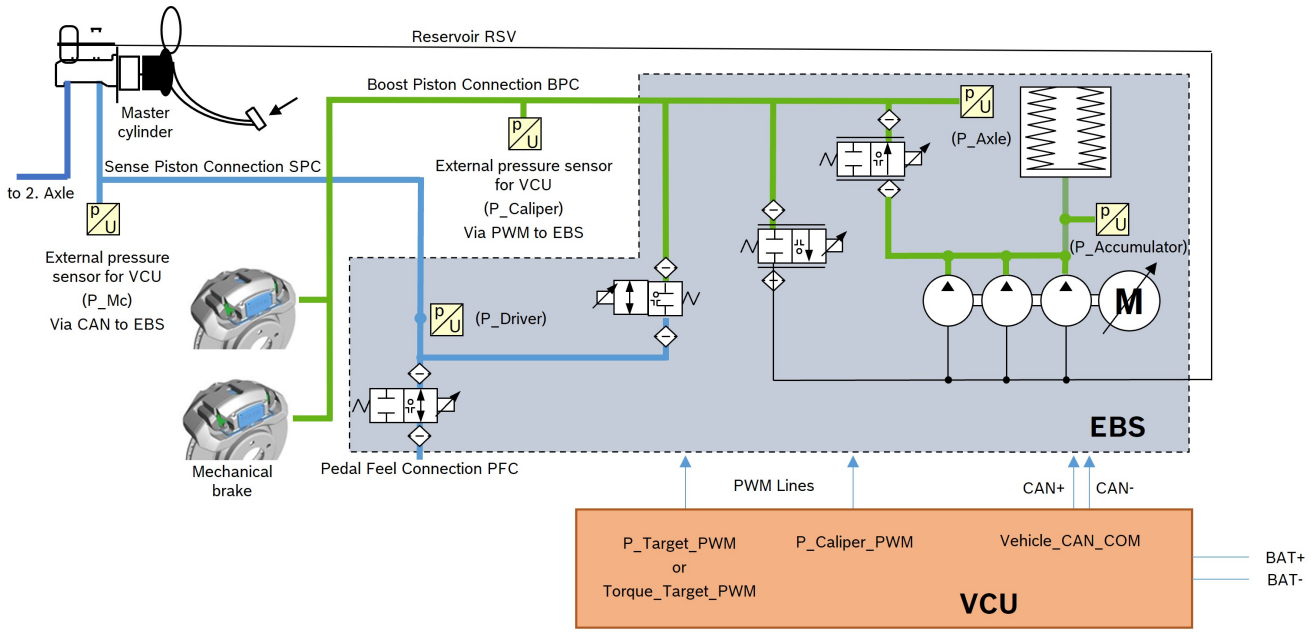


2.3 Principle of Operation

Bosch Motorsport EBS is suitable for **one axle actuation**. It is based on a series production type and adapted in years of development work to meet motorsport requirements.

The EBS is controlling the hydraulic pressure in one axle according to the recuperation values. The EBS has a 160 bar pressurized reservoir. By applying the brake pedal, a valve will cut the connection between the pedal and the calipers.

Simultaneously the VCU will calculate the regeneration level and extract from the driver brake request the amount of electrical part. The remaining amount will be generated by EBS as hydraulic pressure using the 160 bar prefilled accumulator. By releasing the brake pedal, the brake fluid from caliper will be fed into the Master Cylinder MC reservoir.



Three types of EBS

In general, we distinguish between three types of EBS systems:

- Type 1 gets pressure target from external software (used in LMDh).
- Type 2 gets torque target from external software.
- Type 3 works with EBS internal calculations and sends requirements to the electrical motor. This project will be finished only on customer request.

Six different braking characteristics

As an example, we designed six different characteristic profiles for the EBS system to enable different actuation strategies. With a six-steps-switch, you can choose between these profiles, e.g., from

1. very soft EBS controller activity to
2.
3.
4.
5.
6. maximum EBS controller activity.

3 Technical Data

Mechanical Data

Hydraulic unit	
Serial housing, dust- and damp-proof	
Vibration damped circuit board	
38 pin connector	
6 hydraulic valves for inlet/outlet	
1 separation backup valve	
1 electric pump motor	
1 hydraulic accumulator	160 bar/90 cm^3
Standard fittings	M12 x 1
Size	176 x 144 x 157 mm
Operating temperature	-30 to 130°C
Max. shock	50 g less than 6 ms
Max. working pressure	130 bar; max. recommended locking pressure 120 bar
Max. pressure gradient	up to 2,000 bar/s

Pressure Medium

DOT 4 brake fluid	
DOT 5.1 brake fluid	

Electrical Data

Supply voltage	10 to 16 V max. 24 V for 5 min
Max. peak voltage	35 V for 200 ms
Max. peak at start	<165 A
Current consumption Pump	<40 A
Current consumption Relay	<16.5 A
Power consumption Electronics	<1.5 A

Inputs

1 x PWM Target (Pressure or Torque)
1 x PWM input calliper pressure
1 x CAN1; 500 k or 1 Mb selectable
1 x CAN1 DC (Daisy Chain)
EBS function switch 6 positions via CAN1

Outputs

EBS warning light (MIL) via CAN1
EBS diagnostic via CAN1

Required Additionals

Mounting Board for Hydraulic Unit	
Pressure Sensors Fluid PSS-260	2 required
Com Interface MSA Box II	Required for communication and programming, not mandatory if available

Spare Parts

Mounting Rubber Elements Kit	5 sets (10 units Ø 18 mm; 5 units Ø 23 mm)

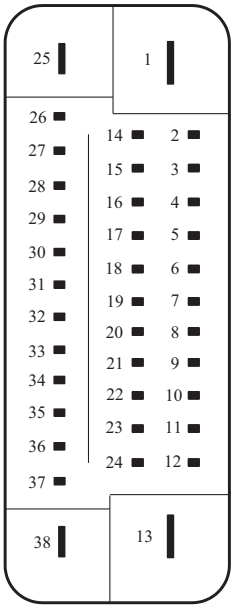
Component Weights

Hydraulic Unit	3,630 g
Mounting Board for Hydraulic Unit	300 g
2 Pressure Sensors Fluid PSS-260	40 g/each
Vehicle specific wiring harness with motorsport connectors	Depends on version

Connectors

Connector EBS Unit 38-1 EuCon	F02U.B00.238-01
Connector Pressure Sensor	D261.205.335-01
Connector Diagnosis	F02U.000.258-01

Connector 38-1 EuCon



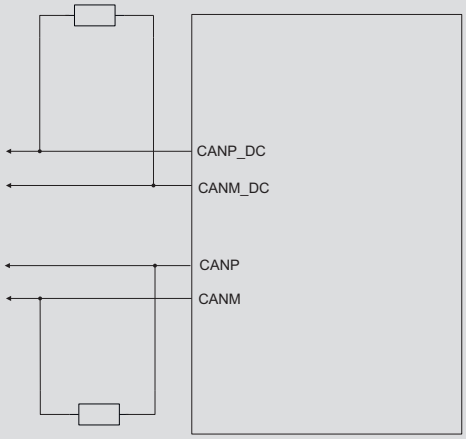
Pin Configuration

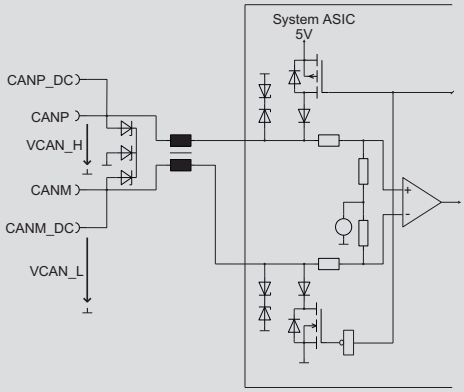
1	**UB_MR**
...	
13	**GND_MR**
14	CAN1M
15	CAN1M-DC
...	
25	**UB_VR**
26	CAN1P
27	CAN1P-DC
28	WAU_IN
...	
31	PWM Gnd
...	
33	PWM 5 V
...	
36	P_Target_PWM
37	P Caliper PWM in
38	**GND_ECU**

Daisy Chain

Please note that inside the ECU CAN and daisy chain CAN are linked.

Signal Name: CAN1M	Pin Number: 14
Signal Name: CAN1M-DC	Pin Number: 15
Signal Name: CAN1P	Pin Number: 26
Signal Name: CAN1P-DC	Pin Number: 27
Schematic (vehicle side)	Interface circuit (ECU side)





Item	Min	Typ	Max	Unit
Reference		GND_ECU		
Bit rate		500 k		bit/s
Differential Input voltage (Dominant) VCAN_H - VCAN_L, UinDifDom	0.9			
Differential Input voltage (Recessive) VCAN_H - VCAN_L, UinDifRec			0.5	
Differential Output voltage (Dominant) VCAN_H - VCAN_L, UoutDifDom	1.5		3.0	
Differential Output voltage (Recessive) VCAN_H - VCAN_L, UoutDifRec	-0.5		0.05	
Input resistance, Rin	11.25 k	22.5 k	33.75 k	Ohm
Output bus voltage (Dominant) VCAN_H, U_CANP_dom	2.75	3.5	4.5	V
Output bus voltage (Dominant) VCAN_L, U_CANM_dom	0.5	1.5	2.25	V
Output bus voltage (Recessive) VCAN_H, U_CANP_rec	2.0	2.5	3.0	V
Output bus voltage (Recessive) VCAN_L, U_CANM_rec	2.0	2.5	3.0	V

4 Adaptations to your Vehicle

Physical vehicle data

For optimum brake performance, each EBS unit has to be customized to suit the vehicle in which it is to be used.

Wiring harness

A wiring harness can be provided.

⚠ WARNING

Do not connect ABS M4 or M5 loom to EBS.

This would destroy the EBS module.

Electrical requirements

The EBS needs to be networked electrically to the VCU .

The EBS does not have a separate MIL. The MIL function is sent to the driver display via CAN. In the driver's display this CAN signal must be translated into a message to the driver indicating the absence of the CAN signal.

You need a DBC file to run the EBS.

⚠ WARNING

Please ensure that the system is in Force Passive mode during the boot phase.

Hydraulical requirements

All hydraulic connections between EBS, master brake cylinder, pedal feel modulator and axle must meet a brake-specific standard.

The suction line of the EBS needs to be connected hydraulically to the main brake pressure fluid reservoir of the main cylinder. The use of two separate reservoirs could lead to them taking each other's volume.

4.1 Transport of your Vehicle

⚠ DANGER

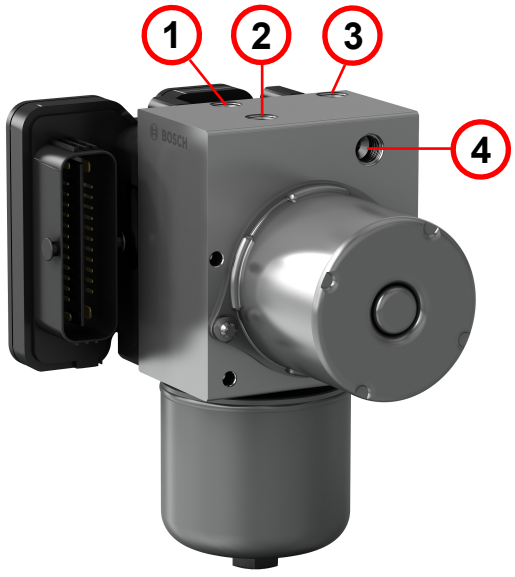
Depressurize the EBS System of your vehicle before transporting it by airplane.

5 Assembling the Parts

5.1 Mounting Bracket

Avoid the mounting in an area where vibration can damage the master cylinder. Flexible lines can avoid defects, if master cylinder and EBS are mounted very close together. Fit rubber pads between the assembly plate and the vehicle chassis to reduce vibration. Maintain a 10 mm distance between the vehicle chassis and the bottom of the assembly plate to allow easy connection of the EBS electrical connector.

5.2 EBS Unit



No	Shortcut	Description	Synonymous
1	SPC	Sense Piston Connection	Connection to Master Cylinder
2	PFC	Pedal Feel Connection	Pedal Simulation Connection
3	BPC	Boost Piston Connection	Caliper
4	RSV	Reservoir	Brake Fluid Reservoir

When installing EBS unit, make sure the Sense Piston Connection and the Pedal Feel Connection are facing upwards to ensure air can be bled out.

⚠ CAUTION

The EBS unit is prefilled with brake fluid. During assembly, make sure as little brake fluid as possible is lost.

When the hydraulic unit is delivered, it is pressure less and the pump is locked by software. After installation, both the pump and the rest of the brake system must be bled, see also chapter Repair Bleeding Wizard. Unlock the pump at the right moment by diagnostic command.

⚠ CAUTION

The system is not ready for use when delivered!

Bleed and unlock the system before first use.

Now the pump can build up its operating pressure of 160 bar and is ready for operation.

For more on assembly see Offer Drawing EBS Unit [▷ 49].

NOTICE

We recommend an exchange of the EBS Unit after one year.

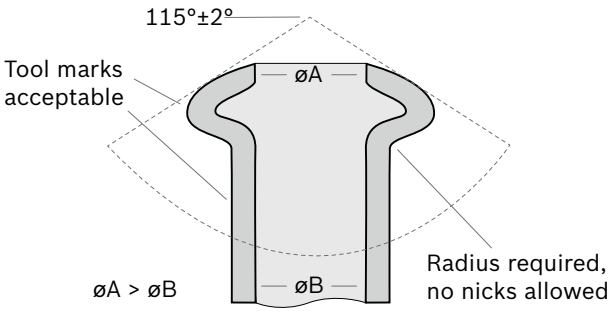
In racing vehicles, hydraulic units are subjected to significantly higher loads than in production vehicles. We therefore recommend replacing them even when they are fully functional, to keep the residual risk of failure as low as possible.

5.3 Brake Lines

All hydraulic connections between EBS master brake cylinder, pedal feel modulator and axle must meet a brake-specific standard.

Use rigid steel brake lines for as much of the plumbing as possible. Flexible lines should be kept to an absolute minimum for optimal brake control and pedal feel.

The EBS units use a DIN (bubble) flare convention common to European OEM applications. For sizes, also see Offer Drawing Hydraulic Unit.



The EBS unit is secured in the vehicle on the provided mounting plate. During operation, the EBS unit will vibrate. These vibrations are then transferred to the brake lines. To prevent vibration-induced damage to the brake lines, they must not be secured at a distance of up to 20 cm from the hydraulic unit so that they can vibrate freely.

NOTICE

We recommend using rigid metal brake lines; use flexible lines only at points where they are necessary.

Do not secure brake lines 0 to 20 cm from the hydraulic unit. The unit vibrates and would cause risk of damage to the lines.

Use brake lines with a minimum inside diameter of 3.3 mm.

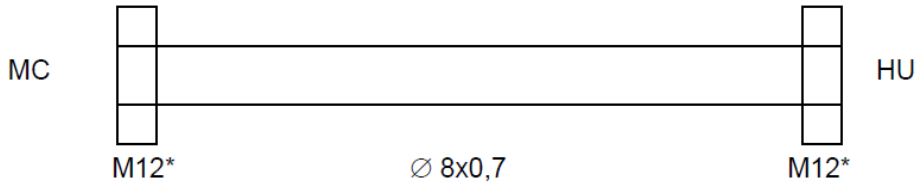
5.4 Suction Lines

At EBS

Brake lines with an outer diameter of 4.7 mm (inner diameter 3.3 mm) are not sufficient for an optimized pressure build up dynamic for the EBS. For a good pressure build up dynamic over the complete temperature range, Bosch recommends the use of 8 mm (outer diameter) brake lines.

