BMW Motorrad – HP Race Calibration Kit Pro HP4Race

(Version 1.0, 22.01.2018)

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Warnings

ATTENTION

The BMW Motorrad – HP Race Calibration Kit Pro HP4Race software influences the electronic systems of your motorcycle. In contrast to the standard series production model, changing the parameters can produce critical driving conditions. BMW Motorrad provides no safeguards for critical driving conditions.

WARNING

Use of this product can change the handling of the motorcycle to such an extent that life and limb can be endangered and/or material damage can occur. Interventions in the engine control unit with this product can lead to serious consequences for rider and equipment. The durability of the engine can be significantly reduced. Engine damage might occur. Read and comply with the instructions in the rider's manual.

NOTICE

- Use this product only if you have the necessary experience and training.
- The BMW Motorrad – HP Race Calibration Kit Pro HP4Race software can be used only for the HP4Race motorcycle with the BMW adapter cable. The BMW Motorrad – HP Race Calibration Kit Pro HP4Race software is not suitable for use with other parts.
- Do not use a vehicle modified by the BMW Motorrad – HP Race Calibration Kit Pro software on public roads.

List of abbreviations

CLP	Closed Loop (control; in contrast to "static" precontrol)
DTC	Dynamic Traction Control
EBR	Engine Brake
GPS	Global Positioning System
HR	Rear wheel
LNC	Launch Control
RCK Pro	BMW Motorrad – HP Race Calibration Kit Pro HP4Race software
SASS	Shift Assistant
VCI	Virtual Communication Interface
VR	Front wheel
WC	Wheelie Control

Introduction

The BMW Motorrad – HP Race Calibration Kit Pro HP4Race software (RCK Pro) allows adaptation of various engine control functions. Modifications to the vehicle are taken into account. This includes tyres, for example. Rider preferences are also taken into account in the setup.

The following functions can be adapted:

- Injection
- Engine brake
- Driver request (power levels or precontrol)
- DTC (Dynamic Traction Control)
- Launch control
- Shift assistant
- Gear dependencies
- Pit-lane speed limiter
- Fault memory
- Adaptation

Components

Figure 1 Components

Installation

BMW Motorrad recommends downloading the latest software version from the website
http://www.bmw-motorrad.com/com/en/bike/sportbikes/hp4_race/hp4_race_overview.html

Content of the download package

- Race Calibration Kit Pro HP4Race
- Drivers for Bosch VCI
- Spreadsheet files for power levels and gear adaptation
- Help file
- Readme file

Refer to the readme file for the current installation instructions.

Procedure

- Download the current HP4RACE download package from the page http://www.bmw-motorrad.com/com/en/bike/sportbikes/hp4_race/hp4_race_overview.html
- Open the file MTS6512_BMW_RCK3_setup_V2.2.44.8.exe in order to install the drivers for Bosch VCI.
- Follow the instructions on the screen.
- Connect the Bosch VCI to the USB port.
- Open the file RCKpro-HP4Race_v1.0.0.0_setup.exe to install the RCKProHP4Race software.
- Follow the instructions on the screen.

NOTICE

One of the following conditions must be met so that you can work with RCK Pro:

- The tool is connected with a motorcycle (online).
- An existing data record is loaded (offline).

RCK Pro is not downwardly compatible.

Working with RCK Pro

You can create and edit data records with this software. The created data records contain the adaptations of the various functionalities.

User interface

The interface of RCK Pro is divided into five areas:

- **Menu bar**

  The menu bar contains all functions of RCK Pro. The following functions can be set using the menu bar:

  - Call up existing keyboard shortcuts.
  - Activate and deactivate toolbar under Options→ Symbol bars.
  - Activate HP Race Calibration Pro bar under Options→ Symbol bars.
  - You can also access Help and change settings.

- **Toolbar**

  You can access the most important functions using the toolbar.

- **HP Race Calibration Pro bar**

  You can see the motorcycle to which RCK Pro is connected in the HP Race Calibration Pro bar.

- **Working area**

  The working area changes depending on the selected subject area.

- **Status area**

  The connection status with the motorcycle is shown in the status area.

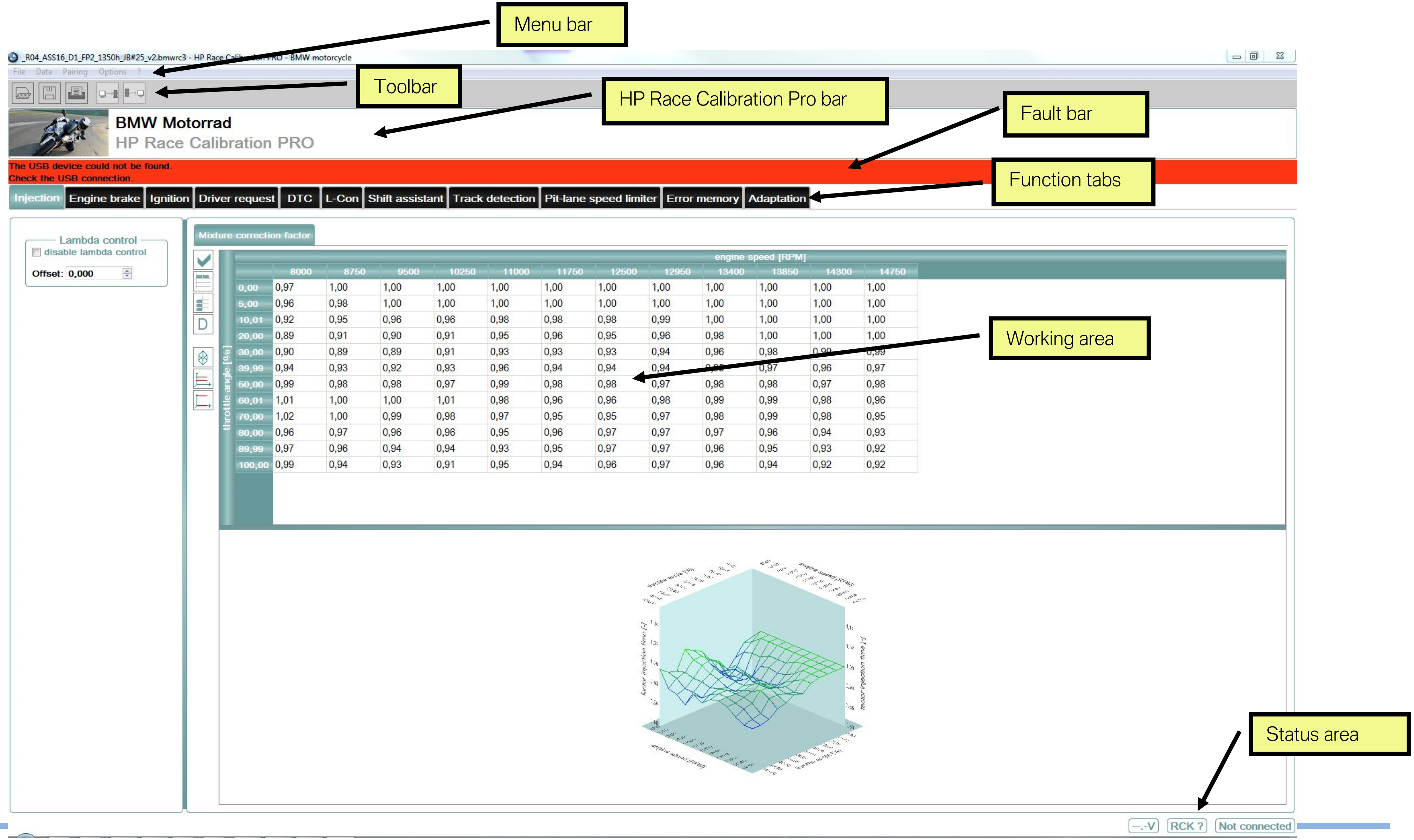


Figure 2 Interface

Connection to the motorcycle

You can adapt the data records without a connection to the motorcycle. A connection between the motorcycle and computer is a prerequisite for data transfer.

Proceed as follows to establish a connection between the motorcycle and computer:

- Using the BMW RCK3 VCI adapter cable, connect the computer with the diagnosis port on the motorcycle.
- Switch on the ignition.

The following can be seen in the status area after successful connection:

- Communication status
- Enabling status for RCK Pro
- Motorcycle vehicle voltage

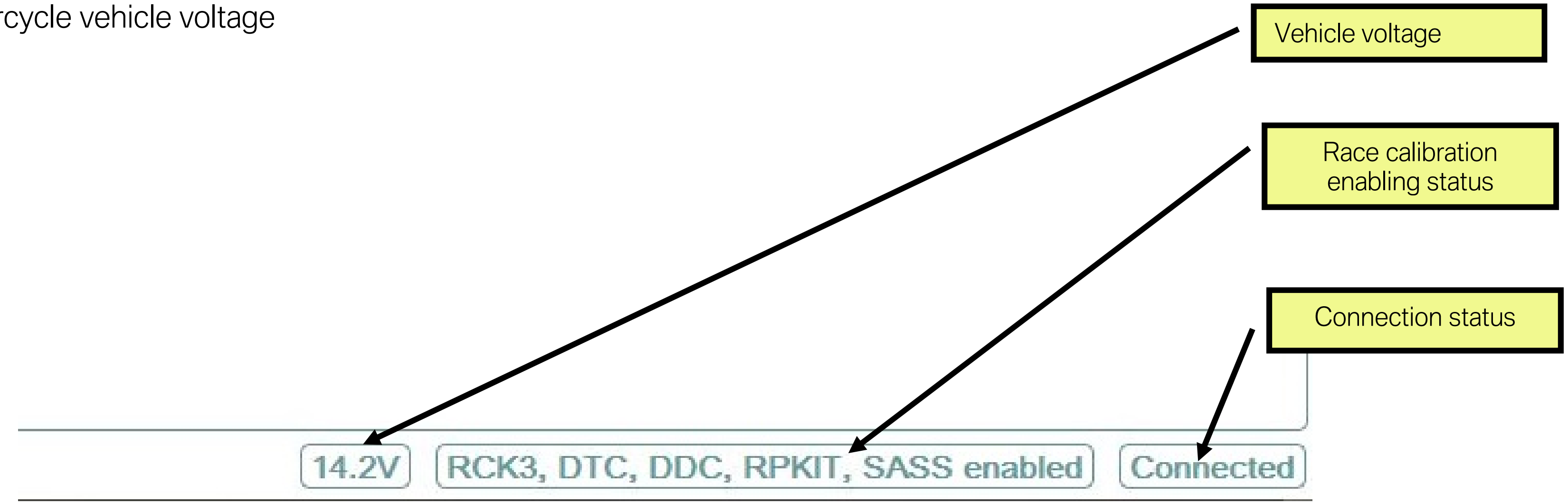


Figure 3 Connection to the motorcycle

Saving and loading data

You can save a data record in a file or load a record from a file. Different data records can be managed and shared with other users. You can save a data record in a file or load a record from a file in two ways. Proceed as follows to load a data record:

Via the menu bar

- Click on "File".
- Click on "Load".

Proceed as follows to save a data record:

- Click on "File".
- Click on "Save as".

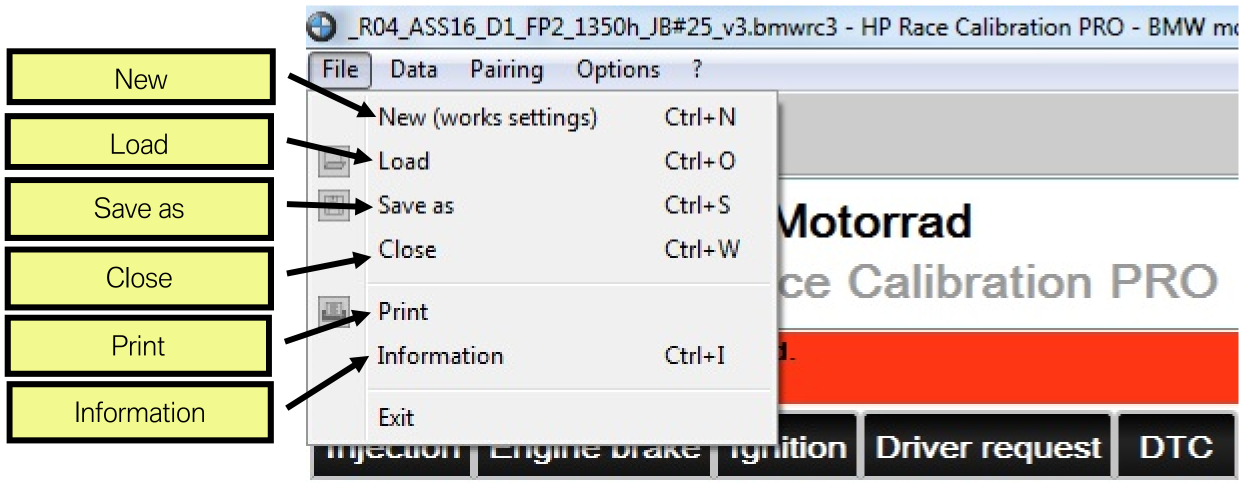


Figure 4 Load

Via the toolbar

- Click on the "Load" button.

Proceed as follows to save a data record:

- Click on the "Save as" button.

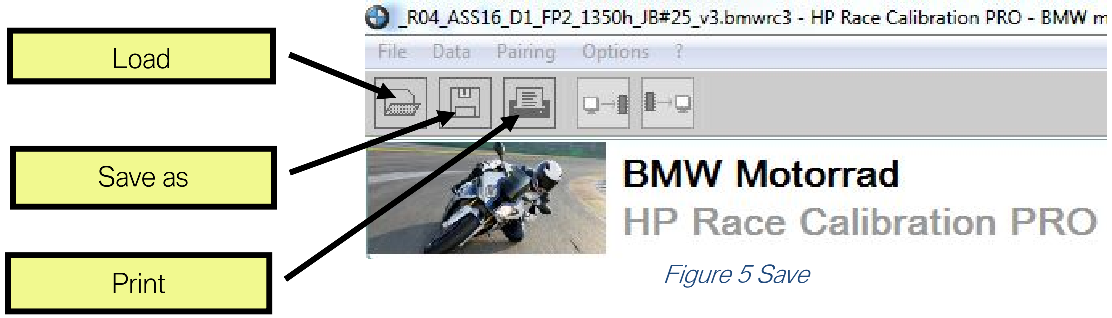


Figure 5 Save

You can specify additional metadata when saving:

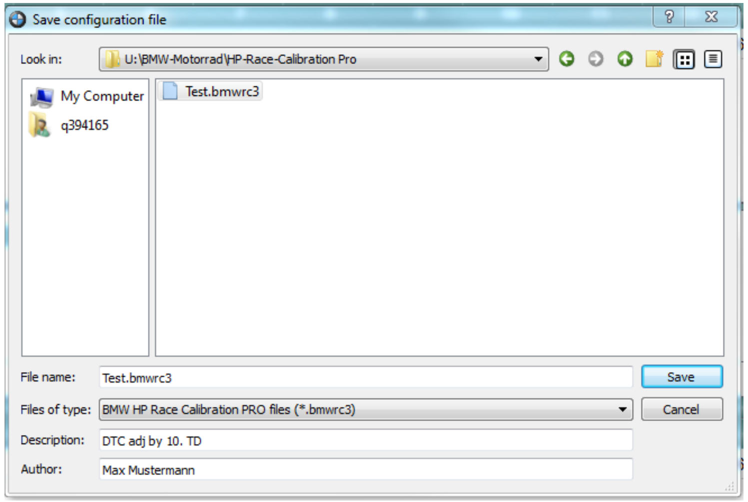


Figure 6 Save

You can view the metadata of the current data record in the "File information" dialogue box.

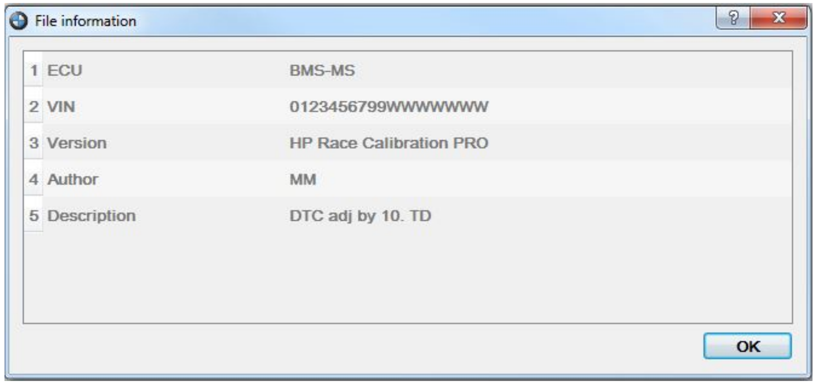


Figure 7 File information dialogue box with metadata

Printing data

You can print data in two different ways:

- All data
- Current characteristic map

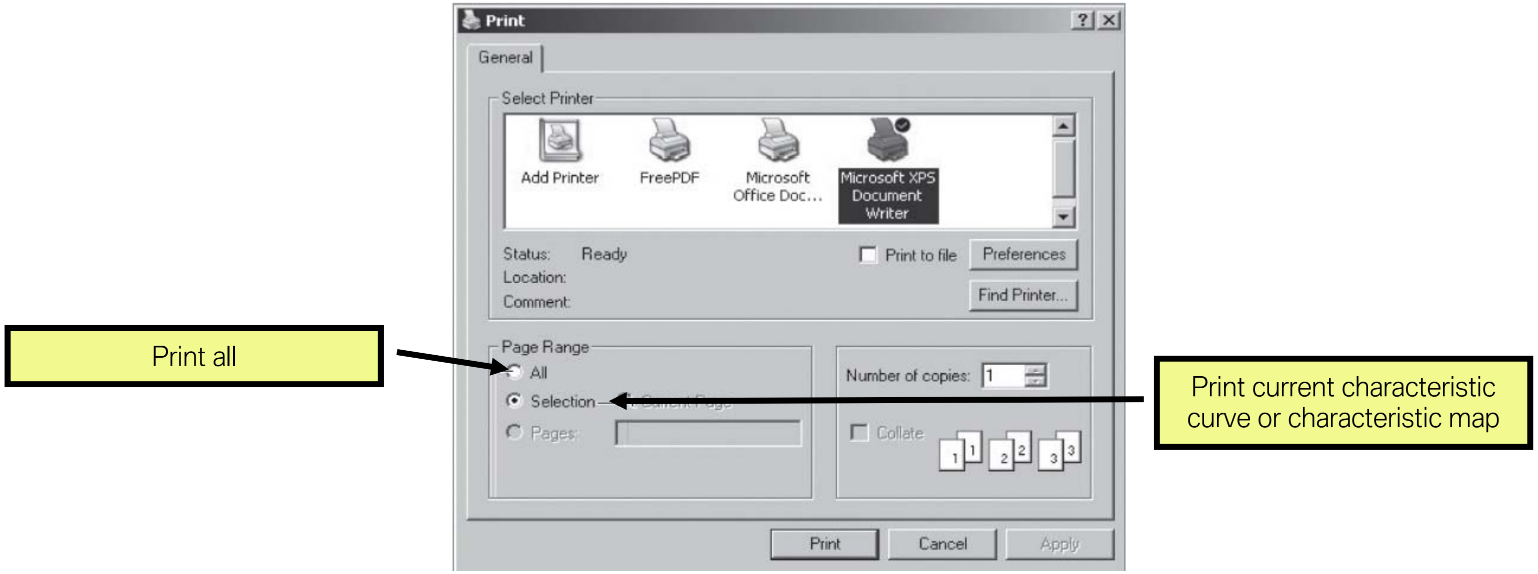


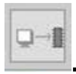
Figure 8 Print data

Transmitting a file

You can transfer parameters that have been changed in RCK Pro to the motorcycle. All changes in the data record are then replaced. The data record must be written to the control unit in order to also activate the settings in the motorcycle again.

