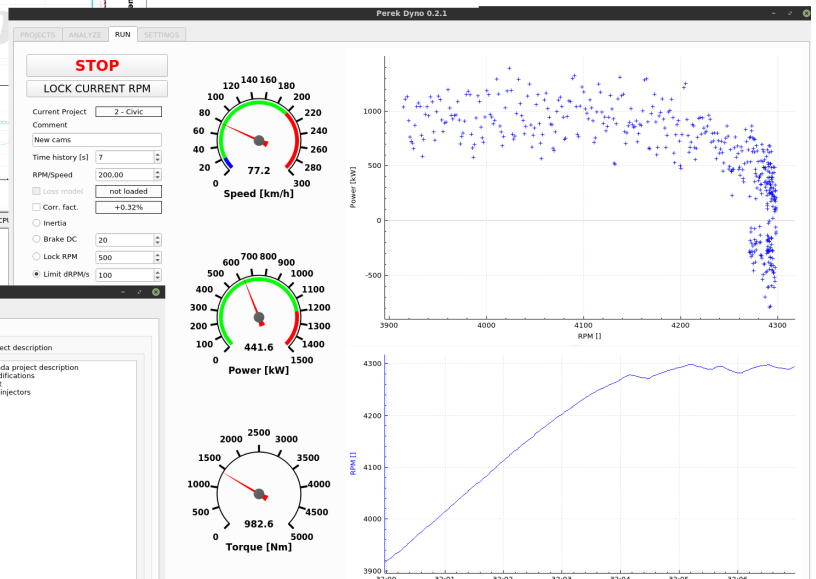
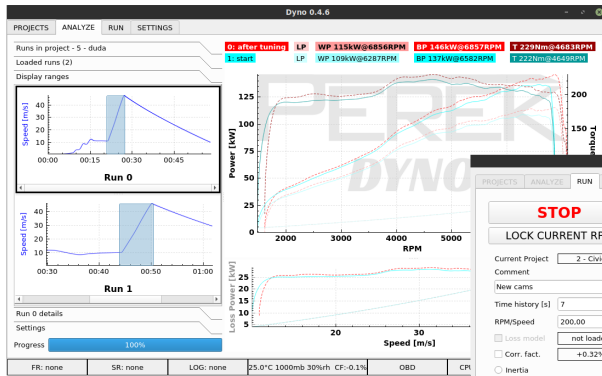


PEREK

DC1 Dyno Controller

Dyno2 software manual



Perek Dyno

id	name	car	registration	last run	peak power [kW]	run count	Selected project description
52	Marcin		KR12345	2018-05-12_10:01:54	1.53784	2	Tom's Honda project description
58	Tom's Honda	Honda Civic	TOH123	2018-06-30_20:38:25	256.115	3	List of modifications: -stroker kit -high flow injectors

Runs in project - 58 - Tom's Honda

id	project id	timestamp	length [s]	peak power [kW]	comment
1	261	2018-06-19_20:38:13	5.869	231.629	first run after injectors change
2	262	2018-06-19_20:38:20	4.051	256.115	second run
3	263	2018-06-19_20:38:25	3.013	227.669	ignition problem

FR: 17220012 SR: none LOG: 18050028 25.0°C 1000mb 40/hh CF-0.3% OBD: none CPU 4.8% 18-06-19 20:41:54

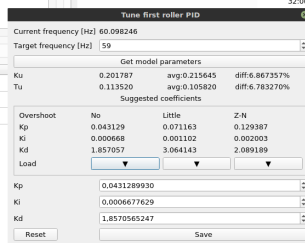


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1 General information

1.1 Requirements

The software is supplied with controller that covers its hardware requirements. User should not run additional applications in background when the software is running.

To use the software, display with resolution at least 1024x720 is required. Recommended resolution is FullHD (1920x1080). Keyboard and pointing device (mouse) is required. Mouse with scroll wheel is recommended.

1.2 Functions

- Fully adjustable software compatible with all dyno types - engine, chassis, inertial, absorption and others.
- Lots of wizard tools to shorten dyno setup. Tools for load cell calibration, dyno inertia calculation, brake PID tuning and more.
- Flexible sensor characteristic tables to convert analog signals to physical units.
- Independent selection of measurement units - metric and imperial.
- Live dyno parameters plotting during measurement.
- Unlimited data acquisition time.
- Scatter plotting. For ex. Power as a function of Ignition Angle.
- Flexible absorber control modes: power %, speed lock, acceleration limit, programmable brake and throttle sequences.
- Filtering and smoothing settings available to the user.
- Unlimited comparison of measurements.
- Easy measurement and project management.
- Run data saved in industry standard HDF format for ease of analysis in external software (e.g. MATLAB)
- CSV export of processed data.
- Programmable logic module for outputs control.
- USB and Bluetooth support for OBD interface readers.
- Automatic throttle control with CAN-Bus and Ecumaster control units.
- Programmable CAN-Bus parsing to user data.

Future functions:

- Support for external weather stations.
- Programmable CAN-Bus data export.

1.3 Operating system

The software runs on Raspbian OS installed on the DC1 controller / computer.

DC1 is supplied with installed and configured system and Dyno2 software placed on desktop, ready to run.

Dyno2 software works only on custom, prepared, system. It wont run on clean Raspbian installation.

Doing system updates is not recommended, as it could break correct Dyno2 software operation.

Power must not be cut off when the software is running or during any data write operation. It could lead to data corruption. Our experiments prove that powering down the device, with operating system running idle, doesn't have any negative consequences. Despite that, it is suggested to shut down the operating system before powering down the device.

If the operating system gets damaged, whole system image can be downloaded from our website: <http://perek.it>

User system password is: **dynoadmin**

When DC1 device is shipped, default LAN configuration is static IP address: 192.168.1.11 To connect the device to LAN network it is usually required to set IP settings to automatic DHCP.

All application data - settings and measurements are stored in /home/pi/.dyno2 directory.