In general, it is recommended to install the hydraulic unit (HU) as near as possible to the master cylinder (MC) to minimize the length for the suction line and the pressure drop. If this is not possible, one of the following variants of the brake lines should be used.

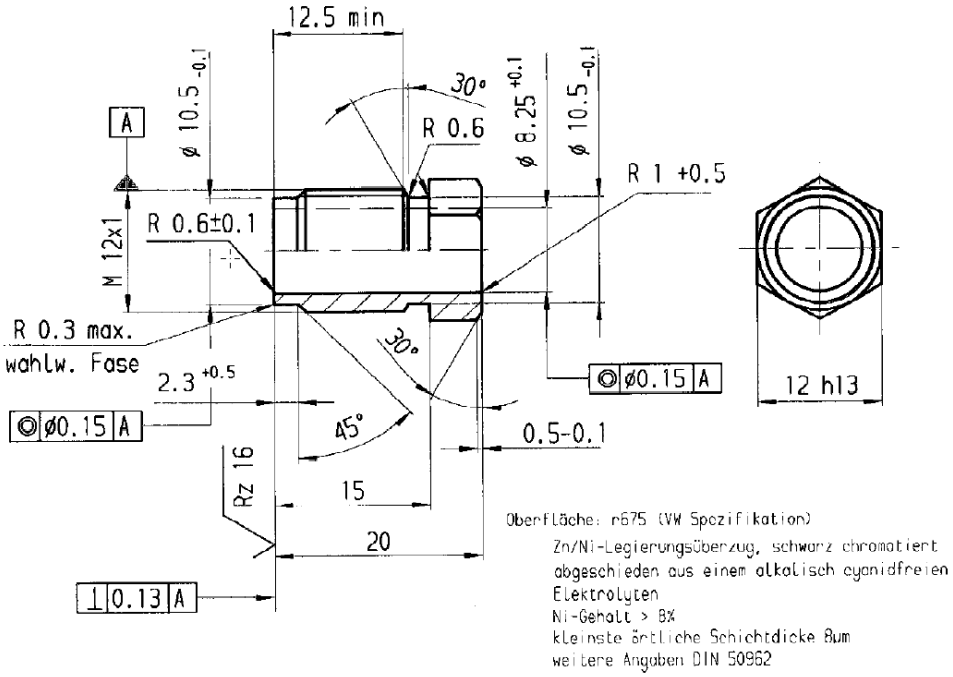
- Suction line length < 1.0 m



- Suction line length > 1.0 m
  - Prevent a suction line > 1.0 m, because the pressure drop and the function pressure build up dynamic is restricted by a longer brake line.
  - If it is impossible to install the hydraulic unit near to the master cylinder, an exception should be checked together with Bosch, additional pressure build up measurements are necessary.

Fittings

Do not use anything else but the standard M12 fittings.



5.5 Brake Fluid

Safety relevant due to influence on tightness of system to the outside and threat to life and physical condition

The accumulator must be capable of utilizing any of the following glycol or glycol-ether based brake fluids listed below (defined in SAE J1703, FMVSS 116 and ISO 4925 (JIS K2233)) including a mix of any of the fluids in any combination.

- DOT3
- DOT4
- DOT4+(plus)
- DOT4NV
- DOT5.1
- SuperDOT4+(plus)
- As the accumulator is to be used in a braking system, it is necessary that the accumulator does not contain chlorine- or sulphur-containing inorganic substances or free copper, as this can lead to critical corrosion in the hydraulic unit, with the risk of internal/external leakage or loosening of HU components under high pressure (->highest severity). As well, it must also not contain mineral oil nor plasticizers/softeners on phthalate basis (including components that may segregate these substances).

⚠ DANGER

Contamination with mineral oil can result in a breakdown of the brake system!

6 Laptop Communication

The MSA-Box II from Bosch Motorsport is the communication interface between EBS and the programming and diagnostic software on your laptop. The MSA-Box II has two connectors: a USB connector for connection to the laptop and a motor sports connector for connection to the mating connector in the vehicle wiring harness.

Installing the MSA-Box II driver:

Before using the MSA-Box II for the first time, you need to install a specific driver on your laptop. Find the driver for free download on our website www.bosch-motorsport.com.

NOTICE

Please make sure that the MSA-Box II is not connected to the laptop while you are installing the driver.

Connect the MSA-Box II to the laptop after installing the driver. This will trigger the initial communication between the laptop and the MSA-Box II. Follow any prompts that may follow to install the MSA-Box II. Once you complete any prompts and computer recognizes the MSA-Box II, the MSA-Box II is ready for use.

Steps:

1. Unplug the MSA-Box II from the laptop.
2. Install the driver.
3. Plug the MSA-Box II into the laptop.

You can connect EBS to a laptop with the MSA-Box II via the "diagnosis interface" connector. The diagnosis interface connector should be placed so it is easily accessible. You can use programming and diagnosis software, see section Programming and Diagnosis Software, to program settings specific to the vehicle and open/delete error messages.

7 Programming and Diagnosis Software

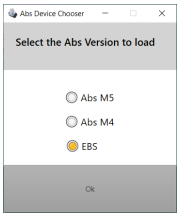
7.1 Installing

After installing the MSA-Box II, you need to install the programming and diagnostic software RaceABS. You can find the software for free download on our website: www.bosch-motorsport.com

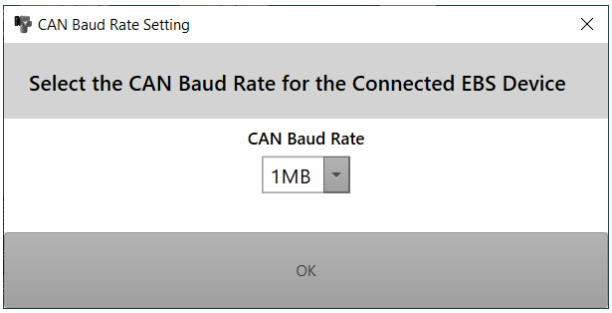
Switch on the ignition

Plug the MSA-Box's USB connector into your laptop and its motorsport connector into the EBS wire harness diagnostic interface to enable communication.

The installation creates a shortcut on your desktop to the RaceABS software. Click it to start the application. A green status indicator shows when the connection is successful. A window pops up where you can select your brake system, choose EBS in this case.

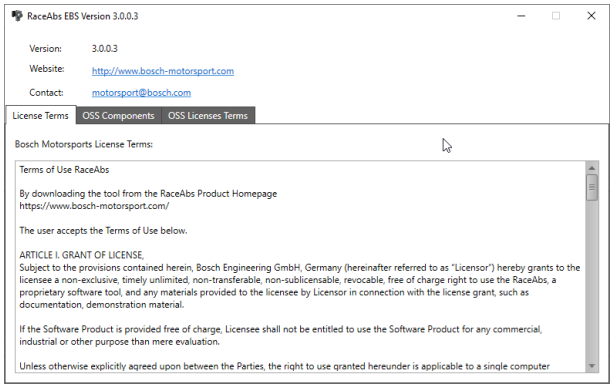


Next step is to choose the CAN Baud Rate of your EBS system. It is the same CAN Baud Rate as your ECU: 500 kB or 1 MB .

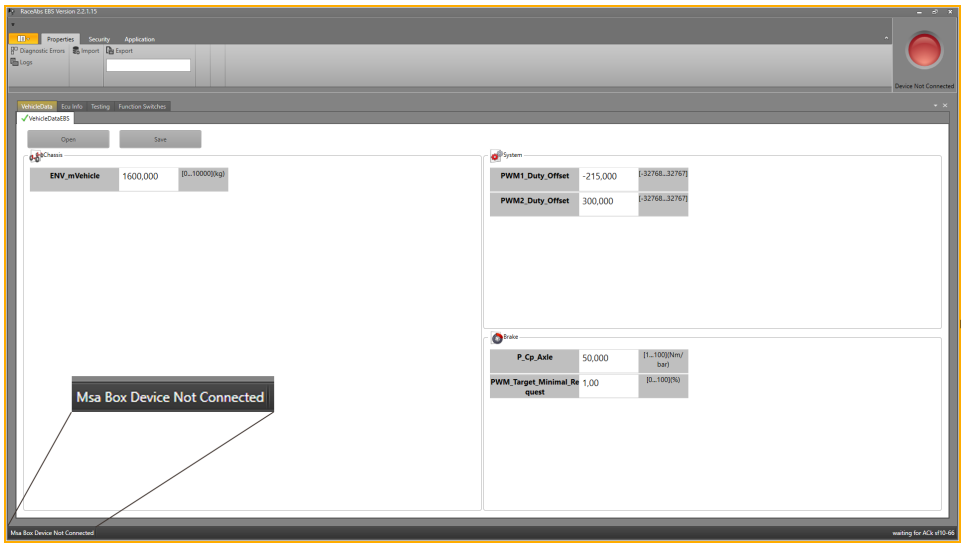


Click OK and the main window opens.

Behind the orange button in the left corner of the headline, you will find information about your RaceABS version, license terms and OSS details.



If you try to launch the software without the MSA-Box II to laptop connection, the status indicator in Explorer lights red / yellow and an error message appears in the status bar:



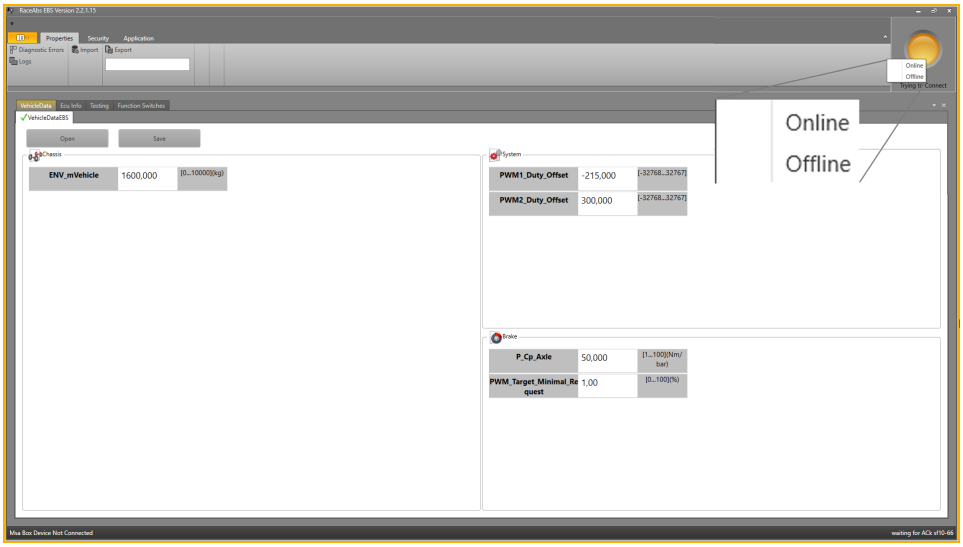
Colors of the status indicator

The status indicator can light up in the following colors:

Red	No connection
Yellow	Connection in progress or MSA-Box II cannot create a connection with the EBS (e.g. EBS switched off)
Green	Connection successful, Online mode
White	Offline mode
Red / Yellow flashing	MSA-Box II is not connected to the laptop

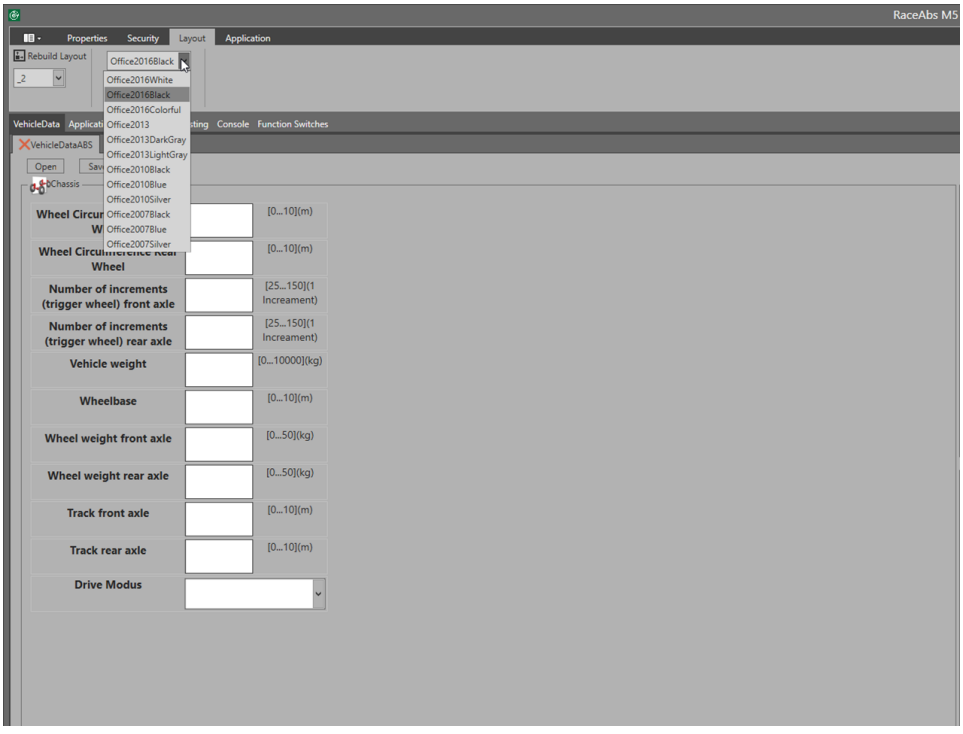
Change between Online and Offline Mode

If a connection does not exist, it is easier to operate with the diagnosis software in Offline Mode. Please click with the right mouse button on the status indicator to choose between Online and Offline Mode:



Custom Theme Selection

Selection of Custom Themes / Skin is now possible in RaceABS. This helps the customer to configure the Tool as per his requirements.



7.2 Features

Diagnostic Code

The EBS-ECU sends the stored errors as coded data to RaceABS. These codes are then translated by a translation file and displayed on the page “Ecu Info” in RaceABS as plain text.

After installation of RaceABS, a default file will be used for the translation. If you don´t see plain text or if there is an orange colored warning, you do not have the matching translation file to your software. With a not matching file, some codes cannot be translated or might be translated in the wrong way. Therefore it is important to use the correct translation file.

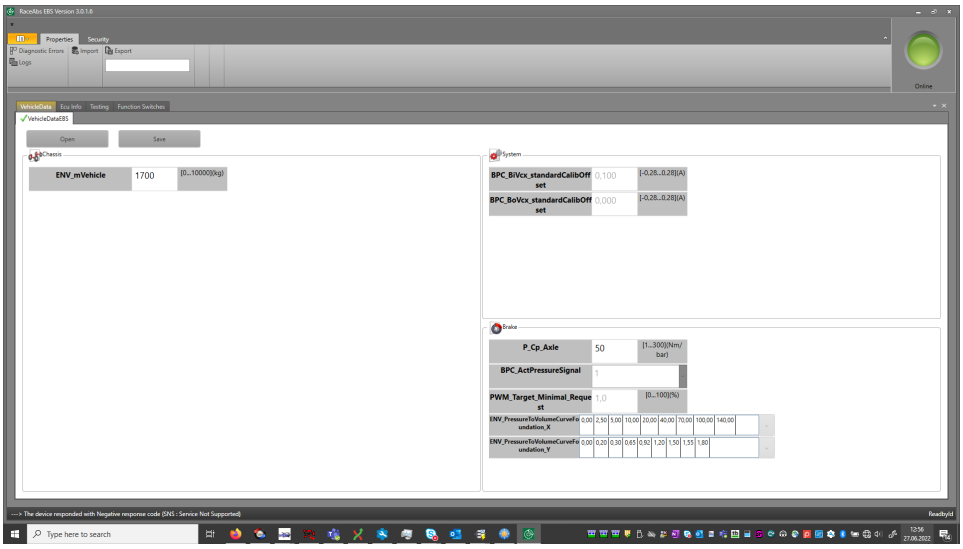
To get the correct translation file, please conduct the following steps:

- Check on the top of the “ECU Info” page which software number and software version is used in your EBS.
- Go to the Bosch Motorsport homepage and download the matching diagnostic translation file to your software. You will find in the naming of the diagnostic translation file the software number as BB number and the version as a V number, zeros at the end might be skipped in the naming. The numbers of the file need to match the numbers of the software. The file is an .XML file.
  - For example if your EBS runs on the Software Number 99703 and the Software Version 03.00.07.01.00.00, you will need the Diagnostic errors file (99703/v03.00.07.01.00.00).

