RSX ABS

Technical Information Manual

Revision 1.1
July 28, 2022

Contents

1. Glossary

ABS	Anti-lock Braking System
AWD	All Wheel Drive
CAN	Controller Area Network
CES	Continental Engineering Services GmbH
COG	Centre of Gravity
DTC	Diagnostic Trouble Code
EBS	Electronic Braking System
EBD	Electronic Brake Force Distribution
ECU	Electronic Control Unit
EMC	Electromagnetic Compatibility
EOP	End of Production
ESC	Electronic Stability Control
FWD	Front Wheel Drive
HCU	Hydraulic Control Unit
HECU	Hydraulic-Electronic Control Unit
IMU	Inertial Measurement Unit
PS	Pressure Sensor
RWD	Rear Wheel Drive
SW	Software
WSS	Wheel Speed Sensor

2. Safety Warnings

2.1. General

	**WARNING**
	Hazard from failure to observe the safety instructions! Failure to observe the safety instructions and handling instructions given in this Installation Manual can result in significant hazards. ► Observe the warnings and instructions given here.

For safety and guidance please read this 'Technical Information Manual' document before installation or deployment of the RSX ABS product.

The RSX ABS is engineered to perform in motorsports on closed test and racing tracks only. It is strictly prohibited to use the RSX ABS on the public road or use it for any vehicle homologation, type approval or IVA tests that would lead to a road release certification for the vehicle. Please be aware that integrating the RSX ABS Kit into a production road vehicle will invalidate the homologation road release status for that vehicle. Failure to comply with the intended use of the RSX system could lead to legal action and damages. The persons/entity who is conducting the integration of the RSX system into the vehicle is solely the responsible for ensuring that the RSX system is used for its intended purpose. No claims or liability of any kind will be accepted by Continental Engineering Services for damages as a result of unintended use of the product.

2.2. Qualification for Installation

	**WARNING**
	Injury hazard due to insufficient qualification. Installation by unqualified personnel can result in considerable personal injury and equipment damage. ► All work must be carried out by appropriately qualified staff.

The brake system in general is a highly safety critical subsystem of the vehicle. Integration of the RSX ABS into the vehicle's braking system requires professional knowledge of vehicle mechanics and electronics, especially in a motorsport environment where high temperatures, forces and vibrations are often present. The RSX ABS implementation should only be performed by qualified staff. Qualified staff are deemed to be capable of carrying out work assigned to them and are competent at recognizing and avoiding potential hazards due to their technical education, training, and experience. For safe and reliable operation of the RSX ABS, all persons responsible for the installation of the RSX ABS into the vehicle must be competent with hydraulic braking systems and have relevant mechanical and electrical automotive experience. The persons/entity who is conducting the installation of the RSX system is solely the responsible for ensuring that the RSX system is installed correctly and safely in the vehicle. No claims or liability of any kind will be accepted by Continental Engineering Services for damages as a result of incorrect installation of the product.

2.3. System Responsibility

	**WARNING**
	Injury hazard due to an inappropriate braking system layout definition. An unsuitable braking system can lead to compromised vehicle deceleration ► An evaluation of the vehicles overall braking system must be conducted

The persons/entity who is conducting the integration of the RSX ABS into the vehicle is solely responsible for the overall vehicle braking system definition, performance, and durability. This includes the correct sizing and specification of the brake master cylinders, calipers, disc assemblies, pads, and tires etc. Continental Engineering Services is only responsible for the scope of the delivered product and does not take responsibility for the definition of the vehicles overall braking system. A suitable braking system with respect to brake line pressures, brake force distribution and heat dissipation must be defined to ensure it meets the application requirements and use case of the vehicle. The functionality of the RSX ABS is to avoid locking wheels and increase the vehicles stability during hard braking. Prior to installing the RSX ABS into the vehicle it is essential that the brake system definition has been completed and evaluated for suitability with the system.

It is mandatory to integrate an ABS warning lamp within the driver's field of view in order to warn the driver in the event of an ABS malfunction where the functionality of the system is degraded and becomes non-functional.

After the initial integration or after any change to the RSX ABS hardware or software, perform a non-dynamic test drive in safe environment to ensure the brake system functions without failure.

Be sure to follow the instructions provided in the manuals when installing the product.

2.4. State of Delivery

	**WARNING**
	Non-Operational State of Delivery The RSX Hydraulic-Electronic Control Unit is delivered with a provisional software. This software will not provide the ABS functionality. ► Update the software according to chapter 5.3.10 ("Programming")

3. Vehicle Description

The following list shows the vehicle environment the RSX ABS Kit should be used in. According to chapter 2.3 the persons/entity who is conducting the integration of the RSX ABS into the vehicle is solely responsible for the overall vehicle braking system definition, performance, and durability.

- Race/track car (no public road usage)
- Compatible with rear-wheel drive, front-wheel drive or all-wheel drive vehicles
- Hydraulic brake system:
  - Front/rear hydraulic brake circuit split only
  - Compatible with a tandem master cylinder or two individual master cylinders (front/rear) incorporated into a pedal box assembly with brake balance bar
  - The volume consumption of the hydraulic system (including calipers, hydraulic pipes, flex lines, etc.) must not exceed the values of 34mm³/bar on the front axle and 15mm³/bar on the rear axle
  - The maximum brake pressures to enter ABS control (wheel locking pressures) must not exceed 100 bar

4. Content of the CES RSX Kit

- RSX ABS HECU (see chapter 4.1)
- IMU (see chapter 4.2)
- External Pressure Sensor (see chapter 4.3)
- Rotary Switches (see chapter 4.4)
- Connectors (see chapter 4.5)
- Software tool for configuration and diagnosis (see chapter 4.7)

Figure 1: RSX Control Unit

4.1. Electronic Brake System

With the origin in the series product, the MK 100® is the proven in use electronic brake system from Continental. For the use in motorsport vehicles the MK 100® setup is chosen according to the special needs in this area, as front/rear brake circuit split in combination with a balance bar.

- Continental MK 100® HECU
- Reference no.: 3-75000-013
- Weight: 1,990 g
- HCU (Hydraulic Control Unit)
  - Internal pressure sensor for front axle master cylinder pressure measurement (for rear axle master cylinder pressure measurement an external pressure sensor is used)
  - Delivered pre-filled
- ECU (Electronic Control Unit)
  - 58-pos TE MCon connector

	WARNING
⚠	**Hazards from high wear during motorsport application.** Motorsport usage of the RSX ABS applies high material stress on the parts. ► An exchange of the Electronic Brake System after two years is recommended.

4.1.1 Hardwired Interfaces

The following interfaces are available hardwired. Some of these hardwired interfaces can alternatively be operated via CAN signals, but some need to be used to allow proper functionality.

- 4x Wheel Speed Sensor interface (mandatory)
  - Active type sensors are supported: 2-Level (7/14 mA) or 3-Level (7/14/28 mA) with Manchester protocol
  - Pulse Width Modulation (PWM) protocol currently is not supported by the RSX ABS, but will be soon. Please check latest firmware updates (see chapter 5.3.10).
  - Wheel speed sensors are not included in the RSX ABS Kit and need to be sourced independently

	**ATTENTION**
	Damage to the RSX ECU can be caused by connecting incompatible hardware Risk of damaging the RSX ECU when connecting passive wheel speed sensors. ► Use active wheel speed sensors only!

- External pressure sensor for rear axle master cylinder pressure measurement, see chapter 4.3 (mandatory)
- ABS mode selection switch (provided hardwired switch or via CAN)
- Function disable switch – independent of selected mode switch position (hardwired): ABS on/off (hardwired switch or via CAN)
- “ABS Warning Lamp” signal output, active in case of disabled ABS function (hardwired or via CAN)
- “DTC Warning Lamp” signal output, active in case of present failures (hardwired or via CAN)
- Tachometer speed signal output (hardwired or via CAN)
- Brake light activation signal output (hardwired or via CAN)

4.1.2 CAN Interfaces

- Private CAN (500 kBaud) – not terminated
  - For communication with external IMU

- Vehicle CAN (Configurable 1 MBaud / 500 kBaud) – not terminated
  - Comprehensive information on ABS status and signals:
    - Wheel speeds, including direction and wheel ticks (FL, FR, RL, RR)
    - Vehicle reference Speed
    - Brake circuit pressures (Front, Rear)
    - Wheel pressures (FL, FR, RL, RR – calculated values)
    - Accelerations (X, Y, Z; -5 g … +5 g)
    - Angular rates (X, Y, Z; -156°/s … +156°/s)
    - Status and activation flags
    - ABS activation flags (individually for each wheel)
    - Mode selection states
    - Function disable flags
    - Warning lamps
  - Mode selection switches & function On/Off switches via CAN instead of hardwired switches
  - Tire circumference selection for front and rear axle – for quick adaption when changing to wet weather tires in the pits
  - Standardized interface for a steering angle sensor
  - Standardized transmission interface for reading information from an auto gearbox
  - Diagnostic interface (UDS)
  - Software updates via CAN

- FlexRay
  - Available for customer-specific adaptation

4.1.3 Software – Functions

- ABS - Anti-lock Braking System

Continental Engineering Services' RSX Racing ABS assures maximum performance under racing conditions. The RSX ABS is based on the newest generation of ABS. This new software approach provides the best braking performance in-class, outperforming our competitors, especially on bumpy courses such as the Nürburgring Nordschleife.
Only using eight valves (inlet & outlet) in the hydraulic control unit, it can be used in racing series where the regulation prohibits the usage of side slip control systems and only permits ABS (e.g., GT3). If only ABS is activated, the unit can be provided with a FIA seal that allows application for these kinds of FIA racing series.

The RSX Tool allows the user to tune the ABS functionality according to the driver's preferences and driving style. For details see chapter 5.3.6.

- ABS Mode Switch:

The RSX ABS offers the possibility to select different ABS modes. They can either be switched by a hardwired switch, or a predefined CAN interface. The following table in Figure 2 gives an overview of the settings behind the switch positions:

Valve control	Name	Position		Name	Valve control	ABS control entry	Wheel Dynamic Control	Comment
Digital, thus more feedback of ABS activity in the brake pedal. Designated for race drivers, who adjust the brake pressure very close to the locking pressure. The digital valve control makes sure that even small pressure increase steps can be performed at low differences in pressure.	**Digital 1**	**12**	**1**	**Analog 1**	**Analog**, thus less feedback of ABS activity in the brake pedal. Designated for race drivers, who adjust the brake pressure above the locking pressure considerably. The analog valve control allows a sensitive control even at high differences in pressure.	Early	More dynamic	Focus on stability / less performance For a tire-road-combination with low demand for slip.
	Digital 2	**11**	**2**	**Analog 2**				
	Digital 3	**10**	**3**	**Analog 3**				
	Digital 4	**9**	**4**	**Analog 4**				
	Digital 5	**8**	**5**	**Analog 5**				Focus on performance / less stability
	Digital 6	**7**	**6**	**Analog 6**		Late	Less dynamic	For a tire-road-combination with high demand for slip

Figure 2: RSX ABS Mode Switch Setup

The RSX ABS provides two times six modes: Six mode-configurations in analog valve control mode and six mode-configurations in digital valve control mode. The analog mode is recommended for gentlemen drivers, whilst the digital mode should be used by drivers braking closed to blocking pressure.

In both, analog and digital valve control mode the ABS control behavior is influenced according to Figure 2. With a changing focus from stability to brake performance the following ABS characteristics occur:

- The entry into ABS control is changed to "later", providing more freedom to experienced race drivers.
- Less dynamic wheel control leads to a pressure modulation that provides an increased feedback in the brake pedal.

For wet conditions an earlier ABS entry & more dynamic wheel control is recommended, as these setups focus on stability.

The selection can be done by a hardwired switch (see chapter 4.4) or a CAN interface. For the configuration of the interface (hardwired or CAN), please see chapter 5.3.4.

- EBD – Electronic Brake Force Distribution

A fixed brake force distribution defined by the brake system layout cannot provide an optimal utilization of the friction level in all situations, e.g., due to dynamic axle load distribution during braking. Hence, an overbraked rear axle can be the result, with negative impacts to the stability of the vehicle.
EBD prevents from under- as well as overbraking of the rear wheels, by controlling the brake force on the rear wheels dependent on the rear wheel's slip.

For racing purposes, a slightly overbraked rear axle can increase the vehicle's agility when braking into corners. Therefore, tuning options are provided and explained in chapter 5.3.6.

- Curve Brake Feature

The RSX ABS control strategy is adapted during corner braking to improve the steer-in ability and to provide the best compromise of braking performance and steerability when cornering.

- FIA Regulations

The RSX ABS is meeting the FIA requirements for using eight active valves only. The software is tagged with a version and build date.

4.2. IMU – Inertial Measurement Unit

The Continental SC13S is a 6-DOF (degrees of freedom) inertial measurement unit.

- Weight < 50 g
- IP6K9K protection level according to ISO 20653
- 3x acceleration
  - X, Y and Z direction
  - Range from -59 m/s² to +59 m/s²
- 3x rotation rate
  - yaw rate, roll rate and pitch rate
  - range from -300°/s to +300°/s

Figure 3: IMU

4.3. External Pressure Sensor

The Continental PS20 pressure sensor is used to measure the pressure in the rear brake circuit in case a balance bar or a similar device is implemented for brake balance adjustments. The measured pressure is used to optimize the pressure modulation on the rear wheels.

- Robust design
- IP6K9K protection level according to ISO 20653
- M12 → M10 adapter included in delivery

Figure 4: External Pressure Sensor, incl. M10/M12 adapter

4.4. Rotary Switch

The 12-position rotary switch allows the selection of the most suitable mode for the specific vehicle under current conditions.
Analog switches are used intentionally because of their reliable function and cost-efficiency.

Figure 5: Mode Switch

For switching off the ABS control functions a separate push-button switch can be used. This allows the user to keep the preferred mode when switching off the function temporarily.
Instead of using the hardwired switches it is also possible to select the control mode and the off mode by using predefined CAN messages.

4.5. Diagnostic CAN Hardware

The connection between the RSX Tool and the RSX ABS unit is established via the Vehicle CAN.
To connect the User-PC with the vehicle CAN, the Diagnostic CAN Interface (PEAK PCAN-USB; p/n: IPEH-002021) is included to the RSX Kit and so is part of the delivery.

4.6. Connectors

The RSX ABS Kit includes all connectors to build the wiring harness according to the needs of the vehicle.
If requested, CES is also able to design and manufacture custom-designed wiring harnesses.