You can write a data record to the control unit in two ways:

Via the toolbar

- Click on the button .

Via the menu bar

- Click on "Data".
- Click on "Write data into the control unit".

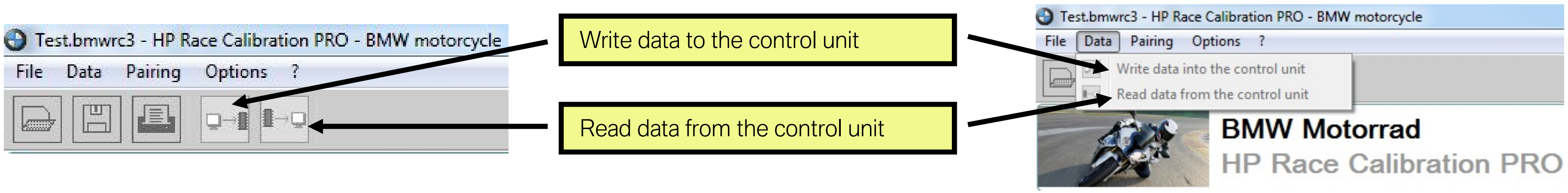
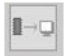


Figure 9 Transfer file

You can read a data record from the control unit in two ways:

Via the toolbar

- Click on the button .

Via the menu bar

- Click on "Data".
- Click on "Read data into the control unit".

Editing data

A data record consists of adjustable parameters. The parameters are part of the engine control functions. You can adjust the following parameters:

- Injection
- Engine brake
- Driver request
- DTC
- Launch control
- Shift assistant
- Pit-lane speed limiter
- Error memory
- Adaptation
-

Proceed as follows to edit the parameters:

- Click on the desired tab on the user interface.

» The tab opens.

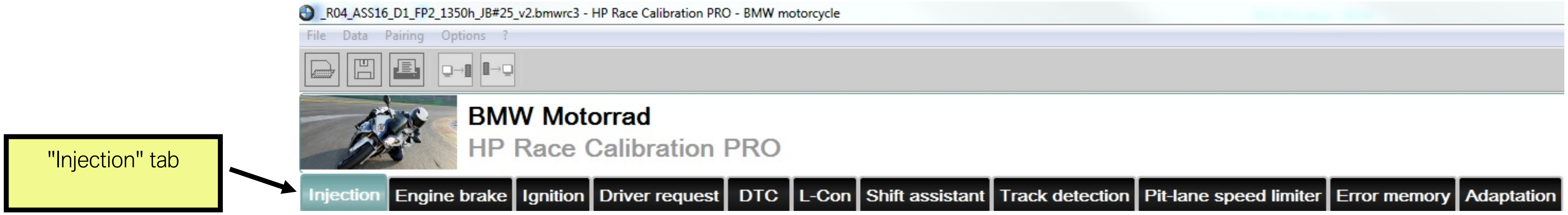


Figure 10 Edit data

You can change four parameters, which are displayed immediately by RCK Pro. The changes become active in the motorcycle only after the data record has been written to the control unit.

Four parameters are described below:

1. Option button

Option buttons can be activated or deactivated via checkboxes. An active option button is indicated by the activated checkbox.

- Click on the checkbox to activate the option.

The text on the right next to the checkbox describes the active option button.

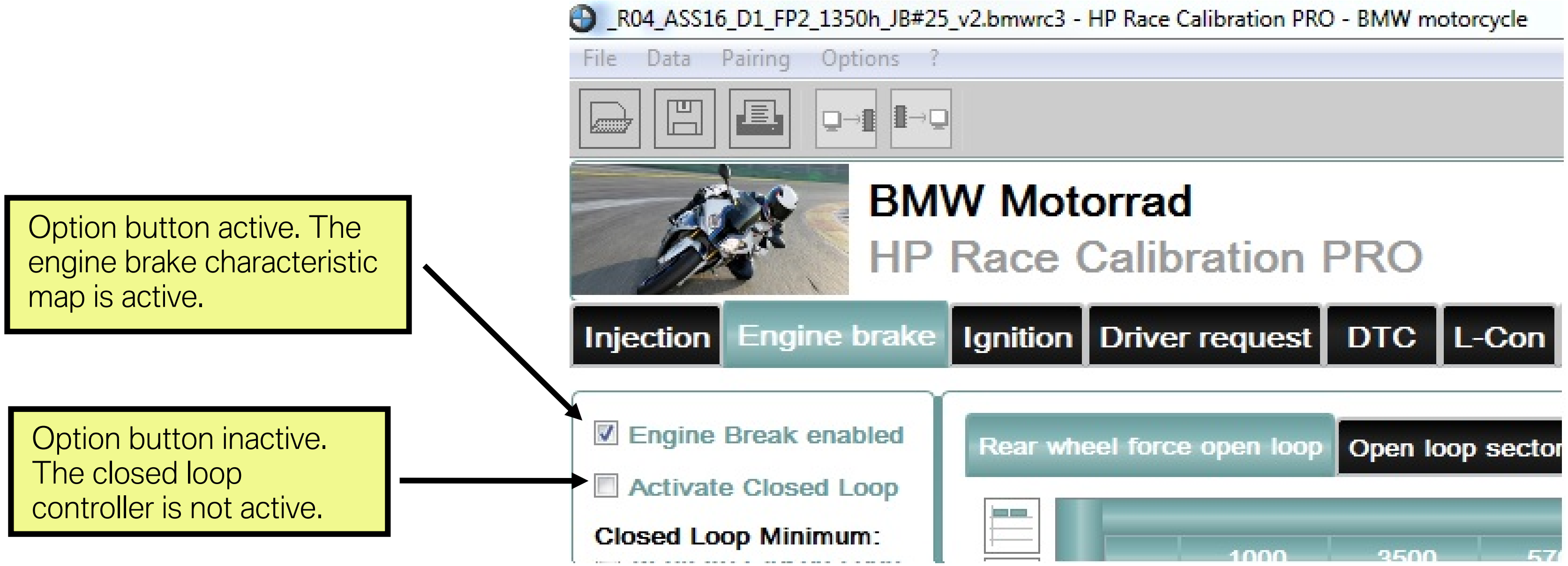


Figure 11 Option buttons

2. Characteristic values

Characteristic values can be activated or deactivated via checkboxes. An active characteristic value is indicated by the activated checkbox. The text above the checkbox describes the active characteristic value.

- Click on the checkbox to activate the characteristic value.
- When a characteristic value is activated, enter values in the number field below the checkbox.
    - When a characteristic value is not activated, the number field is greyed out and cannot be modified.
    - In this case, the factory settings apply to this parameter.
    - The greyed out value is not valid.
- Enter numerical values vis the keyboard.
  In order to avoid confusion when entering the decimal separator, points will be automatically replaced by commas.
- The entered numerical value can be changed in steps by clicking on the arrow buttons (increment, decrement).
- Make changes using the commands "Select", "Copy" and "Paste" from the clipboard.

- You can additionally make changes by means of the context menu.
- All input is restricted to a valid range and a valid increment.

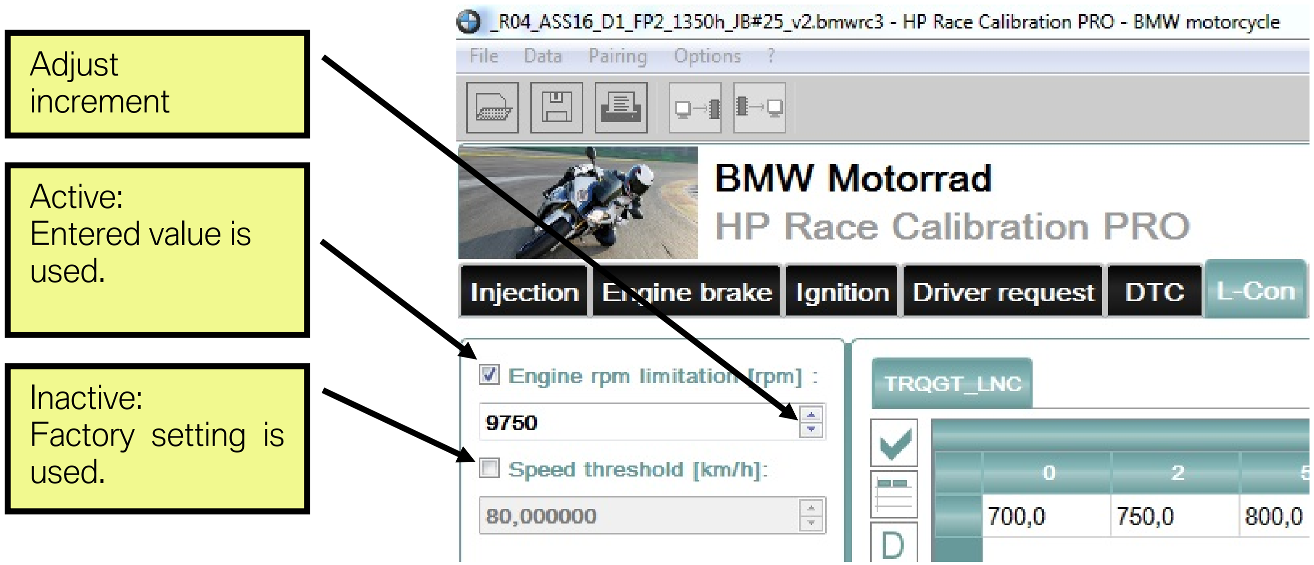


Figure 12 Characteristic values

3. Characteristic maps

Characteristic maps consist of the following elements:

- Activatable element
- Table of values
- Three-dimensional representation
- Various buttons

Activate characteristic maps

Characteristic maps are activated as follows:

- Click on the element that can be activated.
  - » The red cross is replaced by a tick.
  - » The characteristic map is activated.
  - » You can edit the number fields.

When a characteristic map is not activated, the number field is greyed out and cannot be modified. In this case, the factory settings apply to this parameter. The greyed out value is not valid.

NOTICE

Also observe these settings for "New" (works settings).

A characteristic map consists of two axes and a table of values. Each axis has an input variable that corresponds to a modifiable variable in the motorcycle. The current value of both input variables determines where the current operating point lies in the characteristic map. This determines the value to be used from the table of values. Linear interpolation is used when an input variable does not precisely fit to a value of the corresponding axis.

The three-dimensional representation shows the input variables of the axes (e.g. current values such as engine speed).

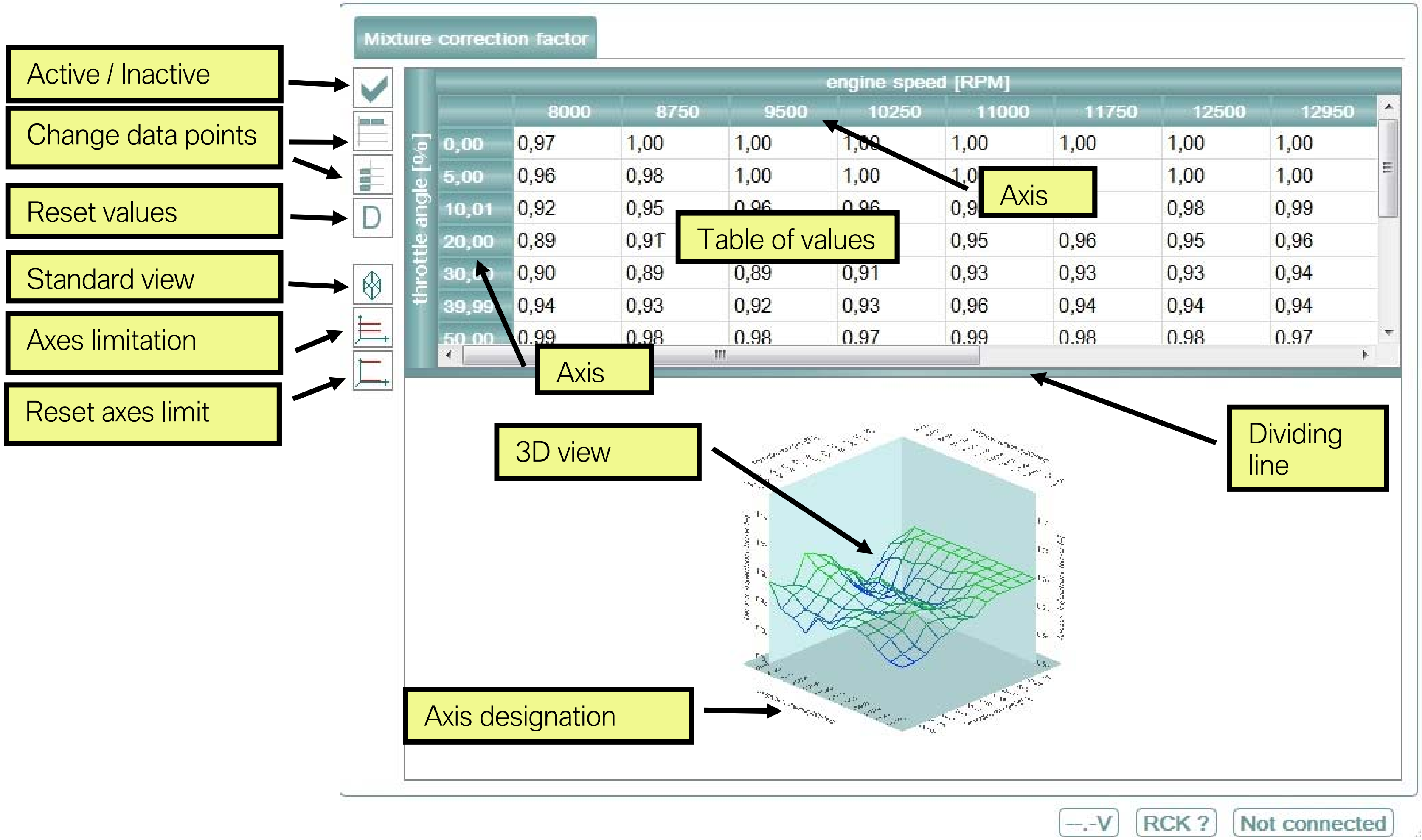


Figure 13 Activating characteristic maps

You can modify the axes and the table of values when a characteristic map is activated.

Proceed as follows to modify the axes:

- Open the data point editor by means of a button on the left of the table of values.
- Mark one or more cells with the mouse or keyboard.
- Enter numerical values via the keyboard.
  Points will be automatically replaced by commas.
- Configure "Settings" via the context menu.
  The corresponding keyboard shortcuts are also specified in the "Settings" context menu.

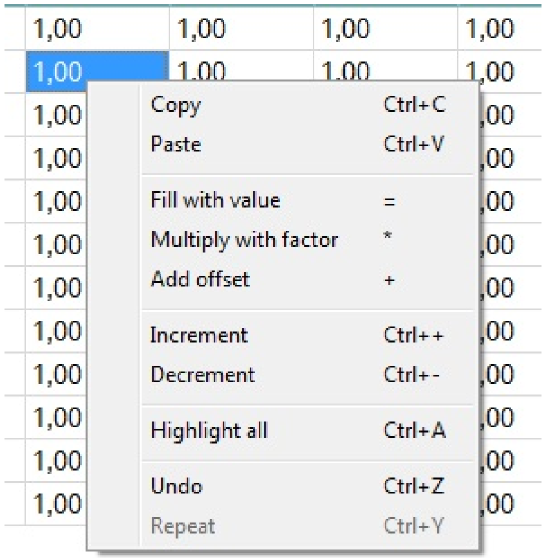


Figure 14 "Settings" context menu

You can make the following changes and adjustments:

- The entered number can be modified in steps using Increment/Decrement.
  Marked cells can be jointly filled with a value, multiplied by a factor or have an offset added.
  Changes can be made by "Select", "Copy" and "Paste" from the clipboard. This allows the data to be used in other programs.
- The table of values and the axes can be reset to the stored default values by means of a button on the left of the table of values. This procedure does not have an effect on the rest of the data record.

All input is restricted to a valid range and a valid increment.

The characteristic map is shown graphically in the three-dimensional representation. You can move the dividing line of the table of values in order to adjust the size and make further settings:

- Rotate view by means of the left mouse button.
- Restore standard view by clicking with the right mouse button or by clicking on a button (on left of table of values).
- Change the Min/Max values of the Z-axis by clicking on the "Axis limitation" button (on the left of the table of values). This allows you to optimise the three-dimensional representation.

This change affects only the 3D representation and does not influence the data record. The axis limit can be removed again using the "Remove axis limitation" button (on the left of the table of values).

4. Characteristic curves

Characteristic curves behave similarly to characteristic maps, but have only one input variable and one axis. The graphic representation of the characteristic curves is two-dimensional.

The axis on some characteristic curves cannot be changed since the input variable only assumes fixed values. The fixed values are all included in the standard axis (e.g. DTC mode).

Application information

Observe the following instructions, which are intended to ensure your safety and make work easier.

NOTICE

- **Continuous parameters**

  - Make sure that characteristic maps and characteristic curves always have harmonious progressions. "Jumps" or "corners" in the data input can lead to unexpected and possibly even dangerous behaviour of your motorcycle.
  - Make sure that the parameters are continuous in the 3D or 2D view.
  - Implement a graphic check of your modifications for characteristic curves without 2D view (Engine Braking).

- **Gradual approach**

  - Approach the optimal values of the parameters gradually if you cannot immediately determine the optimal value.
  - Measure and enter the tyre radius.
  - You can find the optimum values of an offset characteristic map of the DTC by small changes and assessment by riding and data analysis.
  - Do not make extensive changes.
  - Approach the optimal setting in small steps.

- **Save, document and manage intermediate states**

  - Save your data records regularly in a file.
  - Document the changes that are contained in the data record.
  - Document which changes can still be improved.

This allows you to return to a previous status and compare the two statuses.

Consistent naming of your RCK-Pro settings provides a useful extension of this documentation.

- Create a data archive in combination with a consistent folder structure.
- Create a separate folder for each event.
- Integrate this folder in a higher folder level according to race series and, where applicable, according to year.
- The setting name should contain the date, race track, session, rider name and setting version.
- Consistently maintain an introduced structure in order to improve clarity.
- Document the respective modifications, e.g. in a comment field when saving the setting or in a separate file.
- Pay attention to chassis and suspension setup and geometry, tyres and similar parameters. The measures allow systematic implementation of the desired behaviour for the overall system of motorcycle-rider.

Injection

Various interventions relating to fuel injection can be made on the "Injection" tab.

Lambda control off

The lambda control evaluates the signals of the oxygen sensor in the exhaust system and corrects the fuel injection period. This results in a suitable air/fuel ratio for combustion.

- You can deactivate lambda control by activating the checkbox next to "disable lambda control".

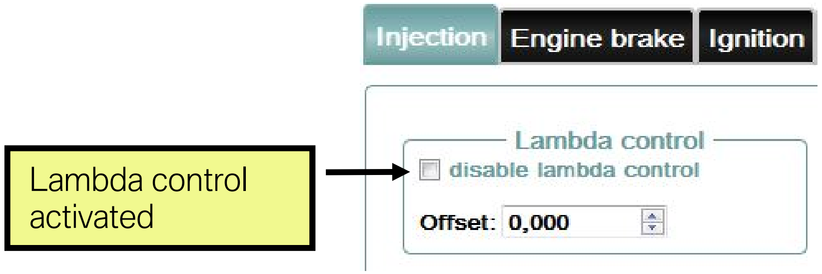


Figure 15 Deactivating lambda control

Mixture correction factor

The engine control calculates the injection period. Using the characteristic map "**Mixture correction factor**", you can correct the injection period calculated by the engine control. The engine control ensures optimum combustion in the factory condition of the motorcycle. Different air/fuel ratios (lambda) for combustion are achieved depending on the operating point.