- Store the file on your computer.
- Click in RaceABS on “Properties” - “Diagnostic Errors” and select the matching diagnostic translation file.

You will find the most common translation files on our homepage. If your needed file is missing, please contact your dealer or the OEM customer service.

7.2.1 Vehicle Data



Fill in the weight of your vehicle in kg at **ENV_mVehicle**.

The parameters in the **Brake** area in the right part of the window are pre-filled by Bosch Motorsport and can only be changed after consultation with us.

- **P_Cp_Axle** shows the friction value between brake pad and disc.
- **PWM_Target_Minimal_Request** shows in percentage the minimum triggering limit. Beneath this value, no PWM target will be implemented. The value should be a little higher than the toggle value. You will get the toggle value by analyzing the EBS data.

7.2.2 ECU Info (Diagnostics)

If you connect your vehicle with your laptop via MSA box, the EBS will fill in the values for Software Number, Software Version, Ignition Cycle Counter, App Name and Build Data.

Indication lamp

When you turn on the ignition or the EBS, the warning light (MIL) comes on briefly and then turns off again. This indicates the light's self-testing process. If the warning light (MIL) does NOT light up when you turn on the ignition or the EBS, you must establish the reason for this before taking any further action or before driving the vehicle.

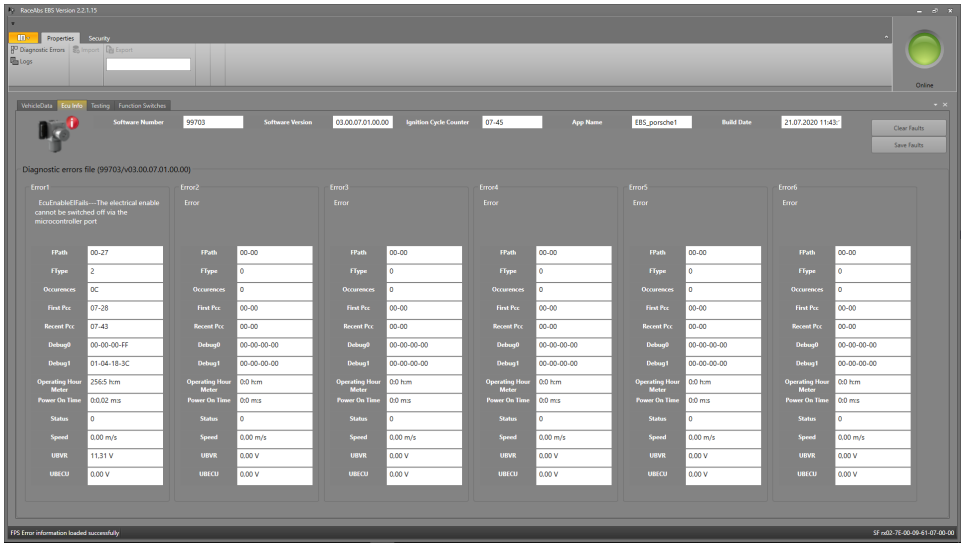
NOTICE

The MIL will stay illuminated as long as the diagnostic tool is switched on.

If you use a wrong software version, the MIL will blink from the moment you are driving. It will not blink in standstill.

Error log

If the warning light (MIL) is illuminated PERMANENTLY when you turn on the ignition or the EBS, or while driving, there is a system error. Extract the system's internal error log to analyse the error. You can access the log by clicking on the **ECU Info** tab in the RaceABS software.



Old errors are grey, actual errors are highlighted in orange.

You'll find a complete overview of error log entries in an Excel sheet on the EBS product site at www.bosch-motorsport.com.

NOTICE

System reset after drive cycle faults.

Drive cycle faults, e.g. PWM faults, need an EBS-ECU reset (Power off - Power on) in the proof of a good signal.

ECU soft reset

Quicker than an ECU reset is an ECU soft reset. You can run it with a right mouse click and ECU soft reset. ECU soft reset deletes error logs.

Save Faults

If any error log entries occur which are not explicit translated, please contact your dealer or the OEM customer service. Communication would be easier if you also send a copy of your error log entries.

Click on the right button named "Save Faults" to get a copy of your saved error files.

Clear Faults

After carrying out the problem-solving actions, delete the entry from the error log by clicking on the **Clear Faults** button. Then turn EBS off and on again. After you deactivated the software, the indication lamp will no longer glow.

After **Clear Faults** and **ECU soft reset**, only the actual remaining faults will be displayed.

NOTICE

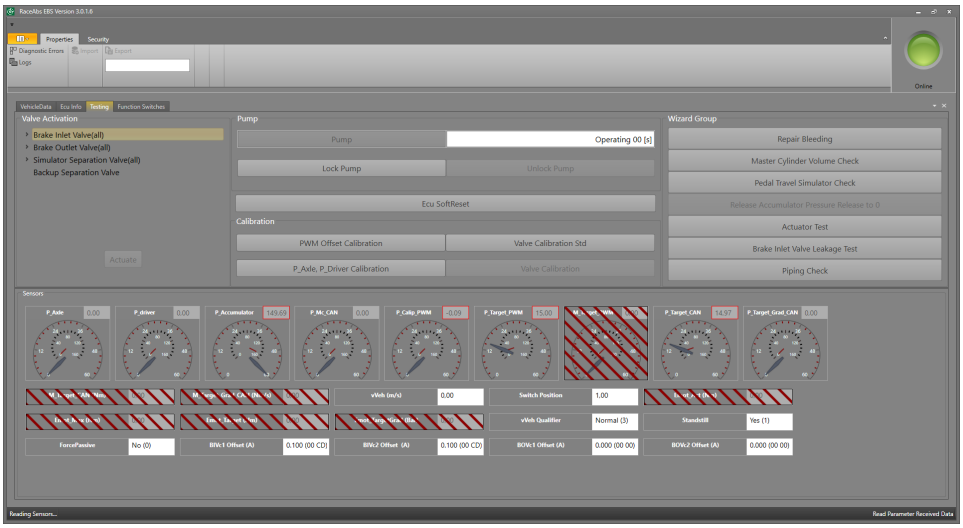
If the faults are not all clearly described or if there is no error description, please check if you used the correct XML-file or contact Bosch Motorsport for update.

Ignition Cycle Counter

The Ignition Cycle Counter shows how often you switched on the ignition. If you compare the values of the Ignition Cycle Counter and ICC at Failure Occurrence, you can trace back at what time the faults occurred. If both fields show the same values, it is an actual fault.

The values of Ignition Cycle Counter ICC and Power Cycle Counter PCC are identical.

7.2.3 Testing



Valve Activation

The specific valve activation functionalities are for advanced troubleshooting and should only be used by Bosch specialists.

Pump

Lock Pump

This function deactivates the electrical pump. With a locked pump, you can check how many brake cycles are possible in the case of a pump failure. You also use this function if you want to decrease the hydraulic pressure of the EBS system to zero.

Unlock Pump

Press **Unlock Pump** to reactivate the pump and rise the system pressure to 160 bar. Pump should run now until the system pressure reaches 160 bar and switch off then.

⚠ WARNING

Hands off from the calipers during the calibration process. The EBS will activate the brakes, and this can lead to injuries.

Calibration

Calibration in general is not necessary periodically. We recommend it after installing the EBS system into the vehicle. Please contact us if you need help or if you have any questions.

Press **PWM Offset Calibration** to calibrate the values P_Calip_PWM and P_Target_PWM to zero. Make sure the VCU is sending "0", then press the button and follow the step-by-step procedure.

The pressure sensors P_Axle and P_Driver are system-internal factory calibrated sensors. If the hands of the P_Axle- and the P_Driver-clocks are not facing to zero in stillstand, press the **P_Axle, P_Driver Calibration** button and follow the step-by-step procedure.

If the values for **BIVcX Offset** and **BOVcx Offset**, displayed at the bottom of the **Testing page**, are different from the respective **standardCalibOffset** values displayed in the **VehicleData page**, you need to run the **Valve Calibration Std** routine. After running the routine, please make a power cycle.

If you still have problems, please contact Bosch Motorsport.

Wizard Group

Repair Bleeding

With this button, you will be guided step by step through the bleed of the EBS unit. This might be required if air got trapped in the accumulator of the EBS unit. It is recommended to perform the EBS unit bleed after installation or if air got trapped in the brake lines and might got caught in the EBS unit.

Click on the button “Start Wizard”, a new window will open and lead you step by step through the instruction for bleeding the EBS unit. You will need three people to conduct the instruction. See also Repair Bleeding Wizard [▷ 26].

Master Cylinder Volume Check

Check your logged data before you start this function.

Here you can check if the volume of the main break cylinder offers enough volume to run the EBS system safely. Therefore, the system closes the valve to the pedal feel simulator abruptly and opens the valve to the mechanical brake at the same time. Now the brake pressure on the axis should have at least 50 % of the value measured before. If the brake pressure on the axis is significantly lower, the volume of the master cylinder is too small and should be changed against a bigger one.

This check can also be very helpful in the case of suspected leakage at the master cylinder.

To run the check, press the **Master Cylinder Volume Check** button and follow the step-by-step procedure.

Please log the data of P_Mc and P_Caliper shortly after the backup change for later analysis.

Pedal Travel Simulator Check

This function can be used for running the purposes of the pedal travel way. What is the drivers feeling of the break? Does it feel too hard or too soft? Best would be if the driver would not realize the EBS systems work.

Press the button and follow the step-by-step procedure.

Release Accumulator Pressure Release to 0

This function depressurizes the system to zero. Use it to depressurize the system for a longer time or if you have to open the hydraulic system e.g., for repairing. Please lock the pump at first.

The hand in the P_Accumulator clock should point to zero. Repeat if you have rests of pressure in the system.

Please realize that the system was designed for a maximum number of 900 high pressure/ low pressure cycles.

Actuator Test

This function checks the proper work of the valves. Please contact Bosch Motorsport for using this function.

Brake Inlet Valve Leakage Test

Use this function if you have the suspicion of a leakage. Click the button and follow the step-by-step procedure.

Piping Check

After assembling the pipes, you should check if all parts like pedal feel simulator, caliper or reservoir are fitted correctly. Therefore, click the button and follow the step-by-step procedure.

Sensors

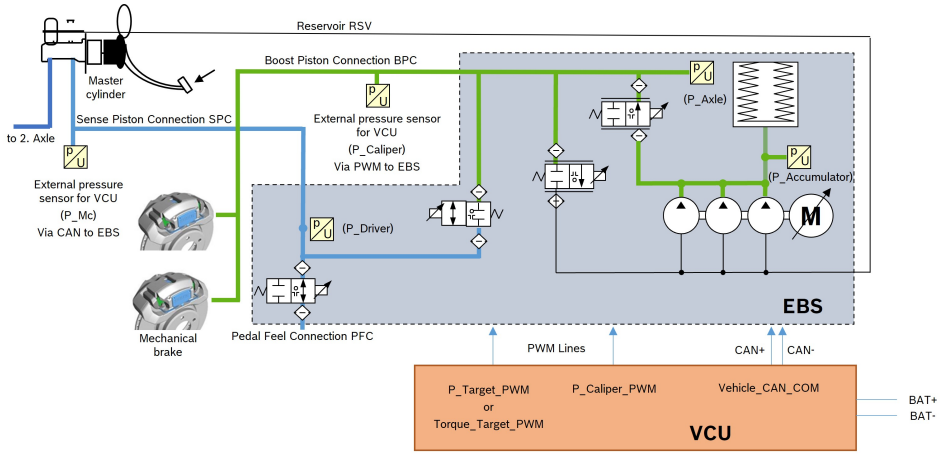
P_Axle (internal sensor inside the EBS unit) shows the hydraulic pressure of the mechanical brake at the axle, see also graphic below.

P_Driver (internal sensor inside the EBS unit) shows the drivers pressure on the brake pedal.

P_Accumulator (internal sensor inside the EBS unit) shows the pressure of the hydraulic accumulator of the EBS, see also graphic below.

P_Mc_CAN (external sensor) shows the hydraulic pressure at the master cylinder. It is measured by the VCU and is transmitted to the EBS via CAN.P_Driver andP_Mc_CAN should be identical. See also graphic below.

P_Calip_PWM (external sensor) measures the pressure between the calipers and the EBS and communicates with ECU and EBS system via CAN and PWM.



Targets

The EBS system gets the target values from an external software. They are handed over as a torque value M or a pressure value P.

vVeh (m/s)

The vehicle speed vVeh should be zero in standstill.

Switch Position

Here you see the chosen switch position 1 to 6.

vVeh Qualifier

Quality information of the vVeh signal, as received via CAN.

Standstill

EBS recognized standstill when the vVeh is close to 0 m/s and the quality is valid.

ForcePassive

Indicates if the VCU is sending the "Force Passive" request on CAN

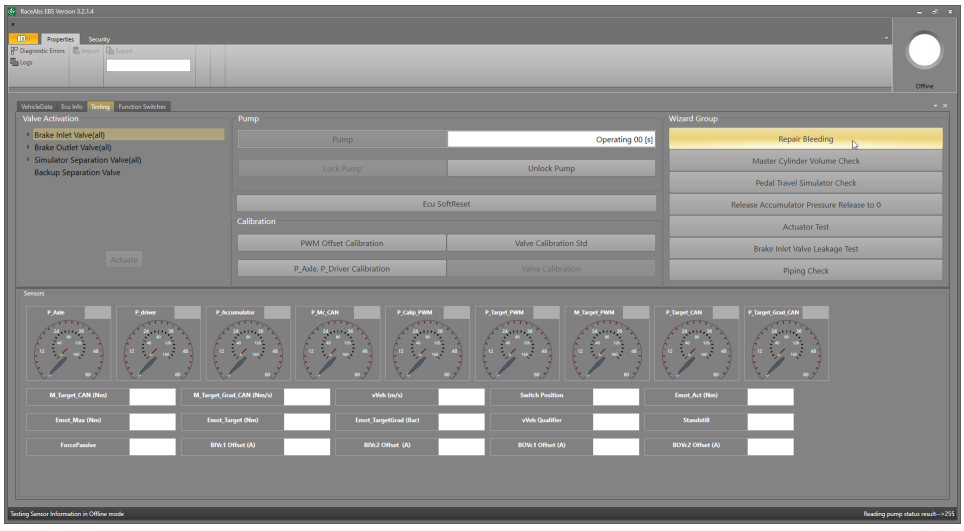
Bxxx Offsets

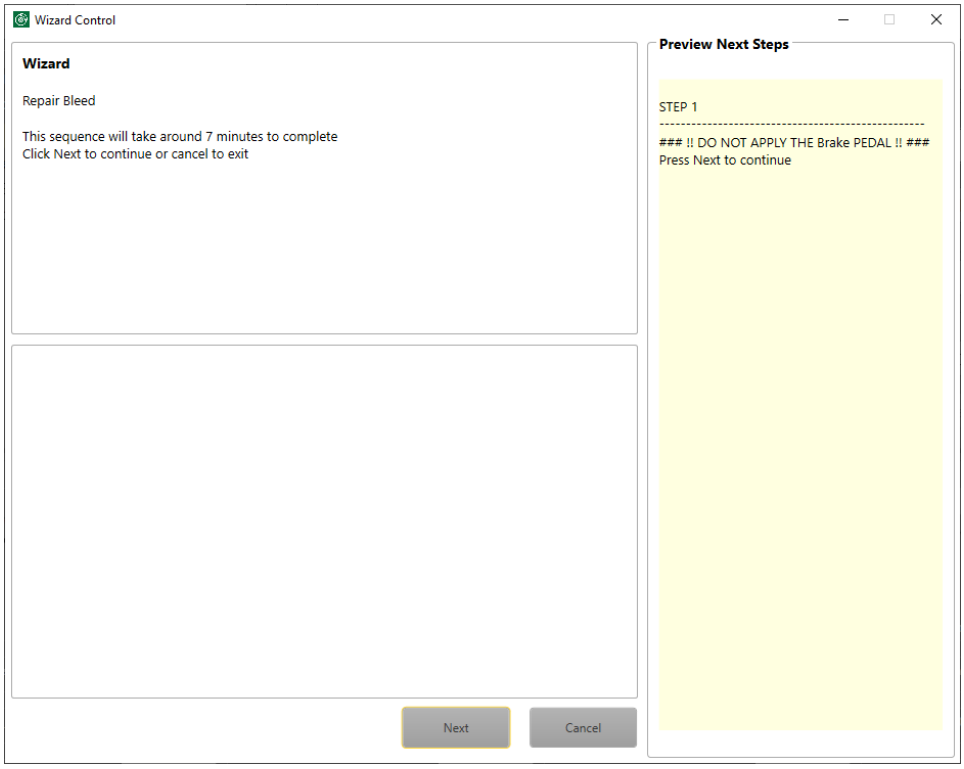
Show internal offsets for the different actuation valves. Used by Bosch specialists.