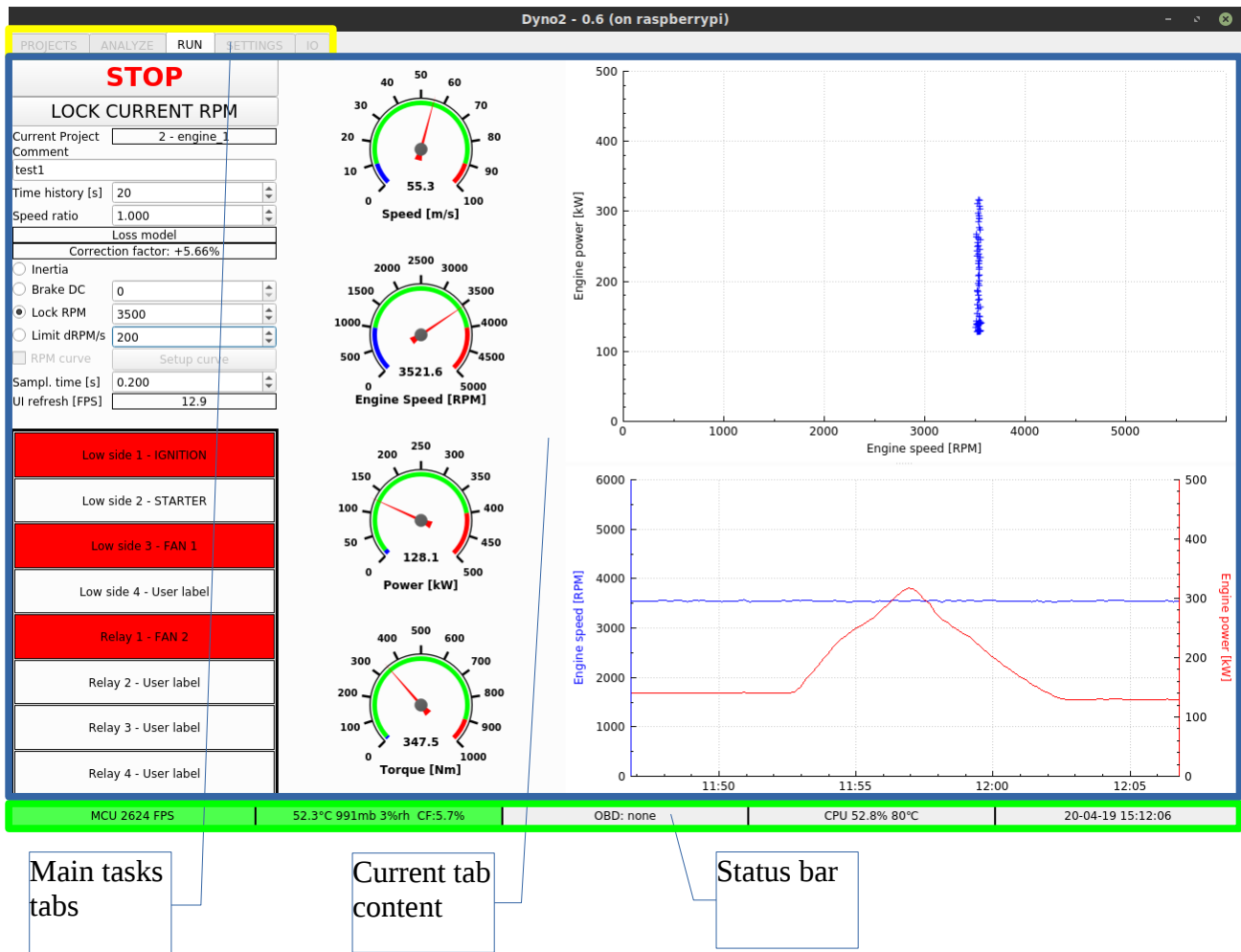
- **runs** - directory with measurement data. The .hdf data file contains all information needed to open it on another device.
- **saved** - default directory for data export (e.g. PDF, CSV).
- **functions.xml** - user programmed logic functions.
- **projects.db** - database with information about projects and associated runs.
- **settings.ini** - file with software and dyno configuration.

Dyno manufacturer / distributor can place additional files in main (.dyno2) dyno directory:

- **branding.png** - default plot background.
- **about.txt** - default text displayed in **SETTINGS / About** tab.

2 User interface

The interface consists of three main parts.



2.1 Main tasks

PROJECTS - project and measurement management

ANALYZE - measurement data analysis and compare

RUN - new measurements and vehicle tuning

SEQUENCE - test sequence configuration

SETTINGS - dyno and software configuration

IO - controller inputs / outputs preview

2.2 Projects

The screenshot shows the 'PROJECTS' tab with a navigation bar containing 'PROJECTS', 'ANALYZE', 'RUN', and 'SETTINGS'. The main area is divided into two sections. The top section, titled 'Projects', contains a table with columns: id, name, car, registration, last run, peak power [kW], and run count. The second row is selected, and a 'Selected project description' box is open to its right. The bottom section, titled 'Runs in project - 58 - Tom's Honda', contains a table with columns: id, project id, timestamp, length [s], peak power [kW], and comment.

id	name	car	registration	last run	peak power [kW]	run count	
1	52	Marcin	KR12345	2018-05-12_10:01:54	1.53784	2	
2	58	Tom's Honda	Honda Civic	TOM123	2018-06-19_20:38:25	256.115	3

Selected project description

Tom's Honda project description
List of modifications
-stroker kit
-high flow injectors

id	project id	timestamp	length [s]	peak power [kW]	comment	
1	261	58	2018-06-19_20:38:13	5.869	231.629	first run after injectors change
2	262	58	2018-06-19_20:38:20	4.051	256.115	second run
3	263	58	2018-06-19_20:38:25	3.013	227.669	ignition problem

PROJECTS tab is used to browse and manage projects and runs associated with them.

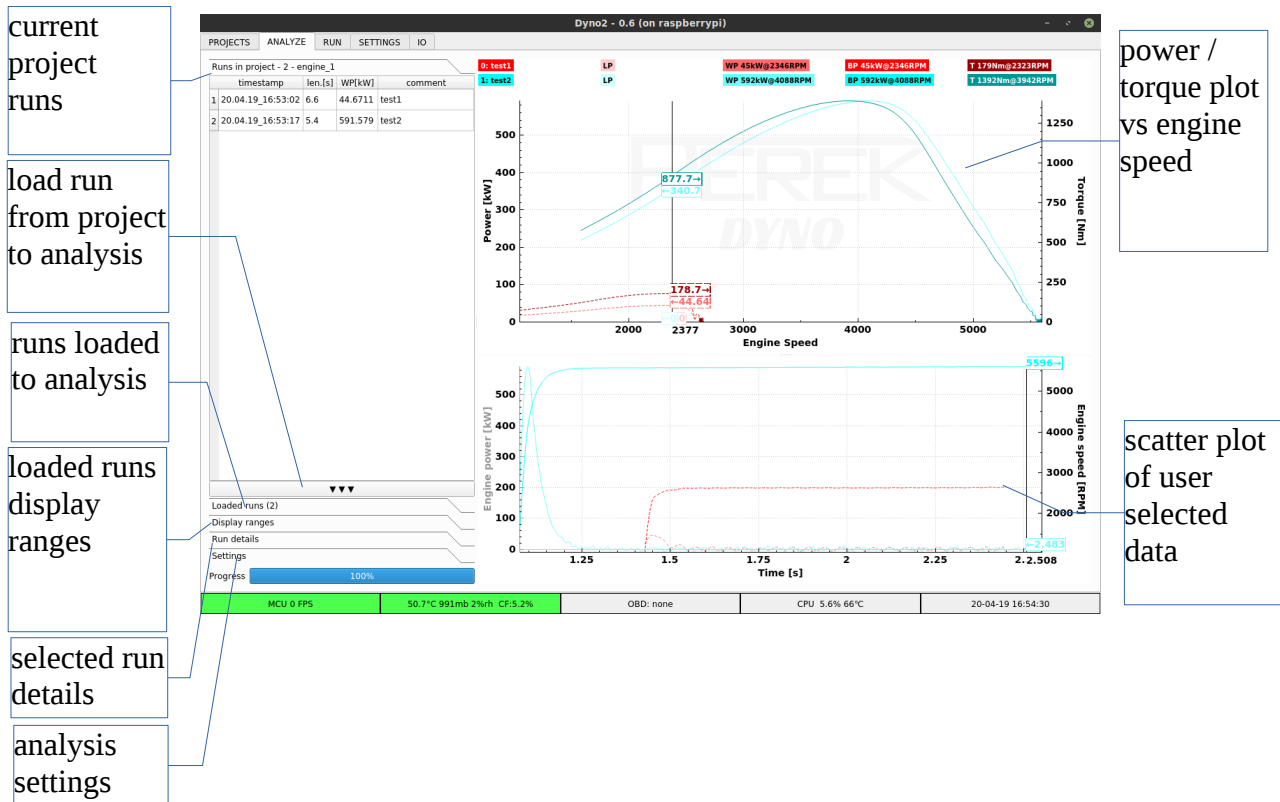
Project list shortcuts:

- **N** - add **New** project.
- **Del** - **Delete** selected project.