You can multiply the injection period calculated by the characteristic map by a factor if

- you have made modifications to the motorcycle. These changes include the air mass drawn in (e.g. exhaust system).

You can multiply the injection period calculated by the characteristic map by a factor if

- you wish to deviate from the optimum air/fuel ratio.

Additionally observe the following:

- Values greater than one extend the injection period.
- Values greater than one increase the injected fuel quantity and thus create a "richer" air/fuel ratio.
- Values equal to one do not change the injection period calculated by the engine control.
- The correction factor can be stored in the characteristic map depending on the engine speed and throttle valve opening angle.

NOTICE

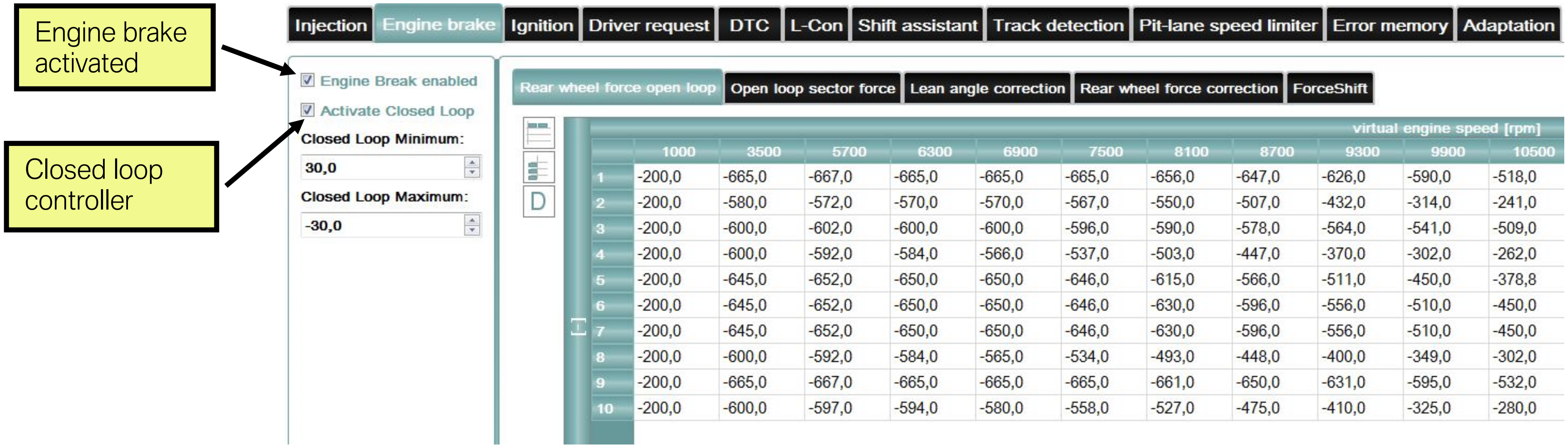
- The air/fuel ratio has a very large influence on engine running (misfiring) and various component temperatures (e.g. pistons, exhaust valves).
- Make changes only in order to compensate the intake air mass. BMW Motorrad recommends this particularly at high engine speeds and large throttle valve opening angles.
- Use suitable oxygen sensor measuring technology to ensure that data input for the characteristic map results in an optimum air/fuel ratio.

- The correction factor will likewise be included in the calculation for all fuel injectors.

The "**offset**" adds the entered value to the target lambda ($\lambda_{Target} = 0.9$).

Engine brake

Under "**Engine Brake**" you can influence the deceleration of the motorcycle in coasting overrun mode (throttle grip closed). The engine brake can be adjusted only when "**Engine brake enabled**" is activated.



	1000	3500	5700	6300	6900	7500	8100	8700	9300	9900	10500
1	-200,0	-665,0	-667,0	-665,0	-665,0	-665,0	-656,0	-647,0	-626,0	-590,0	-518,0
2	-200,0	-580,0	-572,0	-570,0	-570,0	-567,0	-550,0	-507,0	-432,0	-314,0	-241,0
3	-200,0	-600,0	-602,0	-600,0	-600,0	-596,0	-590,0	-578,0	-564,0	-541,0	-509,0
4	-200,0	-600,0	-592,0	-584,0	-566,0	-537,0	-503,0	-447,0	-370,0	-302,0	-262,0
5	-200,0	-645,0	-652,0	-650,0	-650,0	-646,0	-615,0	-566,0	-511,0	-450,0	-378,8
6	-200,0	-645,0	-652,0	-650,0	-650,0	-646,0	-630,0	-596,0	-556,0	-510,0	-450,0
7	-200,0	-645,0	-652,0	-650,0	-650,0	-646,0	-630,0	-596,0	-556,0	-510,0	-450,0
8	-200,0	-600,0	-592,0	-584,0	-565,0	-534,0	-493,0	-448,0	-400,0	-349,0	-302,0
9	-200,0	-665,0	-667,0	-665,0	-665,0	-665,0	-661,0	-650,0	-631,0	-595,0	-532,0
10	-200,0	-600,0	-597,0	-594,0	-580,0	-558,0	-527,0	-475,0	-410,0	-325,0	-280,0

Figure 16 Adjusting the engine brake

The following settings are additionally possible:

- Under "Rear wheel force open loop" you can define ten different characteristic curves for the negative force on the rear wheel.

- You can freely adjust the engine brake via the engine speed.
- You can assign individual gears to the characteristic curves shown above.

NOTICE

Please note that the engine speed is the calculated speed (channel name 2D: "**n_engbr_ref**"). It is not the actual engine speed, which is influenced by the slip.

- Using "**Activate Closed Loop**", you can re-adjust the used characteristic curve via the slip calculation when riding.
- "**Closed Loop Minimum**" and "**Maximum**" define the limits (brake force at the rear wheel).
- The closed loop controller can act within these limits.

On page 32 you can see a sample setup for the engine brake.

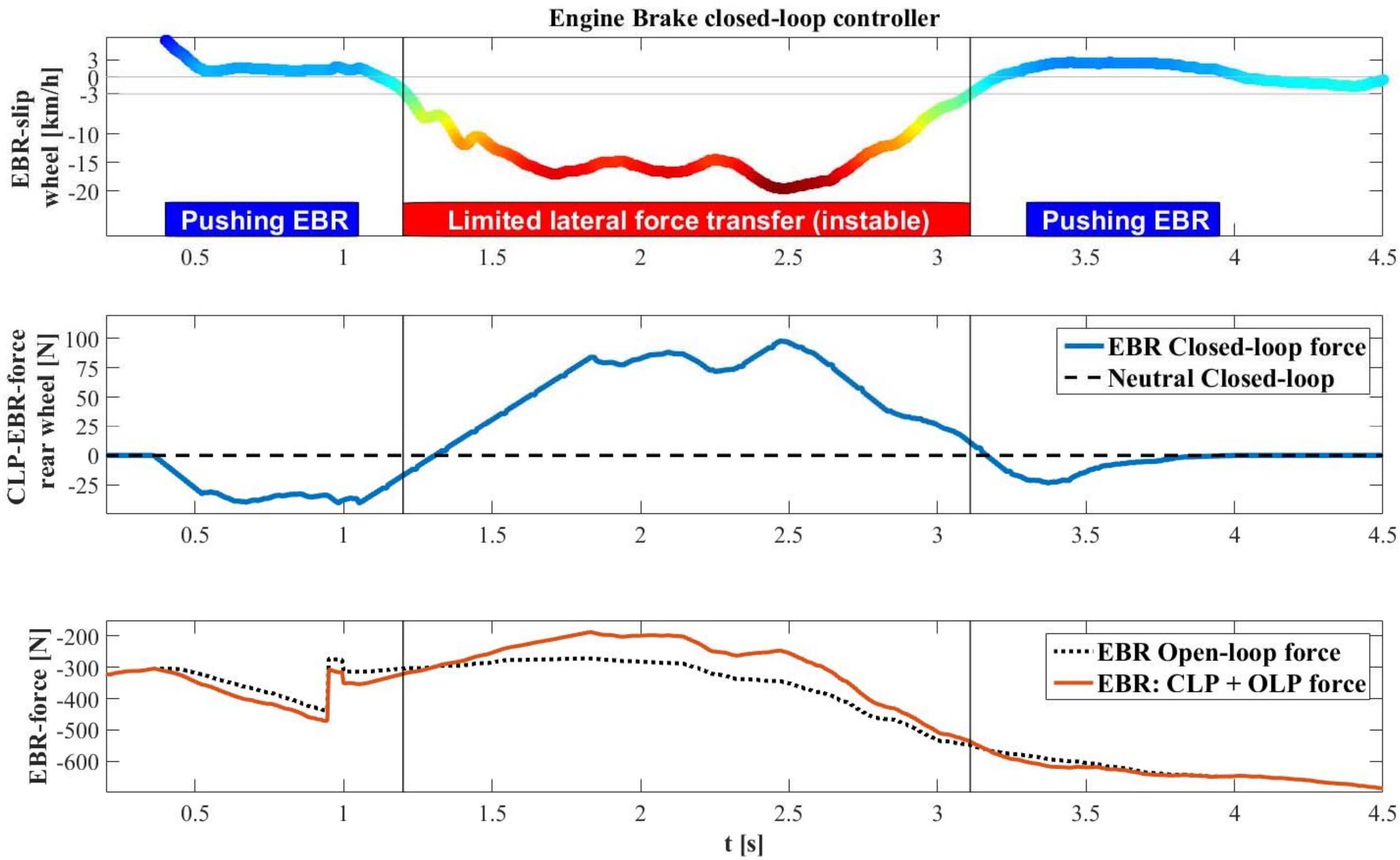


Figure 17 "Engine brake closed-loop controller"

The above graphic shows an example for the main function of the closed loop controller. The main value of this controller is above all the slip at the rear wheel (channel name 2D = **slip_engbr**). The above figure shows this.

In the case of positive slip (Pushing EBR), the brake force of the CLP component is increased. This situation is shown in the above figure in the middle diagram in the left and right areas around the blue bars.

If the slip is too high, the brake force characteristic curve specified by the application engineer is reduced further. This situation is shown in the middle area in the above figure (see red bar). The brake force effectively requested by the engine is shown by the orange characteristic curve in the bottom diagram in the above figure. The closed loop controller can be used as a valuable aid to compensate for different track conditions.

In "**Rear wheel force correction**", the characteristic curves for "**Rear wheel force open loop**" can be multiplied with a factor depending on gear. This characteristic curve addresses the gear-dependent change in the inertia torque in the drivetrain and the resultant change in the effective brake force at the rear wheel.

Rear wheel force open loop | Open loop sector force | Lean angle correction | Rear wheel force correction | ForceShift

gear [-]							
0	1	2	3	4	5	6	7
1,00000	1,06000	1,01501	1,00000	0,98001	0,94000	0,92001	1,00000

Figure 18 "Rear wheel force correction"

A mode-dependent correction factor is stored in "**Lean angle correction**" for slip calculation during initial braking. The wheel speeds behave differently in relation to the lean angle due to the different tyre sizes (rain tyres compared with slick tyres).

Rear wheel force open loop | Open loop sector force | Lean angle correction | Rear wheel force correction | ForceShift

vehicle mode [-]					
1	2	3	4	5	6
1	2	3	4	4	1

Figure 19 "Lean angle correction"

NOTICE

Only applications for rain (1) and slick tyres (2 – 4) are stored.

In "**ForceShift**" you can set offsets that shift the complete engine brake characteristic curve by the entered values.

The offset used depends on the engine brake button position (can be read off on the dashboard). This allows the rider to vary the engine brake when riding. This offset is applied globally over the entire engine speed range.

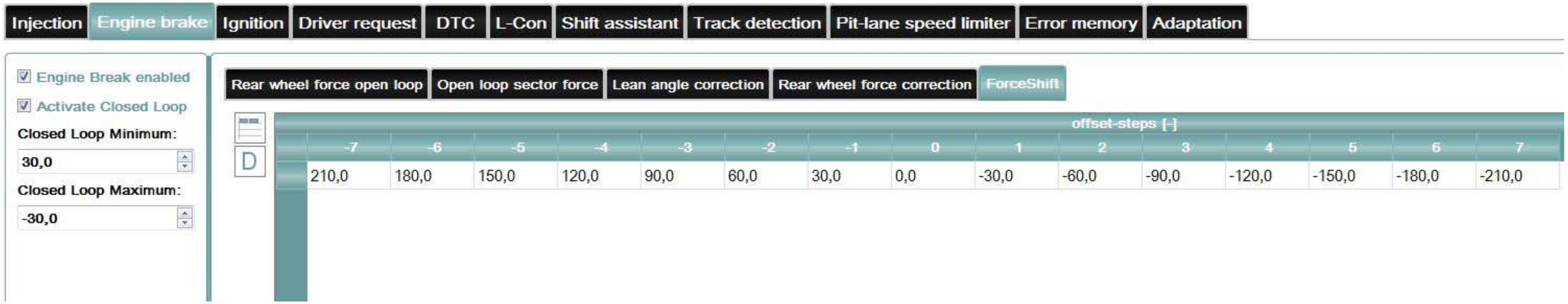


Figure 20 "ForceShift"

Driver request

You can influence the power level of the motorcycle under "**Driver request**". This allows the maximum power output to be adapted to the respective driving condition.

Gear-dependent global precontrol of the power is possible under "**Power Levels**". The numerical value entered here is added to the "**Power Level Offset**" in the respective gear (this results in a different Power Level in the respective gear).

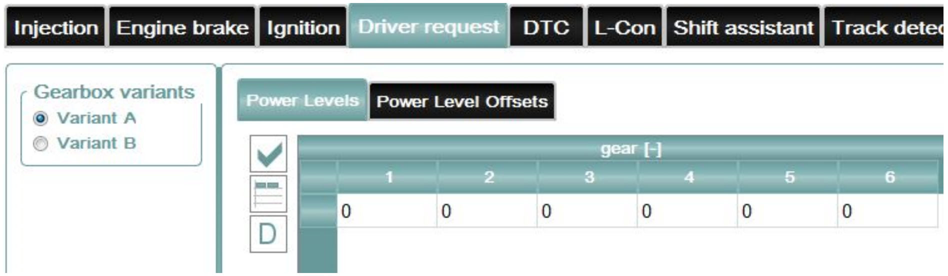


Figure 21 "Driver request"

Under "**Power Level Offsets**" , it is possible to select 64 combinations from electromotive throttle controller characteristic maps with different, gear-dependent power levels for each riding mode.

Refer to the supplied spreadsheet file (Power_Levels_%_HP4RACE_v1.5.xlsx) for the incremental stepping of the 64 characteristic curves. The spreadsheet file is part of the download package. On page 66 you can see an example of how Power Levels can be used.

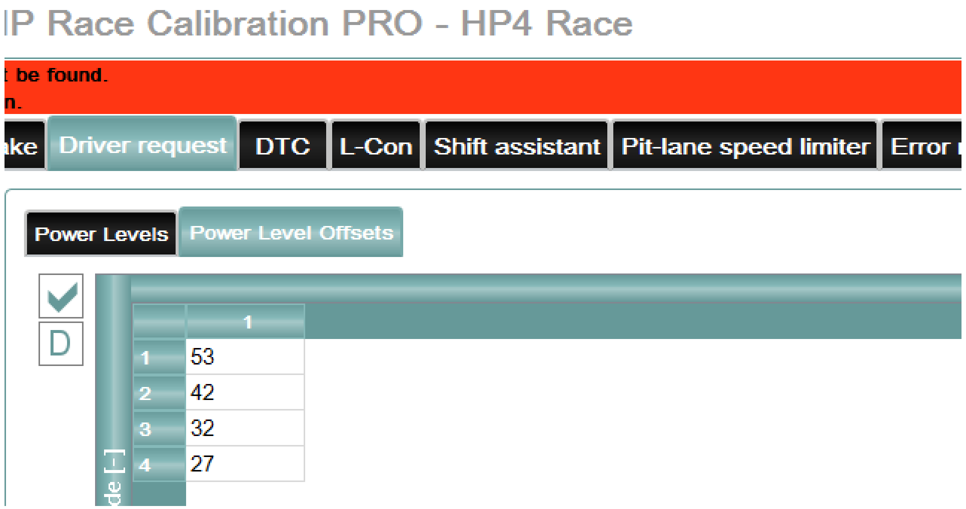


Figure 22 "Power Level Offset"

DTC

Summary of DTC control

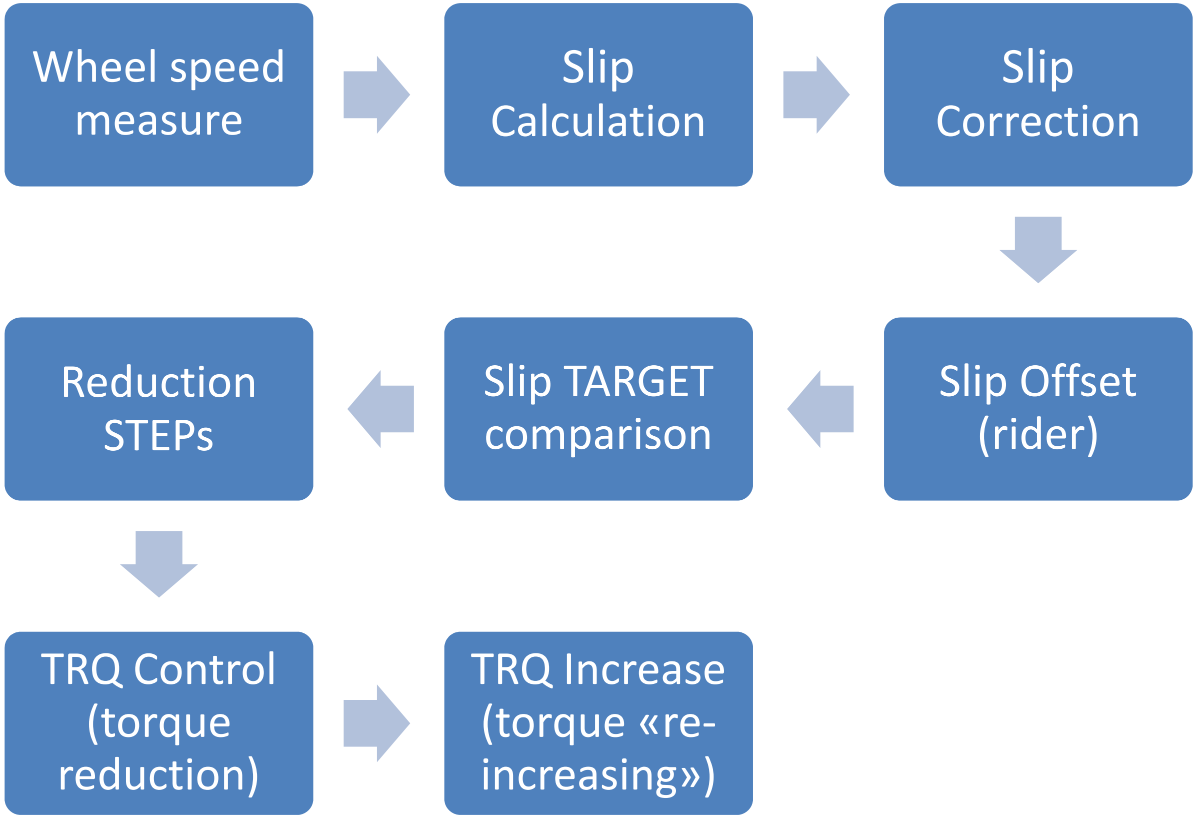


Figure 23 Summary of DTC control

DTC sensors

- The wheel circumferential velocity and the angular rate sensor signals for lean angle calculation are used for the DTC function.