7.2.4 Repair Bleeding Wizard

This chapter describes the procedure of bleeding the hydraulic unit of the EBS system in 13 steps:

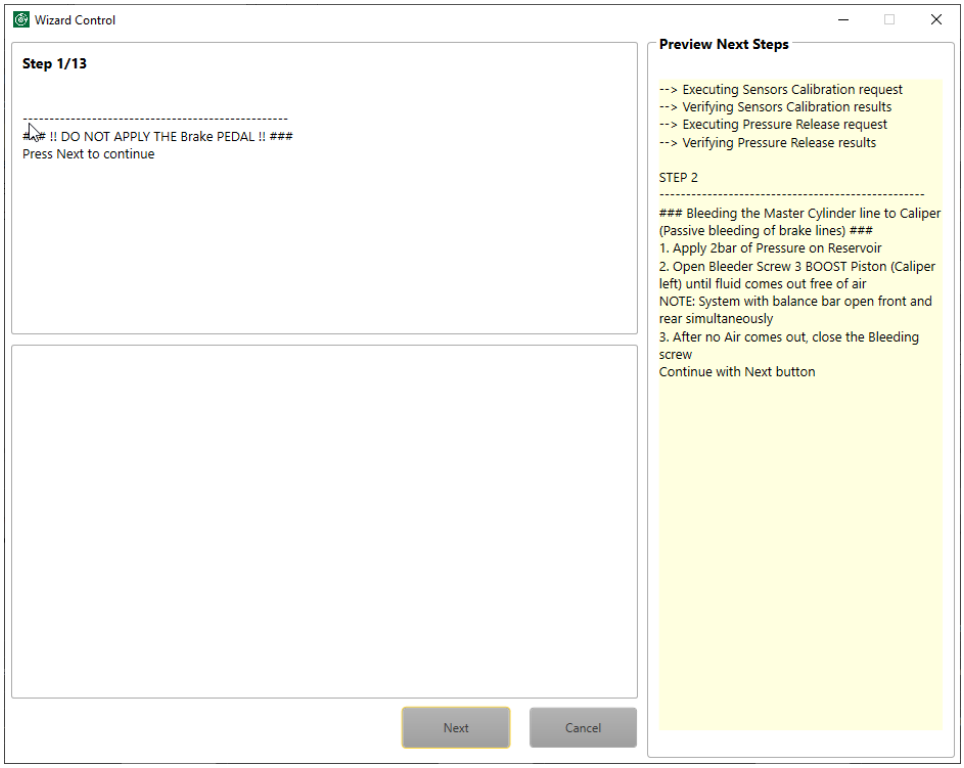
1. Unit preparation for bleeding
2. Bleeding MC to Caliper left without pedal pressure.
3. Bleeding MC to Caliper right without pedal pressure.
4. Bleeding MC to Caliper right/left with pedal pressure.
5. Bleeding MC to Pedal feel simulator without pedal pressure.
6. Bleeding MC to Pedal feel simulator with pedal pressure.
7. Close Bleeder Screw for pedal feel simulator
8. Bleeding Accumulator to Caliper left or right line without pedal pressure.
9. Close Caliper Bleeder Screw
10. Remove the 2 Bars from Reservoir
11. Bleeding Accumulator to Reservoir suction line
12. Recharge Accumulator with valves actuation
13. Bleeding Pressure release valves to Reservoir





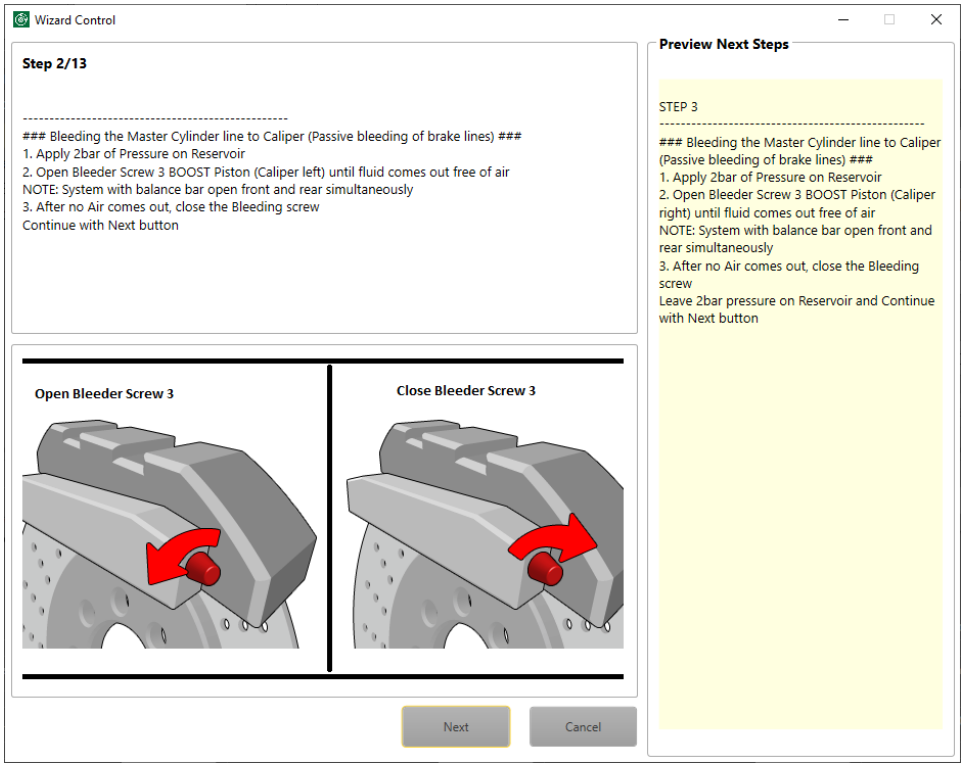
Step 1: Unit preparation for bleeding

This step is preparing the system for bleeding.



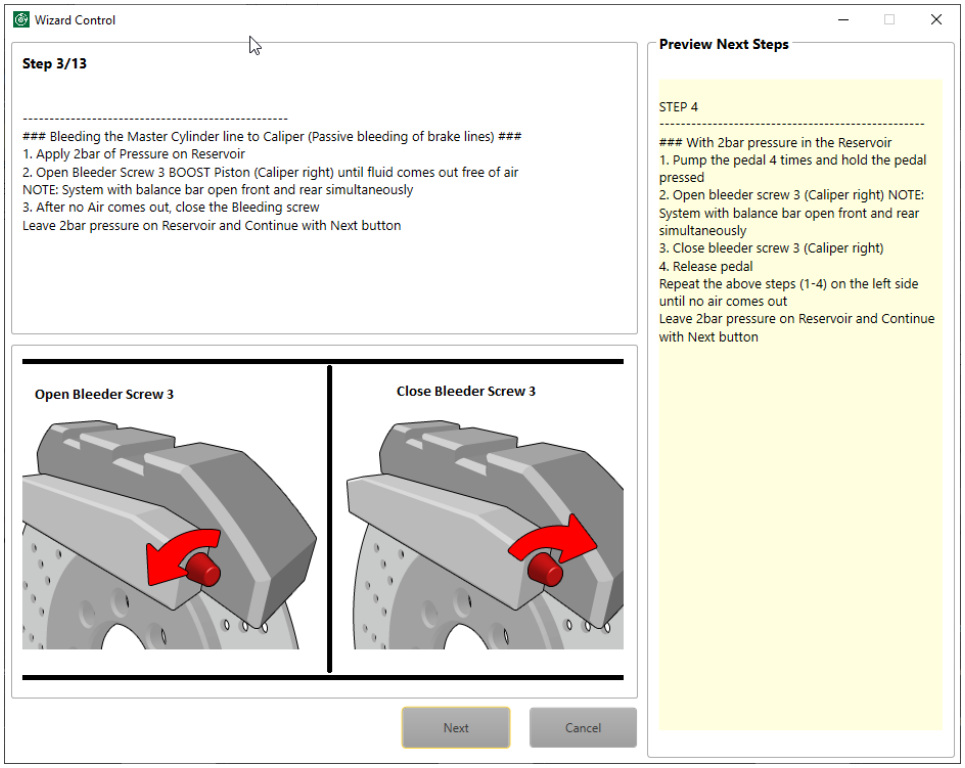
Step 2: Bleeding MC to Caliper left without pedal pressure

Bleeding the line between Master Cylinder and Caliper left. System is in passive mode, no valves actuation. By using the 2 bar on the reservoir, the fluid will be pushed to Caliper.



Step 3: Bleeding MC to Caliper right without pedal pressure

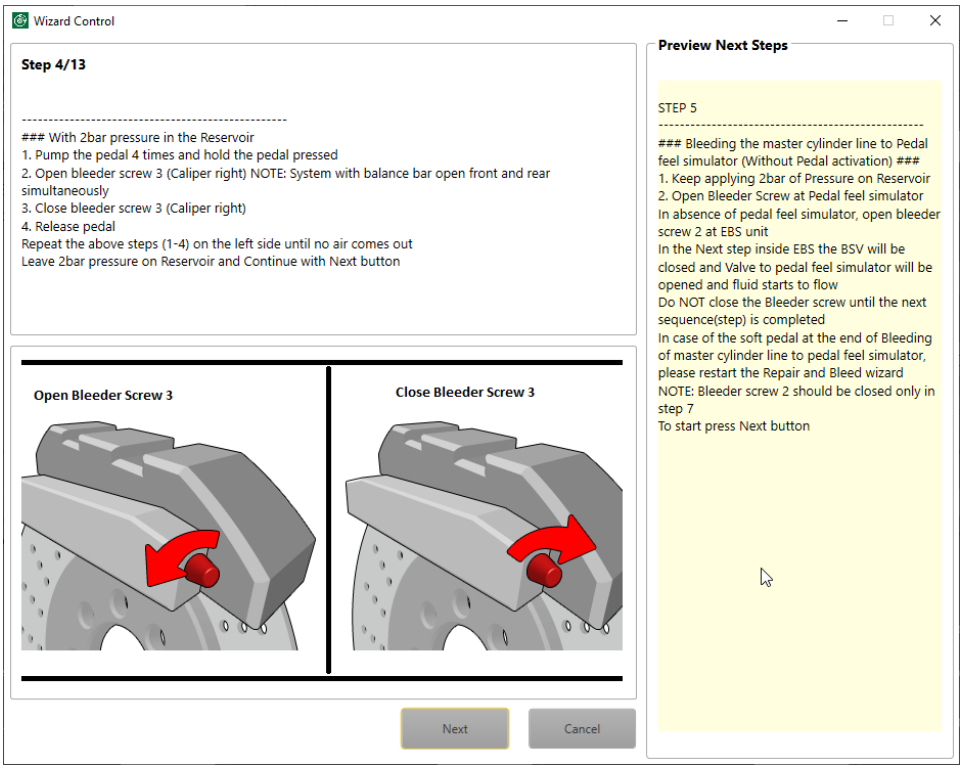
Bleeding the line between Master Cylinder and Caliper right. System is in passive mode, no valves actuation. By using the 2 bar on the reservoir, the fluid will be pushed to Caliper.



Step 4: Bleeding MC to Caliper right/left with pedal pressure

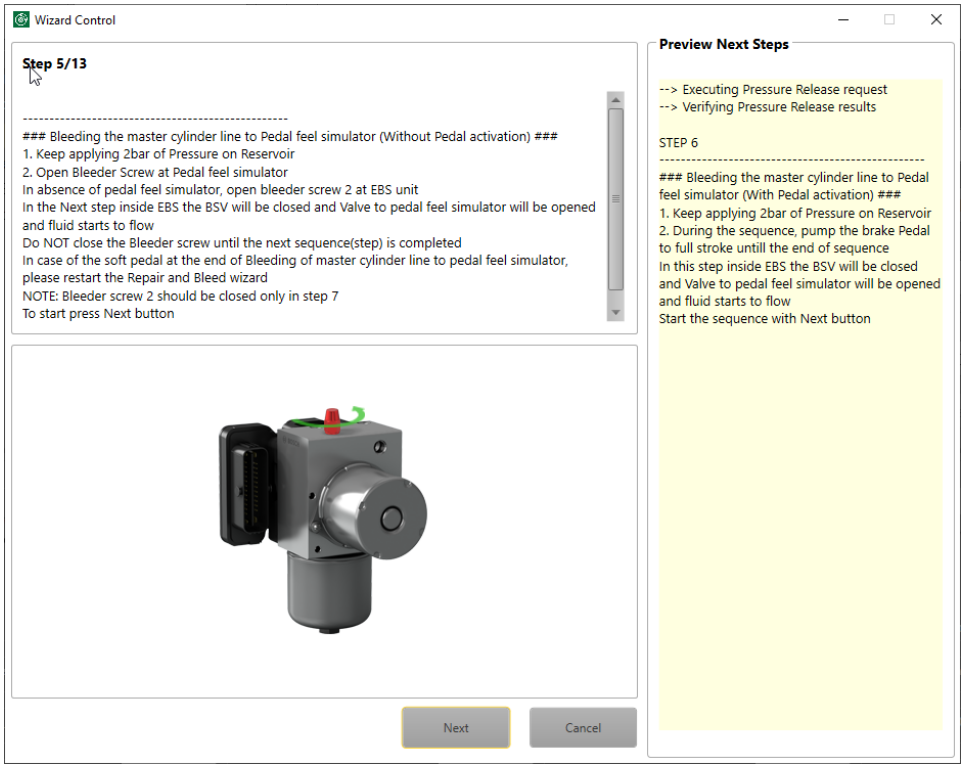
Bleeding the line between Master Cylinder and Caliper right and left under pedal pressure. System is in passive mode, no valves actuation. The pedal pressure pushes the air towards the brake Caliper.

Note that by using balance bar you need to open front and rear bleeding screws simultaneously.



Step 5: Bleeding MC to Pedal feel simulator without pedal pressure

Bleeding the unit and pipe to pedal feel simulator. The fluid will start leaking after you pressed **Next** button.