Run list shortcuts:

- **L** - **Load** run data from file.
- **Del** - **Delete** run from project (run data file will not be deleted).

2.3 Analyze



Runs in project displays all runs associated with current project. Shortcuts available in this list are:

- **L - Load** run from file.
- **Del - Delete** selected run from project (run data file is not deleted).

Load run button (▼ ▼ ▼) loads selected run to analysis and compare.

Loaded runs lists all runs, that are currently displayed on plots on the right side of the window. Available shortcuts:

- **L - Load** run from file.
- **Del - Delete** run from analysis (run data file is not deleted).
- **Space** - load recently made run.

Additional functions available in context menu (RMB):

- **Calculate Loss Model** - opens tool to calculate drivetrain power loss model.
- **Analyze Roller Signal** - opens tool to analyze roller speed signal quality.

Display ranges shows engine speed as a function of time, allowing to select run range that should be displayed on plots on the right side of window.

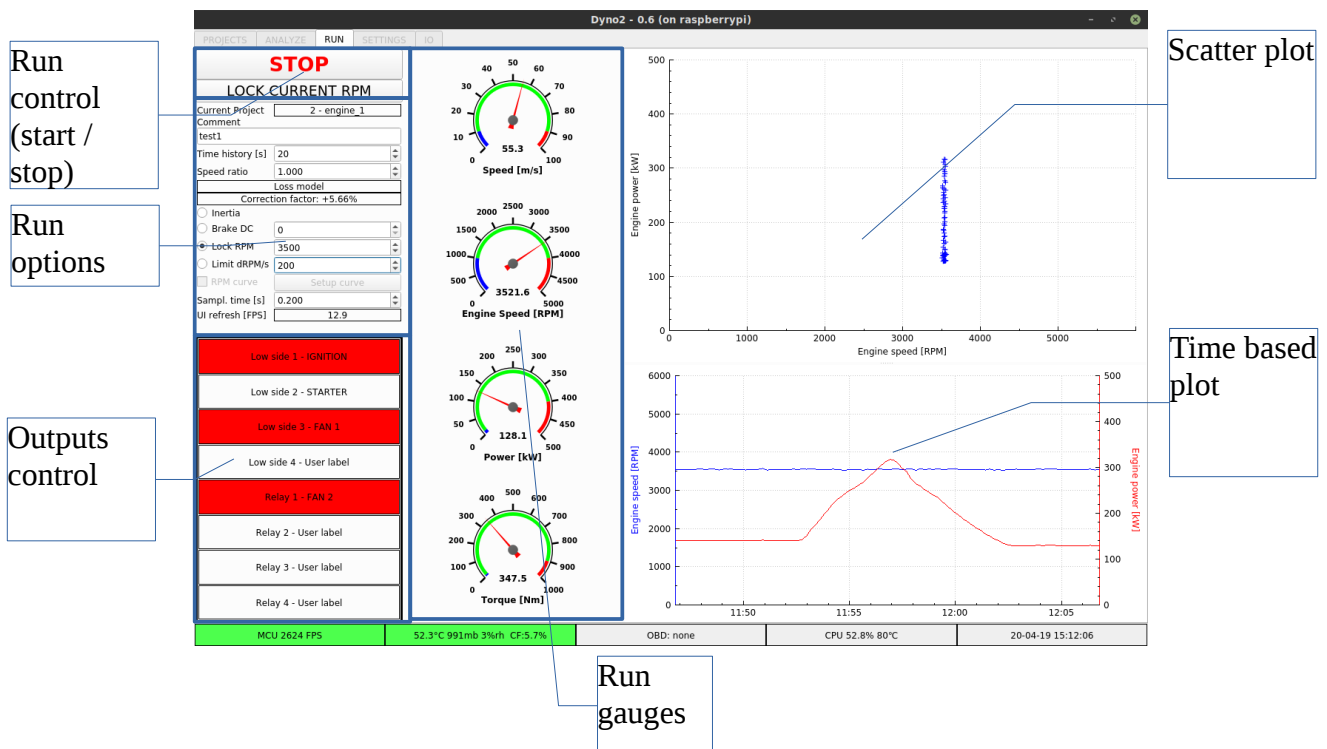
Run details shows additional information about selected run.

Settings shows additional analysis options such as smoothing, power plot selection or SAE engine power correction.

Power / torque plot as a function of engine speed is a typical dyno plot. It shows power on wheels, power on engine, loss power and engine torque. Export options (print, save) are available in context menu (RMB).

Scatter plot of user selected data is used to analyze relation between data channels. Data can be plotted as a function of other data or as a function of time. Data channels to be displayed are selected by right clicking on the axis, which data selection needs to be changed.

2.4 Run



2.4.1 Run control

- **START / STOP** - starts and stops run data acquisition and recording.
- **LOCK CURRENT RPM** - starts to control dyno brake to keep current engine speed constant.

2.4.2 Run options

- **Current project** - indicates which project is currently active. Run data will be associated with active project by projects database. Current project can be changed in **PROJECTS** tab.
- **Comment** - user note that will be saved with current run data.
- **Time history** - time to keep current run data on live plots (scatter and time based).
- **Speed ratio** - ratio required to calculate engine rotational speed from roller rotational speed. Value entered here affects directly engine torque calculation. This ratio is defined as ratio of engine rotational speed to the rotational speed measured with **Frequency input 1**.

Following functions available from context menu (RMB) are available for automatic ratio calculation:

- **Get from last run** - calculates ratio from last or currently active run. Usage:
 - Start the run by clicking **START** button.
 - Rev the engine to a known speed.
 - Optionally stop the run by clicking **STOP** button.
 - Select **Get from last run** from the context menu available on **Speed ratio** field.
 - Enter peak engine rotational speed achieved on the last run.
 - Click OK.
 - Speed ratio will be updated.
- **Get from OBD** - get the ratio through vehicle diagnostic OBD interface. Usage:
 - OBD interface should be connected and ready.
 - Start the run by clicking **START** button.
 - For better accuracy, rev the engine to high speed and keep it constant.
 - Select **Get from OBD** from context menu available on **Speed ratio** field.
 - In about 1s speed ratio should be updated.
- **Loss model** - model used to estimate power lost in the drivetrain and on the tire-roller contact patch. The model is used to calculate engine power from the power measured on dyno rollers. Loss model calculation tool by right-clicking on the Loss model label. More information can be found in Loss model chapter. In an engine dyno, usage of the loss model is not essential for accurate results.
- **Correction factor** - factor used to compare dyno run results made in different ambient conditions - temperature, pressure, humidity. Correction factor is calculated according to **SAE J1349** standard. Ambient conditions can be sourced from sensor build in the controller, or from manually entered values. On power plots, user can select data channels without correction: **Engine power, Engine torque**, or corrected channels: **Engine corr. power, Engine corr. torque**.
- **Run options** are used to select and set up dyno absorber control mode. **PID controller must be properly configured before using dyno absorber (brake)**. PID tuning tool is available by right-clicking on the **Lock RPM** value. Tuning procedure is described in the “DC1 Dyno Controller - installation and configuration” document.
 - **Inertia** - dyno absorber is disabled.
 - **Brake DC** - only set percent of absorber power is used.
 - **Lock RPM** - engine speed is locked - the engine will not accelerate over set speed.