- The following are important for the DTC function:
  - The angular rate sensor must be in the correct position.
  - The angular rate sensor must be installed undamaged.
  - The wheel speed sensors must be at the correct distance (air gap between wheel speed sensor and sensor disc between 1.0 and 1.6 mm).
  - The alignment must be correct.

- Damage to the sensor ring or out-of-round running in the radial or axial direction can generate signal interference.

- On the front and rear sensor ring there must be 48 evenly distributed flanks/teeth made of magnetic material and an equal number of recesses.

- The angular rate sensor is mounted vertically downwards and the black base plate faces to the rear, opposite to the direction of travel.

⚠ WARNING

Deviations when installing the angular rate sensor or the wheel circumferential velocity sensors can lead to measuring errors or even to a lean angle that is detected as implausible. Both scenarios can lead to DTC deactivation.

Tyre radii

To ensure correct wheel velocity calculation, enter the tyre radius of the front and rear wheels for straight-ahead driving ("**Tyre radius**", "**Front [m]**", "**Rear [m]**"). These tyre radii are mode-dependent since rain tyres normally have different dimensions than dry tyres.

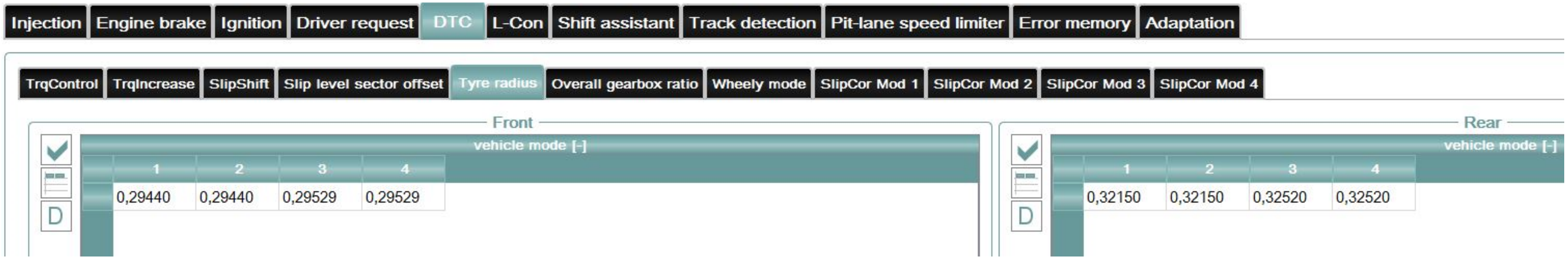


Figure 24 "Tyre radius"

Take into account the current tyre pressure for the application and slip assessment. The current tyre pressure influences the tyre rigidity and the current rolling radius.

You can measure and correct the tyre radii with pulled clutch. The following situation requirements must be met for this purpose:

- Rolling straight ahead without braking.
- No lean angle.

If the radii in the RCK-Pro settings are correct, this results in the same speeds for the front and rear wheels (**V_Front** and **V_Rear).** A prerequisite for this is that it is possible to neglect the residual braking torque at the front and rear brakes.

Speed-dependent differences must be taken into account or adapted in the characteristic maps "**SlipCor Mod 1-4**".
An entered 1% smaller rear-wheel radius will generate a 1% greater slip across all riding modes.

Slip correction – SlipCor Mod 1-4

The wheel slip is calculated according to the following procedure: first, the difference between vehicle speed (measured variable **Speed**) and rear wheel speed (measured variable **V_Rear**) is calculated. The wheel slip is calculated beginning at 30 km/h from the difference of the rear wheel speed and the driving speed in relation to the driving speed.

A correction then occurs, which takes into account the deviation in the tyre rolling radius in relation to lean angle (measured variable **Bank_dtc**). There is a separate characteristic map ("**SlipCor Mod 1-4**") for each mode (WET=1, INT=2, DRY1=3 and DRY2=4). The slip calculated from the wheel speed signals can be reduced or increased in these mode-dependent characteristic maps.

Effects of the tyre contour and the increase in the lateral guide can be taken into account there by means of inclination-dependent slip reduction. The system initiates an engine intervention when approx. 10% calculated wheel slip is reached. The basic application is based on the Metzler Racetec Interact K3 in the sizes 120/70-17 and 190/55-17 and the Pirelli Supercorsa SC2 in the sizes 120/70-17 and 200/55-17.

The following diagram shows that the tyre radius of the front and rear wheels becomes smaller with increasing lean angle:

- The tyre radius at the front wheel decreases by approx. 5% for a lean angle of 45° (reference value).
- The tyre radius at the rear wheel decreases by approx. 10% for a lean angle of 45° (reference value).

A speed difference of approx. 5% results between the front and rear wheels.

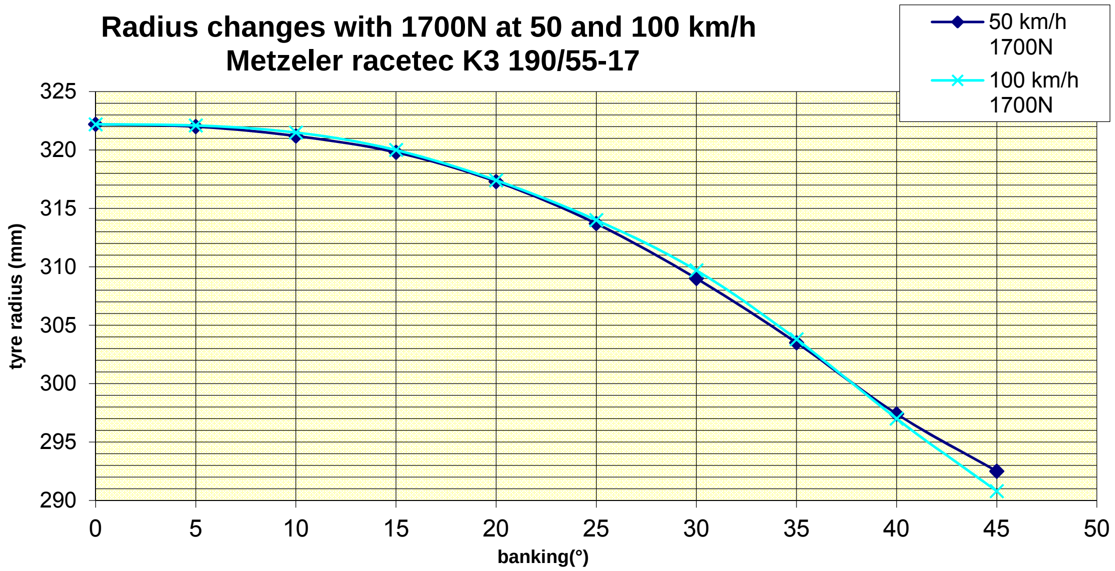


Figure 25 Radius changes

This difference between the front and rear tyre radii caused by the bank angle must be deducted from the calculated actual slip. This is achieved with the characteristic maps "**SlipCor Mod 1-4**". These are in % and can be applied in dependence on driving speed and angle of inclination. A DTC intervention occurs as from a calculated wheel slip of approx. 10%.

If 1% more slip is to be generated with a "**SlipCor**" characteristic map than with the previous one, then the entire characteristic map is reduced by the value 1%. The motorcycle then reaches the DTC control range earlier. The vehicle then tends to feel more defensive (fewer slides).

The following diagram shows an example for a Metzeler Racetec K3 tyre. The diagram shows the change in the tyre radius for different modes or SlipCor characteristic maps. The bottom characteristic map generates 1.29% more slip than the upper characteristic map at 100 km/h and 50° lean angle.

front wheel speed [km/h] \ lean angle [deg]	15,00	24,00	32,00	39,00	45,00	50,00	54,00	57,00	60,00	63,00
50,0	34,70	29,86	26,81	23,53	21,03	19,37	[illegible]	17,36	17,03	16,82
75,0	28,91	27,61	24,98	22,24	19,92	18,35	17,20	16,51	16,18	15,95
100,0	27,44	26,00	23,60	21,14	18,93	17,41	16,29	15,67	15,33	15,08
125,0	26,94	25,37	22,87	20,30	18,07	16,56	15,45	[illegible]	14,48	14,22
150,0	26,51	24,79	22,18	19,37	17,18	15,69	14,67	14,07	13,68	13,40
175,0	25,83	23,96	21,06	18,18	16,12	14,59	13,73	13,24	12,85	12,58
200,0	24,98	22,97	20,03	17,02	14,71	13,15	12,43	12,20	11,82	11,56
225,0	23,82	21,68	18,80	15,86	13,59	11,92	11,21	11,03	10,66	10,38
250,0	22,50	20,22	17,39	14,56	12,34	10,65	10,03	9,83	9,43	9,15
275,0	21,18	18,75	15,98	13,24	11,10	9,48	8,84	8,61	8,20	7,92

front wheel speed [km/h] \ lean angle [deg]	15,00	24,00	32,00	39,00	45,00	50,00	54,00	57,00	60,00	63,00
50,0	27,30	20,02	20,17	20,19	19,33	16,95	14,67	13,35	12,38	11,38
75,0	18,45	19,37	19,29	19,06	18,16	16,38	14,54	13,30	12,17	11,05
100,0	17,93	18,93	18,68	18,60	17,64	16,12	14,41	13,25	11,98	10,72
125,0	18,00	18,92	18,62	18,32	17,21	15,87	14,28	13,20	11,79	10,38
150,0	18,63	19,31	18,80	18,16	16,84	15,56	14,04	13,16	11,61	10,05
175,0	19,17	19,11	18,77	18,32	17,00	15,23	13,99	13,10	11,42	9,72
200,0	18,91	18,43	18,22	18,18	17,00	15,18	13,80	13,05	11,23	9,38
225,0	17,47	16,77	16,69	16,86	16,19	14,52	13,58	12,66	11,03	9,05
250,0	15,35	15,30	15,26	14,97	14,93	13,68	12,94	12,17	10,83	8,72
275,0	13,22	13,14	13,07	13,18	13,34	12,64	12,27	11,69	10,64	8,38

Figure 26 Change in tyre radius for different modes and SlipCor characteristic maps

Adaptation by means of lean angle

You can adapt the DTC by means of the lean angle if

- the DTC displays satisfactory control behaviour at a specific lean angle on a race track and under the given marginal conditions (weather, chassis and suspension, tyres etc.),
- the DTC behaves in an undesirable way at other bank angles because the DTC interventions are too strong or too weak.

Fix the value at which the desired control performance is achieved. Increase or reduce control in the other ranges.

NOTICE

- Increasing the values leads to reduced/later DTC interventions because lower slip is detected.
- Reducing the values leads to stronger/earlier DTC interventions because higher slip is detected.
- Changes in these characteristic maps compared with the basic data input should always remain small and be performed with the greatest caution.

front wheel speed [km/h] \ lean angle [deg]	15,00	24,00	32,00	39,00	45,00	50,00	54,00	57,00	60,00	63,00
50,0	34,70	29,86	26,81	23,53	21,03	19,37	18,12	17,36	17,03	16,82
75,0	28,91	27,61	24,98	22,24	19,92	18,35	17,20	16,51	16,18	15,95
100,0	27,44	26,00	23,60	21,14	18,93	17,41	16,29	15,67	15,33	15,08
125,0	26,94	25,37	22,87	20,30	18,07	16,56	15,45	14,85	14,48	14,22
150,0	26,51	24,79	22,18	19,37	17,18	15,69	14,67	14,07	13,68	13,40
175,0	25,83	23,96	21,06	18,18	16,12	14,59	13,73	13,24	12,85	12,58
200,0	24,98	22,97	20,03	17,02	14,71	13,15	12,43	12,20	11,82	11,56
225,0	23,82	21,68	18,80	15,86	13,59	11,92	11,21	11,03	10,66	10,38
250,0	22,50	20,22	17,39	14,56	12,34	10,65	10,03	9,83	9,43	9,15
275,0	21,18	18,75	15,98	13,24	11,10	9,48	8,84	8,61	8,20	7,92

Figure 27 "SlipCor Mod 2"

Adaptation by means of speed

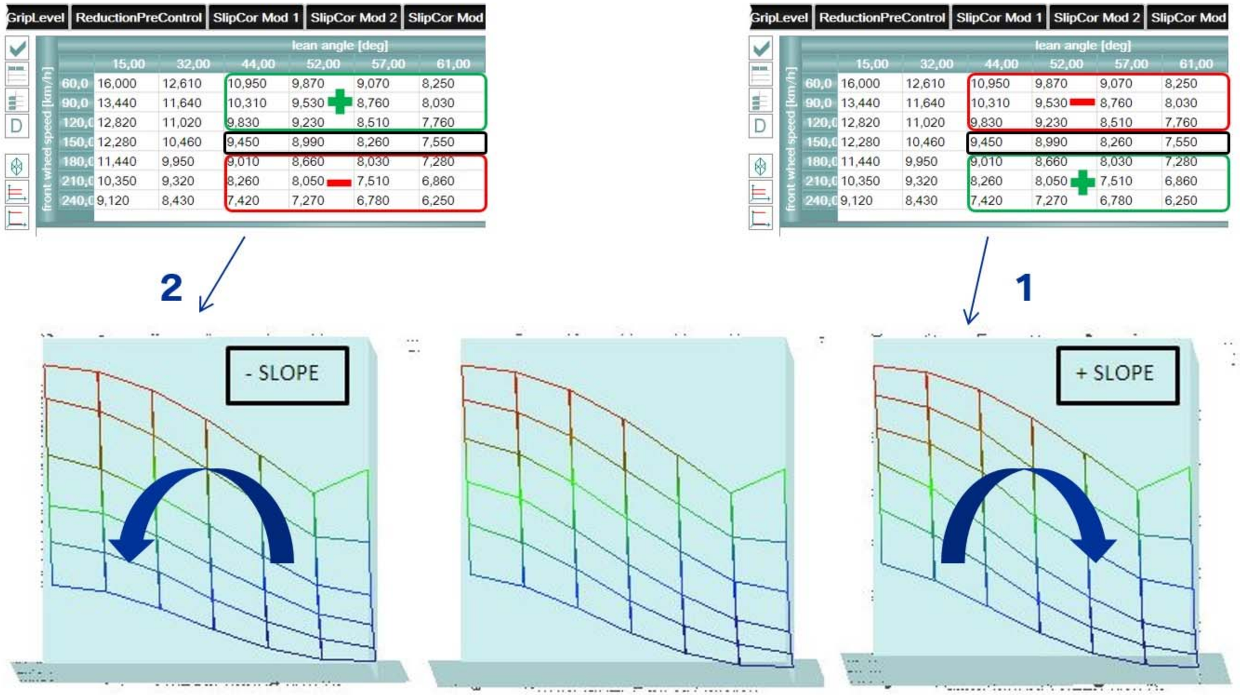
You can adapt the traction control function by means of the speed if

- the DTC displays good control behaviour at a certain speed (**V_Front**) on a track with the existing weather conditions,
- but does not provide the behaviour corresponding to the rider's wishes in other speed ranges because DTC control interventions are too early or too late / insufficient.

Fix the value at which the desired control performance is achieved. Increase or reduce control in the other ranges.

NOTICE

- Increasing the values leads to reduced/later DTC interventions because lower slip is detected.
- Reducing the values leads to stronger/earlier DTC interventions because higher slip is detected.
- The changes in these characteristic maps compared with the basic data input should always remain small and be performed with the greatest caution.



	15,00	32,00	44,00	52,00	57,00	61,00
60,0	16,000	12,610	10,950	9,870	9,070	8,250
90,0	13,440	11,640	10,310	9,530	8,760	8,030
120,0	12,820	11,020	9,830	9,230	8,510	7,760
150,0	12,280	10,460	9,450	8,990	8,260	7,550
180,0	11,440	9,950	9,010	8,660	8,030	7,280
210,0	10,350	9,320	8,260	8,050	7,510	6,860
240,0	9,120	8,430	7,420	7,270	6,780	6,250

Figure 28 Value change for DTC intervention

Engine torque reduction

The reduction characteristic curve allows you to influence the engine torque reduction in dependence on the racetrack and tyres. The following applies to the "**TrqControl**" characteristic curve:

- The value 1.0 corresponds to no reduction.
- The value 0.0 corresponds to 100% reduction (engine off).

NOTICE

The reduction characteristic curve must decrease strictly monotonically. A hard-breaking tyre already requires a larger engine torque reduction at small reduction levels (decreasing degressively, see diagram on the left). In contrast, a tyre with a soft/wide limit range requires less engine torque reduction for small reduction levels (decreasing progressively, see diagram on the right).

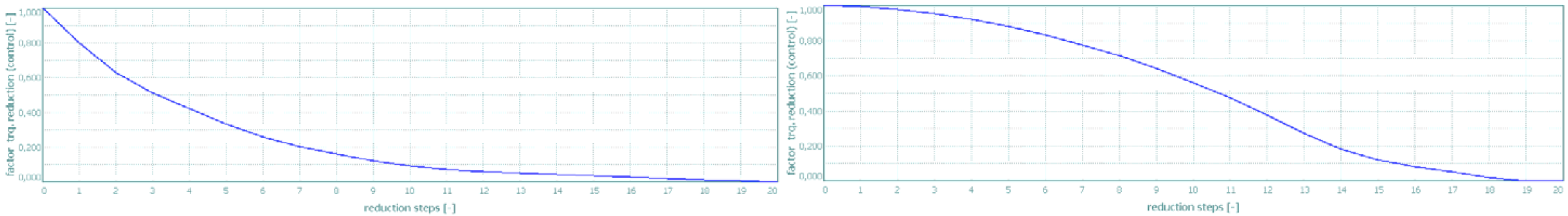


Figure 29 Reduction characteristic curves

Engine torque reversal

If the rear wheel slip falls below the values applied in the "**SlipCor**" characteristic maps, the engine torque is regulated back (increased) again. The preset values can be changed dependent on speed by the characteristic curve "**TrqIncrease**".
The following applies:

- A larger value accelerates engine torque return.
- A smaller value delays engine torque return.

Depending on the spring/judder damper settings, engine torque return can cause greater or lesser vibration of the motorcycle.

You can address the following with this characteristic curve:

- Chassis and suspension pumping with superposed DTC interventions.
- High control interventions that are applied too slowly.

NOTICE

It is recommended to delay engine torque return, for example, so that the vibration frequencies for slip control and the spring/judder damper/tyre system can be separated from each other.

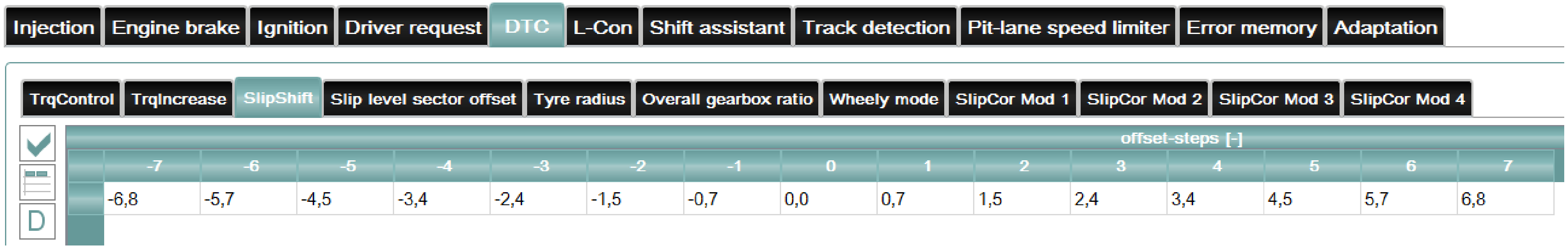
If an extremely small engine torque return value is entered, the motorcycle will be sluggish and lose accelerating ability, particularly after strong control interventions.