#	Connector	Description	Wire Size [mm²]	Parts per Kit
1	ABS	RSX HECU connector - housing		1
2	ABS	RSX HECU connector – wire cover		1
3	ABS	Pin - Size 1.2	0.5 - 0.75	35
4	ABS	Blind Plug - Size 1.2		25
5	ABS	Pin - Size 2.8	0.5 - 1.0	5
6	ABS	Wire Seal - Size 2.8		3
7	ABS	Blind Plug - Size 2.8		8
8	ABS	Pin - Size 4.8	2.5 - 4.0	6
9	ABS	Wire Seal - Size 4.8		4
10	IMU	IMU Connector Female 4 Pos		1
11	PS	IMU Connector Female 3 Pos		1
12	IMU & PS	Pin - Size 0.63	0.5 - 0.75	10
13	IMU & PS	Wire Seal - Size 0.63		7

Figure 6: Connector Parts

4.7. RSX Tool

The RSX Tool is the interface for setting up the RSX ABS. It is used for the initial setup, calibration, failure handling and the final finetuning.
The latest version of the RSX Tool can be downloaded free of charge from the distributor's website.
Distributors overview:
www.conti-engineering.com/rsx

5. Implementation Guideline

	**WARNING**
	Injury hazard due to an inappropriate braking system layout definition. An unsuitable braking system can lead to compromised vehicle deceleration ► An evaluation of the vehicles overall braking system must be conducted

	**WARNING**
	Injury hazard due to insufficient qualification. Installation by unqualified personnel can result in considerable personal injury and equipment damage. ► All work must be carried out by appropriately qualified staff.

	**WARNING**
	Non-Operational State of Delivery The RSX Hydraulic-Electronic Control Unit is delivered with a provisional software. This software will not provide the ABS functionality. ► Update the software according to chapter 5.3.10 (“Programming”)

Make sure the vehicle’s brake system is set-up according to motorsports requirements. Meeting these requirements lies within the responsibility of the installer. Furthermore, take the restrictions in chapter 3 into account.
Installation, electrical connection, maintenance, and commissioning should be accomplished by qualified personnel only.

The ECU will be delivered without firmware. Please make sure to download and flash the latest firmware onto the RSX ABS (chapter 5.3) after integration of the hardware (HECU).

5.1. QuickStarter

- Integration of all RSX ABS components
  - HECU
  - External Pressure Sensor
  - IMU
- Connection of the hydraulic lines
- Conventional bleeding
- Wiring harness build up
- Installation of ABS warning lamp in the driver’s field of view
- RSX Tool installation on suitable PC
- Update of the RSX ABS firmware
- Setting of vehicle specific parameters
- Calibration of all sensors
- RSX Tool – Bleeding by using the “Initial/Rework Bleeding” routine
- Roll out
- Tuning of RSX ABS parameters

5.2. Hardware Setup

The following chapters describe the integration of the RSX ABS components.

5.2.1 Hydraulic & Electronic Control Unit

The hydraulic setup is shown in Figure 7. It requires a front/rear brake circuit split and can either be used with a tandem master cylinder or two master cylinders in combination with a balance bar. The integration of the HECU and the external pressure sensor (PS) is described in the following.

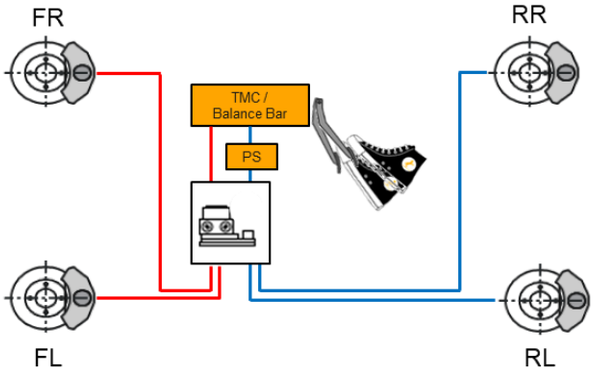


Figure 7: Hydraulic Setup

Avoid introducing air into the system when connecting the brake lines coming from the master cylinder.
The HECU is delivered in a prefilled state. This means that conventional bleeding basically is sufficient after the installation. Anyway, it is recommended to perform bleeding by using the “Initial/Rework Bleeding” routine of the RSX Tool (chapter 5.3.7).

The following steps guide through the major tasks for the integration of the HECU:

- Disconnect the battery
- Mount the RSX HECU

Mount the RSX HECU with at least two M6-screws to a bracket. Use at least two of the three possible mounting points, shown in Figure 8. Tighten the screws with 8-10 Nm. Anti-vibration mounts are required when installing the HECU into the vehicle. The shore rating of the rubber mounts and overall mounting solution is vehicle specific and careful consideration into the transmission of vibrations to the HECU should be made to avoid damage to the hardware.

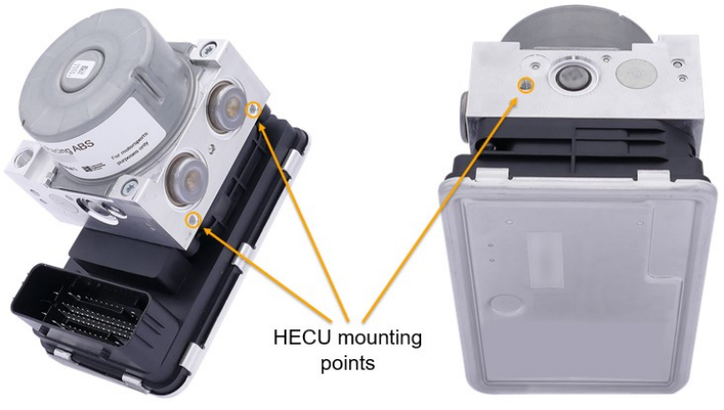


Figure 8: HECU mounting points

As illustrated in Figure 9, the HECU has defined mounting position requirements. The HECU can be mounted 360 degrees around the vertical Z-axis and must be kept with the positional limits on the X and Y axes.

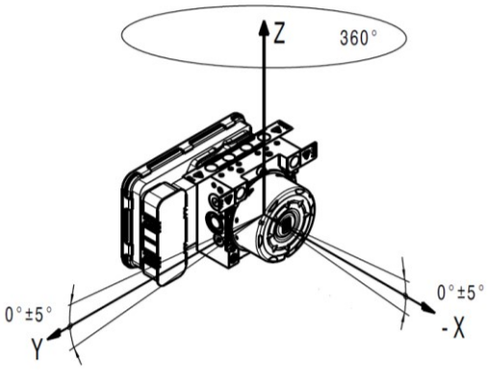


Figure 9: possible HECU mounting directions

The hydraulic connections are shown in Figure 10. The union screw sizes in brackets [M12x1] or [M10x1] are listed according to the hydraulic connection. Screws should be tightened with 13-20 Nm.

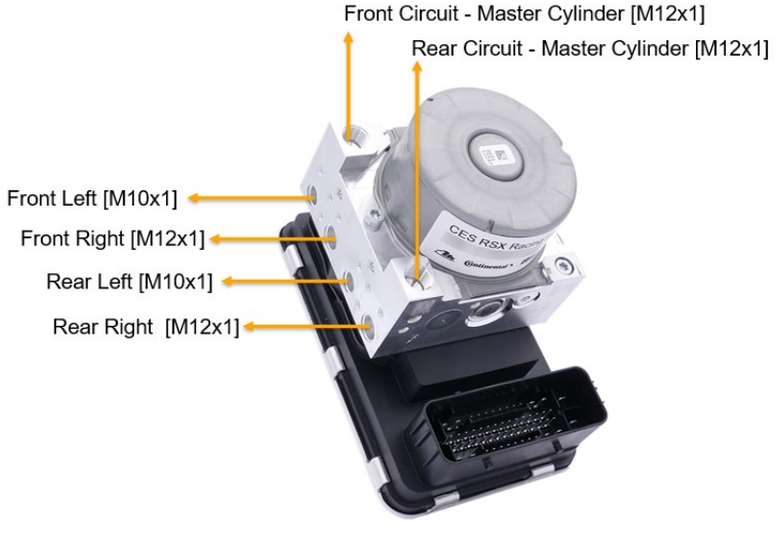


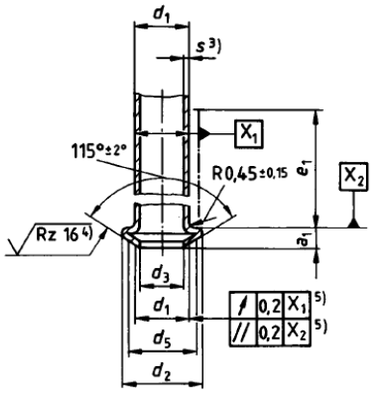
Figure 10: Hydraulic Interfaces

The connections to the calipers are described with “Front Left”, “Front Right”, “Rear Left” and “Rear Right”. Depending on the hydraulic setup, the tandem master cylinder or the balance bar master cylinders are connected to the “Front Circuit – Master Cylinder” and “Rear Circuit – Master Cylinder”, respectively. Keep in mind, that the external pressure sensor is mounted in the rear axle brake circuit between HECU and master cylinder.

	WARNING
⚠	**Injury hazard due to contact with brake fluid.** Brake fluid is an abrasive substance. Brake fluid can cause immediate damage of painted areas. Immediately flush the contaminated area with clear water. ► Always follow the safety instructions when handling brake fluid.

- Mount the provided external pressure sensor (see 5.2.2)
- Mount brake pipes

The brake line diameter should be ≥ 4.75 mm [3/16”]. Flare type F, according to Figure 11, is required to establish a dense connection. Use a union nut to connect hydraulic pipes to the HECU.



d_1	d_2 js 14	d_3 +0,3 −0,2	d_5 min.	e_1 min.	a_1 ± 0,3
4,75	7,1	3,2	5,0	17	2,3
6,00	8,4	4,5	6,0	18	2,5
8,00	10,7	6,5	8,0	24	2,6
10,00	12,7	8,5	10,0	28	2,9

Figure 11: Flare Type F [DIN74234]

- Connect cable harness (see chapter 5.2.7)
- Install warning lamp in the driver’s field of view (see chapter 5.2.5)
- Bleed the hydraulic system

The HECU is delivered in a prefilled state. This means that conventional bleeding basically is sufficient after the installation. Anyway, it is recommended to perform bleeding by using the “Initial/Rework Bleeding” routine of the RSX Tool (chapter 5.3.7).
Make sure the master cylinder(s), the pipes and the reservoir never run out of brake fluid.

	ATTENTION
	Air in the hydraulic brake system may be shifted into the RSX ABS. Risk of damaging the prefilled status of the RSX ABS. Air in the RSX ABS may not be eliminated by a conventional bleeding process. ► Perform the “Initial/Rework Routine” with the RSX Tool, see chapter 5.3.7.

	ATTENTION
	Wrong brake fluid can damage the RSX ABS. Risk of damaging the RSX ABS due to wrong brake fluid. Do not use mineral oil! ► Using ATE DOT 4 SL6 brake fluid is recommended.

- Connect the battery

The RSX ABS HECU should be supplied with a voltage between 10 V and 13.6 V. An inrush current (when the pump starts running) of 75 A for 50 ms is required at a supply voltage of 14 V and a resistance of 14 mOhm. A steady-state current of 30 A needs to be available.
For more Details see chapter 5.2.7

- Perform the software setup process according to chapter 5.3

Connect the provided CAN interface to the Vehicle CAN, install and open the RSX Tool and establish the connection to the RSX ABS. It might be necessary to adapt the baud rate setting in the options menu. Update the factory firmware with the latest version provided by the distributor of the RSX ABS. Read & clear the failure memory with the RSX Tool. The roll out session should not be started, if there are failures detected by RSX Tool.

- Bleeding process with RSX Tool

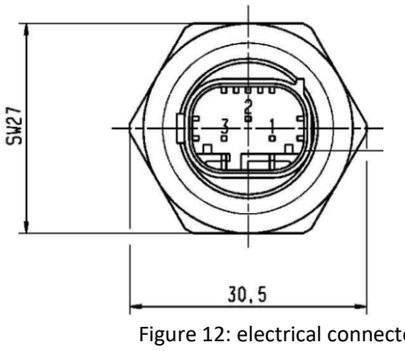
After a conventional bleeding in the previous step, the “Initial/Rework Routine” can be started. See chapter 5.3.7.

- Initial test / Roll out

The functionality of the RSX ABS should be checked carefully before racing usage. It is recommended to perform an ABS controlled braking maneuver in a safe environment, without other cars and a sufficient runoff area. Bleed the hydraulic system again if required.
Make sure the ABS Warning Lamp is always visible to the driver. An illuminated ABS Warning Lamp indicates that the ABS is not available.

5.2.2 External Pressure Sensor

The external hydraulic Brake Pressure Sensor should be installed between the Master Cylinder and the HECU in the rear circuit, as shown in Figure 7: Hydraulic Setup.
For an easier installation of the M12 Pressor Sensor, an M12/M10-adapter is part of the delivery of the RSX ABS Kit.
Prefill the external pressure sensor PS20 (10.0522-9963) with brake fluid, to avoid air in the system. Make sure the sensor connector is pointing downwards to allow an optimal bleeding.



Contact- No.	Description
1	Ground (-)
2	Signal Output
3	Power Supply (+)

Figure 12: electrical connector of the external pressure sensor

For an easier bleeding process, the opening of the sensor should point upwards (electrical connector pointing downwards).

	ATTENTION
⚠	**Damage to the RSX ECU can be caused by connecting incompatible hardware** Risk of damaging the RSX ECU when connecting any other than the delivered external pressure sensor. ► Only use the delivered external pressure sensor.

5.2.3 IMU

The IMU should be mounted in a protected area in the vehicle. No other components shall be mounted onto the bracket of the IMU apart from the IMU itself. Anti-vibration mounts are required when installing the IMU in the vehicle to prevent external vibrations from affecting the sensors signal output. The shore rating of the rubber mounts and overall mounting solution is vehicle specific, and consideration should be made to the amplitude and frequency of the vehicle vibrations to ensure a robust and reliable IMU signal output. A mounting location with a low temperature range and low temperature gradients should be selected.