- **Limit dRPM/s** - engine acceleration is limited - this function limits engine acceleration to an entered value in rotations per minute per second (RPM / s).
- **Throttle control** - enables engine throttle control. Throttle control must be properly configured in **SETTINGS / Throttle control** tab.
- **Run sequence** - selecting this option will enable engine throttle and speed control according to sequence programmed in **SEQUENCE** tab. The sequence starts with run start (**START** button click).
- **UI refresh** - performance information about UI refresh rate in refresh count per second.

2.4.3 Outputs control

The outputs section of the application shows current output state and allows to control their state.

Output control is possible in two modes: **manual** and **automatic**.

In **manual** mode, the output is activated with mouse click on the output label. It can be also activated with press of a keyboard button (F1 - F8 from top to bottom). Output state can be monostable or bistable. Monostable output is active only when activating signal is present (keyboard key or mouse button pressed). It is a good option for controlling starter motor. Bistable output state changes and latches every time it receives activating signal.

In **automatic** mode, the output is controlled with programmable logic function. User functions can be created in **SETTINGS / Functions** tab. Function creation is described in Functions chapter.

Output configuration is available by right-clicking the output label. Available options are:

- Creation of own text label for the output.
- Control source selection (**Manual / Function**).
- Bistable output mode option.
- Control function selection.

New function and **Edit function** shortcuts are available on hand.

2.4.4 Run gauges

The gauges display current values or dyno parameters, such as vehicle speed, engine speed, power and torque. Gauge range can be adjusted by right-clicking it.

- **min** - scale start
- **max** - scale end
- **step** - scale label step
- **low** - end of blue range
- **high** - start of red range

2.4.5 Scatter plot

Scatter plot allows to analyze relations between any data channels. These can be for example power and ignition angle. Channel selection is made by right-clicking the plot axis to which we want to assign different channel. Plotting can be paused or cleared during the run. Data retention time can be adjusted with **Time history** value in run options area.

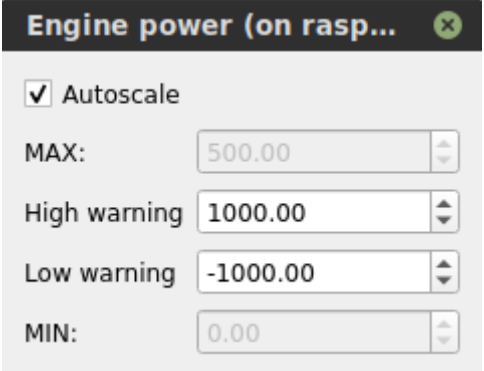
2.4.6 Time based plot

Time based plot shows selected channels as a function of time. On this plot we can see for example recent speed and power values. Channel selection is made by right-clicking the plot axis to which we want to assign different channel. Plotting can be paused or cleared during the run. Data retention time can be adjusted with **Time history** value in run options area.

2.4.7 Data channels configuration

Channels configuration is available by selecting **Setup variable (channel name)** from context menu shown by right-clicking the axis which shows the channel to be configured. The configuration is used only on plots in **RUN** tab.

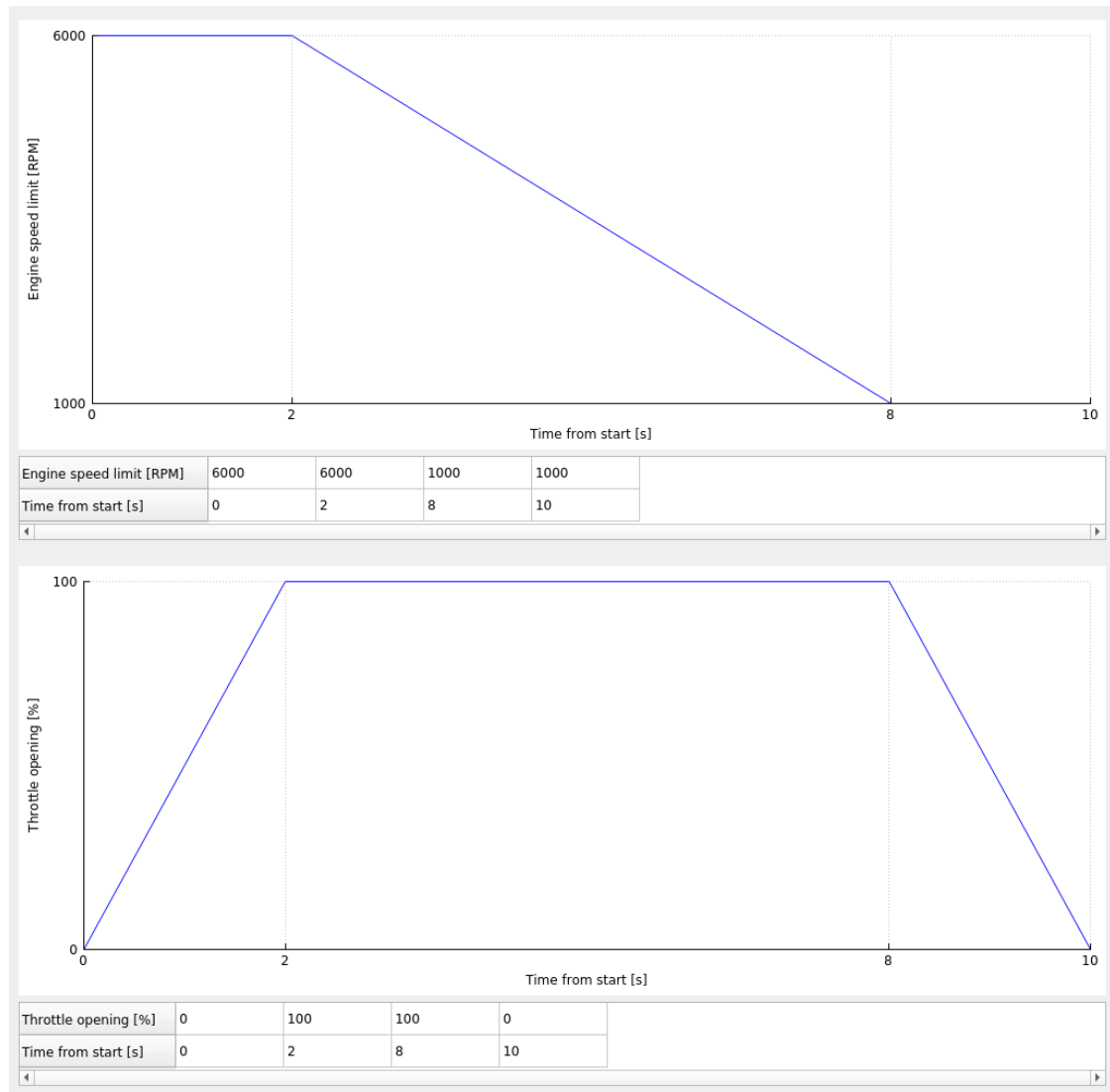
- **Autoscale** - plot ranges will automatically scale to best fit available channel data.
- **MIN / MAX** - plot range when **Autoscale** option is disabled.
- **High / Low warning** - thresholds for warning plot highlighting in red or blue. Warning condition is checked only on displayed data channels.