DTC shift characteristic curve

The DTC +/- buttons are located on the left switch unit on the motorcycle. The target slip of the rear wheel can be corrected with the DTC +/- button in driving modes that are enabled for this.

Step-by-step adjustment is possible (seven steps + / seven steps -). Slip correction values can be stored in the individual steps in the "**SlipShift**" characteristic curve.

The steps -7 to +7 correspond to the display on the dashboard and are fixed in the system. The DTC will allow more slip if you enter smaller values. This will result in fewer control interventions. The tractive power is increased and the cornering stability of the tyre is reduced. Larger values allow less slip and increase cornering stability for larger control interventions and lower tractive power. The slip of the basic application of the respective driving mode is increased or reduced overall in this case (offset over entire "SlipCor" characteristic map).



-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
-6,8	-5,7	-4,5	-3,4	-2,4	-1,5	-0,7	0,0	0,7	1,5	2,4	3,4	4,5	5,7	6,8

Figure 30 "SlipShift"

Gear-dependent offset of slip correction

In order to permit better adaptation of DTC to the track, you can assign an offset to each gear with "**Slip level offset per gear**".

DTC then generates more or less support as a result. This offset refers to the values that are stored for "**SlipShift**". This setting can be defined separately in each driving mode. This allows it to take into account significant changes in the track conditions when wet, for example.

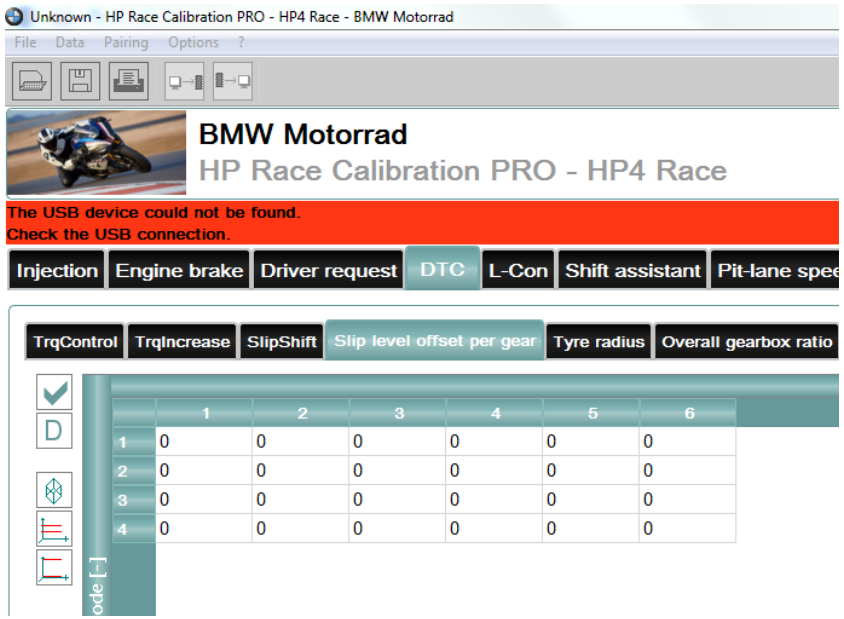


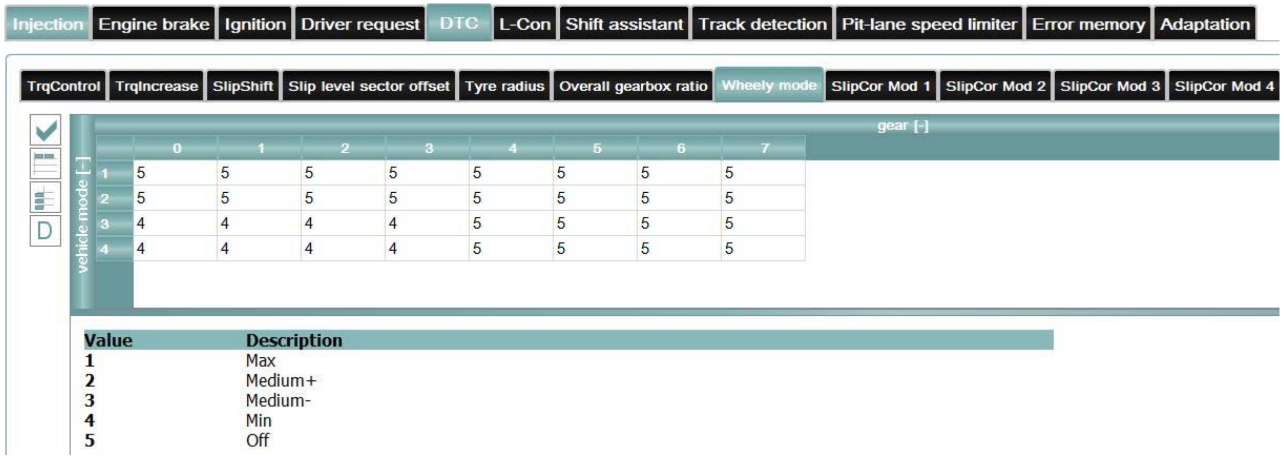
Figure 31 "Slip level offset per gear"

Anti-Wheelie Control

Anti-Wheelie Control reacts independently of the lean angle. The engine torque is initially limited when a wheelie is detected. The engine torque is then subsequently reduced. It is possible to distinguish between five wheelie modes:

"Wheelie Control Max"
"Wheelie Control Medium +"
"Wheelie Control Medium –"
"Wheelie Control Min"
"Wheelie Control Off"

The wheelie modes differ in the amount of torque reduction ("Min" for small reduction and "Max" for maximum possible reduction). The **wheelie mode** can be adjusted depending on gear and mode.



vehicle mode [-] \ gear [-]	0	1	2	3	4	5	6	7
1	5	5	5	5	5	5	5	5
2	5	5	5	5	5	5	5	5
3	4	4	4	4	5	5	5	5
4	4	4	4	4	5	5	5	5

Value	Description
1	Max
2	Medium+
3	Medium-
4	Min
5	Off

Figure 32 "Wheelie mode"

Gear ratio adaptation

The overall gearbox ratio is functionally taken into account for numerous calculations (brake force at rear wheel for engine brake, reduction stages for DTC, pit-lane speed limiter, Launch Control etc.). If the transmission stepping is changed, this can be adapted in the characteristic curve "**Overall gearbox ratio**". Conversion of the overall gearbox ratio is performed with the spreadsheet file (Overall_Gearbox_Ratio_K60_v1.1.xlsx, part of the download package).

NOTICE

When the ratio is modified, the rotational speed and torque relationships in the drivetrain also change. Adapt this characteristic for every ratio change in order to ensure appropriate functioning of the driving dynamics systems.

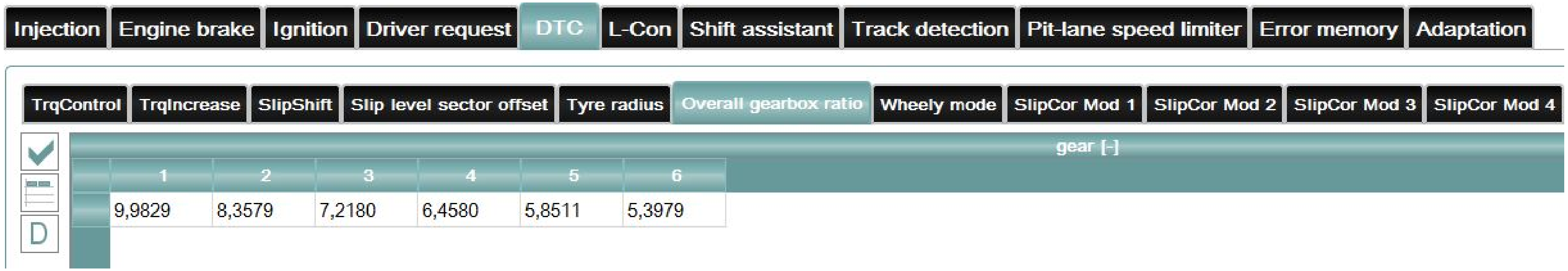


Figure 33 "Overall gearbox ratio"

Launch Control (L-Con)

The goal of Launch Control is to permit reproducible dynamic starts at the physical driving limits.

For this purpose,

- the engine speed is adjusted to and maintained at an adjustable value,
- when driving off, the rear wheel torque during acceleration is kept constant at the highest possible level independently of the engine characteristics.

The following applies to the application variables "**Engine rpm limitation [rpm]**" and "**Speed threshold [km/h]**":

A theoretical engine speed from the rear wheel speed added with "**Speed threshold**" (purely arithmetical, full clutch engagement) is compared with "**Engine rpm limitation**" (static). The engine speed is limited to the larger value in each case.

The figure on page 56 schematically shows the dynamic engine speed limiter for more intuitive data input in RCK-Pro. At point **A**, the engine speed calculated for the LNC (on the basis of the rear wheel speed) exceeds the engine speed limit value. The engine speed limiter always follows the calculated speed from this point.

The parameter "**Limiter Speed Offset [km/h]**" defines the distance between the calculated engine speed from the rear wheel speed and the engine speed limiter based on this after exceeding the point **A**. In the figure on page 56, an arrow at point **B** shows this by way of example.

The maximum rear wheel torque is specified dependent on speed in the torque characteristic curve "**TRQGT_LNC**" [Nm]. The maximum rear wheel torque should correspond to the torque at which the front wheel just still has the minimum vertical force.

This behaviour can be read off as follows:

- From the front spring travel (**Susp_fr_2d**, if installed and should have only minimum stroke),
- from a comparison of **V_Front** and **Speed** (small wheelies should be repeatedly evident).

Always observe the physical marginal conditions (rider weight, position, uphill gradient, wind etc.). The rear wheel torque is calculated and adapted from the engine torque corresponding to the gear-dependent overall ratio (see DTC - Ratio adaptation – "**Overall gearbox ratio**").

The engine speed limiter operates with a precontrol in order to implement precise control without large swings around the limit value. The engine speed limiter starts operation as from around 1,800 rpm before the actual limiter engine speed. In the event of a significant reduction, a permanent torque reduction may result after exceeding the point **A**, such as in the figure below showing the "**Speed threshold [km/h]**" . This permanent torque reduction is initiated by the engine speed limiter. Always observe this point in application of Launch Control.

The adjusted Anti-Wheelie Control and the DTC remain active in the background with Launch Control active.

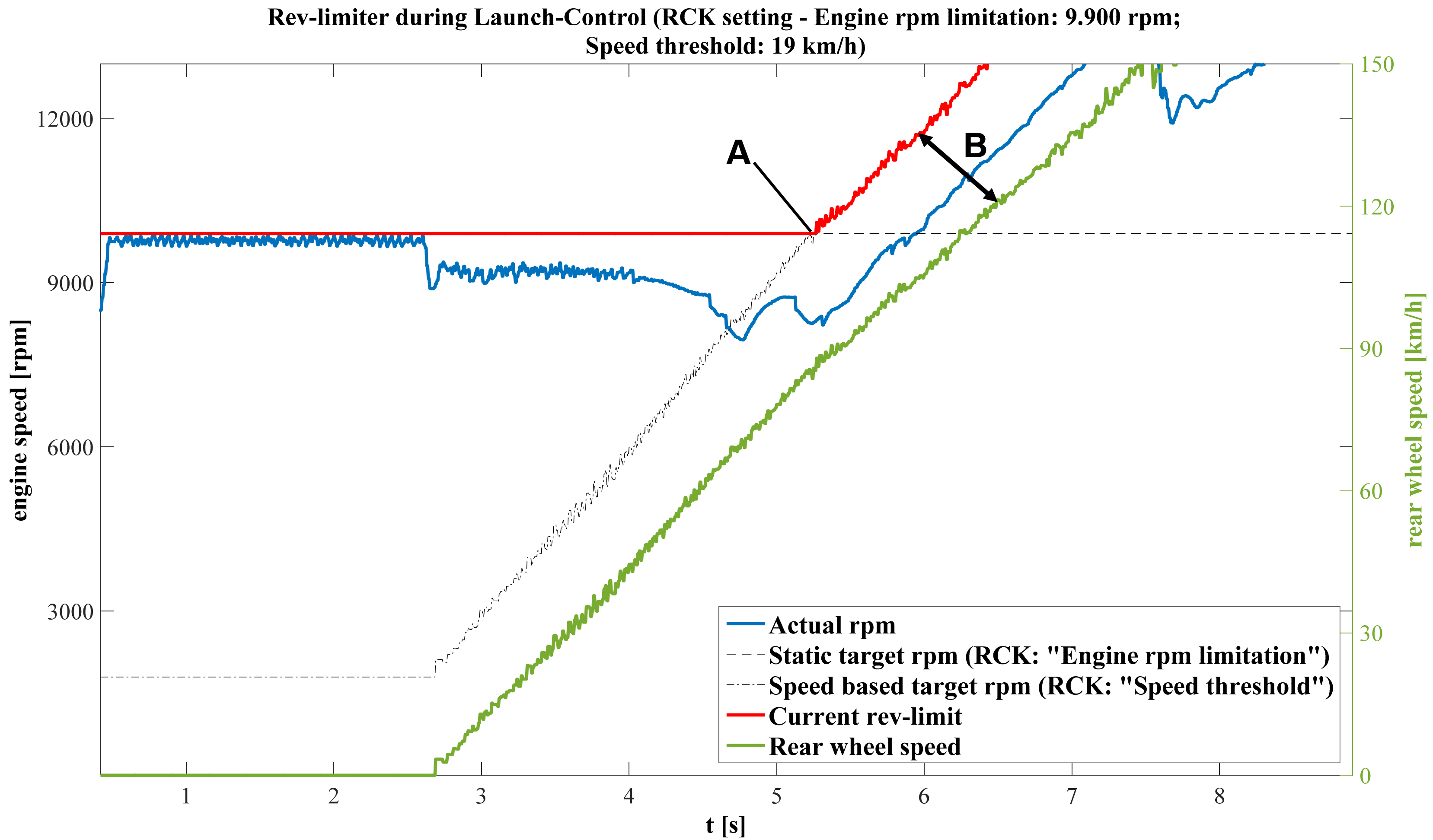


Figure 34 Rev-limiter during Launch-Control

NOTICE

The Launch Control is activated by selection of 1st gear when the vehicle is stationary. A dwell period of 1s must be observed before the rider can apply the throttle. The function is ready for operation as soon as the dash displays "! Launch !".

The Launch Control is deactivated in the following situations:

- automatically when the engine is switched off,
- when 3rd gear is reached or
- if a lean angle of 30° is exceeded.

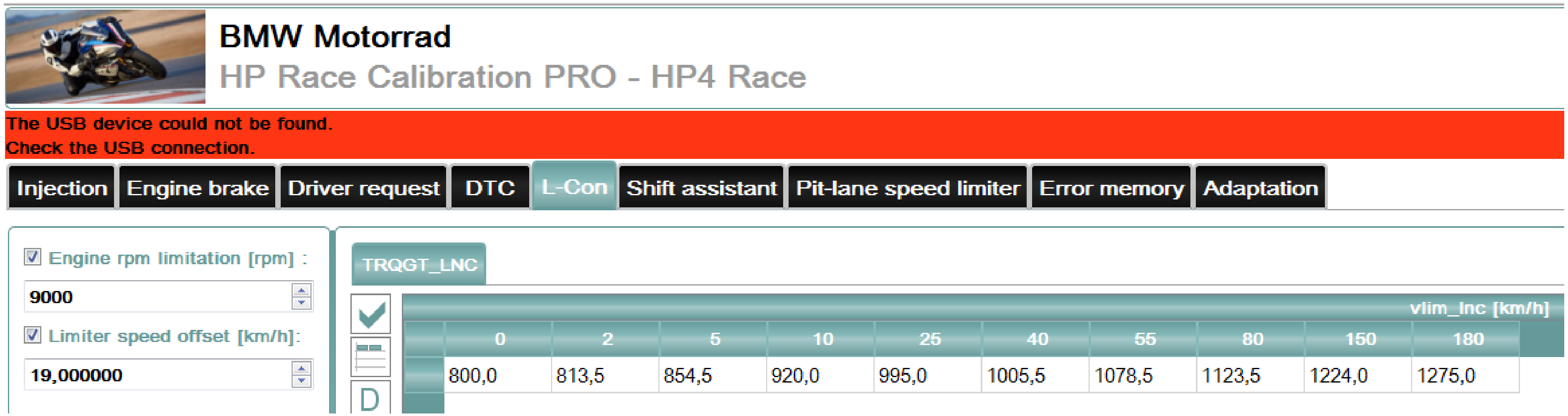


Figure 35 "L-Con"

Shift assistant

The shift assistant allows transmission upshifts without operating the clutch. While the reduction of the engine torque for initiating the actual gearshift with the shift assistant remains fixed, you can influence the build-up of the engine torque after the gearshift via the "**Intervention speed of shift assistant**" factor. Larger values lead to a faster build-up of the engine torque, smaller values to a slower build-up.

NOTICE

Please note that the load reversal reactions of the drivetrain after the gearshift may also be influenced by the rate of engine torque build-up. This can lead to unexpected vehicle response.

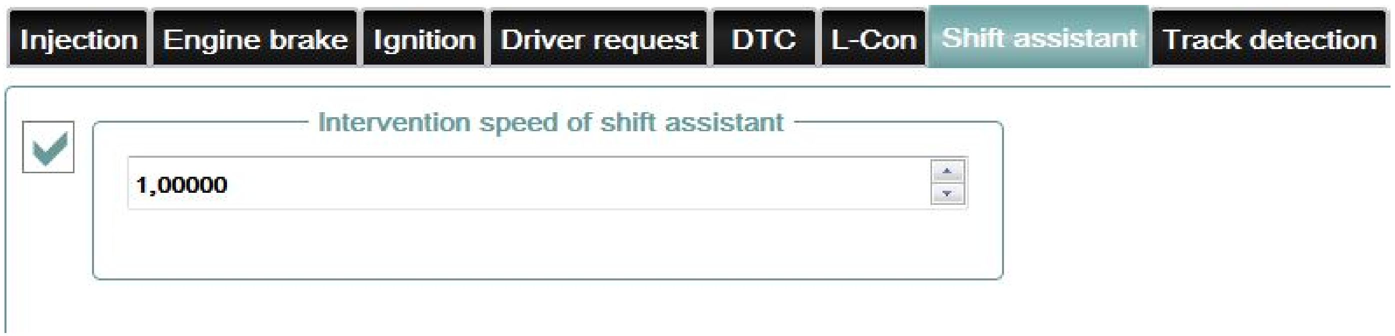


Figure 36 "Shift assistant"

Pit-lane speed limiter

This function allows you to use a speed limiter (Pit-lane speed limiter) that is only active in the first gear with the starter switch pressed. You can set the speed limiter by means of "**Speed limitation [km/h]**" so that the permitted speed is not exceeded in the pit lane in first gear, for example.

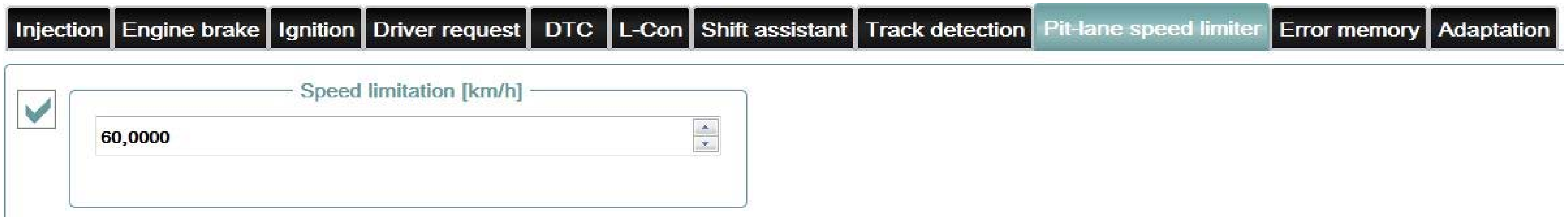


Figure 37 "Pit-lane speed limiter"

Adaptation

You must perform new adaptation if the following parts on the motorcycle are replaced:

- Electromotive throttle controller
- Gear lever sensor
- Transmission controller barrels potentiometer
- Crankshaft drive
- Throttle valve system
- Inclination sensor

BMW Motorrad recommends performing adaptation after changing electrical components.