- Mount the sensor close to the COG and on the longitudinal axis of the vehicle
- The sensor should be mounted in a levelled position
- The sensor should be mounted in or against driving direction:
  - Connector facing backwards (+/- 3°) = 0°-position
  - Connector facing forwards (+/- 3°) = 180°-position

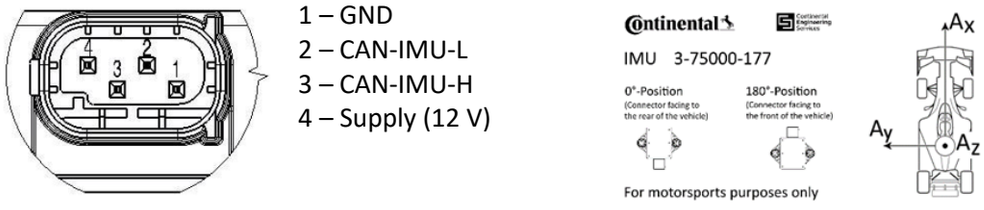


Figure 13: IMU connector – Pinout & IMU Label

5.2.4 Rotary Switch

The rotary switch is connected to the RSX ECU according to the following figure:

Pin No.	Color	Connection to RSX ECU
1	Red	Pin 22: ABS_MODE_SW_SENSEEP
2	White	Pin 23: ABS_MODE_SW_SIG
3	Black	Pin 29: ABS_MODE_SW_GND

Figure 14: Rotary Switch Pinning [Haltech]

To verify the correct setup, check the Switch Position in the “Live Data” tab (chapter 5.3.8) or the failure entries (chapter 5.3.9) in the RSX Tool.

	ATTENTION
⚠	**Damage to the RSX ECU can be caused by connecting incompatible hardware** Risk of damaging the RSX ECU when connecting any other than the delivered rotary switch. ► Only use the delivered rotary switch.

Alternatively, the different modes can be set via CAN Message MMI_24C [0x24C] Signal Switch_ABS_PosReq. Information of how to switch between hardwired and CAN configuration

5.2.5 Warning Lamps

The RSX ABS Kit should not be used for driving sessions without an ABS warning lamp in the driver's field of view.

	WARNING
	**Hazard from undetected ABS function disable!** Undetected failures that disable the ABS function can lead to an unexpected vehicle behavior during high deceleration maneuvers. ► The ABS Warning Lamp Information must be visible to the driver at all times.

The RSX ABS Kit provides two warning lamp information, as shown in the table below.
The ABS Warning Lamp is mandatory and indicates critical failures in the RSX system, that lead to a non-operational state.
The second lamp (Failure Present Lamp) can be used optionally, to indicate stored failures in the failure memory. In case only the Failure Present Lamp is on (while ABS Warning Lamp is off), the ABS is still functional, but may have a reduced performance.

Warning Lamp	**OFF**	**Blinking**	**Permanent ON**	**Output**
ABS	ABS is operational	ABS is in diagnostic mode (via RSX Tool)	ABS not working!	CAN: RSX_06 [0x5C0] – *RSX_ABS_FailureLamp* Hardwired: Pin 47
Failure Present	No failures stored	n/a	Failure present; ABS with reduced performance	CAN: RSX_06 [0x5C0] – RSX_Failure_Present Hardwired: Pin 56

The information about the failure status is provided via two interfaces.
The first option is to read the information via CAN (Message RSX_06 [0x5C0]) and provide it to the dashboard.
The second option is to use the hardwired outputs of the RSX ECU. The ABS Warning Lamp information is provided on Pin 47, the Failure Present Lamp information on Pin 56.
The pin is set to GND actively when the warning lamp should be turned off (ABS is functional/ no failure stored). The pin is open whenever a failure is present, and the lamp should be turned on. This ensures that the warning lamp is always activated if the RSX ECU is broken, the connector has dropped off, or a fuse for the power supply to the RSX ECU is blown.
Figure 15 illustrates the principal circuitry of the hardwired warning lamp.

	ATTENTION
	**Damage to the RSX ECU can be caused by connecting impropriate hardware** The RSX ECU pins are not designed to supply power for a warning lamp. ► Only use the signal output to control transistor logics

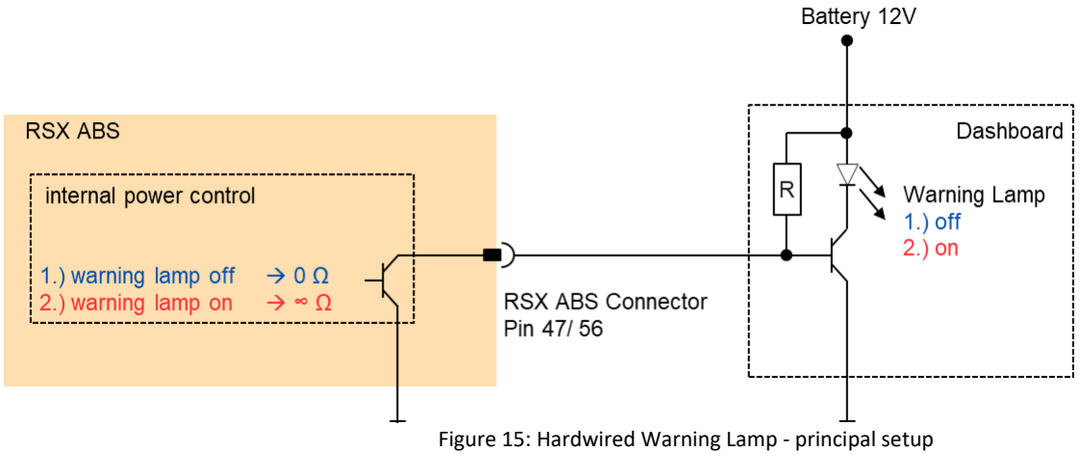


Figure 15: Hardwired Warning Lamp - principal setup

If the hardwired warning lamps are used, a similar transistor logic to the one showed above, needs to be installed available in the dashboard or a warning lamp control module. The maximum current load is 200 mA.

Regardless to how the warning lamp is configured (CAN or hardwired), it is mandatory that the ABS Warning Lamp must be turned on (=illuminated) during the following events:

- An ABS failure occurs
- RSX ABS ECU is missing
- the RSX ABS fuse is blown

5.2.6 Other Hardwired Interfaces

Tachometer speed (Pin 57)

The Tachy Output is an Open-Collector Output limited to 40 mA. The nominal reference voltage is 14 V and has a PWM signal output with a 50 % (+/-5 %) duty cycle. The frequency changes relative to the vehicle velocity. Please note that this output is not concepted to connect an analog HMI directly, but to have an analog speed signal for another ECU-input. The vehicle velocity information is also available on CAN.

The vehicle speed is proportional to the square wave signal:

$$v[kph] = a \cdot f[Hz]$$

linked by a constant factor $a = 0.36$.
The analog signal is set to 0 V for vehicle speeds <1 kph and to 12 V for vehicle speeds >320 kph.

Brake light activation (Pin 43)

The interface provides a signal output when the brake pedal is activated. The system monitors the master cylinder brake pressure, and the brake light signal output is activated when a defined brake pressure threshold is exceeded. In the event of a brake pedal activation, pin 43 is supplied with 12 V. The signal can be used for further analog control logics. Due to the maximum current output of 20 mA, it is not possible to supply power for the brake lights directly from the RSX ECU.
Alternatively, the brake light activation information is provided on CAN: Message RSX_06 [0x5C0] Signal RSX_Blr_Request, see chapter 6.6.

ABS off switch (Pin 54)

To switch off the ABS functionality the mentioned pin needs to be grounded for a short time. It's recommended to install a push-button switch to this interface that connects pin 54 to GND. This interface allows the user to switch off the ABS function and this is indicated by an illuminated ABS warning lamp. The CAN communication remains active when the ABS functionality is turned off so that vehicle velocity and brake light activation information is still available. A second press of the button will reactivate the ABS functionality and removes the ABS warning lamp request.
Please note: this is not an emergency off switch and when activated the RSX HECU is still in an operational mode but with pressure regulation functionality degraded.

5.2.7 Wiring Harness

The required parts (excluding wires) for the buildup of the cable harness are included in the delivery of the RSX ABS Kit.

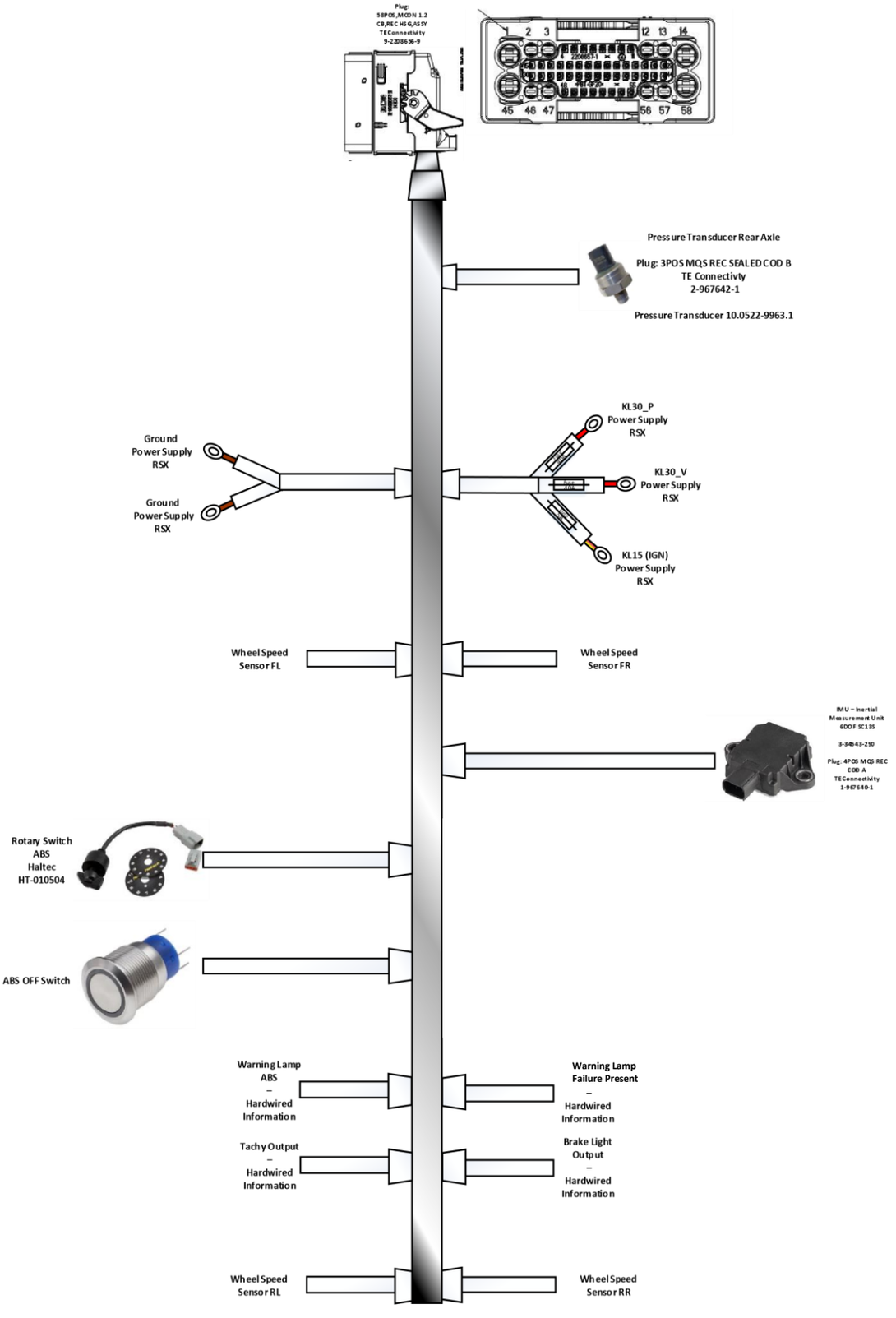


Figure 16: Wiring harness setup

- Electrical diagram (ABS only scope)

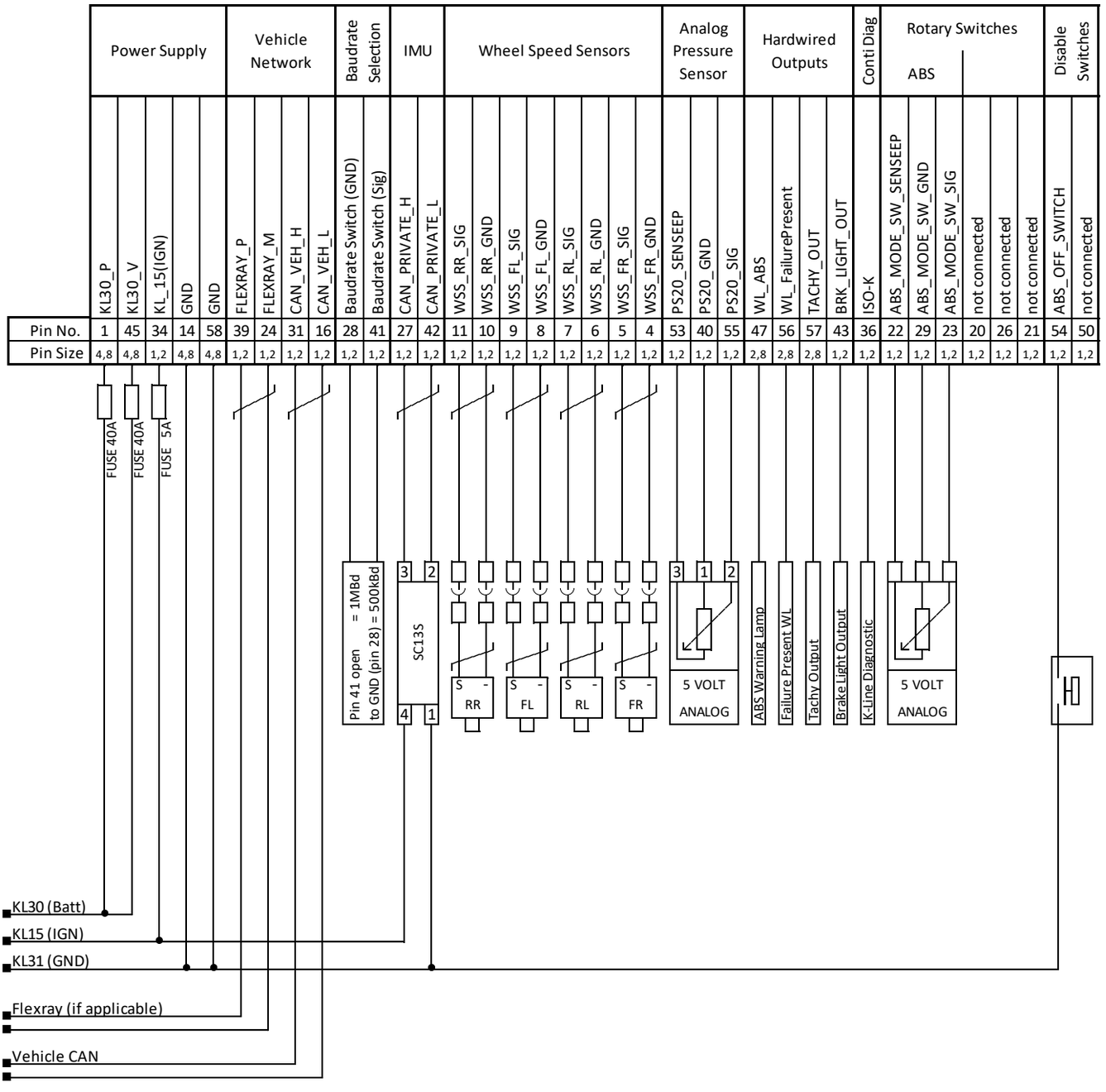


Figure 17: Electrical Diagram RSX ECU – ABS only scope

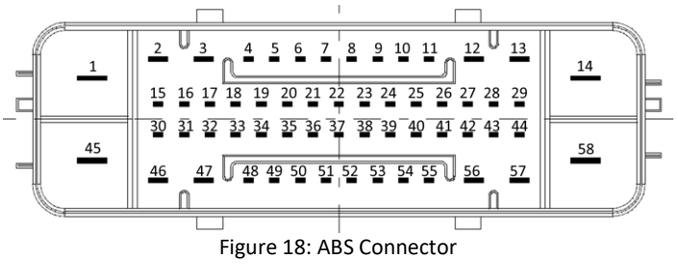


Figure 18: ABS Connector

Detailed pin descriptions are listed in attachments (6.3).