Engine power (on rasp...)	
<input checked="" type="checkbox"/> Autoscale	
MAX:	500.00
High warning	1000.00
Low warning	-1000.00
MIN:	0.00

2.5 Test sequence

Custom throttle opening and engine speed test sequences can be programmed in the **SEQUENCE** tab. To activate sequence playback, **Run sequence** option must be checked in the **RUN** tab.



- **Engine speed limit** - sets the engine speed to be kept by the dyno brake controller.
- **Throttle opening** - sets throttle opening percent during the test sequence.

Keyboard shortcuts used to edit test sequences:

- **Del** - Delete sequence point
- **I** - Insert sequence point to the left of active one.
- **O** - Insert sequence point to the right of active one.

2.6 Settings

SETTINGS tab contains software and dyno controller settings.

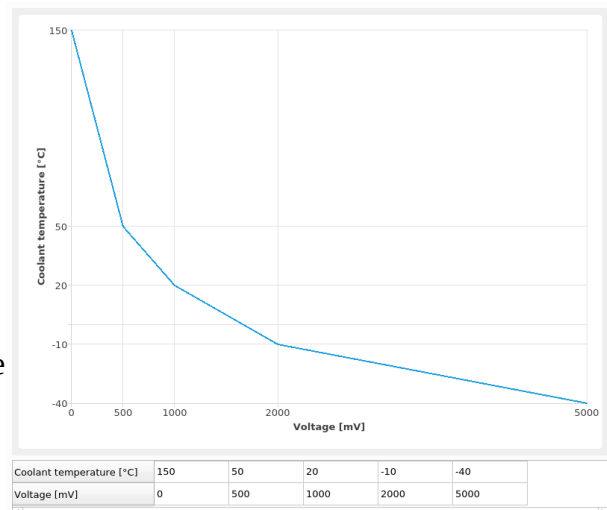
2.6.1 Dyno settings

Collection of settings related with the dyno controller.

- **Frequency Input** - Input 1,2 is used to connect speed signal of first / second roller of chassis dyno. In case of engine dyno, main shaft speed signal should be connected to input 1. Input 3 is optional and it is used to connect engine speed signal. It is useful when there is no constant ratio between input 1 or 2 speed and the engine speed. Frequency input 3 is labeled ENGINE SPEED.
 - **Signals per rotation** - number of signals per rotation of rotating body.
 - **Frequency low pass filter** - cutoff frequency of filter used to smooth speed reading
 - **Frequency change low pass filter** - cutoff frequency of filter used to smooth power reading resulting from roller body acceleration
 - **Inertia** - rotating body rotational inertia.
 - **Wizard** - tool used to calculate inertia with calibration experiment - acceleration of rotating body with constant torque and stopping it with it's own power losses. The wizard usage is described in „DC1 Dyno Controller - Installation and configuration”.
- **Load Cell** - configuration of coefficients to translate input voltage to torque.

Load cell torque = input voltage * a + b.

- **a** - gain
 - **b** - offset
 - **Low pass filter** - cutoff frequency of filter used to smooth load cell torque reading.
 - **Wizard** - tool to calibrate the coefficients. The procedure is described in „DC1 Dyno Controller - installation and configuration”. **If the load cell is not used, the coefficients must be set to 0.**
- **High precision ADC** - high precision analog input settings
 - **High precision ADC mode** - voltage range or thermocouple type.
 - **Differential mode** - enable differential mode. The voltage will be measured between S1 and S2. In the other case the voltage is measured between Sx and GND.



- **User name** - user assigned channel name that will be visible in the plots.
- **Unit type** - type of physical quantity.
- **Characteristic** - used to convert voltage to physical quantity. Keyboard shortcuts available to edit characteristic:
 - **Del - Delete** sequence point
 - **I - Insert** sequence point to the left of active one.
 - **O** - Insert sequence point to the right of active one.
- **Low pass filter** - cutoff frequency of filter used to smooth input signal.
- **Analog input** - 0-5V input - the configuration is analogical to configuration of high precision inputs described above.
- **Dyno type** - option to choose type of dyno in use
 - **engine** - engine dyno - road speed will be hidden
 - **chassis** - chassis dyno
 - **hub** - hub dyno
 - **propeller** - propeller dyno for aviation engines
- **Engine speed source** - selection of engine speed source for torque calculation.
 - **calculate from frequency inputs and ratio** - engine speed is calculated from constant ratio between rotational speed measured on **Frequency 1** input and engine speed.
 - **engine clamp** - engine speed is sourced from **Frequency 3 (ENGINE SPEED)** input.
 - **OBD** - engine speed is acquired by querying vehicle OBD interface.

Dyno absorber control in **Lock RPM** or **Limit dRPM/s** mode currently works only with **calculate from frequency inputs and ratio** setting.
- **Engine speed ratio** - engine speed to **Frequency 1** speed ratio. This field is connected with **Speed ratio** in **RUN** tab.
- **Chassis dyno roller n diameter** - Diameter of chassis dyno roller.
- **Ambient sensor type** - type of sensor that is used to measure ambient conditions (pressure, humidity, temperature).
 - **build in sensor** - sensor build in DC1 controller
 - **failsafe values** - values from **SETTINGS / Ambient data**.
- **PWM low side output** - configuration of controller hardware PWM outputs. Outputs 1 and 2 are programmed to control dyno absorbers associated with **Frequency 1** and 2 inputs. Outputs 3 and 4 are reserved for future functions.
 - **Mode** - output signal generation mode.

- **PWM** - Pulse Width Modulation.
- **RC pulse** - common signal format for servomotors.
- **Frequency** - PWM signal frequency.
- **Max duty cycle** - maximum PWM / RC pulse signal duty cycle - can be used to trim maximum absorber power.
- **Invert** - output level inversion - default output active level is low (connected to GND). **Invert** options swaps low and high output voltage.
- **Analog output** - output used for controlling absorbers that require analog signal.
 - **Range** - output voltage range.
- **Brake group PID** - PID coefficient settings for absorbers group. The controller has two PID algorithms running. First is associated with **Frequency 1** input and **PWM low side output 1**, second one analogically with input 2 and output 2.

2.6.2 Ambient data

Ambient data tab is used to configure ambient conditions failsafe values that are used in calculations in case of sensor malfunction or failsafe values being selected on purpose.

Failsafe values	
Temperature [°C]	25
Air pressure [mb]	1000
Relative humidity [%]	40

2.6.3 OBD

OBD interface type	USB / Serial
USB / Serial interface port	ttyUSB0
Bluetooth interface name	V-LINK

Dyno2 software supports reading vehicle diagnostic data through OBD interface. Hardware interface can be connected through serial port, USB or wireless Bluetooth connection.

To use OBD function, interface type must be selected according to used interface type: „USB / Serial” or „Bluetooth”.

For the „USB / Serial” option, it is required to select communication port that will be used to connect with the interface. Port suggestions are available by right-clicking the port name field.

For the „Bluetooth” option, it is required to fill Bluetooth device name. **The Bluetooth device must be paired with operating system tool before usage in the dyno software.** Connected device list is available by right-clicking the device name field. When configuring and using Bluetooth interface, keep in mind that the device can show up and connect with some delay - even several seconds.

Interface type can be set to „none”, to avoid interface connection warnings.

2.6.4 Throttle control

Currently throttle control in connection with Ecumaster EMU Black engine control unit is possible. To use the control, CAN channel (physical output) that is connected with EMU Black must be selected.