Proceed as follows in order to perform adaptation:

- Delete the old adaptation values with "**Delete all adaptation data**".
- Re-teach the electromotive throttle controller and the gear positions of the transmission.
- Press "**Adapt throttle control sensor**" to adapt the electromotive throttle controller.
- Follow the instructions on the user interface.
- Re-teach the gear positions of the transmission.
- Shift through all gears (including idle/neutral) for at least 10 seconds without applying the throttle.
  - » The gear indicator in the dashboard flashes.
  - » Adaptation for this gear is completed.

You can now teach the next gear.

Please ensure that you do not touch the gearshift lever during the teach-in time.

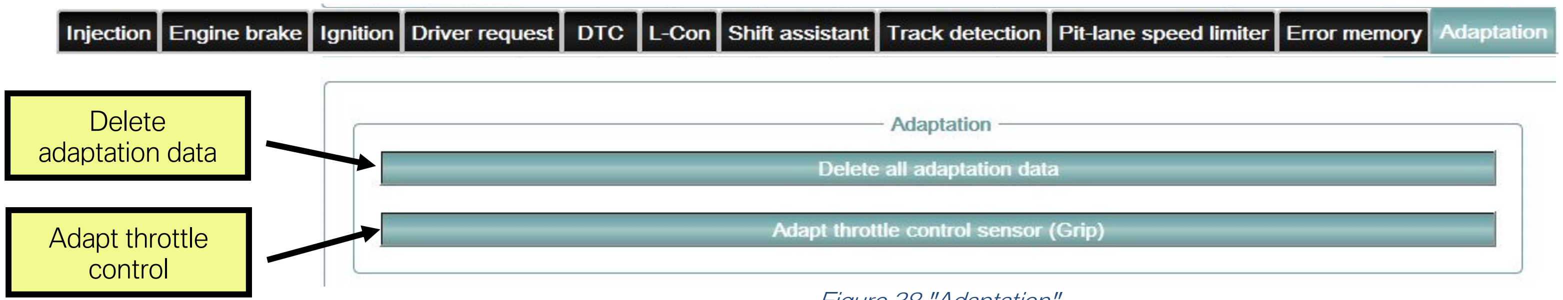


Figure 38 "Adaptation"

Error memory

You can read out the error memory of the engine control unit by pressing the button "**Read fault code memory**". The faults and/or system faults detected by system diagnosis are then displayed.

The "**Delete fault memory**" button deletes the entries in the error memory of the engine control unit. If a fault persists, this will be entered again directly and displayed again.

Nothing will be displayed if there are no faults and/or system faults present. You can see whether the error memory was read out correctly by the updating of the read-out time.

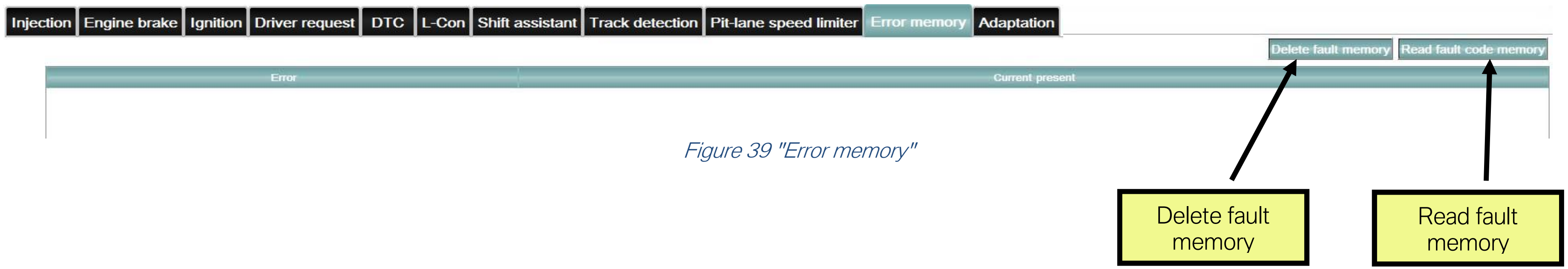


Figure 39 "Error memory"

Data Analysis

Data logger as application help

BMW Motorrad recommends using a 2D data logger for application of a slip control. A measurement with the USB stick logger from 2D data recording is shown below. The description includes an explanation of the measured variables as example values:

Measured variables:

Front wheel speed	white	**v_front**
Rear wheel speed	yellow	**v_rear**
Reference speed for the front wheel	light yellow	**v_ref/Speed**
Lean angle	bright pink	**phi_lean/Bank_dtc**
Throttle grip	orange	**tpd/Grip_pos**
Throttle valve opening angle	blue	**tp_1 / tp/Throttle**
Engine speed	green	**n_eng/RPM**
Virtual engine speed	dark green	**n_engbr_ref**
Reduction from slip	pink	**cf_reltrq_red**
Reduction from Anti-Wheelie Control	purple	**cf_reltrq_whly**
Gear	brown	**gear**
Spring travel sensor, front	light blue	**Susp_F**
Spring travel sensor, rear	red	**Susp_R**
Power Level	grey	**idx_trq_map**
Slip on initial braking	turquoise	**slip_engbr**
Force on initial braking	purple	**fx_engbr**
Brake pressure	gold-brown	**p_brake_fr**

Engine brake

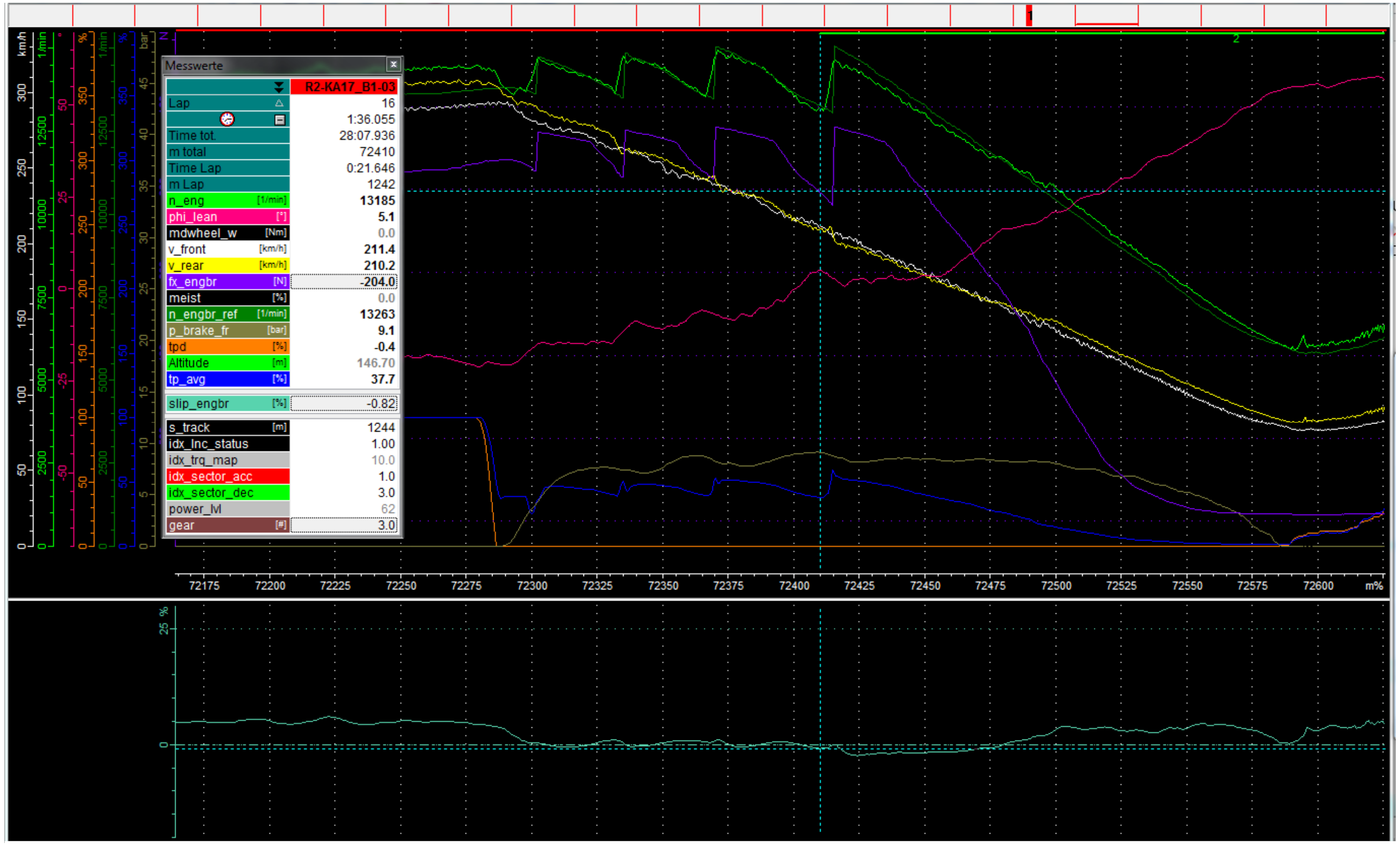


Figure 40 Engine brake

You can adjust the negative force at the rear wheel for strong deceleration. This allows you to decisively influence the slip upon initial braking. The negative force at the rear wheel is shown in purple in the figure and the slip upon initial braking in turquoise.

The following applies:

- If the engine brake is too strong, a high negative slip will occur upon initial braking and the motorcycle can become unstable.
- If the engine brake is too strong, transmission of brake force at the rear wheel will be reduced (µ-slip curve).
- If the engine brake is too weak, the motorcycle will push. The motorcycle cannot be decelerated strongly and the front wheel force will be relieved (risk of crashing).

Always consider the complete vehicle for application of the engine brake.

If the vehicle centre of gravity was raised and the wheelbase shortened, a lifting rear wheel can then sometimes be observed in hard braking phases (rear spring travel is at or very close to "0").

In addition, extremely high negative slip can be expected at the rear wheel. This behaviour cannot be solved electronically.

BMW Motorrad recommends keeping an eye on blipping when carrying out downshifts. If you request a gearshift (down-blip) too early, the follow-on engine speed in the next lower gear will exceed the engine speed limiter.

The shift assistant will then not permit this gearshift. The blip will not occur. The data show the missing peak of **tp/Throttle** and the associated short ignition switch-off **idx_ign_cut_lvl**.

The gear can be engaged mechanically if you remain on the gearshift lever. The engine is then pulled up to the follow-on engine speed. The engine is not revved up automatically by throttle application. This process naturally produces a brief very high braking torque at the rear wheel. Sudden engagement of 1st gear at a high speed serves as a comparison here. A negative slip peak is generated.

The vehicle response can be compensated only to a very restricted extent by the engine brake application. The rider should be informed about the vehicle response.

You can adjust the engine braking force at the rear wheel by the throttle valve opening angle. For this reason, it is recommended that the application engineer observes the throttle valve opening angle in the braking phase.

Application tests may be unsuccessful if you wish to generate more engine braking force although the throttle valve is already closed.

It is necessary to speak to the rider if the throttle valve does not close fully in the last braking phase in a bend. This may mean that there is unused potential for vehicle braking here. The engine brake may have a "pushy" character in the last braking phase and thus not contribute to deceleration.

The slip has a uniform characteristic in the example shown above. The motorcycle is apparently stable during braking. There may be improvement potential in the last braking phase. The throttle valve is not yet fully closed at t = 72.500 s. However, there may be positive slip development at the rear wheel.

Proceed as follows:

- Read off the reference engine speed (**n_engbr_ref**) from the data for this phase.
- Increase the brake force at the rear wheel in negative direction in the corresponding characteristic curve ("**Rear wheel force open loop**").

The rider can also use the EBR +/- button in this situation. This also applies to tracks where there is still a large amount of application effort for the engine brake.

The results can be used for a rapid, high-performance setup.

Driver request

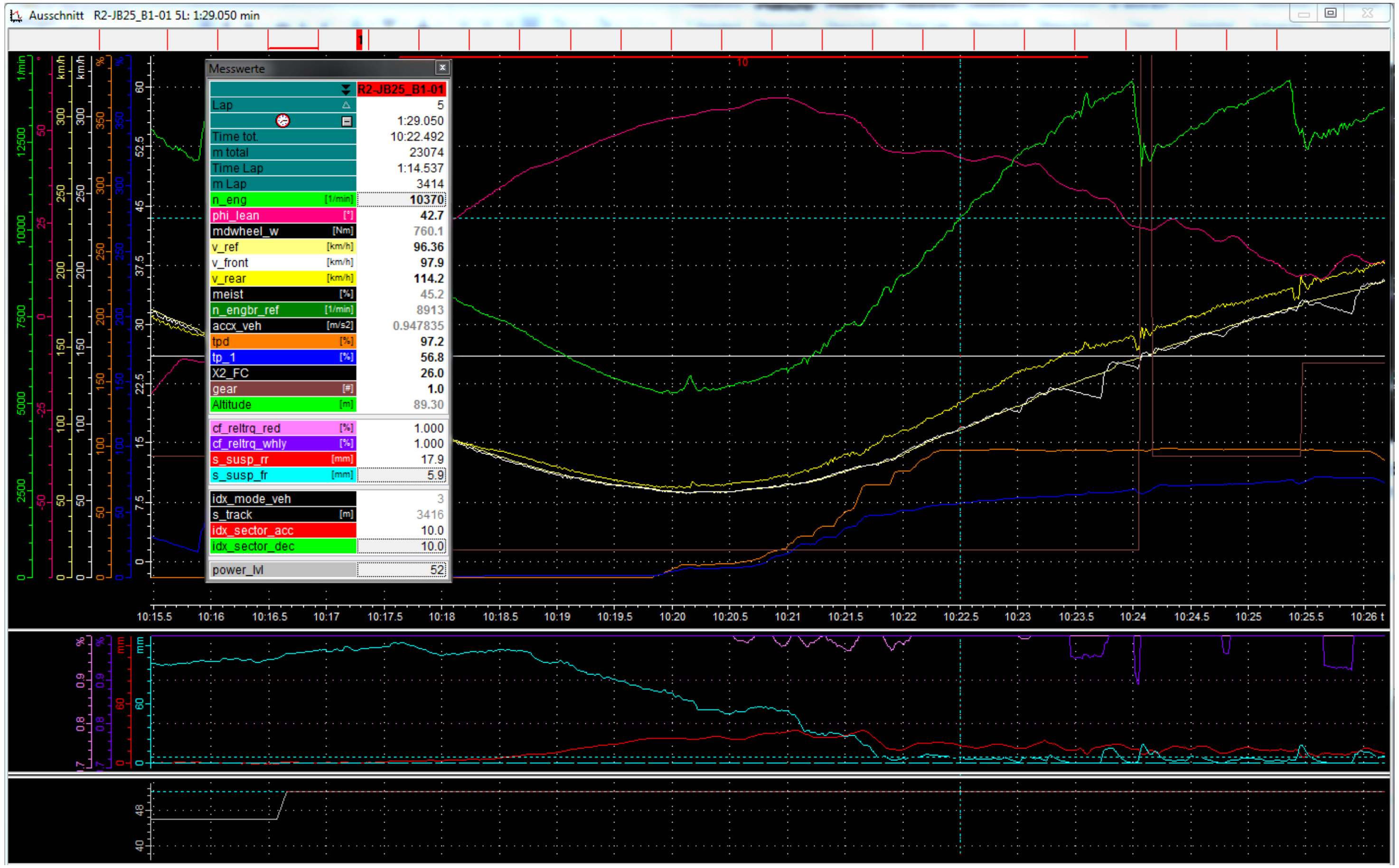


Figure 41 Driver request

An adapted Power Level is used for strong acceleration. With the Power Level used, the engine torque is limited so that the front wheel is at the limit for lifting off. The front spring travel sensor is approximately at zero as a result. The Power Level is shown in grey in the figure and the front spring travel sensor in light blue.
The throttle grip is approximately at 100% and the throttle valve is significantly lower due to the Power Level. Anti-Wheelie Control is used simultaneously in this scenario. The throttle grip is shown in orange in the figure, the throttle valve in dark blue and Anti-Wheelie Control in purple. The goal here is to achieve good precontrol by the Power Level.

The selected Power Level limits the engine torque excessively and the rider loses time due to the conditions:

- The spring travel has a pronounced stroke and
- the motorcycle does not produce any wheelies.

The more pronounced spring travel stroke can result, for example,

- in spite of full load and a smaller bank angle (30° and 5 mm or more).

- Choose a Power Level with less reduction.

The power chosen for the Power Level is too high to keep the repeatedly lifting front wheel close to the ground if

- the motorcycle has a very high wheelie tendency and
- the driver repeatedly has to close the throttle grip.

BMW Motorrad recommends paying attention to the torque in these situations. Lower torque reduces the physical strain on the rider and the speed integral (distance covered) decreases overall. This applies only if the rider is producing high wheelies and is often forced to back off the throttle.

Always also pay attention to the complete vehicle:

- If a Power Level is still necessary in 5th gear, for example, and
- the vehicle tends to produce wheelies in spite of a flat track.

In this situation, the wheelbase or swinging arm length

- is too short or the centre of gravity too high, for example,
- or the setting of the rear spring is too hard.

Try to solve these problems not just by electronic measures.

NOTICE

Power Levels and "**Slip Level Offsets**" are defined for the entire lap of a race track. The application engineer additionally has the possibility of reacting quickly and without fuss to rider requests:

If both the rider comments and data analysis indicate that the motorcycle is handling nervously at the exit of a hairpin bend which is ridden through in 1st gear, for example, a (positive) higher Slip Level Offset in 1st gear can already significantly improve this situation. Editing a "SlipCor" characteristic map to achieve this does not involve a lot of effort.

Nervous handling of a motorcycle can occur in the following situations:

The acceleration slip at the rear wheel does not have a uniform, plateau-like characteristic. The acceleration slip at the rear wheel has a clearly visible peak which may also be associated with a kink in the bank angle signal **phi_lean**/**Bank_dtc**.

Conversely, turning of the motorcycle under load in very fast bends can be supported by a negative Slip Level Offset in the respective gear. However, such offsets should always be replaced by a modification in the SlipCor characteristic map after the session. You should thus try to achieve a "precise" solution.

Always take into account the fact that Slip Level Offsets are used independently of speed and bank angle in the respective gear. This means that other bends may also be influenced!

The engine brake "**Open Loop Force per Gear**" allows adaptation of the engine brake for each gear. An analysis of the track sections where action is necessary can help here. It must also be analysed whether the corresponding gear is used only in this area and whether no significant losses on the rest of the track have to be accepted as a result of modification for this gear.

The engine brake "**Closed Loop**" controller supports the fixed characteristic curves from "**Open Loop Force per Gear**". The closed loop component requests more engine braking force if the brake slip at the rear wheel during braking is significantly less than required (or if there is pronounced positive slip at the rear wheel). In contrast, if there is far too much negative slip at the rear wheel (such as after brief lifting of the rear wheel), the closed loop controller will request less engine braking force (**fx_engbr_clp** > 0).