The required parts for each connector are described in chapter 4.5. Items should be used according to the pin size shown in the electrical diagram (see Figure 17):

Pin size	Connector Item # Pin	Connector Item # Blind Pin	Recommended Wire Size
4.8	#8	#9	4.0 mm²
2.8	#5, #6	#7	0.5 mm²
1.2	#3	#4	0.5 mm²

ATTENTION

Damage of the RSX ABS due to moisture in the connector.
Moisture or even water in the connector can damage the RSX ABS pins and can also lead to errors in the transmitted analog signals.
► Build up the harness & connectors waterproofed.
► Use blind pins in case a pin is not wired.

For more details to the connector housing, please check the information provided by the connector manufacturer (TE – Tyco Electronics Corporation): 9-2208656-9 - 58Way ABS ESP Connector

- CAN Interface

Neither the “Vehicle CAN” nor the “Private CAN” are terminated internally. The two farthest nodes in a CAN need termination resistors (120 Ω), so these resistors must be considered when designing the cable harness.
The RSX ECU can be integrated into 500 kBaud and 1 MBaud CAN environments. The intended baudrate needs to be choosen by setting the jumper of pins 28 and 41 accordingly. Open connectors will set the CAN interface to 1M Baud; closed connectors will set it to 500 kBaud. After changing this setting an a hard reset of the ECU (turning the power supply off and on again) is required.
Before connecting the RSX ABS CAN to the vehicle’s CAN, please check that there are no conflicts in the message identifiers.

- Wheel Speed Sensors:

Characteristics of suitable wheel speed sensors are listed in chapter 4.1.1.
It is recommended to twist the two cables (signal and ground) of each sensor to reduce electromagnetic disturbances.

5.3. Firmware Setup – RSX Tool

The performance of the ABS is dependent on certain vehicle parameters, such as vehicle weight, tire circumference, brake coefficients etc. The RSX Tool allows the user to adapt RSX ABS software parameters for the vehicle it is installed in. This vehicle information is important for the basic functionality of the RSX ABS.
In addition, basic ABS and EBD parameters can be tuned using the RSX Tool. These parameters will affect the control strategy of ABS and EBD and can be set according to the car's special characteristics and the preferences of the driver.

5.3.1 General

	WARNING
	**Hazard from failure in software configuration setup!** Wrong inputs can lead to an underperformance during ABS control. ► Monitor Failure Memory entries. ► Change parameters in small steps with careful test drives in between.

Please read the instructions before using the RSX Tool. In case of any doubts, please contact your supplier. Be aware that a wrong setup of the vehicle parameters can lead to unintended vehicle behavior during ABS control.
The RSX Tool is limited for motorsport use only, as the RSX ABS Kit in general.

5.3.2 Tool Installation

The RSX Tool needs to be installed on a computer.
The installation file of the RSX Tool can be downloaded from your distributor's website.
The RSX Tool will be improved continuously, so please check for latest updates from time to time.

System Requirements:
The RSX Tool was tested on systems with the following or higher system characteristics:
Operating System: Windows 10
CPU: 2.4 GHz
Memory: 7.9 GB RAM
Free Space: 200 MB
Screen Resolution: min. 1024x768

5.3.3 Diagnostic CAN Hardware - Setup

The RSX Tool communicates with the RSX ABS via CAN. The basic setup is illustrated in Figure 19. The connection can be established with the provided third-party CAN interface (for RSX Tool-Version 2.x: PEAK – PCAN; p/n: IPEH-002021).
For correct functioning of the CAN device, the latest PCAN driver need to be installed on your computer. The driver download can be found on the manufacturer's homepage: https://www.peak-system.com/

As shown in Figure 19 the PCAN interface needs to be connected to the Vehicle CAN via a D-Sub 9 Pin-Connector, where Pin 2 is CAN-Low and Pin 7 is CAN-High.

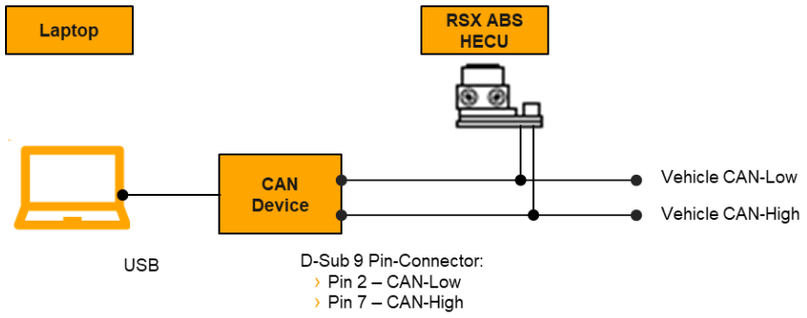


Figure 19: Connection between Laptop running the RSX Tool and the HECU

In order to establish the connection of the RSX Tool to the RSX ABS, the baud rate of the RSX Tool needs to be set according to the baud rate of the connected CAN (Options → Baudrate), see Figure 20.

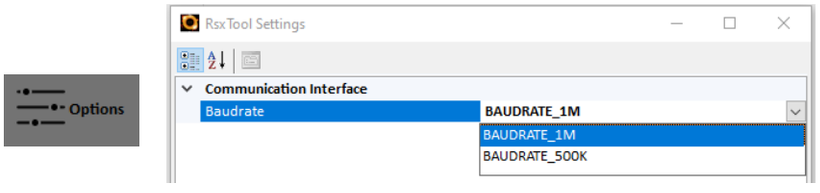


Figure 20: Baud rate selection - RSX Tool

After selecting the baud rate according to the vehicle setup, clicking the “Connect” button will establish the connection to the RSX ABS.
Whenever the RSX Tool is performing actions that require an extended diagnostic session (e.g., calibration of the acceleration sensors), the RSX ABS will indicate this extended diagnostic mode by a blinking ABS warning lamp.

5.3.4 Identification

The Identification tab shows general information about the used hardware and software.

	WARNING
⚠	**Hazard from a non-operational firmware state.** The RSX might be in a non-operational state, due to a wrong setup. Thus, the ABS will not be active. ► Check the “Software Integrity Status” ► Check the present failures (see 5.3.9) ► Check if Warning Lamps are illuminated

Identification	
ECU & HCU serial number	Serial numbers of the electronic and hydraulic control unit.
RSX Part Number	Part number of the RSX ABS unit.
RSX-SW Version	Firmware version ID running on the RSX HECU.
RSX-SW Date	Built date of the running software – relevant for FIA regulations.
Bootsoftware ID	Developer information.
Calibration Information	Developer information.
Software compatibility index	Developer information.
Total Flash Attempts	Number of flash attempts.
Successful Flash Attempts	Number of successful flash attempts.
Software Integrity Status	Current status of the application software and the parameters running on the RSX ABS. Possible states are: **No issues: Application running**

	Software not available: (Re-)Flash Software Initial software flash required: (Re-)Flash Software Parameter not available: (Re-)Flash Parameter Parameter set corrupted: (Re-)Flash Parameter Software version not supported: (Re-)Flash correct Software Dataset and software do not match: contact your supplier
Flush and Bleed Status	Most recent executed Flush&Bleed routine of the RSX ABS. Possible states are: • Production Fill & Bleed ok: Delivery Status; Prefilled unit; execute the conventional bleeding process and the Initial/Rework Bleeding with the RSX Tool, after the hydraulic installation of the brake system. • Bleeding Status not ok: Bleeding Routine was not executed correctly • Pump Flushing ok: Pump Flushing Routine was performed correctly • Rework Routine ok: Rework Flushing Routine was performed correctly

5.3.5 Configuration

The Configuration tab allows the user to adapt the base parameters of the RSX ABS to the vehicle. Ensure that the parameter values are correct and entered carefully before writing them to the RSX ECU. If you are insecure, please contact your supplier. Incorrect parameter input can lead to poor control performance of the RSX ABS.

- Read from ECU: Read the current configuration from the ECU
- Load Configuration: Load a formerly saved configuration file
- Write to ECU: Write the set configuration to the ECU
- Save Configuration: Save the configuration shown in the RSX Tool to a file

Configuration

Powertrain	Select the driven axle: front-wheel driven (FWD); rear-wheel driven (RWD); all-wheel driven (AWD) AWD will be available in upcoming RSX versions
Gearbox	Automatic (torque converter), DSG or Manual If no traction or stability control function is used, “Manual” setup should be selected. Furthermore, if the expected CAN message from the Gearbox is not available, "Manual" should be selected, too.
Tire circumferences via CAN	• Choose between: On or Off. - “Off” means, the values given in “Vehicle Parameters” will be used. - “On” means the information provided in CAN Message *MMI_24C* [ID 0x24C] / Signals *MMI_Tcf_FrontAxle* & *MMI_Tcf_RearAxle* will be used. This option allows to change circumference parameters during a race, e.g., when changing from slick to rain tyres. Please note that a change of the tire circumference values sent on CAN can only be taken over at standstill of the car. The values given in “Vehicle Parameters” will be used as a fallback level. • valid range of values: 1600 mm - 2500 mm
EBD function	Enable or disable the Electronic Brake Force Distribution. EBD allows a sensitive control of the rear axle to avoid overbraking of the rear axle during partial braking.

Steering Wheel Angle Sensor	The information of the steering angle is not mandatory for the ABS function, but if available, it is used to improve agility when quickly turning into a corner and to improve the ABS performance dependent on the desired lane radius of the car. The steering wheel angle can be provided optionally via CAN (Message SWA_CUSTOM_DATA [0x321]). This information is not mandatory. Options: not available; Custom SWA sensor or Bourns® Automotive SWA sensor, on Vehicle CAN or Private CAN
ABS Mode Switch	ABS allows 12 different modes. It is possible to omit the mode switch; in this case mode 3 is selected as a standard. If mode switching is desired the two options are available: • Hardwired Switch (part of delivery scope) • via CAN (Message MMI_24C [0x24C]; Signal Switch_ABS_PosReq)
ABS On/Off Switch	The ABS can be switched off independently of the selected mode. Options to switch off the function are: • Hardwired • via CAN (Message MMI_24C [0x24C]; Signal Switch_ABS_OffReq) • not connected (= ABS On)
Wheel Speed Sensors	Select which kind of wheel speed sensor is used. Setup all four WSS individually: 2-Level (not direction sensing), 3-Level (direction sensing) or 3-Level (direction sensing, directions swapped). For sensor details see also chapter 4.1.1.
Mounting Position of the IMU	The Inertial Measurement Unit can be mounted either with the connector facing toward (0°) the front or the rear of the vehicle (180°). See chapter 5.2.3

5.3.6 Parameters

In the Parameter section the control parameters of ABS and EBD can be adapted.

- Load Parameters: Load a formerly saved parameter file
- Save Parameters: Save the parameters shown (all tabs) to a file
- Flash Parameters: Flash the set parameters to the ECU

	**ATTENTION** **Wrong parameters on the RSX ECU due to unintended entries in the RSX Tool.** When pressing the Flash Parameters button all available parameters are flashed. ► Make sure all parameters are correct when pressing the Flash button. ► Load and Save Options can help to avoid to unintended changes in the parameter set.

- Vehicle Geometry / IMU Mounting Position / Brake Setup

The vehicle and brake system specific parameters are required for proper functionality of the RSX ABS. Thus, the following values are asked:

Vehicle & Brake Parameters

Axle Load front/rear	The axle load of the front/rear axle when the car is standing on a leveled surface. The sum of both values should match the vehicle mass. Measurement should be done with a half-filled tank and driver in the car.
Wheel Base	Distance between front and rear axle.
Track width front/rear	Distance between the left and right tire centerline on the rear/ front axle.

Height of COG	The height of center of gravity above the ground.
Wheel Circumferences front/rear	Circumference of wheels on front/rear axle. The tire circumference is needed to calculate the correct wheel speed. If tire circumferences are additionally sent via CAN, the value given here will be used as a fallback value (e.g., in case of CAN communication problems).
Number of Teeth front/rear	Number of teeth of the encoder wheel. It is necessary to know how many pulses are sent per one rotation of the wheel to calculate the correct wheel speed. A common encoder wheel has 48 teeth.
Steering Ratio	Ratio between the steering wheel angle and the resulting angle on the wheel. An average value of this ratio for commonly used steering wheel angles should be used. In doubts, keep default value.
IMU – Lateral offset	Distance between IMU and the longitudinal vehicle axis. When sitting in the car and looking forward, if the IMU is positioned on the right hand vehicle side, the lateral offset is a positive value, if mounted on the left hand side, the value needs to be negative.
IMU – Distance to front axle	Distance between front axle and the IMU. If the IMU is positioned behind the front axle, a positive value needs to be put in here, if mounted in front of the front axle, the value needs to be negative.
Brake Caliper Type	Select whether a fixed or a sliding (floating) brake caliper is used.
Brake Caliper Stiffens	Choose the category where your brake calipers are classified. Soft, medium and stiff means the flexibility of the calipers itself.
Brake Coefficient front/rear	The coefficient describes the relation of brake pressure to brake torque. If known, the value can be put in here directly. If unknown, the value can be estimated with the following parameters: • Effective Brake Disc Radius: distance between the center of the brake pad & disc surface, and the hub center. • Piston Area: accumulated piston area of a single caliper; (all piston areas on both sides of a caliper are summed up). Usually, this value can be found in the data sheet of the brake caliper, but it can also be determined by calculating the base area of all pistons of the brake caliper. • Friction Coefficient: This value is dependent on the combination of brake disk and pad, but usually it can be found in the data sheet of the brake pad. If the friction coefficient is heavily dependent on the pad's temperature, an average value of the most important temperature range should be used.