Ecumaster EMU Black throttle control

CAN bus ID (hex)	667
CAN channel	1

Throttle control must be enabled in the EMU Black software by checking **Enable CAN control** option in **DBW - Parameters**. **CAN ID** must be the same in dyno controller and the ECU.

The screenshot shows the 'DBW - Parameters' window. The 'Parameters' list includes:

Enable	<input type="checkbox"/>
EMU compatibility	<input checked="" type="checkbox"/>
Output frequency	4000 Hz
Invert motor direction	<input type="checkbox"/>
Pos. sensor input	None
Pos. inv. sensor input	None
Max pot error	0.12 V
Positive int. limit	10
Negative int. limit	10
Position min.	0.59 V
Position max.	3.92 V
Idle range	5
Use Throttle plate as TPS	<input type="checkbox"/>
DC ref table	Uses throttle position
Enable friction accrue	<input type="checkbox"/>
Second PPS pot. input	None
PPS Plausible check type	2nd pot voltage is half of 1st
Enable CAN control	<input checked="" type="checkbox"/>
CAN ID(hex)	667
Characteristic switch	None
Disable when no RPM	<input type="checkbox"/>
BMW ITB mode	<input type="checkbox"/>
BMW ITB output	None
Use MAP for characteristic	<input type="checkbox"/>

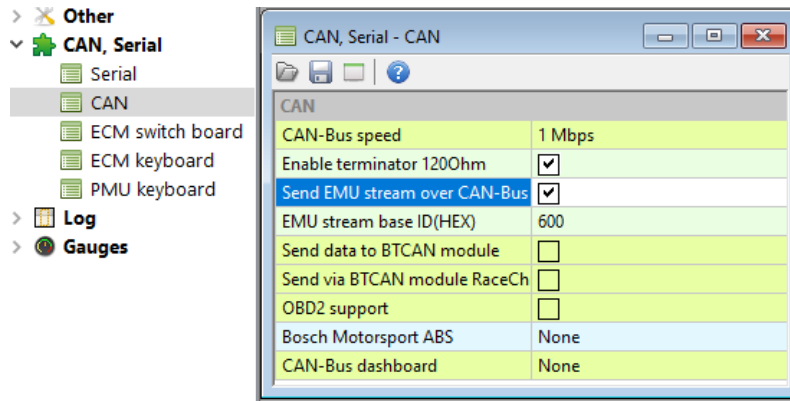
The CAN bus must be set to the same speed in both devices and must be equipped with terminating resistors. It is possible to enable built in terminating resistors with software in both devices.

CAN bus settings in **SETTINGS / Dyno settings** tab.

CAN bus

1	2
Enable terminator	<input checked="" type="checkbox"/>
Speed	1Mbps

CAN bus settings in Ecumaster EMU Black device.



2.6.5 Units

Units tab allows to select preferred units for physical quantities in the application.



2.6.6 Branding

Branding tab is used to set plot background image. The tab allows to set up image opacity, scaling and position. The image can be loaded by “Drag and drop” method on the plot preview or by right-clicking it and selecting **Load image** option.

2.6.7 Functions

Functions module allows to create custom programmable logic. Functions can perform logic, mathematical and lot of other operations such as hysteresis or SR latch. Functions can be used to control device outputs or to display custom calculated information on the plots. Functions values are refreshed every 10ms. The value is calculated once during the refresh. Functions are processed from top to bottom according to table in **SETTINGS / Functions** tab. Standard conversion from numbers to logic value is used:

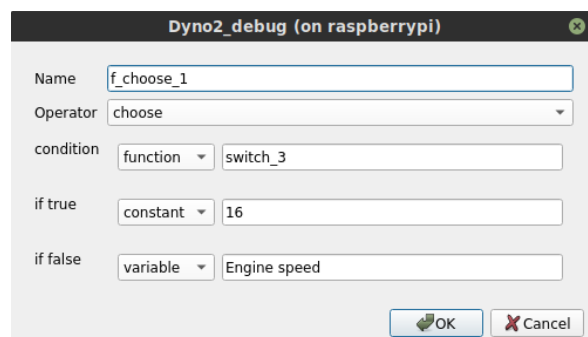
- 0 -> false
- value different from 0 -> true

Keyboard shortcuts for function list operations:

- **Enter** - Edit function.
- **Del** - Delete function.
- **Alt + Up** - Move the function up in the table - earlier in the processing order.
- **Alt + Down** - Move function down in the table - later in the processing order.
- **N** - New function

Function configuration

- **Name** - User assigned function name



- **Operator** - type of operation performed by function - arithmetic or logical operator, advanced function.

Argument of function can be a:

- constant
- variable - dyno data channel
- function - other function
- can input - CAN bus data channel

Tool with list of valid arguments of selected type is available by double clicking argument value field. Constant argument is entered manually.

2.6.8 CAN parser

CAN parser module allows to extract data from CAN bus stream for further use in the application. Extracted data can be shown on the plots or used to control device outputs. The data channel is referred to as **CAN Input**.

Keyboard shortcuts for can input list operations:

- **Enter** - Edit CAN Input.
- **Del** - Delete CAN Input.
- **Alt + Up** - Move the input up in the table
- **Alt + Down** - Move the input down in the table
- **N** - New input

Channel configuration

Name	<input type="text" value="CAN pressure sensor"/>																																
Channel	<input type="text" value="2"/>																																
CAN ID (hex)	<input type="text" value="500"/>																																
	<input checked="" type="checkbox"/> Compound message																																
Compound ID	<input type="text" value="0"/>																																
Endianness	<input type="text" value="big endian"/>																																
Bit count	<input type="text" value="16"/>																																
Byte offset	<input type="text" value="0"/>																																
Bit offset	<input type="text" value="0"/>																																
Signedness	<input type="text" value="unsigned"/>																																
<table><thead><tr><th>MSB</th><th colspan="6"></th><th>LSB</th></tr><tr><th>byte 0</th><th>byte 1</th><th>byte 2</th><th>byte 3</th><th>byte 4</th><th>byte 5</th><th>byte 6</th><th>byte 7</th></tr></thead><tbody><tr><td>XXXXXXXX</td><td>XXXXXXXX</td><td>XXXXXXXX</td><td>XXXXXXXX</td><td>XXXXXXXX</td><td>XXXXXXXX</td><td>01110111</td><td>10001000</td></tr><tr><td>0x11</td><td>0x22</td><td>0x33</td><td>0x44</td><td>0x55</td><td>0x66</td><td>0x77</td><td>0x88</td></tr></tbody></table>		MSB							LSB	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	01110111	10001000	0x11	0x22	0x33	0x44	0x55	0x66	0x77	0x88
MSB							LSB																										
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0x11	0x22	0x33	0x44	0x55	0x66	0x77	0x88																										
Multiplier	<input type="text" value="1.0000000000"/>																																
Divider	<input type="text" value="1.0000000000"/>																																
Offset	<input type="text" value="0.0000000000"/>																																
	<input checked="" type="checkbox"/> Enable timeout																																
Timeout [s]	<input type="text" value="1.000"/>																																
After timeout value	<input type="text" value="5.0000000000"/>																																
<input type="button" value="OK"/> <input type="button" value="Cancel"/>																																	

- **Name** - user assigned CAN Input name.
- **Channel** - interface CAN bus channel id. The interface is equipped with two physical CAN buses.
- **CAN ID** - CAN message ID
- **Compound message** - option to parse the message as compound type. This format is based on sending multiple information with the same CAN message ID. Information frame is identified with a number sent in byte 0 of the message.
- **Compound ID** - byte 0 value to trigger message parsing.
- **Endianness** - Byte order in the CAN message. Big Endian is the most common format. In this format the most significant byte is sent first (byte 0). It is possible to decode CAN

message in Little Endian format. In Little Endian byte order is reversed and byte 0 is the least significant.