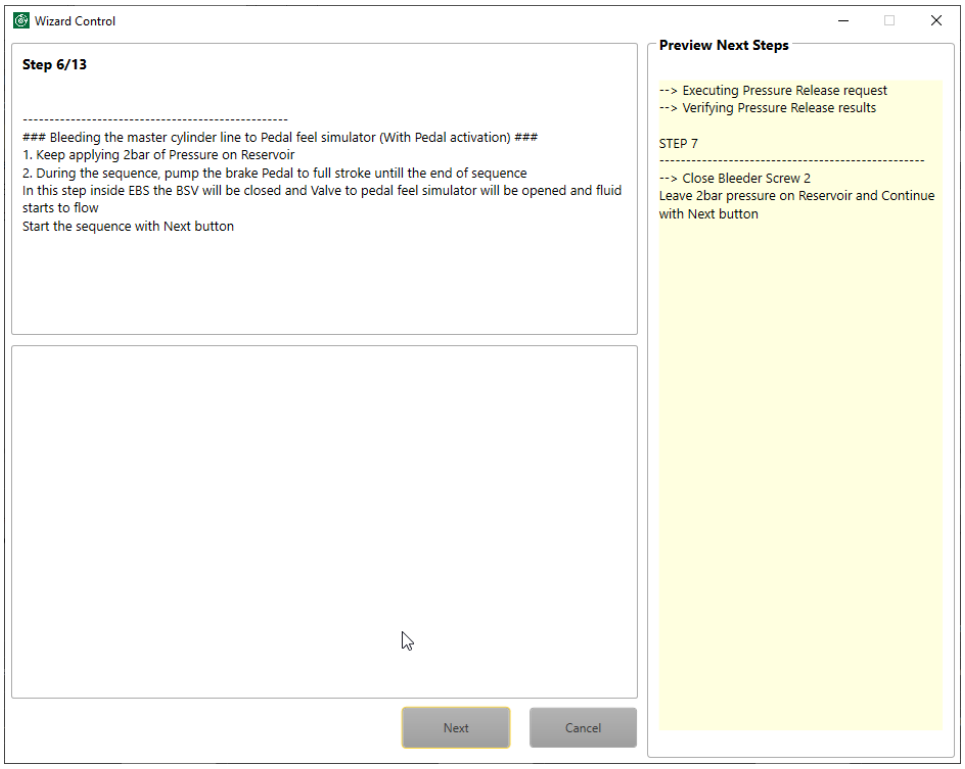


Step 6: Bleeding MC to Pedal feel simulator with pedal pressure

Bleeding the unit and pipe to pedal feel simulator with pedal pump. The fluid will start to leak after you pressed **Next** button.

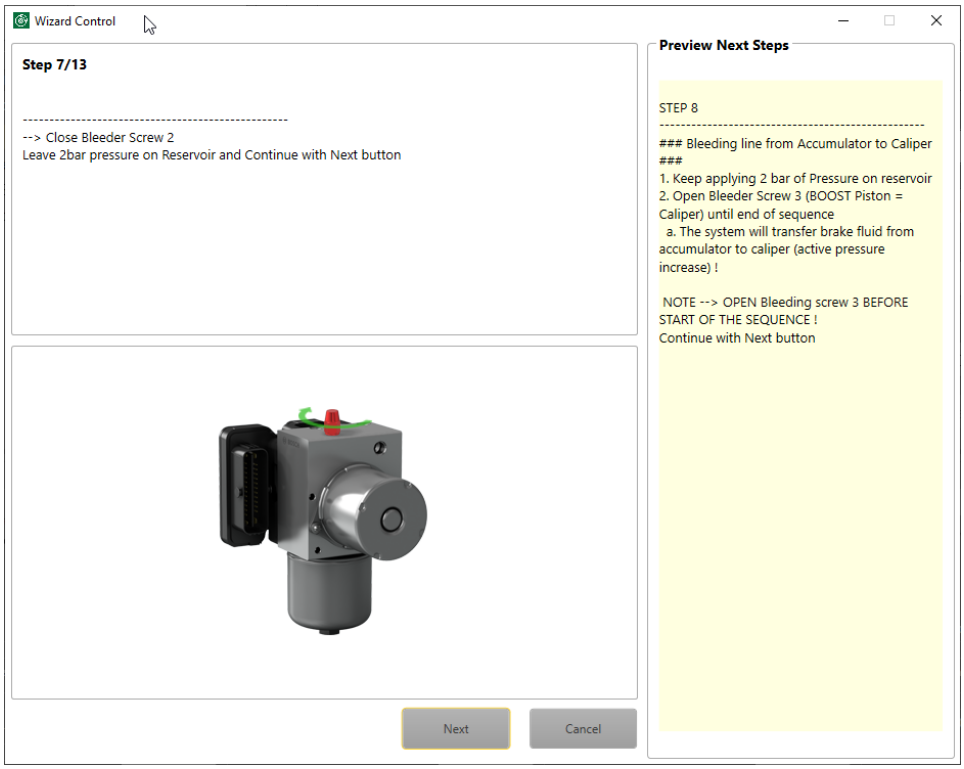
When Step 6 is finished, close the Bleeder Screw.

If step 5 and 6 are not correct, air will be the reason for a long pedal in active mode.



Step 7: Close Bleeder Screw for pedal feel simulator

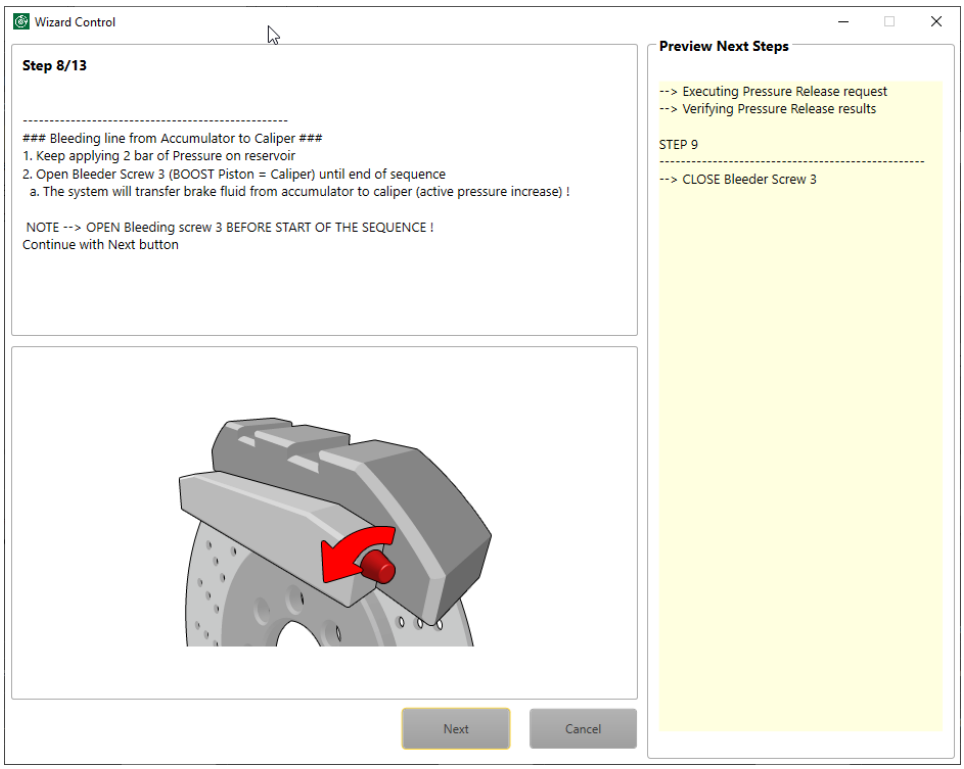
If not done after step 6, close Bleeder Screw for pedal feel simulator.



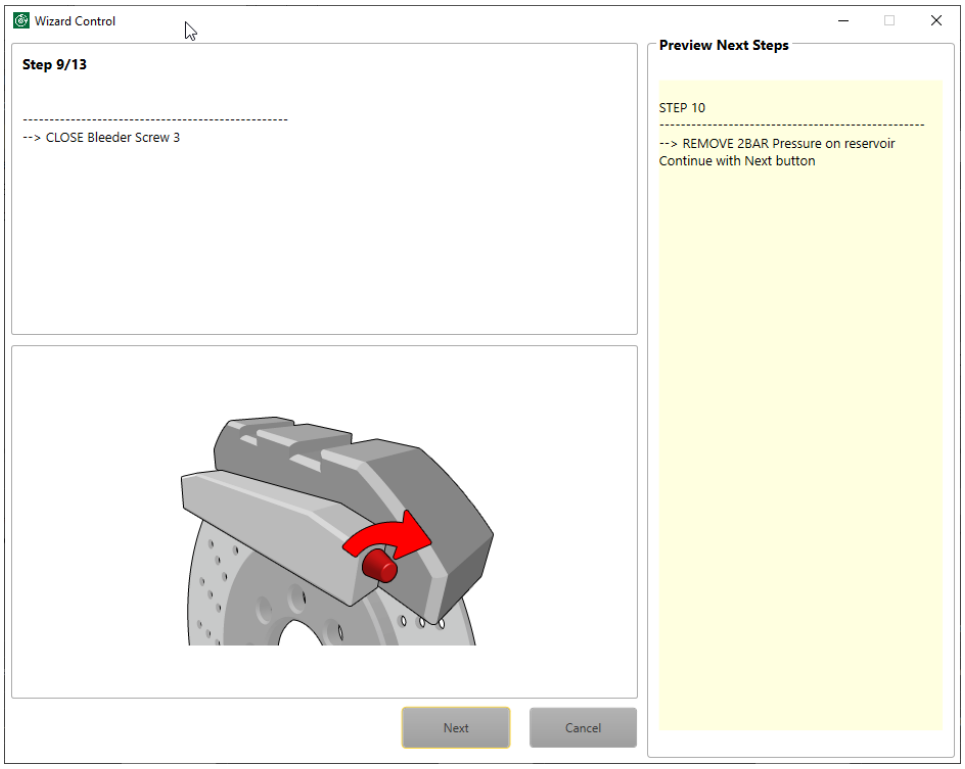
Step 8: Bleeding Accumulator to Caliper left or right line without pedal pressure

System will start an active pressure increase after pressing the **Next** button.

In this step, it does not matter whether you use the Bleeder Screw 3 on the right Caliper or the Bleeder Screw 3 on the left Caliper for bleeding. Both works equally well. We recommend using the Bleeder Screw that is more accessible.

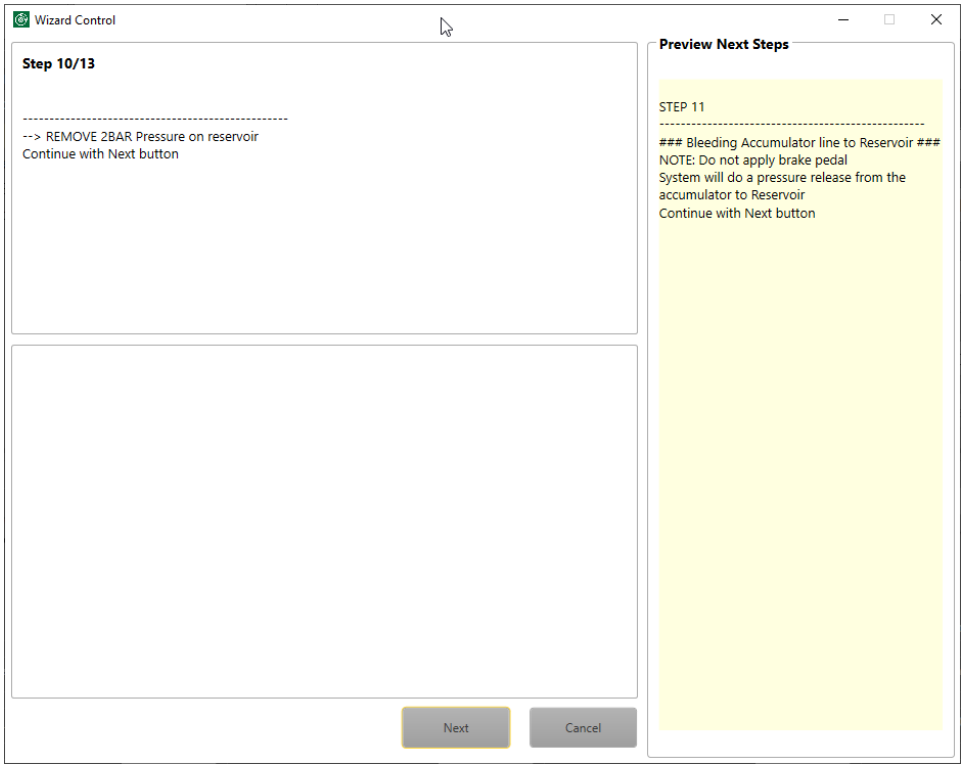


Step 9: Close Bleeder Screw 3 at the Caliper



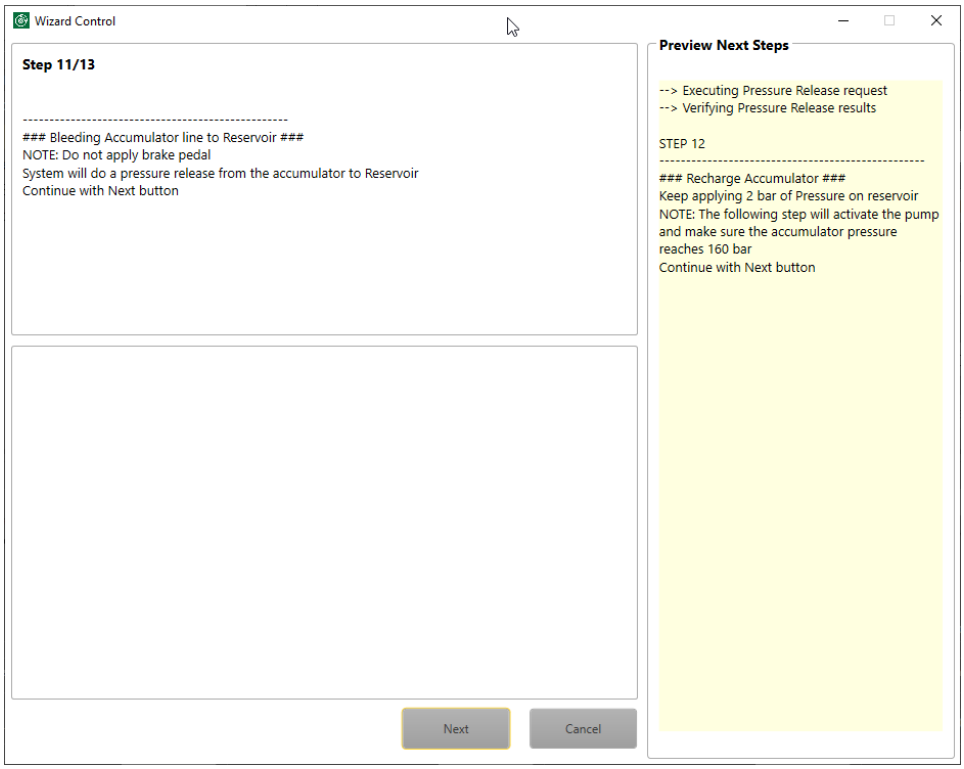
Step 10: Remove the 2 bar from Reservoir

Reservoir needs to be opened to be able to collect the brake fluid volume from the pressure release in step 11.