Check these modifications. These adaptations should be implemented to a high degree at the places where an uncontrollable increase in the engine braking force (**fx_engbr**) or throttle valve (**tp/Grip_pos)** is possible.

The figure below shows an example intervention of the closed loop controller in both directions.

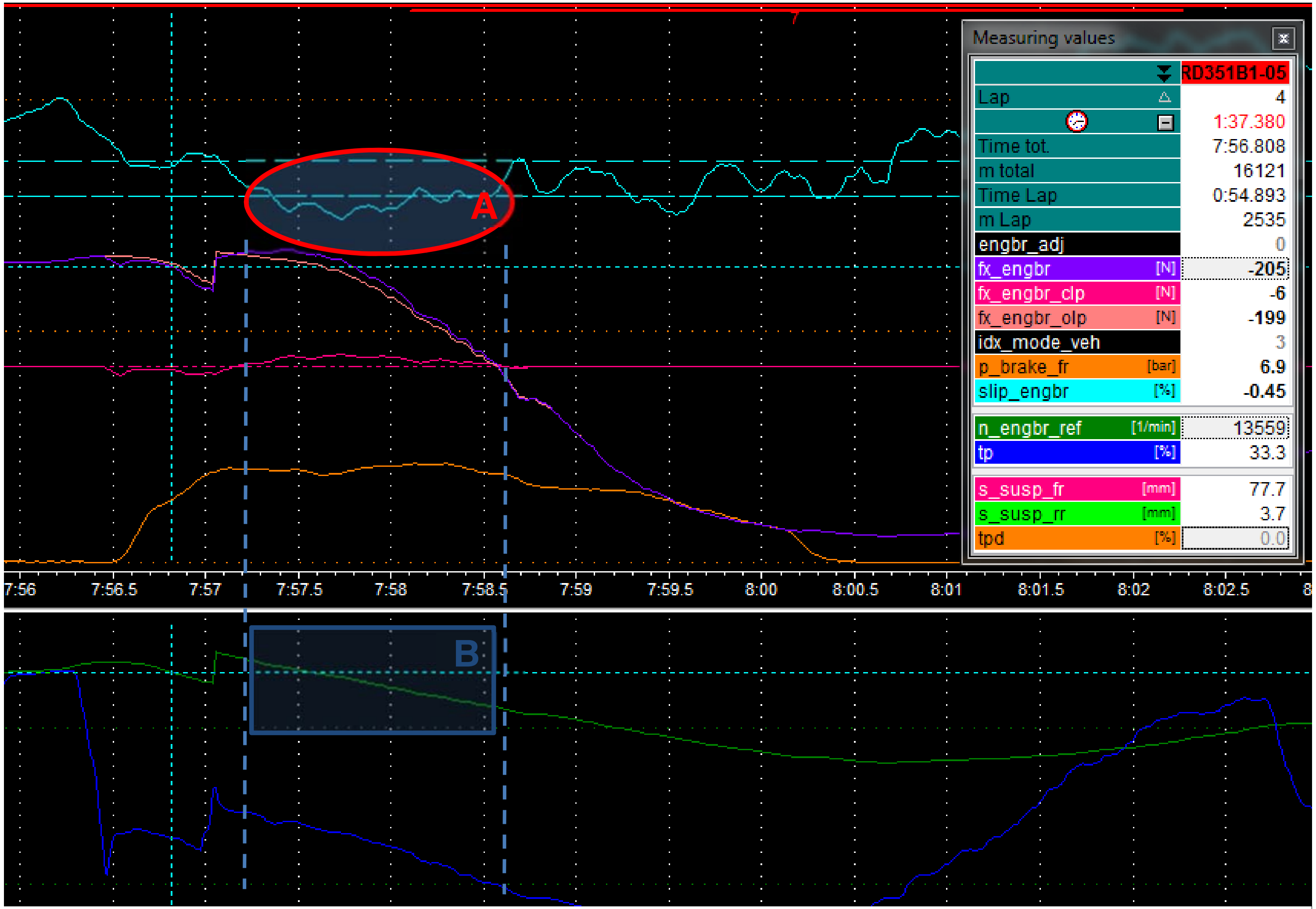


Figure 42 Example intervention of the closed loop controller

Modification of the engine brake characteristic curve is explained in detail on the basis of this example case:

- Analysis of **slip_engbr** for uniformly negative characteristic:
  The characteristic does not have any extremes in either negative or positive direction. The area marked red **A** has an excessively negative value range. Correct the negative value range.

- Read off the reference engine speed **n_engbr_ref** in the relevant area of the measurement:
  the reference engine speed range can be determined in area **B**. The figure shows an example between 12,000 rpm and 14,000 rpm.
  The relevant area of the measurement is shown by dashed lines in the figure.

- Read off the gear (**gear**) and vehicle mode (**idx_mode_veh**) in order to unambiguously assign the characteristic curve.
  For example, 2nd gear in vehicle mode DRY1.

- Determine characteristic curve by RCK-Pro Settings. The figure below shows how to determine the characteristic curve from RCK-Pro Settings. The vehicle mode DRY1 corresponds to "3" in the figure below. Determination of the characteristic curve from RCK-Pro Settings results in "**Rear wheel force open loop**" with characteristic curve 9.

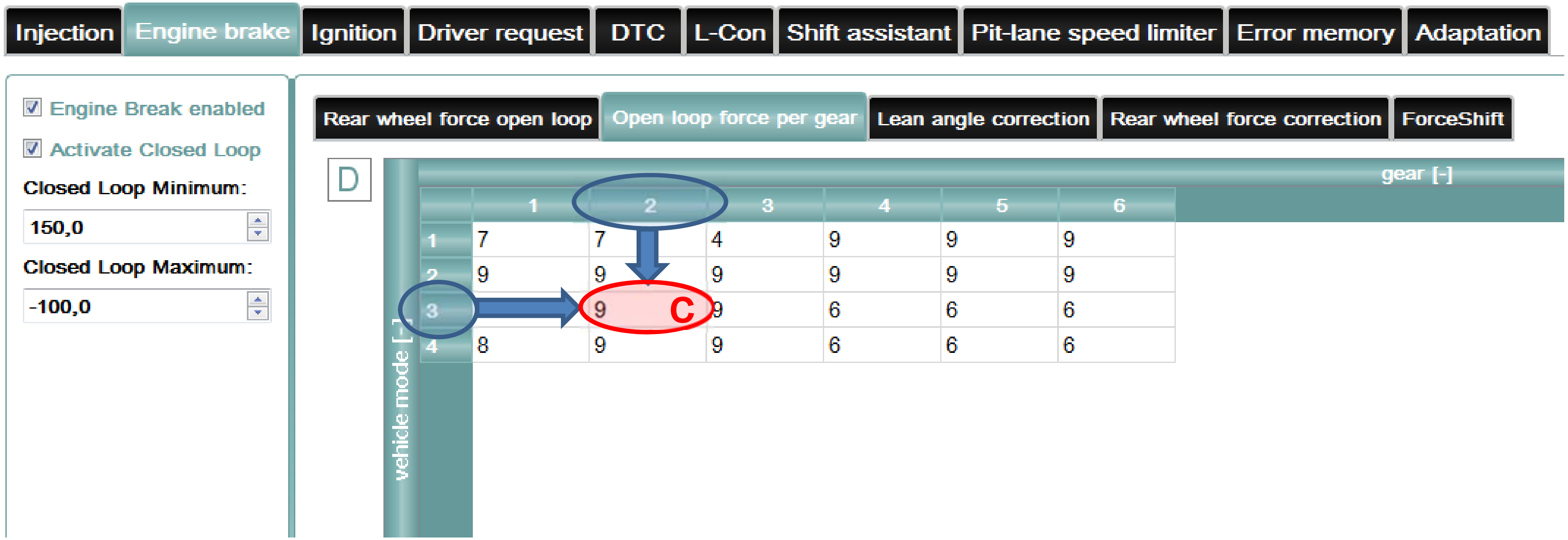


Figure 43 "Open loop force per gear"

Refer to the following table in order to solve a problem with modification of the engine brake characteristic curve:

Question	Possible cause	Possible solution/Information
What is disadvantageous?	Brake slip may be too low.	In the figure on page 70, the light-blue, dashed horizontal line in the middle of ellipse A indicates a brake slip of -3%.
How can this problem occur?	Because a down-blip does not take place.	If this applies, you should observe the peak in the throttle valve opening angle shortly before the

		jump in the reference speed. Check whether the rear wheel has ground contact (not shown).
Can a modification be practically implemented?		Yes, the throttle valve can be opened further in the relevant engine speed range. However, this solution is situation-dependent: If the brake slip is too high ("pushy" characteristic), for example, the throttle valve should be closed further. However, this is possible only if the throttle valve is not already fully (**tp** < 1%) closed.

You can select and edit the characteristic curve in "Rear wheel force open loop" . Observe the following figure for this:

Rear wheel force open loop | Open loop force per gear | Lean angle correction | Rear wheel force correction | ForceShift

	virtual engine speed [rpm]															
	1000	3500	5700	6300	6900	7500	8100	8700	9300	9900	10500	11100	11700	12300	12900	13500	14
1	-200,0	-725,0	-721,3	-720,3	-718,1	-712,2	-690,6	-655,2	-597,2	-520,7	-451,0	-407,6	-352,7	-282,2	-210,5	-158,8	-129,9
2	-200,0	-725,0	-721,3	-720,3	-718,1	-692,2	-650,6	-560,2	-422,2	-333,2	-291,0	-287,6	-300,2	-314,7	-307,3	-274,6	-196,4
3	-200,0	-725,0	-721,3	-720,3	-718,1	-712,2	-685,6	-625,3	-502,4	-373,4	-278,8	-223,8	-206,8	-197,7	-190,1	-185,5	-183,7
4	-200,0	-693,0	-690,5	-689,5	-684,3	-676,5	-659,4	-634,6	-595,2	-535,5	-456,1	-383,3	-311,8	-252,4	-207,4	-173,9	-148,7
5	-200,0	-725,0	-721,3	-720,3	-718,1	-712,2	-700,6	-675,2	-627,2	-563,2	-473,5	-380,1	-292,7	-222,2	-178,0	-143,8	-129,9
6	-200,0	-725,0	-725,0	-725,0	-725,0	-725,0	-725,0	-705,2	-680,5	-639,9	-586,0	-528,4	-469,4	-424,7	-389,9	-370,0	-357,7
7	-200,0	-600,0	-599,3	-596,4	-591,8	-584,2	-571,3	-554,0	-524,0	-487,4	-435,2	-374,1	-311,8	-252,4	-207,4	-173,9	-148,7
8	-200,0	-725,0	-721,3	-720,3	-718,1	-712,2	-700,6	-680,3	-582,4	-418,4	-313,8	-253,8	-231,8	-222,7	-215,1	-210,5	-208,7
9	-200,0	-725,0	-721,3	-720,3	-718,1	-712,2	-700,6	-680,3	-632,4	-533,4	-433,8	-355,5	-298,2	-252,7	-216,8	-188,8	-163,7
10	-200,0	-725,0	-721,3	-720,3	-718,1	-712,2	-700,6	-675,2	-627,2	-563,2	-486,0	-405,1	-330,2	-272,2	-221,1	-182,6	-156,8

Figure 44 "Rear wheel force open loop"

- Work in Microsoft Excel or another spreadsheet application.
- Always also use a visual representation of the values (e.g. 2D graph).
- Always compare the previous and new, modified characteristic curve.
- Always also use a visual representation of the values (e.g. 2D graph).

You can use the characteristic curve shown in red in the figure on page 75 as a reference for the result of the above example.

The previous characteristic curve is shown in green. The engine speed range identified as suboptimal in the data is marked in blue.

When making modifications, always pay attention to adjacent data points so that the vehicle does not respond abruptly in any situation. The vehicle must always remain predictable and stable.

- Insert the change back into RCK-Pro Setting.
- Document the change.

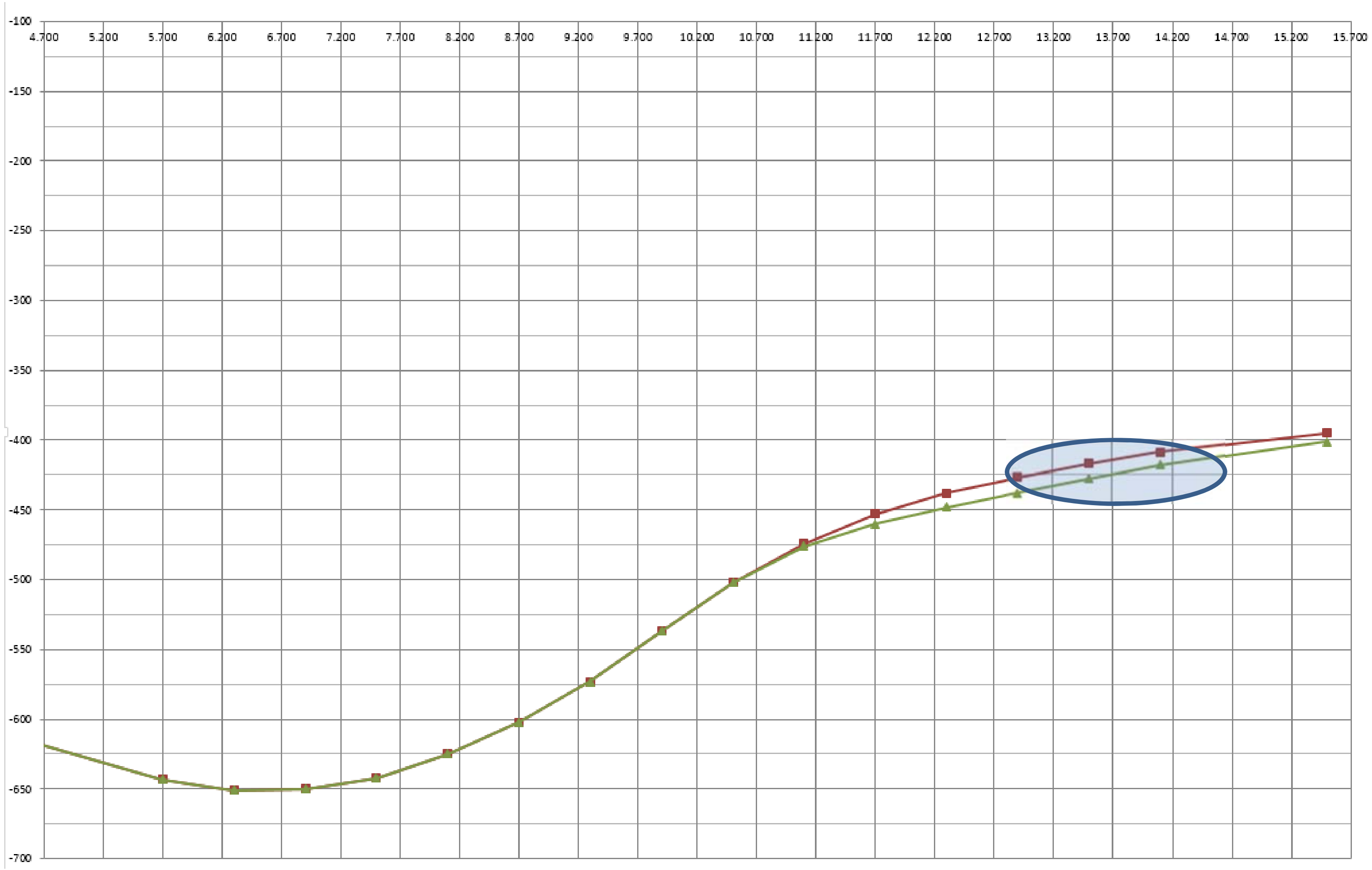


Figure 45 Characteristic curve representation

Troubleshooting

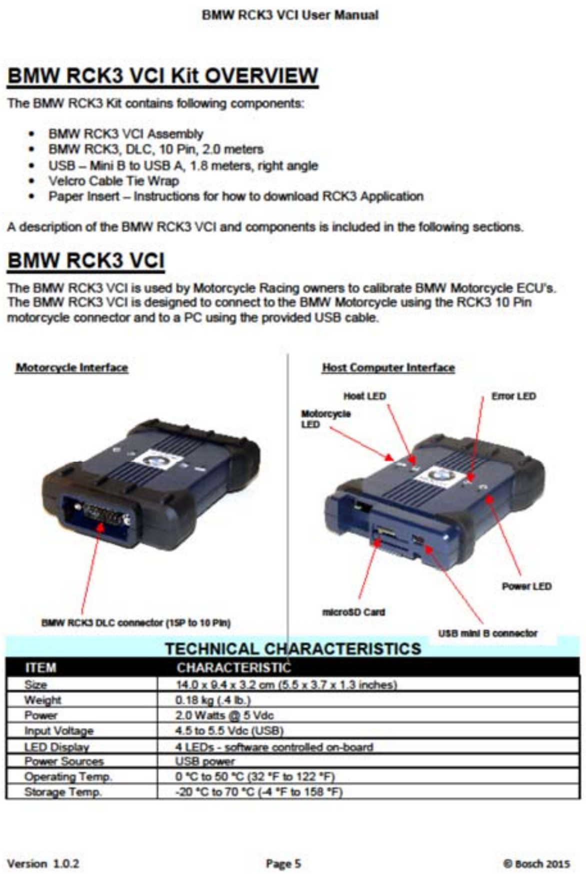
Problem	Cause	**Rectification**
Data is not transmitted.	Data record of a different motorcycle or a modified configuration of the motorcycle.	Transfer new data record to the control unit via "File"→ "New" (works settings). Copy old data to a spreadsheet application (e.g. Microsoft Excel). Copy this data into the new data record. This allows you to produce a backup and transfer the old data to the new data record.
Engine could run on 3 cylinders, but permanent ignition switch-off is visible in the data under load.	DTC fault, e.g. wheel speed at front and/or rear	Carry out a data analysis. If **idx_ign_cut_lvl** > 0 under load without requests from DTC/WC/LNC: Check on which wheel strong noise or brief peaks are visible in the wheel speed signal. Examine the hardware for mechanical faults, etc. Check whether the air gap between the sensor and sensor disc is between 1.0 and 1.6 mm. Check whether the sensor disc is functioning properly. Check whether the installation angle of the sensor is identical to series condition. Check whether the sensor is damaged. Check whether there is a chafed location or cable breakage on the sensor cable. Check whether the pins on the connectors are OK. Delete the fault memory entries after troubleshooting.

Engine could run on 3 cylinders, but **no** permanent ignition switch-off is visible in the data under load.	Fault in the area of the ignition.	Read out the fault memory. The spark plugs / ignition leads may be damaged. Check connectors for loose/pressed back pins. A loose contact on the main voltage supply (battery terminal) can possibly irreparably damage the ECU.
The throttle valve no longer opens during riding operation.	Diagnosis detects malfunction that is critical for riding safety – vehicle is in emergency mode.	For fault elimination, first check the fault memory. Various scenarios are possible: Carry out an analysis on the basis of the data and fault memory entries. In riding operation, it is possible to often exit emergency mode again by a Power Cycle (ignition off/on) in order to quickly return to the pit. Permanent continued operation of the motorcycle should not take place under any circumstances without thorough troubleshooting and data analysis.
The engine stops.	Petrol tank is empty, kinked/damaged fuel hose. The fuel pump is faulty.	Check the characteristic of **p_fuel_abs** in the data. If this value falls significantly below 2,000 mbar, troubleshooting for the cause must be performed in the fuel system.
Bank angle signal jumps to 90° / possibly DTC fault.	Oscillations are excited in the angular rate sensor (heel angle sensor). The signal is faulty.	Check the screw connection/rubber sleeves of the angular rate sensor. Check the cabling.
No wheel speed(s)	No correct signal processing possible.	If both wheels are affected: Check whether a 2D wheel speed unit is installed and that it is not damaged. Check whether wheel speed sensors are installed and connected. Check whether magnetic sensor discs are used. If only 1 wheel is affected: Check whether the sensor disc is installed.