- **Bit count** - Number of bits to extract from the CAN message.
- **Byte offset, Bit offset** - Position in the message to start data extraction. The offset is always counted from the right side, from the least significant bit after taking the endianness into account.

Position = Byte offset * 8 + Bit offset.

- **Signedness** - Defines if extracted number will be interpreted as **unsigned** or **signed**. Signed number is a number that can have negative values. Two's complement format is used for signed numbers.

Next window area shows preview of the data extraction. Most significant byte is always placed on the left side.

Next line shows byte numbering same with CAN bus byte numbering. Byte 0 is the one that is sent first. Byte numbering labels are changed according to the selected **Endianness**.

Next line shows message bits which will be extracted according to **Bit count, Byte offset and Bit offset**. X characters mark the bits that are not extracted. If the line is highlighted in red, it means that required bit count can't be extracted at the set position.

Next line shows live preview of data being received on entered CAN channel with matching ID.

- **Multiplier** - extracted number multiplier
- **Divider** - extracted number divider
- **Offset** - constant added to the extracted number

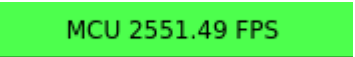

CAN Input value = extracted number * **Multiplier** / **Divider** + **Offset**

- **Enable timeout** - Enables the timeout function that overwrites CAN Input value when the required CAN message is not received.
- **Timeout** - Time required to pass, to override CAN Input value.
- **After timeout value** - The value that will be set in the absence of required CAN message.

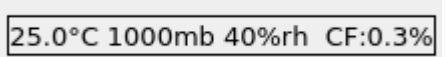
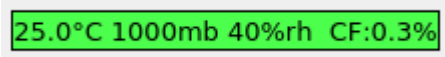
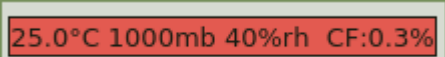
2.7 Status bar

The status bar contains information about connected modules, system load and current system time.

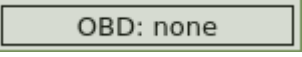
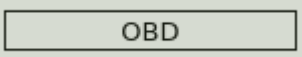
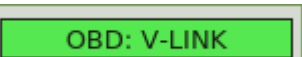
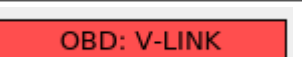
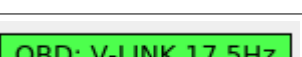
2.7.1 Microcontroller status

	MCU communication is correct. 2551 data frames are sent every second.
	MCU communication error. This status should not occur during normal device operation. If it shows up, contact us to solve the problem.

2.7.2 Ambient condition status

	Failsafe values are selected for usage. Temperature: 25°C, pressure: 1000mb, relative humidity: 40%, SAE J1349 correction: +0.3%
	Ambient conditions sensor selected and working correctly.
	The sensor is selected but it's not working correctly. Failsafe values are used.

2.7.3 OBD status

	No OBD interface selected.
	Interface selected. Waiting to connect.
	Interface "V-LINK" selected, connected and ready to be used.
	Problem with interface connection. The interface can be disconnected, powered down or out of Bluetooth range.
	Interface connected and receiving data. Average data polling frequency: 17.5Hz. The frequency is dependent on ECU and interface used.

2.7.4 CPU load

The dyno microcontroller sends a lot of data that requires processing in real time. Loss if this data will result in invalid measurement result. It's important for the operating system to work smoothly and be ready for incoming data. When new measurement is made, no application should be running except the dyno application. High CPU usage can be a result of another application using system resources or that there is another kind of problem with the operating system. Indicator lighting up can signal potential problems.

- Yellow background - CPU load over 60% or CPU temperature above 80°C.
- Red background - CPU load over 80% or CPU temperature above 85°C.

Frequent red indication will likely result in dyno operation problems.

2.7.5 System time

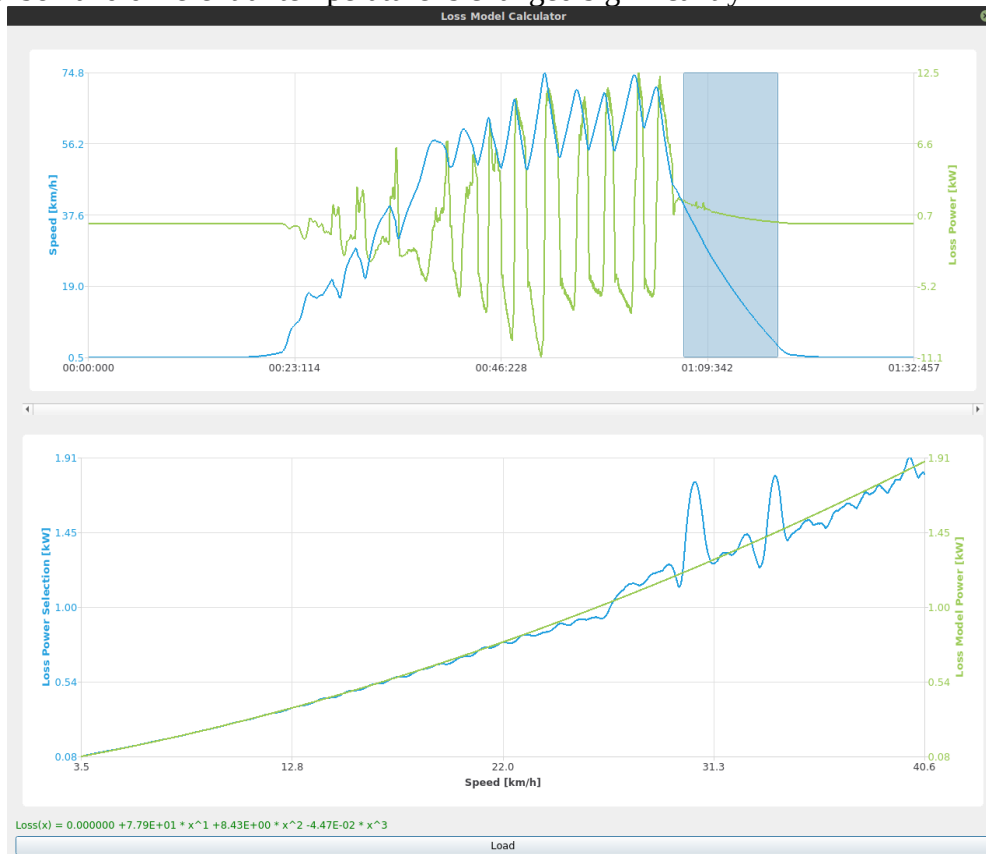
Current date and time are the source of information for run data files naming. The files are timestamped with current date and time. It is important to check if system time is correct before making new measurements. It will keep run data well organized and easy to analyze. Real time clock and network time synchronization are responsible for keeping system time correct.