Step 11: Bleeding Accumulator to Reservoir suction line

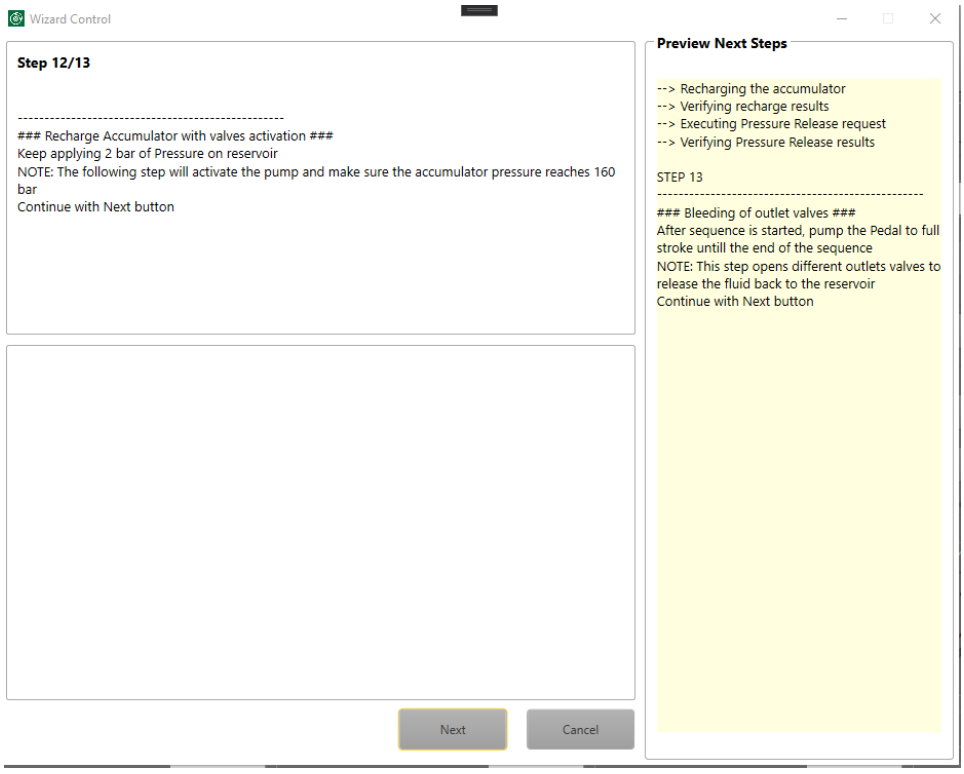
Pressure release will start after pressing the **Next** button.



Step 12: Recharge Accumulator with valves actuation

2 bar of pressure on the reservoir is optional. It is important that the reservoir is filled with enough brake fluid.

After pressing **Next** button, the system will start a pressure increase with valves control.

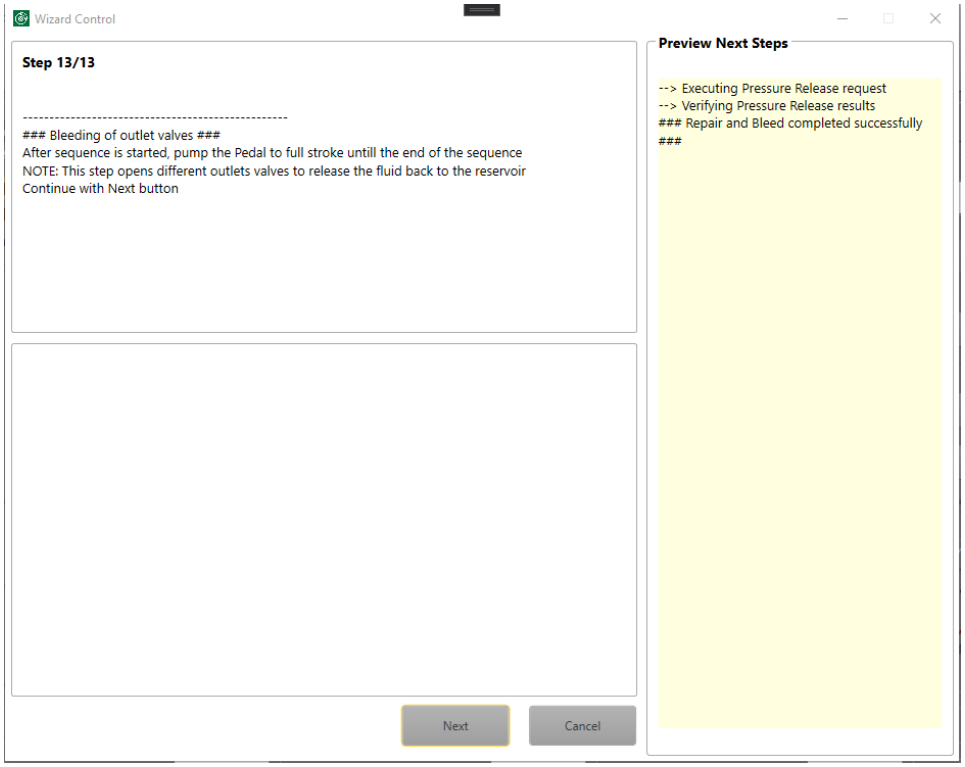


Step 13: Bleeding Pressure release valves to Reservoir

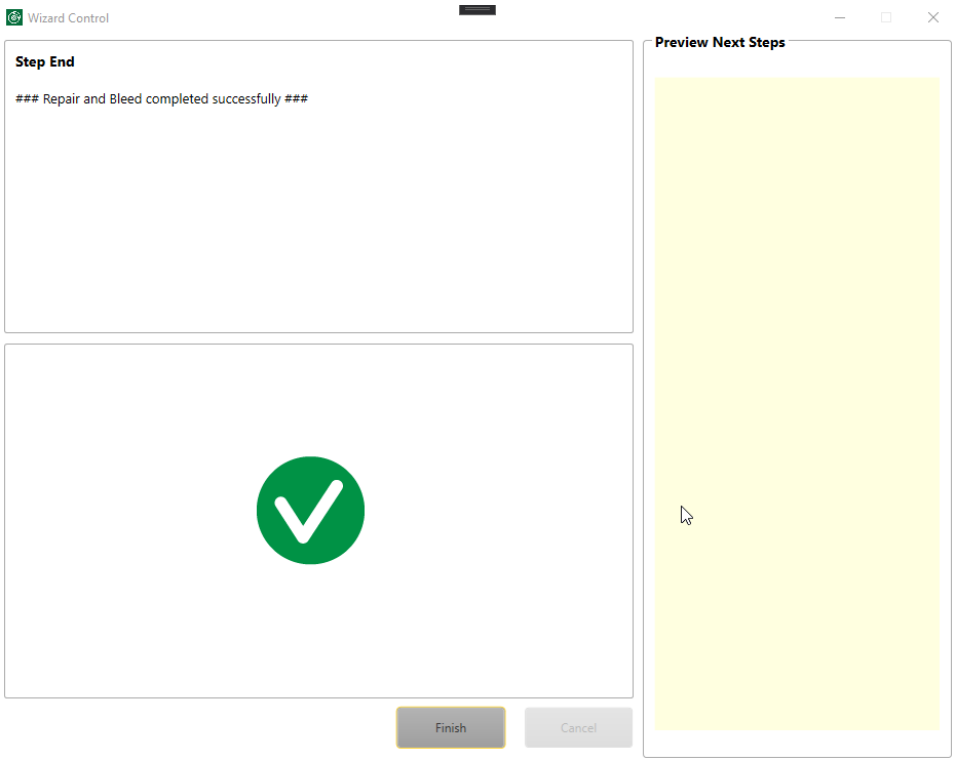
This is a verification step.

Press the pedal in normal frequency, but with full stroke. Pressure needs to drop by releasing the pedal below 3 bar.

Action will start after pressing the **Next** button.



Pressing **Finish** will close the bleeding session.



7.2.5 Function Switch

Configuration

CanBaudrateSwitch

Choose 500 kB or 1 MB for the communication of the EBS with the other devices inside the car.

EBSType

Choose the type of your EBS system

- Type 1 gets target pressure from external software.
- Type 2 gets target torque from external software.
- Type 3 works with EBS internal calculations and sends requirements to the electrical motor. This project will be finished only on customer request.

MCU CAN Monitoring

Deactivate specific monitorings in case the Bosch electric motor is not used.

Multiswitch

Default Position

For the function switch, you can specify a default value. If the switch fails for any reason, it automatically takes the position of the default value. To assign a position for the default value, select a number between 1 and 6 under “MultiSwitch” in the field “Default Position”. When making your choice, take into account the information on the characteristics in chapter Principle of Operation [▶ 6].

PWM Offset Calibration

The PWM Duty Offset values shown here are the results of the PWM Offset Calibration you have previously performed in the **Testing** window, see also Testing [▶ 23]. The values can only be manipulated after consultation with Bosch Motorsport.

8 Startup Checklist

This short checklist is intended to supplement the EBS's manual, not replace it. Prior to using this checklist, the user/installer should read the EBS manual, especially section Laptop Communication to Assembling the Parts.

Basics

- EBS unit mounted as specified in the drawing Offer Drawing EBS Unit [▶ 49].
- Brake pressure sensor installed in proper location? See section Brake Pressure Sensor.
- Everything plugged in to harness, power ring terminals connected to battery, ground ring terminals connected to solid and clean chassis ground, circuit breakers installed properly, map switch turns off system. See section Brake Pressure Sensor.

Software Tool and Error Checking

- Connect to the EBS unit with MSA-Box II using RaceABS Software and ensure that all vehicle data has been entered correctly. The vehicle data can be saved and or loaded by right clicking in the screen.
- With the system on, switch to the "ECU Info" page and clear errors with clicking on Clear faults. Wait a moment (system will self-refresh error stack). Reset the system by switching off/on. Check if any errors reappear in the error stack. If errors reappear, diagnose errors before proceeding. If anything was unplugged during the diagnostic process, errors will be present and need to be removed from the error stack. Next, verify no errors are present after cycling power, see section ECU Info (Diagnostics).

Error Notes

- Critical failures (like CAN or PWM), or the ForcePassive request, will prevent the pump from running.

Function Check

- While connected with the RaceABS software, switch to the "Testing" page. Check all sensors for plausibility and proper function. Rotate map switch, the value **Switch Position** should turn up clockwise.

NOTICE

If the pump does not start, make sure that there is neither an error message nor a Force Passive request.

"Force Passive request" means a request from the VCU to the EBS not to switch to the active state under any circumstances, refer to CAN DBC.

⚠ WARNING

Please ensure that the system is in Force Passive mode during the boot phase.

9 CAN Protocols

The following tables give a short summary of the CAN protocol. If you need any details, Bosch Motorsport will send you the latest .dbc version. Please send an email to motorsport@bosch.com

Name	ID	GenMsgSendType	DLC...	Cycle Time
TqM_EBS_Ctrl1	0x30	Cyclic	8	5
EBS_TqM_Ctrl1	0x41	Cyclic	8	5
Dash_EBS_Multiswitch	0x24D	Cyclic	1	40
EBS_Info1	0x311	Cyclic	8	5
EBS_Mes1	0x3FF	Cyclic	8	5
EBS_Diag_RaceABS_Rx	0x741	Event	8	0
EBS_Diag_RaceABS_Tx	0x761	Event	8	0

The message EBS_Mes1 (0x3FF) only contains data for application and debugging. The VCU / TorqueMaster does not need to read this message.

If you need more information on the CAN interfaces for the variant 2 or 3 of the EBS (torque controlled, or EBS as brake torque master), please send an email to motorsport@bosch.com.

9.1 CAN Signal Description

9.1.1 CAN Input Signal Information

EBSin_p_BrakeTarget

The requested target pressure that the EBS should set at the axle. This value should always match the value transmitted on the PWM channel

EBSin_ForcePassive

Force the EBS to switch to passive mode. The connection from the master cylinder to the brake caliper will be open. The target pressure request will be ignored.

EBSin_p_MC

The pressure measured between the master cylinder and the EBS, by an external sensor. The EBS compares this value to its internal value to ensure the functional safety of the system.

EBSin_p_MC_Quality

Quality information on the pressure measured by the external sensor. Refer to the extended qualifier values description below.

EBSin_Chassis_BrakePedalApplied

The state of the brake pedal measured by an external sensor. The EBS uses this value to ensure the functional safety of the system.

EBSin_Chassis_BrakePedal_Quality

Quality information on the brake pedal state. Refer to the extended qualifier values description below.

EBSin_Chassis_vVeh

The current speed of the vehicle. This information is used to detect when the vehicle is standing still. The EBS switch to passive mode (status Prerun) when the vehicle is in standstill. The Diagnostic communication with RaceABS is also only available when the vehicle is standstill.

EBSin_Chassis_vVeh_Quality

Quality information on the vehicle speed. Refer to the extended qualifier values description below.

EBSin_Force_Active_Standstill

Force the EBS to switch to Active mode, even if the vehicle is in standstill. Some of the safety monitorings are also disable, to allow the execution of brake tests in the box (without brake pedal activation).

⚠ WARNING

This feature should only be used for the duration of the brake tests.

Leaving the EBS in active mode during maintenance work at the wheels is a major risk of injury for the mechanics.
A prolonged active braking (longer than 2 minutes) might overheat the internal valves and permanently damage the EBS. Bosch cannot be held responsible for any damage caused by the mis usage of this feature.

MsgCounter_4bit and MsgChecksum_8bit_J1850

Refer to message counters and checksums section below.

EBSin_Multiswitch

Request the EBS to use the specific set of application parameters (from 0 to 5). If the signal is not available the EBS will use the default application parameters set, as configured via RaceABS.

EBSin_ForceFaultRecovery

Request the EBS to perform a software reset, to recover from a failure state. The request is detected when a signal goes from 0 to 1. The vehicle has to be in standstill *(EBSin_Chassis_vVeh_Quality == Normal(2) AND EBSin_Chassis_vVeh <= 1 m/s)*. During reset, the EBS will be silent on CAN, for up to 500 ms, and the verification of some failures can take up to 5 seconds. The currrent state of the SW reset handling in the EBS is visible on signal *EBS_FaultRecovery_ack*.

9.1.2 CAN Output Signal Information

EBS_CtrlMode_Ack

This signal returns the SW variant of the EBS currently in use (pressure command, torque command, etc.)

EBS_Diag_EBS_Hardware

This bit is set to 1 if a failure has been detected on a hydraulic hardware component (pump, valve relay, etc.)

EBS_Fcount

Returns the number of active failures currently present in the failure memory.

EBS_BPC_Mode

Indicates if the EBS is currently increasing, decreasing, or holding the pressure.

EBS_Diag_p_MC_CAN

This bit is set to 1 if a failure related to the external master cylinder pressure sensor has been detected.

EBS_Fast_Increase_state

This bit is set to 1 if the fast increase feature is active.

EBS_BoVs_state

This bit is set to 1 if outlet switch valve is open.

EBS_BiVs_state

This bit is set to 1 if inlet switch valve is open.

EBS_BoVc2_current

This signal shows the electrical current applied to the second controllable outlet valve.

EBS_BoVc1_current

This signal shows the electrical current applied to the first controllable outlet valve.

EBS_BiVc2_current

This signal shows the electrical current applied to the second controllable inlet valve.

EBS_BiVc1_current

This signal shows the electrical current applied to the first controllable inlet valve.

EBS_CPU_Idle_Time

This signal shows the free CPU processing time.

EBS_safetyIntegrity

This signal shows the safety state of the system:
0 "full system available": no fault has been detected in the system
1 "performance related fault": at least one fault is active, but the EBS can still be used in active state
2 "critical fault": the EBS is forced to passive state because a critical fault has been detected
3 "safety critical fault": the hydraulic braking cannot be guaranteed anymore, the vehicle should go to the box for maintenance. This happens because a leakage on the axle side has been detected, or because the backup separation valve is stuck.

EBS_Diag_pCaliper_extPWM

This bit is set to 1 if a failure related to the external caliper pressure sensor has been detected.

EBS_Diag_pTarget_extPWM

This bit is set to 1 if a failure related to the PWM pTarget channel has been detected.

EBS_Status

This signal informs about the detailed internal status of the EBS.