- ABS & EBD Tuning

The RSX ABS provides the unique opportunity to influence the control functions according to the vehicle, the racetrack, its conditions, and preferences of the driver.

It’s highly recommended to start with the default values! Change tuning parameters in small steps and verify the resulting vehicle behavior carefully. The custom changes might have a negative impact on the RSX ABS; therefore, it is possible to decrease the performance, when used inappropriately.

Tuning	
ABS Stability Index	This parameter adjusts the focus during ABS controlled braking maneuvers between stability and deceleration performance. This should be adjusted depending on the driver's preference.

ABS Pressure Modulation Front/Rear Axle	This parameter allows to adjust the pressure modulation differentiated for the ABS control on the front and rear axle. For a lighter wheel a more moderate setting is recommended, for heavier wheels the dynamic option can be beneficial.
EBD Pressure Modulation	This parameter allows to adjust the pressure modulation for the EBD control. A more dynamic modulation allows a higher pressure increase gradient whereas a moderate modulation utilizes a lesser pressure increase gradient.
EBD Control Entry	This parameter allows to adjust the entry into EBD control differentiated over the vehicle speed range. An earlier activation leads to a more stable rear axle but may reduce the brake performance (deceleration) at the same time.

5.3.7 Interaction

In the Interaction tab the communication with the ECU is handled. Checks for correct implementation, switching between different modes and sensor calibrations are available in this area.

- Test Routines

Two Test Routines allow to warm up the drivetrain (Roller Bench Mode) and checking Brake Light activation (Brake Light output.)

Test Routines

Roller Bench Mode	The Roller Bench Mode should be activated, when spinning the wheels of the driven axle when the vehicle is jacked up. This avoids failure entries due to the RSX safety monitoring.
Brake Light output	Activating the Brake Light switch output on CAN or the hardwired interface

- Sensor Calibration

The sensor calibration tab provides the interface to calibrate the mandatory and optional sensors. A sensor calibration is required after the initial installation and any demounting/ mounting of the sensors.

Sensor Calibration

Longitudinal/ Lateral Acceleration Sensor	After mounting the IMU to the vehicle and connecting the Private CAN to the ECU (see chapter 5.2.3), make sure there are no IMU CAN timeout failures (see diagnostics 5.3.9). To calibrate the sensor signals, park the car on a levelled surface and use the calibration buttons. The status will indicate the result of the calibration process.
Pressure Sensor	Calibrate the internal and external pressure sensors signals. Make sure the brake pedal is not pressed during the calibration.
Steering Wheel Angle Sensor	In case the custom steering wheel angle is coded (according to chapter 5.3.5) ensure the steering wheel is straight when driving straight. During the calibration process should be in 0° position. This routine will in this case not calibrate the sensor itself. Using the Custom Sensor option requires a self calibrating sensor (class 3 sensor). Coding (according to chapter 5.3.5) & Using the Bourns Steering Wheel Angel Sensor this message will also trigger the calibration routine on the sensor itself.

- Flush & Bleed Wizards

The RSX Tool provides two routines to support the bleeding process of the RSX ABS. The processes follow the aim to get rid of air (=bleeding) with in the RSX ABS. Air in the rest of the brake system (callipers, master cylinder, pipes, etc.) needs to be eliminated by manual bleeding and is not scope of the Flush & Bleed Wizards.

	WARNING
	**Hazard from not meeting the preconditions of the Flush & Bleed Wizards!** The concept of the Flush & Bleed Wizards is to bleed the RSX ABS. Air in the rest of the hydraulic system will lead to remaining air in the RSX ABS. ►Execute a conventional bleeding bevor and after running the Flush& Bleed wizards.

	WARNING
	**Hazard from autonomous pressure build up!** The Flush & Bleed Wizards includes autonomous brake pressure build ups in their routines. ►Make sure the hydraulic brake setup is done correctly. Be aware of high brake clamping forces.

The Flush& Bleed Wizards are guiding through the routines. These procedures need also an interaction by the user, e.g. by pushing the brake pedal, open and closing bleeder screws etc. A short description of the routines is given in the following. Detailed information can be found in chapter 6.

Flush & Bleed

Pump Flushing	The Pump Flushing routine activates the pump of the RSX ABS, while controlling the internal valves in parallel to a brake pedal apply by the user. The routine can be executed in addition to a conventional bleeding process, e.g. in between driving sessions. An overview of the routine can be found in chapter 6.4.
Initial/Rework Routine	The Initial/Rework Routine wizard guides through several steps to bleed the RSX ABS. It is required to have a bleeded brake system. Thus, a prefilling of the brake system and a conventional bleeding is required in step 1. After running the routine, a Follow-up Bleeding is recommended. The Initial/Rework Routine is a part of a multistage routine explained in chapter 6.5. The RSX Tool starts the flush cycles and circuit individual bleedings. The RSX Tool supported routines need user interactions by pushing the brake pedal, applying the bleeder unit or opening& closing bleeder screws. 1. Manually: Prefilling Routine 2. RSX Tool: Initial/Rework Routine (incl. Flush Cycle 1, Bleeding 2nd Circuit, Bleeding 1st circuit, Flush Cycle 2) 3. Manually: Follow-up Bleeding The execution of the Initial/Rework Routine is recommended after the initial integration of the RSX ABS or if larger amounts of air an introduced into the system, e.g. after brake components has been exchanged.

- Installation Check

The Installation Check tab provides the opportunity to double check the hydraulic caliper and electrical wheel speed connection.

Installation Check

Pressure	Brake pressure displayed for each wheel individually
Pressure Release	Button to release the brake pressure for one wheel individually while the brake pedal is pressed
Speed	Wheel speed displayed for each wheel individually
Brake Bias	Push the brake pedal once to measure the brake balance (in %) between front and rear axle
Activate Brake Light	Activating the Brake Light switch output on CAN or the hardwired interface

After the initial installation of the RSX ABS it's recommended to check the hydraulic piping and wheel speed sensors wiring. Especially if the calipers and sensors are connected to the correct input of the RSX ABS.

5.3.8 Live Data

The Live Data tab helps analyzing the system in operation mode. Internal values and status information can be read out.

Live Data

ABS Status	Status of the ABS function.
EBD Status	Status of the EBD function.
Dyno Mode Status	Status of the Dyno Mode.
Brake Light Status	Status of the Brake Light determined by using the internal (front axle) pressure sensor.
ABS Warning Lamp	The ABS warning lamp is activated in case of failures that lead to deactivation of the ABS function. Furthermore it is flashing in case of an extended diagnostic session.
Failure Present Lamp	The Failure Present Lamp is activated whenever there is a failure stored regardless of the consequences of this failure. Severe failures may lead to total shut down of the ABS function where other may only affect the function slightly or not at all.
Front Axle Pressure	Pressure value of the internal (front axle) pressure sensor.
Rear Axle Pressure	Pressure value of the external (rear axle) pressure sensor.

Lateral Acceleration	Value of the lateral acceleration sensor. The sensor is located in the IMU.
Longitudinal Acceleration	Value of the longitudinal acceleration sensor. The sensor is located in the IMU.
Steering Wheel Angle	Value of the steering wheel angle sensor, if a sensor is configured and the CAN message received correctly.
Yaw Rate	Value of the yaw rate sensor. The sensor is located in the IMU.
RSX ABS Mode Switch	Selected ABS mode. The information either is determined by the resistance of the hardwired rotary switch or by the CAN signal received in the MMI CAN frame.
RSX ABS Off Switch	Indicates whether either the hardwired push-button switch is depressed or the corresponding CAN signal is active.
RSX TCS/ESC Mode Switch	Selected TCS/ESC mode, if this functionality is configured. The information either is determined by the resistance of the hardwired rotary switch or by the CAN signal received in the MMI CAN frame.
RSX TCS/ESC Off Switch	Indicates whether either the hardwired push-button switch is depressed or the corresponding CAN signal is active.
ECU KL30	Voltage at KL30 of the RSX ABS ECU.
External Pressure Sensor	Voltage at the signal line of the external (rear axle) pressure sensor.
RSX ABS Mode Switch	Voltage at the signal line of the hardwired ABS mode switch.
RSX TCS/ESC Mode Switch	Voltage at the signal line of the hardwired TCS/ESC mode switch.
Wheel Speed	Calculated wheel speed of each wheel. The calculation is dependent on the preset parameters.
Caliper Pressure	Model Brake pressure of each caliper. The value is calculated from the front axle pressure sensor and potential valve activations in the hydraulic control unit of the ABS.

5.3.9 Diagnostics

Read and clear DTCs (Diagnostic Trouble Codes) in the Diagnostic tab.
The color (red or yellow) indicates whether the failure is currently active (red) or appeared in the past and is stored for information (yellow).
The “Freeze Frame Info” tab shows the values of the given signals at the moment the failure became active. A failure description and possible root causes can be found in the “Detailed Failure Description” tab.

- Dyno Mode

The Dyno Mode should be activated, when spinning the wheels of the driven axle when the vehicle is jacked up. This avoids failure entries due to the RSX safety monitoring.

5.3.10 Programming

The RSX ABS is delivered with a provisional software, that does not provide any control functions as ABS and EBD. To activate those functions, an update of the firmware needs to be performed during the initial integration procedure. Furthermore, the RSX software will be improved continuously, so it is recommended to check for new firmware versions regularly.

The latest firmware file can be downloaded from your distributor’s website.

To update the firmware of the RSX ABS, the .rsx-file needs to be loaded. The update process is started by clicking the “Update Firmware” button.
Preconditions:

- Supply Voltage >12V
- Wheel Speed Sensors connected (no WSS failures active)
- Vehicle in standstill

	ATTENTION
	**Damage to the RSX ECU can be caused by an unintended interruption of the firmware update process.** An interruption of the firmware update process can leave the RSX ABS in an undefined state that can't be fixed with RSX Tool. ► Make sure the 12V power supply is secured throughout the entire update process. ► Make sure the mechanical connection of the CAN device is stable. ► Make sure the Vehicle CAN is running stable: no EMC-issues or CAN-ID collisions are present.

After the software update, the Software Integrity Status (5.3.4), Failure Entries (5.3.9) and the ABS warning lamp in the driver's field of view should be checked. Only start the non-dynamic test drive when the integrity status shows "no issues", there are no failures detected and the ABS warning lamp is off.

6. Attachments

6.1. Disposal

	**ATTENTION**
	Electric/electronic components should not be disposed in the normal household waste. ► Make sure all Electric/ electronic components are disposed according to 2002/96/EC-WEEE (Waste Electrical and Electronic Equipment)

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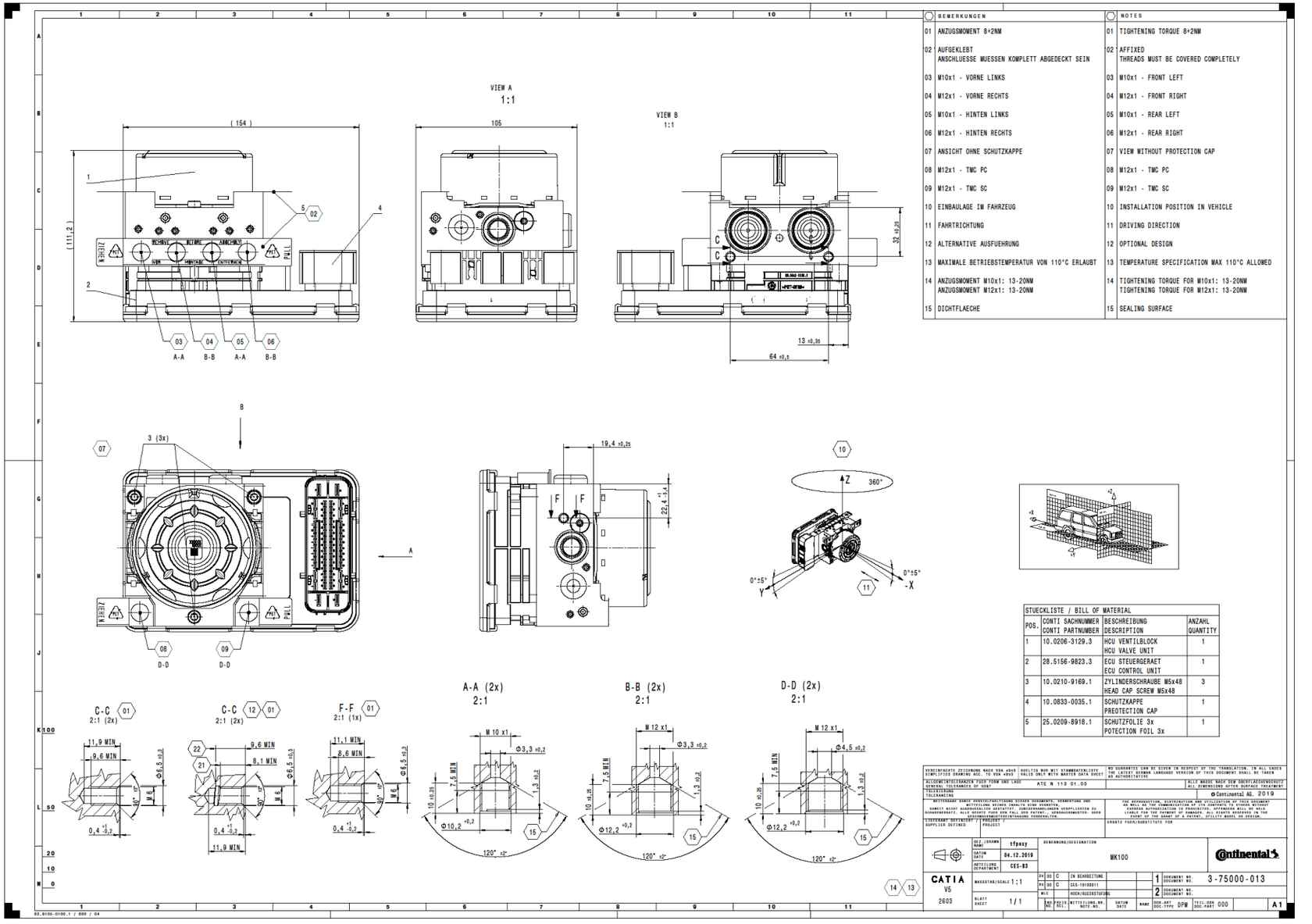
6.2. HECU – Technical Drawing