3 Dyno usage

3.1 Loss model

When power measurement is made, a fraction of engine power is lost in transmission, differential, bearings and on tire - roller contact patch. Loss power is a function of speed and this function can be modeled for further use. Loss power can also change slightly with oil temperature and tire temperature. Once calculated loss model parameters can be used for further measurements. Loss model should be recalculated in following circumstances:

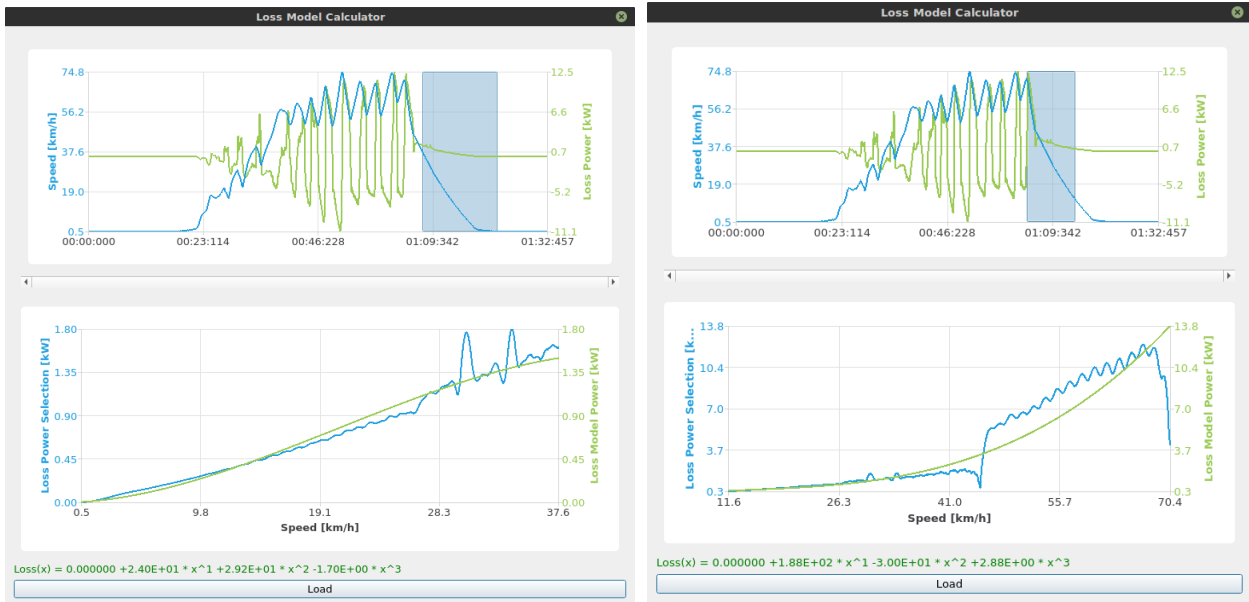
- Car set up or strapping on dyno is changed or tightened
- Tire temperature is changed significantly
- Gearbox and differential temperature is changed significantly



To use **Loss Model Calculator**, during the run after reaching maximum engine RPM you should disengage clutch and let the wheels and roller stop by themselves without braking. During that **loss stage** the roller is decelerated only with loss forces and dyno software records it.

When **Loss Model Calculator** is started, **loss stage** is preselected automatically. You should always verify that **loss stage** is selected correctly and if needed correct the selection.

In top plot Speed and Loss Power is plotted vs run time. You can identify loss stage by steadily decreasing Speed and Loss Power. When you are in doubt about loss stage span, it's better to select part of loss stage that you are sure about, than select data that may contain unwanted transient data. Correct loss stage selection is shown on Loss Model Calculator screen-shot above. Examples of incorrect selections are shown below.



In bottom plot Measured Loss Power and Modeled Loss Power is displayed for verification. If you are satisfied with calculated model you should accept it with **Load** button. By exiting the window you will discard the model. If you accept the loss model, it is saved in the run file used to calculate it.

Using **Loss Model** has following advantages over conventional **Loss Stage Saving** and subtraction used by most dyno software:

Conventional Loss Stage Saving	Loss Model (Perek Dyno)
Mechanical oscillations at transition from power stage to loss stage get projected on engine power curve.	Part of loss stage with transient oscillations is estimated from model and does not influence shape of engine power curve.
Any other wheel - roller resonance during loss stage can get projected onto engine power curve.	Local resonances are perfectly filtered out by model estimation algorithm.
Saved Loss Stage can be only used in engine RPM range that it was measured on.	Once calculated Loss Model can be easily used for further measurements and live tuning in any engine RPM range.

4 Step by step examples

4.1 Dyno minimal setup

Installation and configuration procedures are described in „DC1 Dyno Controller - installation and configuration” document.

4.2 New car / project setup

- Dyno minimal setup should be completed.
- Go to **PROJECTS** tab.
- Click on projects table and press 'N' key. New projects is created.
- Fill in project details (name, car, registration) as needed by double clicking on table fields.
- Strap the car to the dyno.
- Go to **RUN** tab.
- Enter comment for current run. For example “calibration run”.
- Click **START**. You should see live data coming from dyno. All data is now logged.
- Rev the car to the rev limiter, press clutch and let the rollers stop by themselves.
- Click **STOP**.
- Click right mouse button on **Speed ratio** value to get context menu.
- Select **Get from last run** from the context menu.
- In shown dialog enter maximum engine RPM from last run.
- Click OK.
- **Speed ratio** is updated in last run file and in interface for further use.
- Click right mouse button on the **Loss model** label to get context menu.
- Select **Get from last run** from the context menu.
- Follow instructions in Loss model section to set up the dyno loss model
- Base configuration is finished. You are ready for next runs.

4.3 Measuring and comparing engine power curves

- Steps from New car / project setup should be completed for current car strapping.
- Go to **RUN** tab.
- Enter comment for current run. For example “stock setup”.
- Click **START**.
- Make power run. Measuring loss power is optional.
- Click **STOP**.
- Modify car engine setup.
- Enter comment for current run. For example “modified setup”.
- Click **START**.
- Make power run. Measuring loss power is optional.
- Click **STOP**.
- Go to **ANALYZE** tab.
- Select run with “stock setup” comment and click ▼ ▼ ▼ to load it for analysis (**Loaded runs**).
- Engine speed plot will become visible in **Display ranges** panel. Default power run range is automatically selected to plot Power / Engine speed characteristic. Manual range selection is possible by making new selection with left mouse button.
- Select run with “modified setup” comment and click ▼ ▼ ▼ to load it for analysis
- Another run will be displayed in **Display ranges** panel.
- Again, preselected range can be manually changed.
- Now both runs are displayed side by side on the power / torque plot.
- You can save / print plotted data by clicking right mouse button on the plot and selecting **Save / Print** function.

4.4 Tuning ignition angle

To efficiently tune ignition angle, your dyno should be equipped with eddy current brake and you should have OBD interface available to log ignition angle.

- Set up the dyno as described in Dyno minimal setup, including the brake setup.
- In **SETTINGS** -> **OBD** select connected OBD interface type.
- Go to **RUN** tab.
- Click right mouse button on the top right scatter plot. Select **X Axis** -> **OBD 14 Timing advance**.
- Click again and select **Y Axis** -> **Engine Power**.
- Click **START**.
- Rev the engine to desired speed and click **LOCK CURRENT RPM**.
- Press gas pedal to get to desired ignition map cell (combination of RPM and load) in tuning software.
- Modify ignition angle and observe its relation to power on the scatter plot. The plot could be paused by selecting **Pause** from context menu.
- Note the ignition angle that gave maximum power for use in tuning software.

Bear in mind engine knock safety when setting ignition angle.

If you don't have access to OBD interface, you could select Power to be plotted as a function of time. Tune ignition angle and note the angle that gives maximum power.

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www.perek.it

dyno@perek.it