0 "EBS_Status_off": The EBS is in passive mode, due to an error or an external request. The EBS lamp will be on.
1 "EBS_Status_Diag": The EBS is currently connected with RaceABS, and is performing calibration or diagnostic routines. The EBS is generally in passive mode, but can becoming active upon diagnostic request The EBS lamp will be on.
2 "EBS_Status_PreRun": The EBS is in passive mode, because the vehicle is in standstill. This prevents any unnecessary activation of the valves, and avoids any potential overheating. The EBS lamp will be off.
3 "EBS_Status_Act_WoReg_WoExt": The EBS is active, but some issues prevent the accumulator to be refilled. The system will switch to passive if the accumulator is emptied. The EBS lamp will be blinking.
4 "EBS_Status_Act_WoRegen": The EBS is active, but some safety monitorings are disabled, because the EBS is not able to read the current electrical recuperation torque on the axle. The EBS lamp will be blinking.
5 "EBS_Status_Act_WoBackup": The EBS is active, but some issues might prevent the EBS to switch to passive mode. This happens when a leakage is detected, or when the backup separation is stuck. The EBS lamp will be blinking.
6 "EBS_Status_Active": The EBS is active and fully operational. The EBS lamp will be off.
7 "EBS_Status_ActiveGoodCheck": The EBS is active and fully operational. An internal background check is ongoing, because of a failure detected during the previous power cycle. The EBS lamp will be off.

EBS_lamp

The lamp indicates the availability of the system, based on errors and other external requests. This signal should be forwarded to the dashboard to inform the driver:
0 lamp OFF: The EBS is in active mode
1 lamp ON: The EBS is in passive mode, due to an error, an ongoing diagnostic or a force passive request

Blinking lamp: The EBS is in active mode but is functioning in an unsafe state. It happens when a leakage is detected, or when some redundancy check cannot be performed due to missing inputs.

EBS_malfunction

The lamp indicates the availability of the system, based only on errors state.
0: The EBS is in active mode
1: The EBS is in passive mode, due to an error
Toggling 0/1: The EBS is in active mode but is functioning in an unsafe state. It happens when a leakage is detected, or when some redundancy check cannot be performed due to missing inputs.

EBS_pTarget_PWM_Quality

Quality information on PWM pTarget Channel. Refer to the extended qualifier values description below.

EBS_pCaliper_PWM_Quality

Quality information on PWM pCaliper Channel. Refer to the extended qualifier values description below.

EBS_pCaliper_extPwm

Caliper pressure measured by the external sensor and received via PWM.

EBS_pBrakeTarget_Ack

Target pressure request received via PWM.

EBS_pBrakeTargetGrad_Ack

Target pressure gradient as seen by the EBS after filtering.

EBS_TqM_Ctrl1_Cnt and EBS_TqM_Ctrl1_Chksum

Refer to message counters and checksums section below.

EBS_Multiswitch_ack

Returns the index of application parameter set currently being used by the EBS. It should equal to the requested index EBSin_Multiswitch + 1.

EBS_Diag_pAcc

This bit is set to 1 if a failure related to the pressure accumulator has been detected.

EBS_Diag_pAxle_int

This bit is set to 1 if a failure related to the EBS internal axle pressure sensor has been detected.

EBS_Diag_pDriver_int

This bit is set to 1 if a failure related to the EBS internal master cylinder pressure sensor has been detected.

EBS_PumpLocked

This bit is set to 1 if the EBS pump has been locked by diagnostic command.

EBS_pAxle_int

Axle pressure measured by the EBS internal pressure sensor.

EBS_pAxle_Quality

Quality information on the axle pressure measured by the EBS internal sensor. Refer to the extended qualifier values description below.

EBS_pDriver_int

Master cylinder pressure measured by the EBS internal pressure sensor.

EBS_pDriver_Quality

Quality information on the master cylinder pressure measured by the EBS internal sensor. Refer to the extended qualifier values description below.

EBS_pAccumulator

Current pressure inside the EBS accumulator. The normal operating range is between 130 and 165 bar.

EBS_pAccumulator_Quality

Quality information on the EBS accumulator pressure. Refer to the extended qualifier values description below.

EBS_RecuInfo

This signal provides braking recommendations to the VCU, based on the EBS internal state:
0 "Recu Normal Strategy": The EBS is active, and there is no restriction on the electrical recuperation.
1 "deactivate Recu, EBS in backup": The EBS is passive, and the electrical recuperation should be deactivated, to avoid any overbraking.
2 "max Recu, no hyd. axle brake": a strong leakage has been detected between the EBS and the calipers. No efficient hydraulic braking can be performed on this axle. Electrical recuperation should be maximized to ensure a proper deceleration. The vehicle should return to the box for maintenance.

EBS_TqM_Info1_Cnt and EBS_TqM_Info1_Chksum

Refer to message counters and checksums section below.

EBS_FaultRecovery_ack

This signal informs on the state of the SW Reset feature requested via the CAN signal *EBSin_ForceFaultRecovery*. Once the reset is started (*EBS_FaultRecovery_ack == Recovery_ongoing(2)*), it cannot be interrupted. After restart, the EBS will always set the value of the signal *EBS_FaultRecovery_ack* to „*Recovery_done(3)*“.

EBS_Causal_Fault_Path

This signal contains the ID of the fault currently limiting the EBS status, if any (otherwise 0).

9.1.3 Information about Message Counters, Checksum, and Quality Signals

Message Counters

To ensure the proper transmission of the messages, the message counter signal should be incremented by 1 every time a new instance of this message is sent. The counter is 4 bits long, so the values should increment from 0 to 15, and then restart a new loop from 0.

Message Checksums

To ensure the proper transmission of the messages, the message checksum should be calculated every time the message is sent.

The checksum is calculated following the Autosar standard, as described in the following document (page 22):

https://www.autosar.org/fileadmin/standards/R22-11/CP/AUTOSAR_SWS_CRCLibrary.pdf

Qualifier values description

To improve the functional safety of the system, every physical value measured by a sensor, or an external ECU should be linked to a quality information signal. This signal informs the receiver on the level of trust that can be given to the related physical value. The states are defined as follow:

NoInit:

the signal source (sensor or external ECU) is not yet initialized, or the initial checks are not complete. **The associated value cannot be trusted.** However, this is a temporary state, and it should not be considered as a fault.

Normal:

the signal source (sensor or external ECU) is functioning as expected. **The associated value can be trusted.**

Suspicious

the signal read from the source is out of specification, but the failure is not confirmed yet (the debouncing time is not reached). This is a temporary state. **The associated value cannot be trusted.** The receiver can consider the value as invalid or use the last valid value.

Invalid

the signal read from the source is out of specification, and the failure is confirmed (the debouncing time has been reached/exceeded). **The associated value cannot be trusted.**

10 Leakage Recognition

Different leakage recognition logics are present in the EBS system.

Brake Inlet Valves (from accumulator to axle)

The EBS verifies the range of activation of its brake inlet valves during initialization, and monitors in the background that no brake fluid is flowing to the axle when the inlet valves are closed. In case of a minor leakage, a fault will be set, but the system will remain active if it is able to compensate this leakage. If the system does not manage to keep the actual pressure close to the target pressure within 200 ms, the system will switch to passive and return the control to the driver.

Brake Outlet Valves (from axle to reservoir)

The EBS verifies the range of activation of its brake outlet valves during initialization, and monitors in the background that no brake fluid is unexpectedly flowing from the axle back to the reservoir. In case of a minor leakage, a fault will be set, but the system will remain active if it is able to compensate this leakage. If the system does not manage to keep the actual pressure close to the target pressure within 200 ms, the system will switch to passive and return the control to the driver.

Backup Separation Valve

The EBS verifies the range of activation of its BSV during initialization and monitors in the background that no brake fluid is unexpectedly flowing from or back to the master cylinder pipe. The active testing of the valve during normal EBS functioning are currently deactivated, to avoid any unwanted influence on the pedal feeling. In case the BSV is blocked open, the system will be passive. If the BSV is blocked closed, the system won't be able to switch back to passive mode. It will remain active and the different CAN signals will be set to inform the driver of the critical safety issue.

Simulation Separation Valve (Pedal Feel Simulator)

The EBS verifies the range of activation of its SSV during initialization. The active testing of the valve during normal EBS functioning are currently deactivated, to avoid any unwanted influence on the pedal feeling. In case the SSV is cannot be controlled anymore, the system will switch to passive.

Connection from EBS to reservoir

During refilling of the accumulator, the EBS monitors the pump speed and the resulting volume flow. If the volume flow is outside of the defined range, due to air, or in case the canal is blocked, the system will switch to passive.

Caliper Pressure Loss

Based on the calibration data, the monitoring of the pressure buildup and the pump activations, the EBS can detect an unusually high usage of brake fluid.

In such a case, the EBS will consider there is a leakage at the axle or at the calipers. The EBS will remain in active mode and the different CAN signals will be set to inform the driver of the critical safety issue.

This monitoring is meant to detect severe leakages at the caliper side, and Bosch recommends the usage of a brake fluid level sensor to detect any fluid loss over the whole brake circuit.

11 PWM Signal Description

11.1 PWM Pins

Pin 31: Sensor Ground, recommended to connect with the VCU Ground, take care of proper GND concept, avoid Ground loops.
Pin 33: 5 V supply (**Do not connect this PIN**, except when directly recommended by Bosch).
Pin 36: PWM Channel 1 (P_Target_PWM_in).
Pin 37: PWM Channel 2 (P_Caliper_PWM_in).

11.2 PWM Hardware Interface

Signal line has EBS-internally a 3.4 kOhms pull-Up resistor (to 5 V). External PWM signal source must either pull-down signal level actively or (preferably) supply a 5 V logic (TTL-) signal.

Reference signal characteristics:
1 kHz PWM frequency with a signal level of 5 V for 'high' and 0 V for 'low'.

Voltage Levels:
EBS Voltage Level to identify a rising edge = 2.65 V
EBS Voltage Level to identify a falling edge = 2.25 V

Usage of Bosch Motorsport ECUs:
Bosch MS 50.4: pins DIG_OUT_01…04 (pins A30-A33)
Bosch MS 7: ignition driver pins for cyl. 11 and 12 (pins A13 and A14) can be used, with special release of generic PWM signal for these pins is set-up specifically in the IO-map.

11.3 PWM Signal Interpretation

This section of the manual has been reworked with the release of SW v06, to prevent any misunderstanding. However, the signal interpretation is the same as before.

The EBS duty cycle is calculated as follow (duty cycle EBS = tHighLevel / tPeriod).

The EBS has a precision of 0.025 % duty cycle (4,000 Samples per period).

On both channels (Pin 36 und 37), the duty cycle operation range is 10 % - 90 %.
Duty cycles below 10 % or above 90 % are considered as invalid.

PWM Channel 1 (P_Target_PWM in; Pin 36):

Duty cycle 10 % = minimum value
Duty cycle 90 % = maximum value

The signal is interpreted differently based on EBS Variant:

-Variant 1 - signal pTarget (0 to 160 bar)
-Variant 2 - signal MTarget (0 to 16,000 Nm)
-Variant 3 – unused

PWM Channel 2 (P Caliper PWM in; Pin 37):

The duty cycle interpretation is inverted:
Duty cycle 10 % = maximum value
Duty cycle 90 % = minimum value

For all variants, the signal represents the actual brake caliper pressure (0 to 260 bar).

12 Disposal

Hardware, accessories and packaging should be sorted for recycling in an environment-friendly manner.

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

13 Legal

13.1 Legal Restrictions of Sale

The sale of this product in Mexico is prohibited.

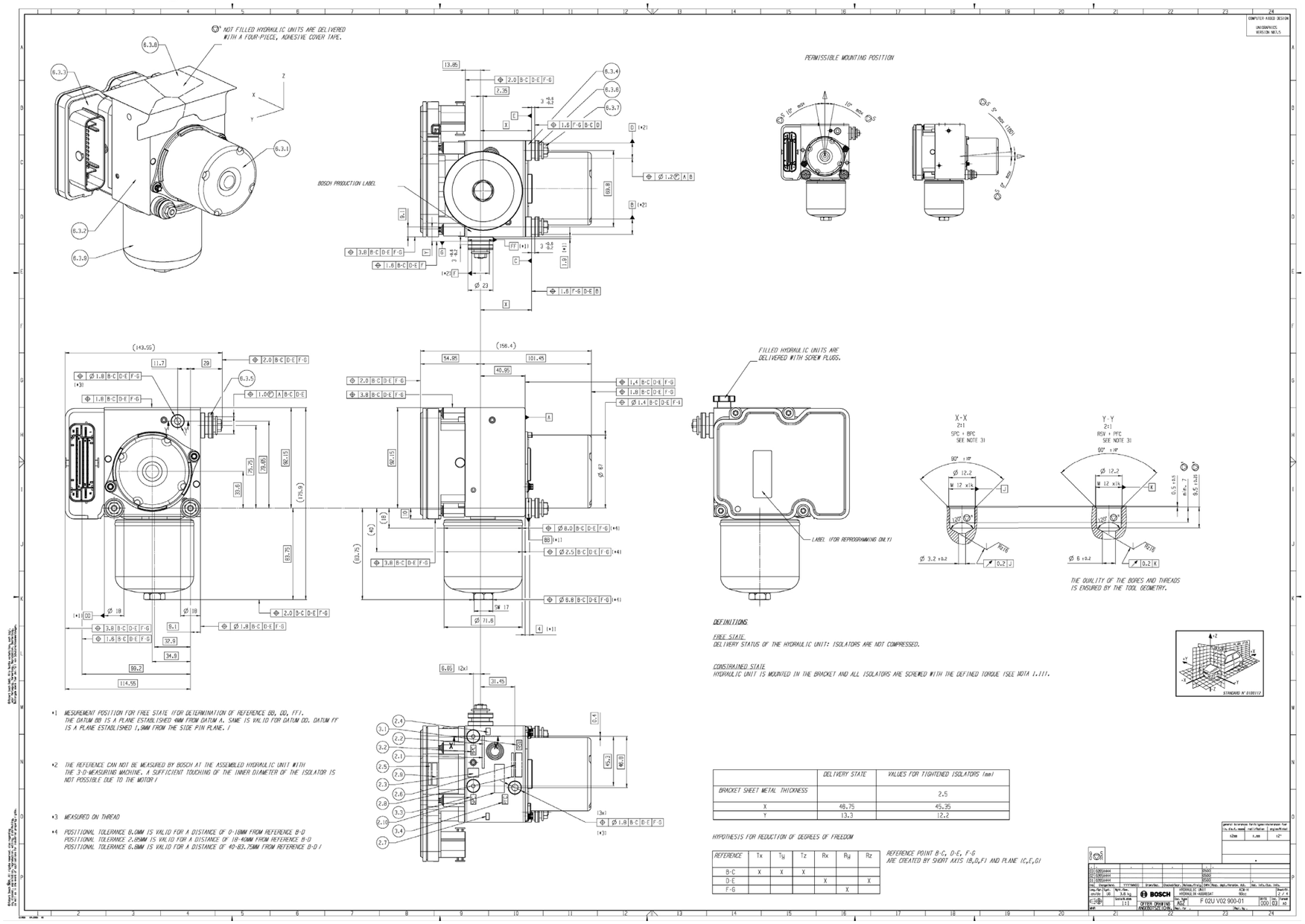
Due to embargo restrictions, sale of this product in Russia, Belarus, Iran, Syria, and North Korea is prohibited.