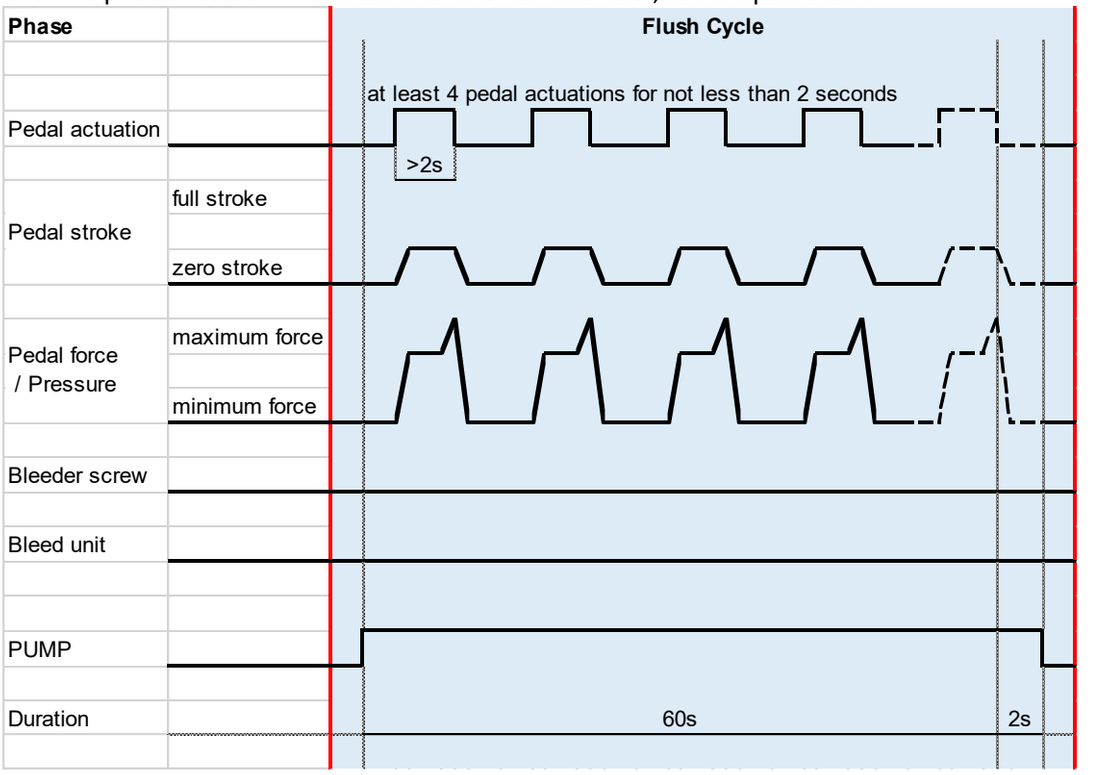


6.3. HECU – Pin Details

Pin #	Signal Name in ED	Description	R max	L max	I nom (ECU off)	I nom (ECU on / no control mode)	I nom (ECU on / in control mode)	I max	I max time	I max inrush	I max inrush time	I short	I short time	U min	U nom	U max	Type of I/O	Fuse Rating recommended	Twisted with	Comment
1	KL30_P	Power Supply		5µH	15µA		28A	40A	6sec	90A	10msec	250A	730µsec	9V	14V	18V	input	40A		MAXI fuse type mandatory
45	KL30_V			5µH		100mA	20A	40A	1sec	45A	10msec	150A	730µsec	9V	14V	18V	input	40A		
34	KL_15(IGN)							10mA						4,5V	14V	18V	input			
14	GND			5µH								250A	730µsec				input			See corresponding KL 30_P value
58	GND			5µH								150A	730µsec				input			See corresponding sum of KL 30_V and Kl 30_S values
39	FLEXRAY_P	Vehicle Network			25µA	15mA	15mA	15mA				100mA		0V	2,5V	3,5V	bidirectional		FLEXRAY_M	Connector & cable should meet FlexRay Communications System Electrical Physical Layer Specification 2.1B
24	FLEXRAY_M				25µA	15mA	15mA	15mA				100mA		0V	2,5V	3,5V	bidirectional		FLEXRAY_P	Connector & cable should meet FlexRay Communications System Electrical Physical Layer Specification 2.1B
31	CAN_VEH_H					44mA	44mA					170mA	25µsec	0V		5V	bidirectional		CAN_VEH_L	For maximum Resistance see ISO 11898.2 CAN High Speed Medium Acces UnitChapter 7.5 Physical Medium Specification
16	CAN_VEH_L					44mA	44mA					170mA	25µsec	0V		5V	bidirectional		CAN_VEH_H	For maximum Resistance see ISO 11898.2 CAN High Speed Medium Acces Unit Chapter 7.5 Physical Medium Specification
27	CAN_PRIVATE_H	ABS Private Network				44mA	44mA					170mA	25µsec	0V		5V	bidirectional		CAN_PRIVATE_L	For maximum Resistance see ISO 11898.2 CAN High Speed Medium Acces Unit Chapter 7.5 Physical Medium Specification
42	CAN_PRIVATE_L					44mA	44mA					170mA	25µsec	0V		5V	bidirectional		CAN_PRIVATE_H	For maximum Resistance see ISO 11898.2 CAN High Speed Medium Acces Unit Chapter 7.5 Physical Medium Specification
11	WSS_RR_SIG	Wheel Speed Sensors	0,5Ohm					34mA				200mA		5,5V		18V			WSS_RR_GND	Twisting only allowed with RR_GND (EMC).
10	WSS_RR_GND		0,5Ohm					34mA											WSS_RR_SIG	Twisting only allowed with RR_SIG (EMC).
9	WSS_FL_SIG		0,5Ohm					34mA				200mA		5,5V		18V			WSS_FL_GND	Twisting only allowed with FL_GND (EMC)
8	WSS_FL_GND		0,5Ohm					34mA											WSS_FL_SIG	Twisting only allowed with FL_SIG (EMC)
7	WSS_RL_SIG		0,5Ohm					34mA				200mA		5,5V		18V			WSS_RL_GND	Twisting only allowed with RL_GND (EMC).
6	WSS_RL_GND		0,5Ohm					34mA											WSS_RL_SIG	Twisting only allowed with RL_SIG (EMC).
5	WSS_FR_SIG		0,5Ohm					34mA				200mA		5,5V		18V			WSS_FR_GND	Twisting only allowed with FR_GND (EMC)
4	WSS_FR_GND		0,5Ohm					34mA											WSS_FR_SIG	Twisting only allowed with FR_SIG (EMC)
53	PS20_SENSEEP	External Pressure Sensor	0,5Ohm			2mA	2mA	4mA				400mA	5msec		5V					
40	PS20_GND		0,5Ohm			2mA	2mA	4mA												
55	PS20_SIG		0,5Ohm			1mA	1mA	1mA				1mA		0V		5V				
22	ABS_MODE_SW_SENSEEP	Analog Rotary Switch	0,5Ohm			2mA	2mA	4mA				400mA	5msec		5V					
29	ABS_MODE_SW_GND		0,5Ohm			3mA	3mA	10mA									output			
23	ABS_MODE_SW_SIG		0,5Ohm			3mA	3mA	10mA				10mA			14V		input			
47	WL_ABS	Hardwired Warning Lamp			0mA	0,175mA	0,18mA	0,268mA						0V		18,1V	output			
56	WL_FailurePresent	Hardwired Warning Lamp			0mA	0,175mA	0,18mA	0,268mA						0V		18,1V	output			
43	BRK_LIGHT_OUT	Brakelight Switch				20mA	20mA	20mA				20mA		6V	16,5V	20V	output			
57	TACHY_OUT	Vehicle Speed				40mA	40mA	50mA							14V		output			
36	ISO-K	Conti Diagnostic				30mA	30mA	46mA				200mA			14V		bidirectional			
54	ABS_OFF_SWITCH	Function Off Switch																		Pin must be connected to GND (e.g. by push button switch) for >100ms to disable and re-enable the ABS function.
28	Baudrate Switch (GND)	Baudrate Selection																		Both pins open: CAN baudrate (Vehicle CAN) is set to 1MBaud.
41	Baudrate Switch (Sig)																			Pins 28 and 41 bridged: CAN baudrate (Vehicle CAN) is set to 500kBaud.

6.4. Pump Flushing Routine

The Pump Flush Routine is started with the RSX ABS Tool; see chapter 5.3.7.



6.5. Full Bleeding Process (incl. Initial/ Rework Routine)

The Full Bleeding Process includes conventional bleeding processes bevor and after the Initial/ Rework Routine.

1.) Pre-filling:

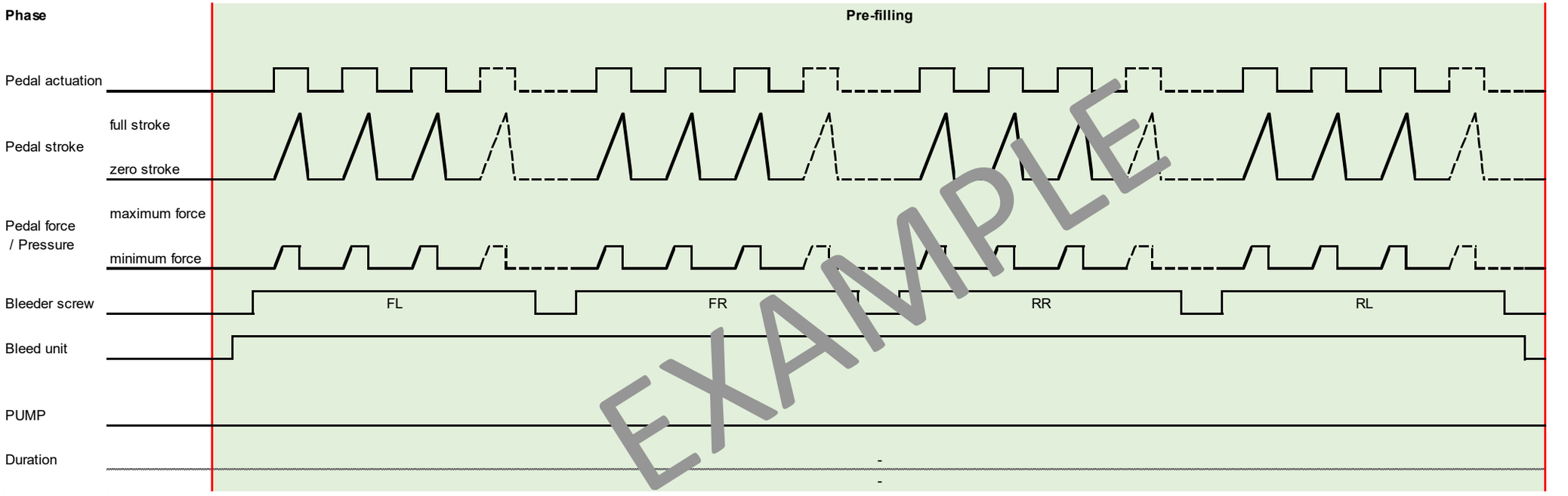
It's recommended to do a conventional bleed first, to get rid of the air in the brake system. The figure below shows an example of such.

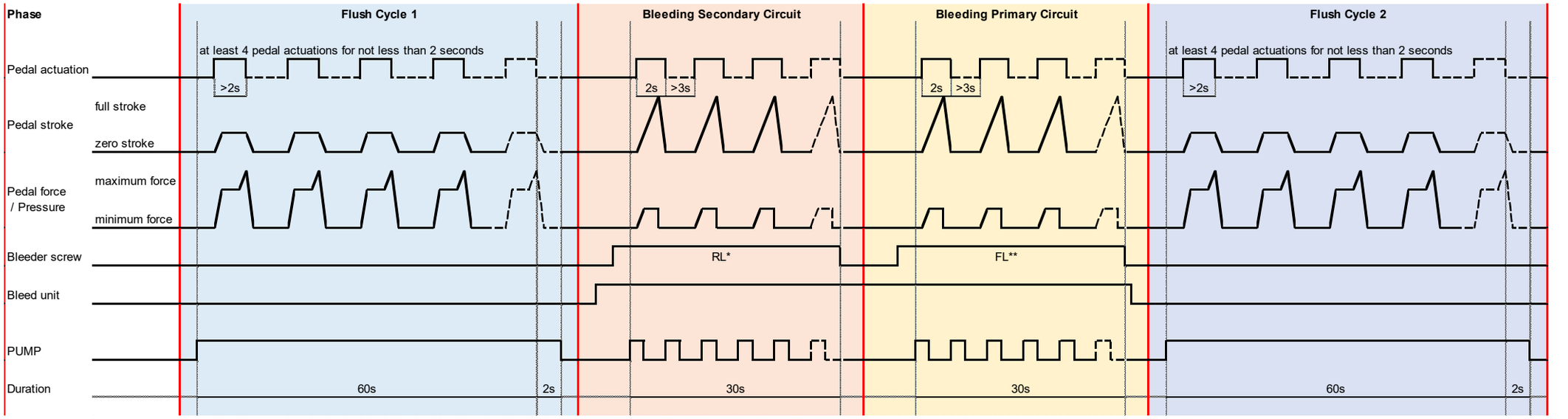
2.) Initial/ Rework Routine

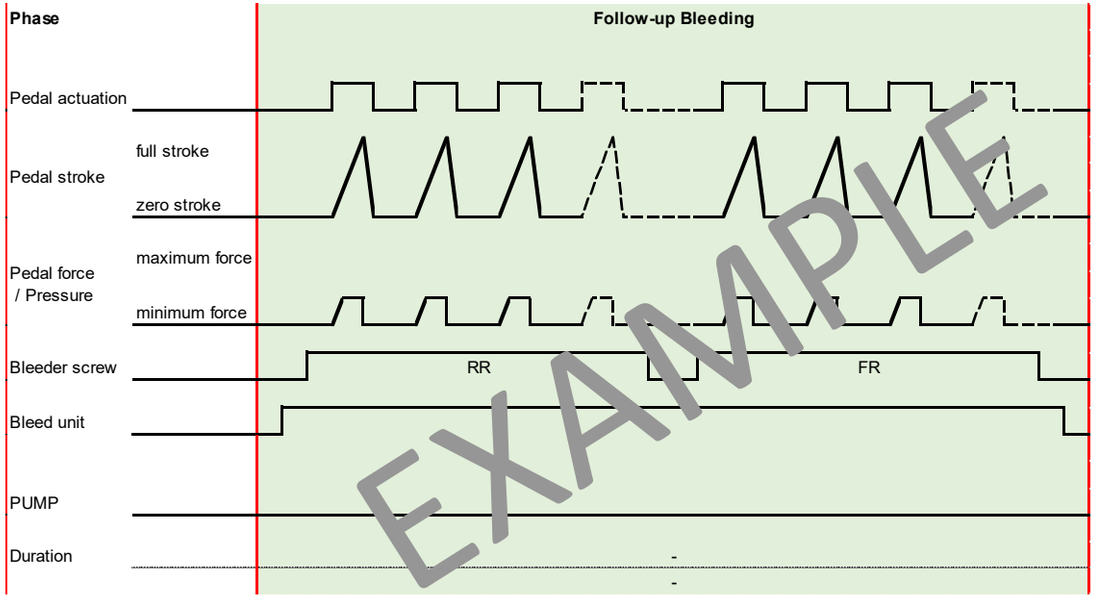
The Initial/ Rework Routine bleeds only the RSX ABS but not the rest of the brake system. It is mandatory to have a prefilled and bleeded brake system before starting the Initial/ Rework Routine. The routine is initiated with the RSX Tool, see chapter 5.3.7.