		Check whether the wheel speed sensor is installed. Check whether the air gap is between 1.0 and 1.6 mm.
Starter motor does not turn.	No start enable.	Check whether the kill switch is pressed.
Starter motor turns, but the engine does not start.	Often no fuel in the combustion chamber or no ignition spark.	Check whether there is sufficient fuel in the tank. Check whether the fuel pressure is adequate (see 83; recommendation: approx. 4,500 mbar when stationary). Check whether the fuel pressure in the system is too high. (Fuel injectors can sometimes no longer open at pressures above 9,000 mbar) Check whether the throttle valve is correctly adapted. Check whether spark plugs are correctly connected.
Quickshifter does not function.	No enable for quickshifter or faulty switching signal.	Check whether the transmission is correctly adapted. Check whether the voltages of the shift sensor are OK (data analysis: **u_shift_1** and **u_shift_2** (0.5x u_shift_1). Check whether the voltage of the shift drum potentiometer is drifting (data analysis: **u_drum_gbx**). The shift drum potentiometer can wear during its service life and should be replaced by a new part at every engine change / inspection! Check whether the cable of the shift sensor is routed under tension or is firmly secured with a cable tie, for example.
Lack of power	No optimum filling / combustion.	Check whether the air-fuel ratio is set optimally for power output at approx. 0.9 (data analysis: **Lambda_2D**). Check whether the funnels in the intake silencer are correctly seated on the rubber seals. Check whether all fuel injectors are connected correctly with the wiring harness. Check whether the fuel pressure under full load is below 4,500 mbar (data analysis: **p_fuel_abs**). If yes, check whether it is necessary to replace the fuel system or pump.

		Check whether there is a constriction in the cross-section of the intake port of the intake silencer. Check whether the air filters are clogged. Check whether an excessively restrictive Power Level is used. Check whether a WET mode is used in dry conditions. Check whether the oil level is correct.
Engine has difficulty starting.	Air/fuel ratio too rich / lean.	Check whether the throttle valves are correctly adapted.
Pit-speed limiter does not function correctly.	Internal speed calculation is faulty.	Check whether the data input for the "**Overall gearbox ratio**" is correct (RCK-Pro Setting). Check whether the data input for "**Tyre radius**" is correct (RCK-Pro Setting).
	Engine turning.	Switch off the engine.
General information	unknown	Download the latest version of the software from the website https://www.bmw-motorrad.de/de/models/sport/hp4race/technicaldata.html#/section-preis-und-produktinformationen and install the software. Contact your Authorised BMW Retailer or BMW HP Race Support (hp-race-support@bmw-motorrad.de)

Attachment RCK VCI



BMW RCK3 VCI User Manual

BMW RCK3 VCI Kit OVERVIEW

The BMW RCK3 Kit contains following components:

- BMW RCK3 VCI Assembly
- BMW RCK3, DLC, 10 Pin, 2.0 meters
- USB – Mini B to USB A, 1.8 meters, right angle
- Velcro Cable Tie Wrap
- Paper Insert – Instructions for how to download RCK3 Application

A description of the BMW RCK3 VCI and components is included in the following sections.

BMW RCK3 VCI

The BMW RCK3 VCI is used by Motorcycle Racing owners to calibrate BMW Motorcycle ECU's. The BMW RCK3 VCI is designed to connect to the BMW Motorcycle using the RCK3 10 Pin motorcycle connector and to a PC using the provided USB cable.

TECHNICAL CHARACTERISTICS

ITEM	CHARACTERISTIC
Size	14.0 x 9.4 x 3.2 cm (5.5 x 3.7 x 1.3 inches)
Weight	0.18 kg (.4 lb.)
Power	2.0 Watts @ 5 Vdc
Input Voltage	4.5 to 5.5 Vdc (USB)
LED Display	4 LEDs - software controlled on-board
Power Sources	USB power
Operating Temp.	0 °C to 50 °C (32 °F to 122 °F)
Storage Temp.	-20 °C to 70 °C (-4 °F to 158 °F)

Version 1.0.2 Page 5 © Bosch 2015

Figure 46 BMW RCK3 VCI Kit OVERVIEW

Double click on the image to open it!

Appendix 2D Dashboard

2D Debus & Diebold Meßsysteme GmbH · Alte Karlsruher Straße 8 · D-76227 Karlsruhe
Tel: +49 (0) 721 944 850-0 · Fax: +49 (0) 721 944 85-29 · E-Mail: mail@2d-datarecording.com

This short manual describes some functions of the 2D dashes, which are not yet described in the general dashboard manual or may differ from the explanations there.

You can find the general dashboard manual on the 2D website 2d-datarecording.com: Downloads, manuals ⇒ general dashboard manual

Content of this short manual:

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Figure 47 2D Dashboard

Double click on the image to open it!

Information source dashboard and switch units

The BigDash 2D data recording provides a large amount of information for problem-free operation of the motorcycle. The basic information provided by the dashboard includes:

- Basic operating variables of the vehicle for technical checks by mechanics
- Vehicle mode as well as DTC and engine brake presettings for the application engineer and rider
- Lap times
- Feedback on adaptations (see page 88)
- Alarms in the event of malfunctions in the engine or electronics (see page 90)

When the ignition is switched on, the dash always switches to the **mechanic page (page 3)**:

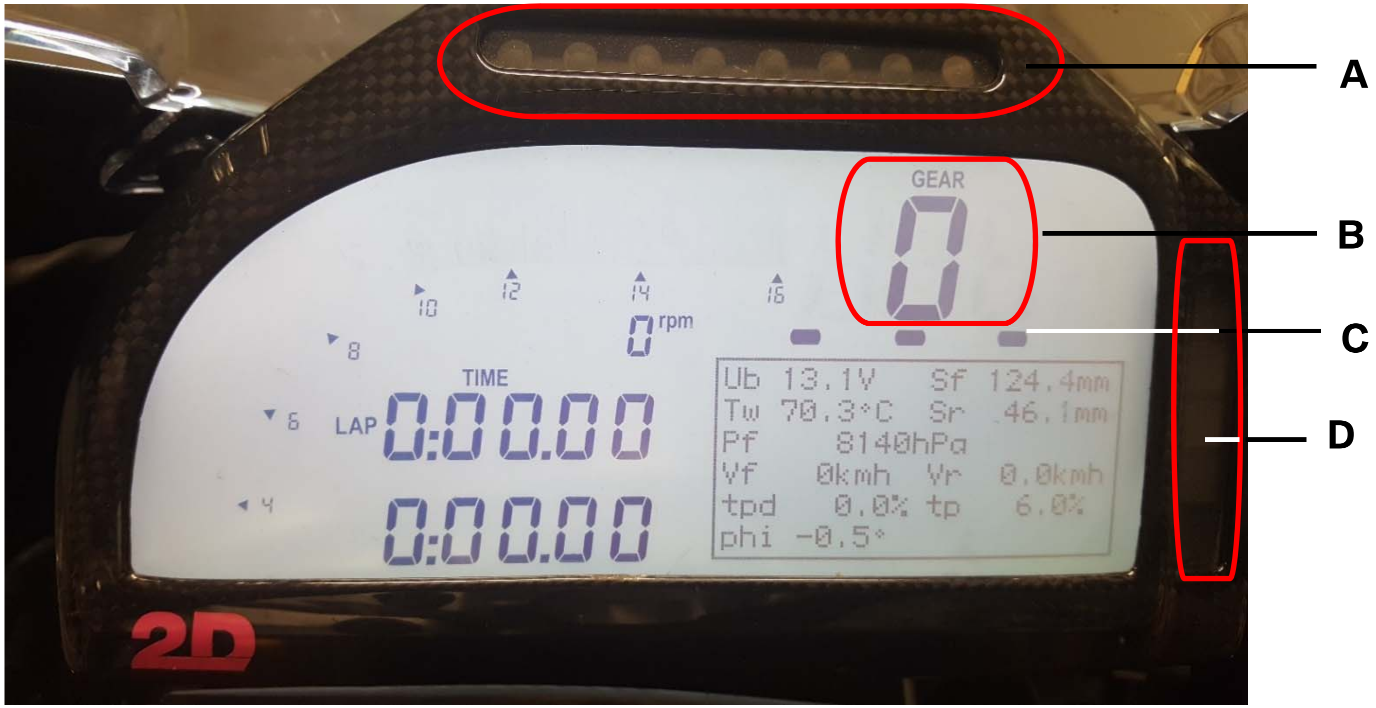


Figure 48 Display (1)

The information box in the right area of the display shows the following information:

Abkürzung	Signal
Ub	Bordspannung [V]
Tw	Kühlwassertemperatur [°C]
Pf	Benzindruck im Rail [hPa]
Vf	Vorderrad-Geschwindigkeit [km/h]
tpd	Gasdrehgriffstellung [%]
phi	Rollwinkel [°]

Abkürzung	Signal
Sf	Federweg vorn [mm]
Sr	Federweg hinten [mm]
Vr	Hinterrad-Geschwindigkeit [km/h]
tp	Drosselklappenstellung [%]

There is an LED bar in area **A**. This provides the driver with information about the pending gearshift. In addition, the LED bar flashes to provide visual feedback in the event of alarms (see page 90).

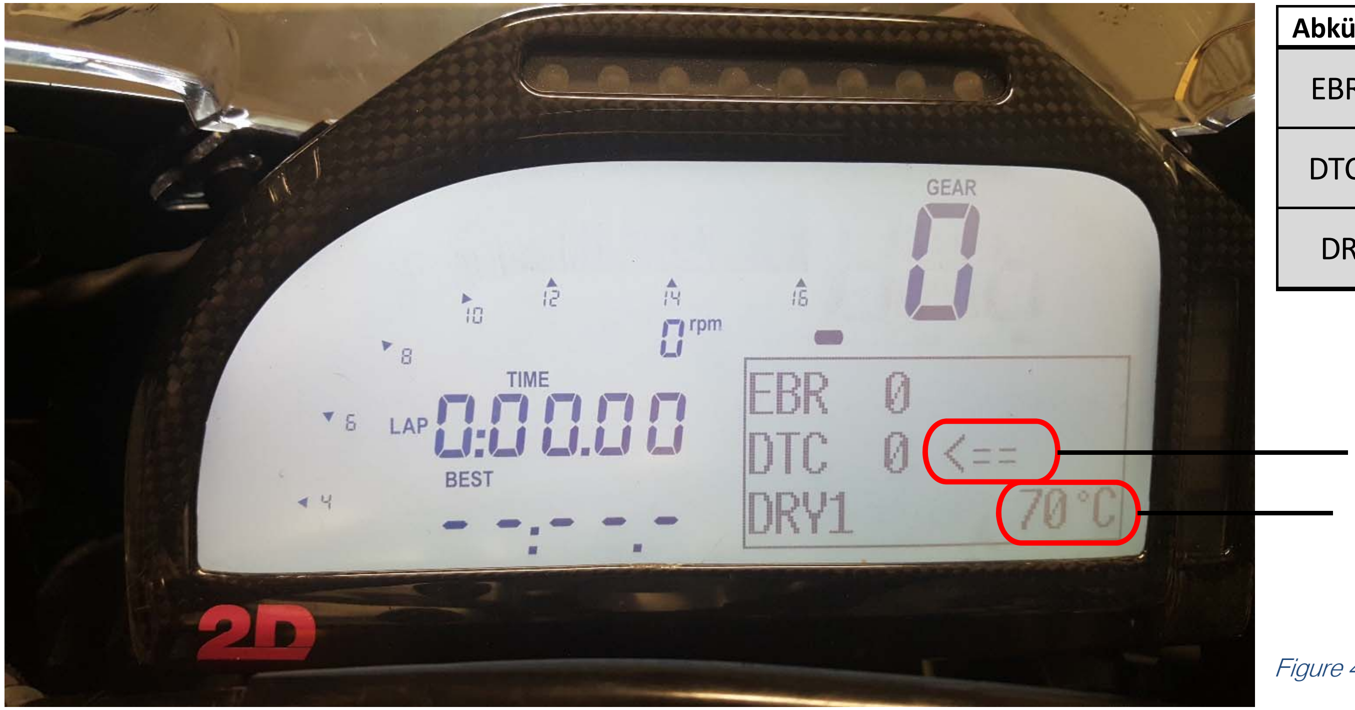
Area **B** shows the selected gear.

Area **C** shows statically illuminated LEDs. These LEDs provide additional visual feedback for various alarms.

Area **D** is located between the gear display and information box. The page number (three in the example) is shown in area **D** by three filled-in bars.

As long as no gear is engaged, you can switch between the pages by briefly pressing the yellow button on the rear of the switch unit of the left.

The dash automatically switches to page 1 (the driver page) when a gear is engaged. You cannot change the pages manually when a gear is engaged. The driver page is structured as follows:



Abkürzung	Signal
EBR 0	Offset für EBR [-7 … 7]
DTC 0	Offset für DTC [-7 … 7]
DRY1	Fahrzeugmodus [WET, INT, DRY1, DRY2]

Figure 49 Display (2)

Area **A** shows the current cursor for the + / - buttons. You can move the cursor between DTC and EBR with the blue button.

Area **B** shows the current coolant temperature (as also on the mechanic page on page 83).

- You can change the vehicle mode by pressing the blue (middle) button on the right switch unit twice.

The throttle grip must **not be at full load.** Feedback about mode switching on a straight with full load is provided only in the following braking zone.

- Press the button briefly three times if you wish to skip a mode (e.g. from WET to DRY1).
- Press the button briefly four times if you wish to skip two modes, etc.

The coolant temperature (large display), fuel pressure and oil temperature are displayed on page two. This page can be used for warm-up.

Figure 50 Display (3)

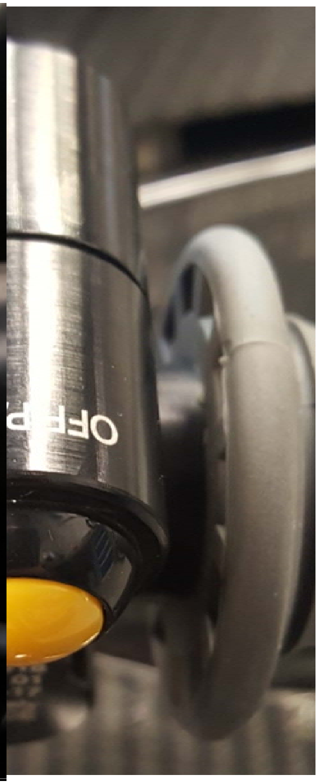
Switch units

The switch units on the left [Figures a) and b)] and right [Figure c)] are described below.
The right switch unit is used for switching the driving modes [centre blue button in Figure c)].

Switching of the modes was described on the previous page.

The bottom button is used for starting the engine [black button in Figure c); applies only if kill switch is in start position].

A start button that is pressed and held when riding in 1st gear controls the pit-lane speed limiter. The kill switch (upper right button) can be seen in Figure c).

a) Left switch u

c) Left switch unit (rear)

b) Right switch unit

The left switch unit is used mainly to control the dashboard. The yellow button on the rear side [see Figure b)] is used to switch between the individual pages on the dash (as long as no gear is engaged; in this case, page 1 is always displayed).

Dash alarms can be acknowledged (and thus hidden) with this button.

Traction control will be deactivated if you press and hold this button for longer than 1 s. This is indicated by illumination of an orange LED on the dash.
This is possible only if the kill switch is in the start position. The blue button [Figure a)] is used for switching between DTC / EBR adjustment (indicated by arrow). Further information on this is provided in the previous chapter.

The + button (top; shown in green in Figure a)) and the – button (centre; shown in red in Figure a)) are located on the left switch unit.

Adaptations

Adaptations are necessary for the main functions of the electronics. For example, the quickshifter will not function if there are no transmission adaptations. Without adaptation of the throttle grip, an undefined offset is unintentionally added to the stored drivability.

The throttle grip should always be adapted again when the grip is replaced.

Delete and re-teach all adaptations in the following cases:

- In the event of engine replacement,
- In the event of throttle valve replacement,
- In the event of shift drum potentiometer replacement.

The throttle grip is not adapted or is not adapted correctly if a value "tpd" of less than -0.5% can be read off on the mechanic page on the dashboard (page 83). Also carry out adaptation if the throttle grip cannot be opened to at least 99%.

The following procedure is recommended for **teaching the transmission**:

- Delete the adaptations and adaptation of the throttle grip.
- Make sure that the rear wheel is installed and that the rear wheel speed is measurable (see "Vr" on mechanic page on page 83).
- Place the motorcycle on an auxiliary stand.
- Remove the tyre heaters.
- Start the engine.
- Allow the engine to run at idle for at least 10 s.
- Pull the clutch.
- Select 1st gear.
- Engage the clutch.
- Allow the motorcycle to run in 1st gear.

Adaptation is started as soon as the gear shown on the display jumps between the actually selected gear and "8".

- Do not touch the gearshift lever under any circumstances during this process. This could corrupt the adaptation values.
- The gear will not be taught if the gearshift lever is touched accidentally. In this case, it is best to delete all adaptations once more and start the procedure again from the beginning.
- Adaptation of the respective gear is complete as soon as gear flashing has ended and the selected gear is displayed continuously.
- In this case, the clutch can be pulled and the next-higher gear selected.
- Repeat the procedure for all gears.
- The quickshifter is also enabled when all gears have been taught successfully. (This can be checked by means of a short data analysis with respect to ignition switch-off and throttle blip when shifting down).
- When all adaptations have been completed, the engine can be stopped and the ignition switched off. The vehicle should now stand for approx. 10 s with the ignition switched off. The adaptation procedure is then complete.

Dash alarms

Alarm text	Lit LED (right of display)	Flashing LED (above display)	Problem	Solution	Example Graphic
! DTC OFF !	No	Yes	DTC & WC & LNC NOT FUNCTIONING; Internal fault in DTC module (e.g. implausible wheel speed) - DTC simultaneously jumps into emergency mode – rider can exit emergency mode with permanent ignition switch-off by PRESSING DTC, MINUS BUTTON riding can then be continued without DTC, WC, LNC	Check wheel speeds in the data; check faulty sensor for correct air gap to sensor disc, installation orientation (twisting), external damage; check plug connectors for loose pins or external damage; check sensor disc for true running; entry present in fault memory – DELETION necessary in order to activate DTC, WC, LNC again	
-	Yes (orange)	No	NOT A TECHNICAL PROBLEM; DTC switched off	DTC, WC, LNC switched off; can be activated again by a long press of the yellow push-button on the left switch unit (only if kill switch is in start position)	
-	Yes (green)	No	NOT A TECHNICAL PROBLEM; GAP Function: fastest lap taking place	-	

Alarm text	Lit LED (right of display)	Flashing LED (above display)	Problem	Solution	Example Graphic
! VBAT LOW !	Yes (red)	Yes	Battery voltage too low; motorcycle does not start (voltage is displayed as numerical value under alarm text)	Charge or replace battery; if applicable, check alternator / controller / battery / wiring harness for leakage currents etc.	
! TWAT HIGH !	Yes (red)	Yes	Coolant temperature too high	At very high ambient temperature: Dissipate heat from radiator or engine block by means of fan / external blower; if applicable, check the cooling system for damage or other faults (ventilation, coolant level, etc.)	
! TWAT LOW !	Yes (blue)	Yes	Coolant temperature too low	At very low ambient temperature; possibly installation of thermostat or masking of radiator; allow engine to warm up at idle speed, no throttle application	
! LAUNCH !	No	Yes	Not a technical problem; feedback to rider about activated Launch Control	-