14 3D Models

You'll find 3D Models of the EBS on our homepage www.bosch-motorsport.com

15 Offer Drawings

15.1 Offer Drawing EBS Unit

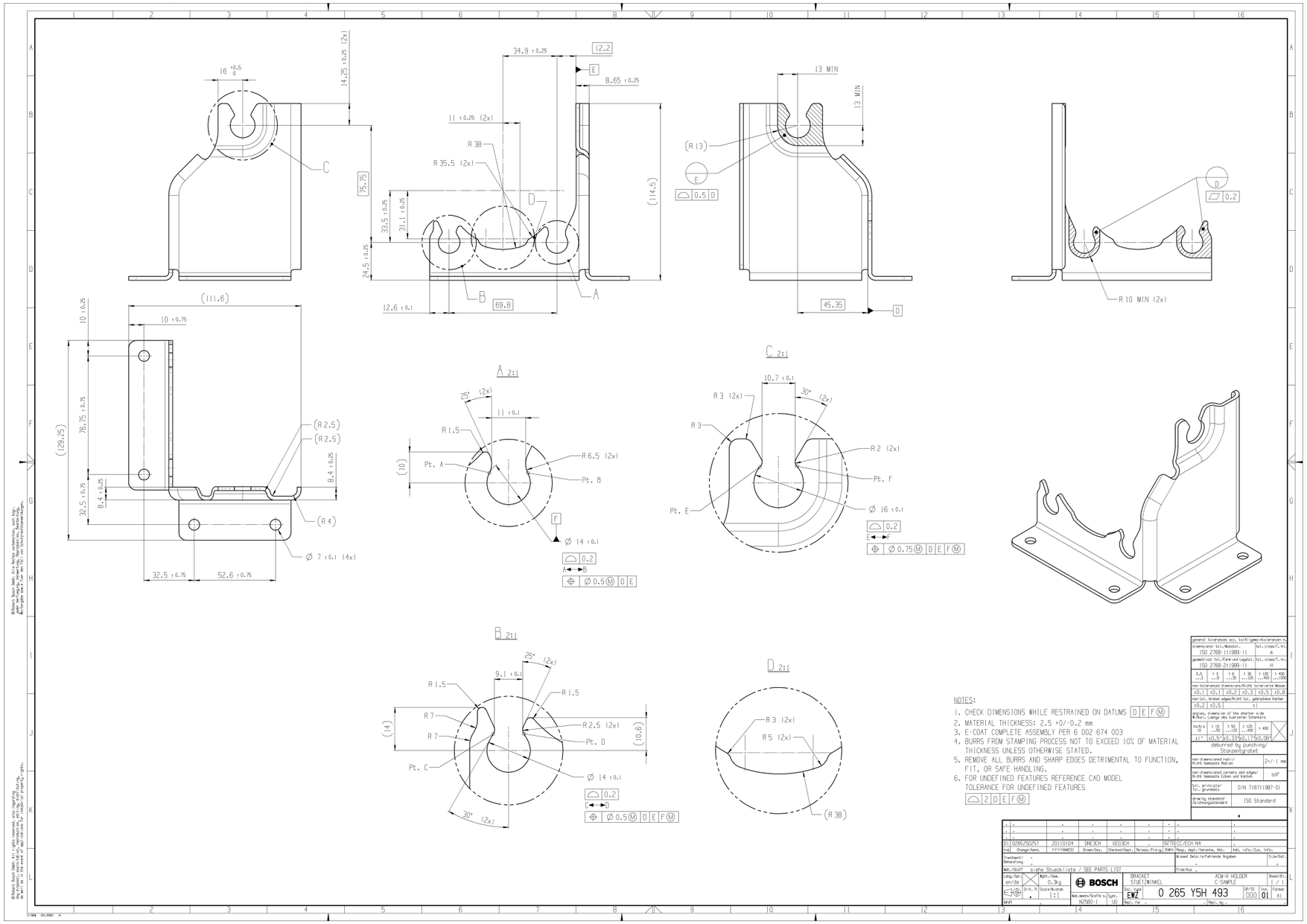


	DELIVERY STATE	VALUES FOR TIGHTENED ISOLATORS (mm)
BRACKET SHEET METAL THICKNESS		2.5
X	48.75	45.35
Y	13.3	12.2

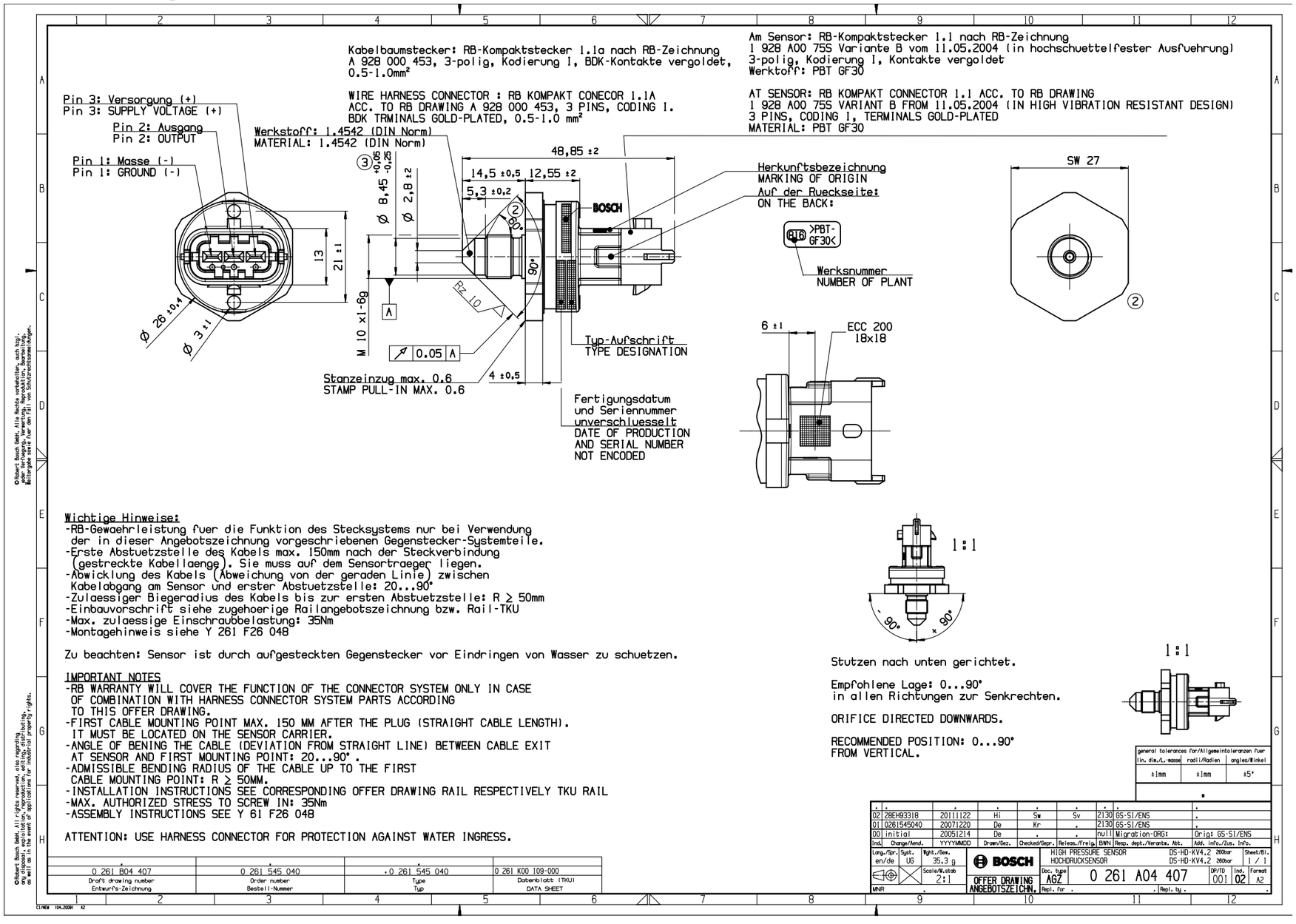
HYPOTHESIS FOR REDUCTION OF DEGREES OF FREEDOM

REFERENCE	Tx	Ty	Tz	Rx	Ry	Rz
B-C	X	X	X			
D-E				X		X
F-G					X	

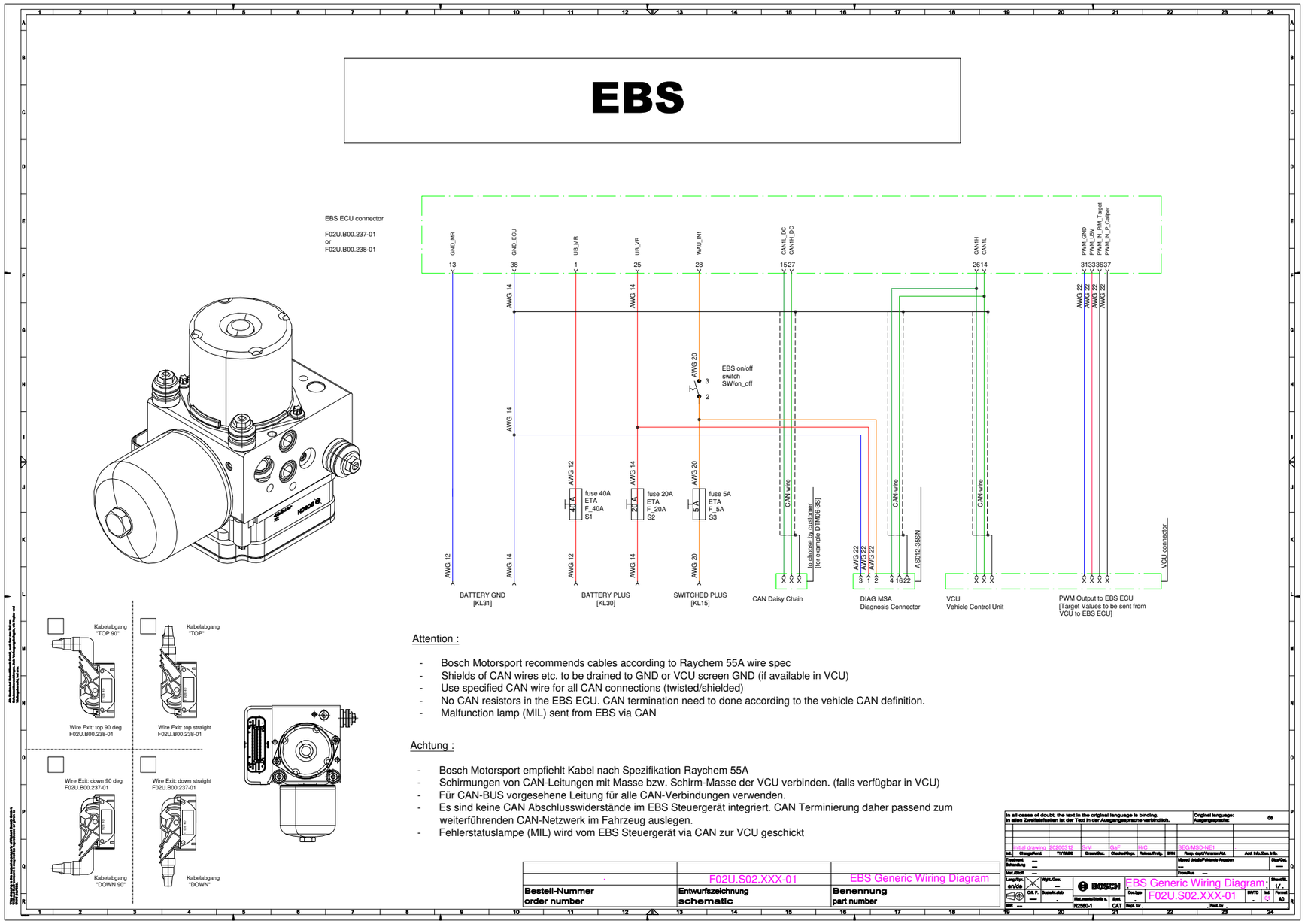
15.2 Offer Drawing Mounting Board



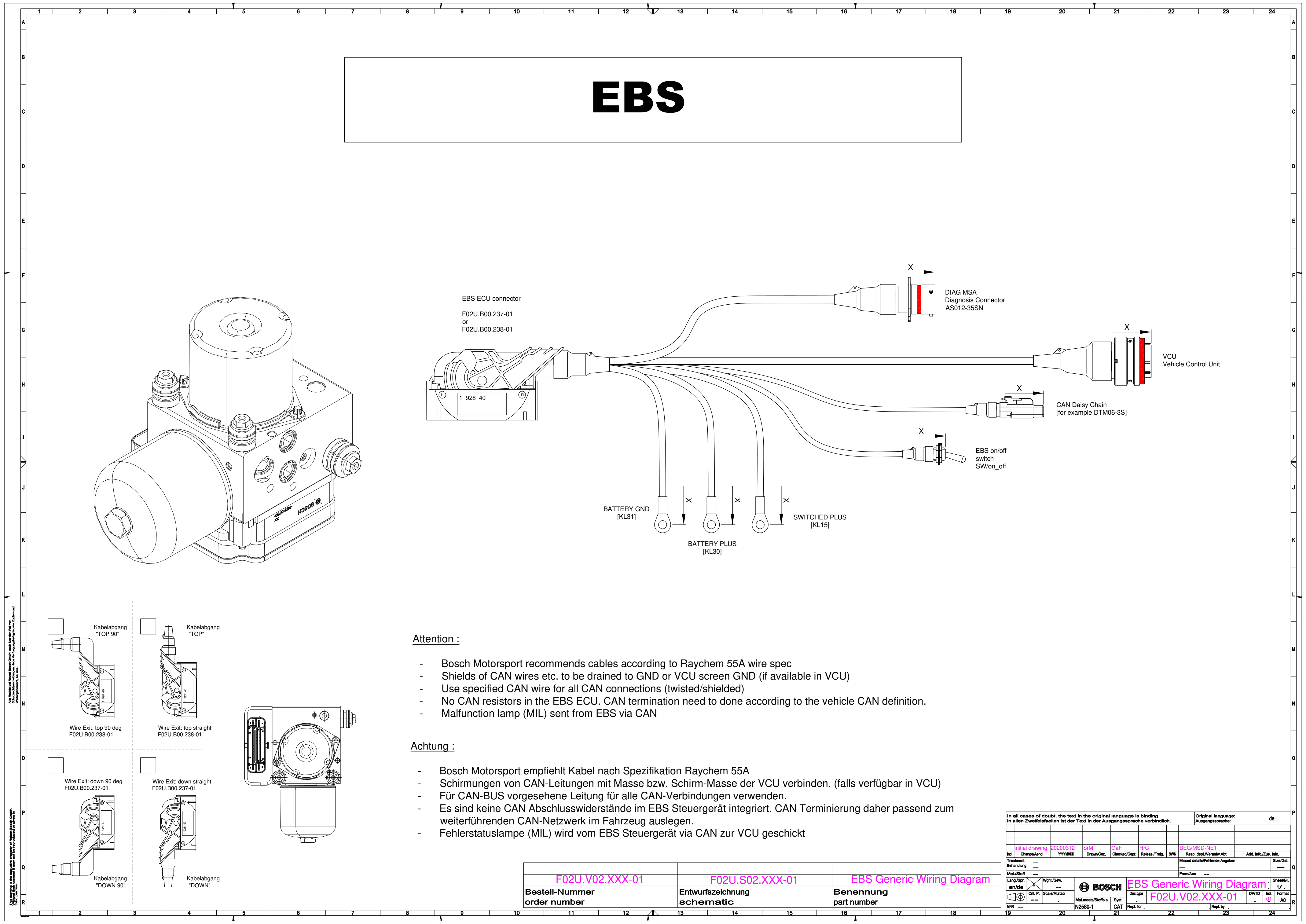
15.3 Offer Drawing Pressure Sensor



15.4 Wiring Diagram



15.5 Wiring Harness



Bosch Engineering GmbH
Motorsport
Robert-Bosch-Allee 1
74232 Abstatt

www.bosch-motorsport.com