3.) Follow-up Bleeding:

After the routine, it's also recommended to do one final conventional bleed on the rear right and front right brake caliper.







*RL&FL **FL&RL, when using a balance bar, with two separate master cylinders

	ATTENTION
⚠	**Master Cylinder can be damaged during circuit bleeding, when using a Balance Bar** When running the routines for bleeding the secondary or primary brake circuit, the balance bar can be pushed in unintended positions due to one-sided pressure. ► Always open one bleeder screw on both circuits at the same time during process of “Bleeding Secondary Circuit” and “Bleeding Primary Circuit”

6.6. CAN Interface Description

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
MMI_24C	0x24C	8	10	Switch_ABS_PosReq	0	4	LSB	Unsigned	0	1	0	1	12		0x0=Initialisation; 0xF=Invalid; 0xE=Invalid; 0xD=Invalid; 0xC=Mode12; 0xB=Mode11; 0xA=Mode10; 0x9=Mode9; 0x8=Mode8; 0x7=Mode7; 0x6=Mode6; 0x5=Mode5; 0x4=Mode4; 0x3=Mode3; 0x2=Mode2; 0x1=Mode1;	Signal to switch ABS function off. Signal timeout: N/A	**R**
				Switch_TCS_ESC_PosReq	4	4	LSB	Unsigned	0	1	0	1	12		0x0=Initialisation; 0xF=Invalid; 0xE=Invalid; 0xD=Invalid; 0xC=Mode12; 0xB=Mode11; 0xA=Mode10; 0x9=Mode9; 0x8=Mode8; 0x7=Mode7; 0x6=Mode6; 0x5=Mode5; 0x4=Mode4; 0x3=Mode3; 0x2=Mode2; 0x1=Mode1;	Signal for ESC mode selection. Signal timeout: N/A	**R**
				Switch_ABS_OffReq	14	1	LSB	Unsigned	0	1	0	0	1		0x0=Button_not_pressed; 0x1=Button_pressed;	Signal for ABS off request. Signal timeout: N/A	**R**
				Switch_TCS_ESC_OffReq	15	1	LSB	Unsigned	0	1	0	0	1		0x0=Button_not_pressed; 0x1=Button_pressed;	Signal for ESC off request. Signal timeout: N/A	**R**
				MMI_Tcf_FrontAxle	24	12	LSB	Unsigned	0	1	0	1600	3000	mm	4095 =Invalid; 0xFFE=Initialisation;	max: 3000 mm Signal timeout: 300ms	**R**
				MMI_Tcf_RearAxle	36	12	LSB	Unsigned	0	1	0	1600	3000	mm	4094 =Initialisation; 0xFFF=Invalid;	max: 3000 mm Signal timeout: 300ms	**R**
				MMI_24C_RollingCounter	48	4	LSB	Unsigned	0	1	0	0	15			Rolling counter of ID24C message. Signal timeout: 100ms	**R**
				Rollerbench_Mode_Req	55	1	LSB	Unsigned	0	1	0	0	1		0x0=Rbm_no_request; 0x1=Rbm_act_deact_request;	Signal to trigger activation of rollerbench mode. Signal timeout: N/A	**R**
				MMI_24C_Crc	56	8	LSB	Unsigned	0	1	0	0	0			Checksum = (Byte1 +Byte2 …+ Byte7) XOR 0xFF. Signal timeout: 100ms	**R**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_01	0x340	8	10	RSX_WhlVel_FL	0	12	LSB	Unsigned	0	1	0	0	320	kph	0x1FFF=Invalid;	Signal Discription: Front left wheel speed value in kph.	**T**
				RSX_WhlVel_FR	12	12	LSB	Unsigned	0	1	0	0	320	kph	0x1FFF=Invalid;	Signal Discription: Front right wheel speed in kph.	**T**
				RSX_WhlVel_RL	24	12	LSB	Unsigned	0	1	0	0	320	kph	0x1FFF=Invalid;	Signal Discription: Rear left wheel speed in kph	**T**
				RSX_WhlVel_RR	36	12	LSB	Unsigned	0	1	0	0	320	kph	0x1FFF=Invalid;	Signal Discription: Rear right wheel speed in kph	**T**
				RSX_v_ref	48	12	LSB	Unsigned	0	1	0	0	320	kph			**T**
				RSX_v_ref_direction	60	2	LSB	Unsigned	0	1	0	0	3		0x3=Standstill; 0x2=Backward; 0x1=Forward; 0x0=Driving direction not defined;		**T**
				RSX_v_ref_Qf	63	1	LSB	Unsigned	0	1	0	0	1		0x1=Invalid; 0x0=Valid;		**T**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_02	0x341	8	10	RSX_WhlDirection_FL	0	2	LSB	Unsigned	0	1	0	0	3		0x3=not_available_or_invalid; 0x2=Init; 0x1=Backward; 0x0=Forward;		**T**
				RSX_WhlDirection_FR	2	2	LSB	Unsigned	0	1	0	0	3		0x3=not_available_or_invalid; 0x2=Init; 0x1=Backward; 0x0=Forward;		**T**
				RSX_WhlDirection_RL	4	2	LSB	Unsigned	0	1	0	0	3		0x3=not_available_or_invalid; 0x2=Init; 0x1=Backward; 0x0=Forward;		**T**
				RSX_WhlDirection_RR	6	2	LSB	Unsigned	0	1	0	0	3		0x3=not_available_or_invalid; 0x2=Init; 0x1=Backward; 0x0=Forward;		**T**
				RSX_WhlTick_FL	8	8	LSB	Unsigned	0	1	0	0	255			Invalid value 0xFF Overflow after 0xFE	**T**
				RSX_WhlTick_FR	16	8	LSB	Unsigned	0	1	0	0	255			Invalid value 0xFF Overflow after 0xFE	**T**
				RSX_WhlTick_RL	24	8	LSB	Unsigned	0	1	0	0	255			Invalid value 0xFF Overflow after 0xFE	**T**
				RSX_WhlTick_RR	32	8	LSB	Unsigned	0	1	0	0	255			Invalid value 0xFF Overflow after 0xFE	**T**
				RSX_02_RollingCounter	48	4	LSB	Unsigned	0	1	0	0	15			Signal Discription: Rolling counter of ID341 message.	**T**
				RSX_StandStill	54	2	LSB	Unsigned	0	1	0	0	1		0x1=Standing_still; 0x0=Moving;	Signal description: Indication whether the vehicle is moving or standing still.	**T**
				RSX_02_Crc	56	8	LSB	Unsigned	0	1	0	0	255			Checksum = (Byte1 +Byte2 …+ Byte7) XOR 0xFF. Invalid Value: N/A	**T**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_03	0x541	8	10	RSX_EngTorqReq	0	14	LSB	Unsigned	0	5	-2500	-2500	2500	Nm	16382=Not_available_initalization; 0x3FFF=Not_available_error;	Max: 2500 (0x1388) Invalid value: 0x3FFF	**T**
				RSX_03_RollingCounter	48	4	LSB	Unsigned	0	1	0	0	15			Init. Value: 0 Invalid Value: N/A	**T**
				RSX_EngTorqDecActive	54	1	LSB	Unsigned	0	1	0	0	1		0x1=Active; 0x0=Not_active;	0: Not active 1: Active	**T**
				RSX_EngTorqIncActive	55	1	LSB	Unsigned	0	1	0	0	1		0x1=Active; 0x0=Not_active;	0: Not active 1: Active	**T**
				RSX_03_Crc	56	8	LSB	Unsigned	0	1	0	0	255			Checksum = (Byte1 +Byte2 …+ Byte7) XOR 0xFF. Invalid Value: N/A	**T**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_04	0x342	8	10	RSX_DrvBraking	0	1	LSB	Unsigned	0	1	0	0	1		0x1=Driver_braking; 0x0=Driver_not_braking;	Signal description: Indication whether the driver is braking	**T**
				RSX_MasCylBrakePressure_PC_Qf	1	1	LSB	Unsigned	0	1	0	0	1		0x1=Invalid_or_not_available; 0x0=Valid;	Signal description: Validity of signal RSX_MasCylBrakePressure_PC	**T**
				RSX_MasCylBrakePressure_SC_Qf	2	1	LSB	Unsigned	0	1	0	0	1		0x1=Invalid_or_not_available; 0x0=Valid;	Signal description: Validity of signal RSX_MasCylBrakePressure_SC	**T**
				RSX_DrvBraking_Qf	6	1	LSB	Unsigned	0	1	0	0	1		0x1=Invalid_or_not_available; 0x0=Valid;	Signal description: Validity of signal RSX_DrvBraking	**T**
				RSX_MasCylBrakePressure_SC	8	12	LSB	Unsigned	0	1	0	0	4095	bar		Signal description: Brake pressure value of the secondary brake circuit (rear brake circuit).	**T**
				RSX_MasCylBrakePressure_PC	20	12	LSB	Unsigned	0	1	0	0	4095	bar		Signal description: Brake pressure value of the primary brake circuit (front brake circuit).	**T**
				RSX_04_RollingCounter	48	4	LSB	Unsigned	0	1	0	0	15			Signal description: Rolling counter of ID342 message.	**T**
				RSX_04_Crc	56	8	LSB	Unsigned	0	1	0	0	255			Signal description: Checksum = (Byte1 +Byte2 …+ Byte7) XOR 0xFF.	**T**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_05	0x343	8	10	RSX_ModelWhlPrs_FL	0	12	LSB	Unsigned	0	1	0	0	409.3	bar	0xFFE=Not_available_initalization; 0xFFF=Failure;	Signal description: Brake pressure value of the front left wheel (calculated from wheel pressure model).	**T**
				RSX_ModelWhlPrs_FR	12	12	LSB	Unsigned	0	1	0	0	409.3	bar	0xFFE=Not_available_initalization; 0xFFF=Failure;	Signal description: Brake pressure value of the front right wheel (calculated from wheel pressure model).	**T**
				RSX_ModelWhlPrs_RL	24	12	LSB	Unsigned	0	1	0	0	409.3	Bar	0xFFE=Not_available_initalization; 0x3FF=Failure;	Signal description: Brake pressure value of the rear left wheel (calculated from wheel pressure model).	**T**
				RSX_ModelWhlPrs_RR	36	12	LSB	Unsigned	0	1	0	0	409.3	Bar	0xFFE=Not_available_initalization; 0xFFF=Failure;	Signal description: Brake pressure value of the rear right wheel (calculated from wheel pressure model).	**T**
				RSX_05_RollingCounter	48	4	LSB	Unsigned	0	1	0	0	15			Init. Value: 0 Invalid Value: N/A	**T**
				RSX_05_Crc	56	8	LSB	Unsigned	0	1	0	0	255			Checksum = (Byte1 +Byte2 …+ Byte7) XOR 0xFF. Invalid Value: N/A	**T**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_06	0x5C0	8	10	RSX_SystemType	0	2	LSB	Unsigned	0	1	0	0	3		0x3=ABS_TCS_ESC; 0x2=ABS_ESC; 0x1=ABS_TCS; 0x0=ABS_only;	Signal description: Info of configured control functions.	**T**
				RSX_Systemstate	2	2	LSB	Unsigned	0	1	0	0	3		0x2=System_ready; 0x1=System_suspended; 0x0=System_init;	Signal description: System state	**T**
				RSX_IgnitionState	4	1	LSB	Unsigned	0	1	0	0	1		0x1=Ignition_on; 0x0=Ignition_off;	Signal description: State of KL15.	**T**
				RSX_PumpActive	5	1	LSB	Unsigned	0	1	0	0	1		0x1=Pump_active; 0x0=Pump_inactive;	Signal description: Indication whether the ABS pump is running.	**T**
				RSX_DiaActive	6	1	LSB	Unsigned	0	1	0	0	1		0x1=Dia_active; 0x0=Dia_not_active;	Signal description: Indication whether a diagnostic session is active.	**T**
				RSX_Coding_Failure	7	1	LSB	Unsigned	0	1	0	0	1		0x1=Coding_data_not_valid; 0x0=Coding_data_valid;	Signal description: Validity of coding data	**T**
				RSX_EBD_Active	8	1	LSB	Unsigned	0	1	0	0	1		0x1=Ebd_active; 0x0=Ebd_inactive;	Signal description: Indication whether EBD control is active.	**T**
				RSX_ABS_Active	9	1	LSB	Unsigned	0	1	0	0	1		0x1=Abs_active; 0x0=Abs_inactive;	Signal description: Indication whether ABS control is active.	**T**
				RSX_5C0_Internal_10	10	1	LSB	Unsigned	0	1	0	0	1				**T**
				RSX_5C0_Internal_11	11	1	LSB	Unsigned	0	1	0	0	1				**T**
				RSX_5C0_Internal_12	12	1	LSB	Unsigned	0	1	0	0	1				**T**
				RSX_ABS_FuncMode	13	1	LSB	Unsigned	0	1	0	0	1		0x1=ABS_off_mode; 0x0=ABS_on_mode;	Signal description: Mode of ABS	**T**
				RSX_5C0_Internal_14	14	1	LSB	Unsigned	0	1	0	0	1				**T**
				RSX_Blr_Request	15	1	LSB	Unsigned	0	1	0	0	1		0x1=Brake_light_active; 0x0=Brake_light_inactive;	Signal description: Brake light activation request if brake pedal is pressed (estimated from internal pressure sensor)	**T**
				RSX_5C0_Internal_16	16	1	LSB	Unsigned	0	1	0	0	1				**T**
				RSX_ABS_FailureLamp	17	1	LSB	Unsigned	0	1	0	0	1				**T**
				RSX_5C0_Internal_18	18	1	LSB	Unsigned	0	1	0	0	0				**T**
				RSX_5C0_Internal_19	19	1	LSB	Unsigned	0	1	0	0	1				**T**
				RSX_5C0_Internal_20	20	1	LSB	Unsigned	0	1	0	0	1				**T**
				RSX_DynoModeActive	22	1	LSB	Unsigned	0	1	0	0	1		0x1=DynoMode_active; 0x0=DynoMod_inactive;	Indication whether the Roller Bench Mode is activated. Roller Bench Mode will be left automatically when the vehicle is moving (one of the front wheel speeds showing a value > 6kph).	**T**

				RSX_FailurePresent	23	1	LSB	Unsigned	0	1	0	0	1		0x1=DTCs_set; 0x0=No_DTCs;	Indication whether a DTC (diagnostic trouble code) is present. If set to 1 please read failure codes and take remedial actions.	T
				RSX_EBDStatus	24	2	LSB	Unsigned	0	1	0	0	3		0x3=Available_in_regulation; 0x2=Available; 0x1=Not_available_error; 0x0=Not_available_initalization;	2: Available 3: Available_in_regulation	T
				RSX_ABSStatus	26	2	LSB	Unsigned	0	1	0	0	3		0x3=Available_in_regulation; 0x2=Available; 0x1=Not_available_error; 0x0=Not_available_initalization;	2: Available 3: Available_in_regulation	T
				RSX_5C0_Internal_28	28	2	LSB	Unsigned									T
				RSX_5C0_Internal_30	30	1	LSB	Unsigned									T
				RSX_CtrAct_FL	32	1	LSB	Unsigned	0	1	0	0	1		0x0=No_control_at_wheel; 0x1=Control_active_at_wheel;	Signal description: Indication whether control is active at the front left wheel	T
				RSX_CtrAct_FR	33	1	LSB	Unsigned	0	1	0	0	1		0x0=No_control_at_wheel; 0x1=Control_active_at_wheel;	Signal description: Indication whether control is active at the front right wheel	T
				RSX_CtrAct_RL	34	1	LSB	Unsigned	0	1	0	0	1		0x0=No_control_at_wheel; 0x1=Control_active_at_wheel;	Signal description: Indication whether control is active at the rear left wheel	T
				RSX_CtrAct_RR	35	2	LSB	Unsigned	0	1	0	0	1		0x0=No_control_at_wheel; 0x1=Control_active_at_wheel;	Signal description: Indication whether control is active at the rear right wheel	T
				RSX_5C0_Internal_40	40	4	LSB	Unsigned	0	1	0	0	15				T
				RSX_ABS_ModeSwPosInfo	44	4	LSB	Unsigned	0	1	0	0	15		0xF=ModeSwFailure_or_not_available; 0xB=Mode11; 0xA=Mode10; 0x9=Mode9; 0x8=Mode8; 0x7=Mode7; 0x6=Mode6; 0x5=Mode5; 0x4=Mode4; 0x3=Mode3; 0x2=Mode2; 0x1=Mode1; 0x0=Initialisation; 0xC=Mode12;	Signal description: Indication which TCS/ESC mode is selected.	T

				RSX_BusTiming	48	4	LSB	Unsigned	0	1	0	3	15		0x3=CAN1_1000_CAN2_1000; 0x2=CAN1_500_CAN2_1000; 0x1=CAN1_1000_CAN2_500; 0x0=CAN1_500_CAN2_500;	Signal description: Indication which ABS mode is selected.	**T**
				RSX_PwtCfg	54	2	LSB	Unsigned	0	1	0	0	3		0x3=Awd; 0x2=Rwd; 0x0=Invalid; 0x1=Fwd;	Signal description: Info of configured CAN Baudrate.	**T**
				RSX_KL30V	56	8	LSB	Unsigned	0	1	0	0	255	V		Measured power supply (@ KL30_V)	**T**

Message	**ID**	**DLC [Byte]**	**Cycle Time [Ms]**	**Signal**	**Startbit**	**Length [Bit]**	**Byte Order**	**Value Type**	**Initial Value**	**Factor**	**Offset**	**Minimum**	**Maximum**	**Unit**	**Value Table**	**Comment**	**RSX_ ABS**
RSX_07	0x70	8	10	RSX_LatAcc	0	12	LSB	Unsigned	0	25	-512	-512	51125	m/s²	4094 =Not_available_initalization; 0xFFF=Failure;	Signal description: Lateral Acceleration (vehicle driving a left hand curve show positive values).	**T**
				RSX_LatAcc_Qf	15	1	LSB	Unsigned	0	1	0	0	1		0x1=Invalid_or_not_available; 0x0=Valid;	Signal description: Validity of signal RSX_LatAcc	**T**
				RSX_LongAcc	16	12	LSB	Unsigned	0	25	-512	-512	51125	m/s²	4094 =Not_available_initalization; 0xFFF=Failure;	Signal description: Longitudinal Acceleration (vehicle deceleration show negative values).	**T**
				RSX_LongAcc_Qf	31	1	LSB	Unsigned	0	1	0	0	1		0x1=Invalid_or_not_available; 0x0=Valid;	Signal description: Validity of signal RSX_LongAcc	**T**
				RSX_YawRate	32	14	LSB	Unsigned	0	1	0	0	93	°/s	16383 =Failure; 0x3FFE=Not_available_initalization;	Signal description: Absolute value of the vehicle's yaw rate. The signal RSX_YawRate_sgn will give an indication of the turning direction.	**T**
				RSX_YawRate_sgn	46	1	LSB	Unsigned	0	1	0	0	1		0x1=Negative; 0x0=Positive;	Signal description: Sign of signal RSX_YawRate (vehicle driving a left hand curve signal is positive).	**T**
				RSX_YawRate_Qf	47	1	LSB	Unsigned	0	1	0	0	1		0x1=Invalid_or_not_available; 0x0=Valid;	Signal description: Validity of signal RSX_YawRate	**T**
				RSX_07_RollingCounter	48	4	LSB	Unsigned	0	1	0	0	15			Init. Value: 0 Invalid Value: N/A	**T**
				RSX_07_Crc	56	8	LSB	Unsigned	0	1	0	0	255			Checksum = (Byte1 +Byte2 …+ Byte7) XOR 0xFF. Invalid Value: N/A	**T**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_08	0x80	8	10	RSX_VertAcc	0	10	LSB	Unsigned	0	3125	-16	-51.2	51.13	m/s²	0xFF=Failure; 0xFE=Not_available_initalization;	Signal description: Vertical Acceleration (vehicle standing on ground show positive gravitational acceleration).	**T**
				RSX_VertAcc_Qf	15	1	LSB	Unsigned	0	1	0	0	1		0x1=Invalid_or_not_available; 0x0=Valid;	Signal description: Validity of signal RSX_VertAcc	**T**
				RSX_RollRate	16	14	LSB	Unsigned	0	1	0	0	93	°/s	16383 =Failure; 0x3FFE=Not_available_initalization;	Signal description: Absolute value of the vehicle's roll rate. The signal RSX_RollRate_sgn will give an indication of the turning direction.	**T**
				RSX_RollRate_sgn	30	1	LSB	Unsigned	0	1	0	0	1		0x1=Negative; 0x0=Positive;	Signal description: Sign of signal RSX_RollRate (vehicle rolling to the right hand side e.g., when initiating a left hand curve, signal is positive).	**T**
				RSX_RollRate_Qf	31	1	LSB	Unsigned	0	1	0	0	1		0x1=Invalid_or_not_available; 0x0=Valid;	Signal description: Validity of signal RSX_RollRate	**T**
				RSX_PitchRate	32	14	LSB	Unsigned	0	1	0	0	163.83	°/s	16383 =Failure; 0x3FFE=Not_available_initalization;	Signal description: Absolute value of the vehicle's pitch rate. The signal RSX_PitchRate_sgn will give an indication of the turning direction.	**T**
				RSX_PitchRate_sgn	46	1	LSB	Unsigned	0	1	0	0	1		0x1=Negative; 0x0=Positive;	Signal description: Sign of signal RSX_PitchRate (vehicle pitching to the front, e.g., diving when initiating a braking, signal is positive).	**T**
				RSX_PitchRate_Qf	47	1	LSB	Unsigned	0	1	0	0	1		0x1=Invalid_or_not_available; 0x0=Valid;	Signal description: Validity of signal RSX_PitchRate	**T**
				RSX_08_RollingCounter	48	4	LSB	Unsigned	0	1	0	0	15			Init. Value: 0 Invalid Value: N/A	**T**
				RSX_08_Crc	56	8	LSB	Unsigned	0	1	0	0	255			Checksum = (Byte1 +Byte2 …+ Byte7) XOR 0xFF. Invalid Value: N/A	**T**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_NMH	0x1B 0000 09	5		NM_RSX_RunAfterType	0	4	LSB	Unsigned	0	1	0	0	2		0x2=Wake_up_ign_off; 0x1=Ign_off; 0x0=Not_supported;		**T**
				NM_RSX_NM_aktiv_KL15	6	1	LSB	Unsigned	0	1	0	0	1		0x1=Ign_on; 0x0=Ign_off;	Ignition state detected by NM.	**T**
				NM_RSX_NM_aktiv_Tmin	7	1	LSB	Unsigned	0	1	0	0	1				**T**
				NM_RSX_State	8	6	LSB	Unsigned	0	1	0	0	2		0x2=Knockout; 0x1=Postrun; 0x0=Normal_operation ;		**T**
				NM_RSX_Wakeup	16	4	LSB	Unsigned	0	1	0	0	2		0x2=Ign_wakeup; 0x1=Bus_wakeup; 0x0=Peripheral_or_unknown_wakeup;		**T**
				NM_RSX_BusKnockOutTimer	24	16	LSB	Unsigned	0	1	0	0	30000			Postrun timer, before BUS communication is switched off and ECU prepares for switch-off. The controller switches-off when BUS communication has stopped.	**T**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_FunReq	0x7DF	8		RSX_Req_Data	0	64	LSB	Unsigned	0	1	0	0	1,84467E+29				**R**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_PhyReq	0x780	8		RSX_Req_Data	0	64	LSB	Unsigned	0	1	0	0	1,84467E+29				**R**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
RSX_Resp	**0x788**	**8**		RSX_Resp_Data	0	64	LSB	Unsigned	0	1	0	0	1,84467E+29				**T**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
SWA_BOURNS_CAL	0x620																**R**
SWA_BOURNS_DATA	0x11F																**R**
SWA_BOURNS_DIAG_RX	0x715																**R**
SWA_BOURNS_DIAG_TX	0x71D																**T**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
SWA_CUSTOM_DATA	0x321	5	10	SWA_STEER_ANGLE	7	16	MSB	Signed	0	1	0	-780	780	°	0x8000=Invalid;	Invalid value: 0x8000	**R**
				SWA_STEER_SPEED	23	8	MSB	Signed	0	8	0	-1016	1016	°/s	0x80=Invalid;	Invalid value: 0x80 Signal Timeout: 500ms	**R**
				SWA_STATUS_FAILURE	24	1	MSB	Unsigned	0	1	0	0	1		0x1=No_failure; 0x0=Failure;	1: No Failure Signal Timeout: 100ms	**R**
				SWA_STATUS_CALIB	25	1	MSB	Unsigned	0	1	0	0	1		0x1=Calibrated; 0x0=Not_calibrated;	1: Calibrated Signal Timeout: 100ms	**R**
				SWA_STATUS_TRIM	26	1	MSB	Unsigned	0	1	0	0	1		0x1=Trimmed; 0x0=Not_trimmed;	(If a custom SWA is not sending this information actively, please always set this signal to 1.) Signal Timeout: 100ms	**R**
				SWA_COUNTER	35	4	MSB	Unsigned	0	1	0	0	15			Max: 0xF Signal Timeout: 100ms	**R**
				SWA_CHECKSUM	39	4	MSB	Unsigned	0	1	0	0	15			SWA_CHECKSUM = higher nibble(temp_result) XOR lower nibble(temp_result) XOR SWA_COUNTER Signal Timeout: 100ms	**R**

Message	ID	DLC [Byte]	Cycle Time [Ms]	Signal	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit	Value Table	Comment	RSX_ ABS
TCU_238	0x238	4	10	TCU_ActGear	8	4	LSB	Unsigned	0	1	0	0	15		0xC=Park_gear; 0xB=Reverse_gear; 0xA=Tenth_gear; 0x9=Ninth_gear; 0x8=Eighth_gear; 0x7=Seventh_gear; 0x6=Sixth_gear; 0x5=Fifth_gear; 0x4=Fourth_gear; 0x3=Third_gear; 0x2=Second_gear; 0x1=First_gear; 0x0=Neutral_gear; 0xF=Not_available_error;	Signal indicates current gear selected by the gearbox. SignalTimeout: 200ms	**R**
				TCU_GearPos	12	4	LSB	Unsigned	0	1	0	0	15		0x4=Position_Manual; 0x3=Position_D; 0x2=Position_N; 0x1=Position_R; 0x0=Position_P; 0xF=Not_available_error;	Signal indicates selected gear by gear lever. SignalTimeout: 200ms	**R**
				TCU_238_RollingCounter	16	4	LSB	Unsigned	0	1	0	0	15			Rolling counter of ID238 message. SignalTimeout: 200ms	**R**
				TCU_238_Crc	24	8	LSB	Unsigned	0	1	0	0	255			Checksum = (Byte1 +Byte2 …+ Byte7) XOR 0xFF. SignalTimeout: 200ms	**R**
				TCU_ShiftInProg	0	1	LSB	Unsigned	0	1	0	0	1		0x1=ShiftInProgress; 0x0=NoShiftInProgress;	Signal indicates if gearshift is in progress or not. SignalTimeout: 500ms	**R**
				TCU_TgtGear	20	4	LSB	Unsigned	0	1	0	0	15		0xC=Park_gear; 0xB=Reverse_gear; 0xA=Tenth_gear; 0x9=Ninth_gear; 0x8=Eighth_gear; 0x7=Seventh_gear; 0x6=Sixth_gear; 0x5=Fifth_gear; 0x4=Fourth_gear; 0x3=Third_gear; 0x2=Second_gear; 0x1=First_gear; 0x0=Neutral_gear; 0xF=Not_available_error;	Signal indicates target gear anticipated by the gearbox. SignalTimeout: 500ms	**R**

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