User guide to

EA Battery Simulator

Version: 2.04

Requirements for installation and operation:

- PC with min. 2GHz and 1GB RAM
- Windows 7 (32bit/64bit) or newer
- Microsoft .NET Framework 4.5.2 (included in the installer)
- This software is compatible to these device series:
    - » PSB 9000 / PSB 9000 Slave
    - » PSBE 9000
    - » PSB 10000
    - » PSBE 10000
- This software is compatible to these interface types:
    - » USB (virtual COM port)
    - » Ethernet/LAN

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1. Copyright and legal notice

This software is only compatible to power supplies of the above listed series and to the listed interfaces. Any changes to the software and its documentation are prohibited. Exceptions require permission of the owner. Resale or rent are prohibited. Dissemination to third parties is permitted, if software and documentation remain unaltered.

2. Introduction

EA Battery Simulator is a Windows™ software to remotely control **one** bidirectional power supply device of PSB series (single unit or master-slave system) in order to simulate specific battery types and their charging/discharging characteristics. The remote control is via digital interface only. Supported are USB and Ethernet.

This software is based upon the programming language Visual C# and requires the Microsoft .NET Framework with a certain minimum version which is probably already installed on the PC system or will be installed by the installer of the software product, if selected by the user.

3. Preparation

Before you start using **EA Battery Simulator**, at least one compatible device should be connected to the PC. If the device is connected via USB cable, it requires an USB driver to be correctly installed. The installed USB device can be found in the Windows Device Manager, in section "Ports (COM & LPT)". Example:
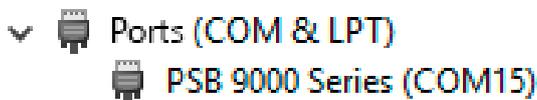
It's furthermore required to install a driver for the license dongle, which comes as USB stick. This is a special dongle driver that is included in the software installer. This USB dongle is not listed in the Windows Device Manager, but can be managed with the CodeMeter Control Center, a tool which is installed along with the driver.

> *The USB drivers are usually installed on the system only once. In case a new device or dongle is connected the first time or a known device is connected to a different USB port of the PC, the device will be installed again. New devices will be assigned an unused and unreserved COM port.*

3.1 Software installation

The installation of the software is done via a standard installer setup. It requires administrator permissions. During installation you can select/deselect additional packages which are required by the software to run correctly, so they should be selected for the first installation and only deselected on updates of the main software:

• Microsoft .NET Framework 4.5.2 or newer
• USB device driver (not needed for devices which are used via Ethernet only)
• License dongle driver (required), installed as "CodeMeter Runtime Kit"

3.1.1 After the installation

> *If there is trouble running or even starting the software, it's recommended to repeat the installation with the package Microsoft .NET checkmarked.*

> *In case the dongle driver is not installed, not correctly installed or not working, the USB dongle can't be recognized by the software and the software won't be fully unlocked.*

After the installation you can start the software via the Windows start menu in path:

Windows 7: Start -> All programs -> EA Battery Simulator

Windows 10: Start -> E -> EA Battery Simulator

4.   General

4.1   Very first start

After the installation and the very first start of the software, the GUI language is set to English as default. This setting can be changed to German, Russian or Chinese. In case the USB license dongle is not plugged or the USB dongle driver is not installed, the software will come up with a warning which can be ignored for the moment. However, you should consider to check if the dongle driver is installed and the dongle is plugged. Without a dongle, the software would enter demo mode which only allows to have a look on the UI.

4.2   Software start

After every start, a requester will come up and ask to select the connection to your power supply. The configuration can either be modified or simply confirmed with the "Connect" button.
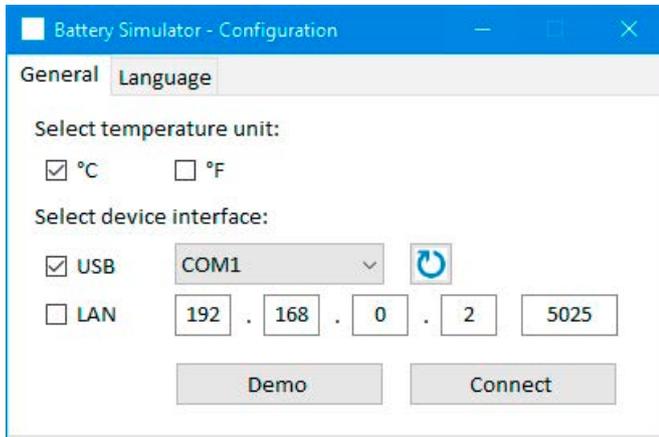

Figure 1 - Configuration window

The drop down selector should at least list the USB COM port of your device, if connected via USB cable. In case the device has not yet fully started or has been connected after the software, the ⟳ button can be used to refresh the list. After clicking the "**Connect**" button the software will try to connect the device via the selected port and if that fails, pop up an error message.

Demo button: When clicking this button, the software won't attempt to connect to the device, but instead open the main user interface in demo mode, with a dummy demo device, even if there is a valid license dongle present.

In case the connection attempt fails there are several possible reasons:

- If the device shall be controlled via USB cable:
    a. The device is connected via USB, but the USB driver is not or not correctly installed (see section „3. Preparation").
    b. The USB cable is not plugged at all or not plugged correctly.
    c. You have a device of a brand-new series and the currently installed version of **EA Battery Simulator** doesn't support it yet. Updating the software should help here.

- If the device shall be controlled via Ethernet:
    a. The Ethernet port which is set on the device does not match the one in "Configuration".
    b. One or more double IPs have been assigned or the default IP of the device has not yet been changed to meet the local requirements (all devices are shipped with the same standard IP).
    c. The PC's network adapter can't access the device's IP due to wrong settings
    d. The port in "Configuration" is accidentally set to 502, which is reserved for ModBus TCP messages, but the software uses only ModBus RTU, so any other port must be chosen

4.3   Licensing

This software is licensed. It only works in full scope when a CodeMeter USB dongle is permanently plugged into the PC you run the **EA Battery Simulator** on. The USB dongle is the license key for the software. It means, the software can be used on any number of PCs as long as the dongle is present. It also means that in case of parallel operation of the software on multiple PCs, the same number of dongles will be required. There are two licenses, i. e. dongles available:

• **License Li-Ion** (dongle labeled with "Li-Ion") for Lithium-Ion battery simulation only

• **License Lead-Acid** (dongle labeled with "Lead-Acid") for Lead-Acid battery simulation only

It means, if a dongle with Lithium-Ion license is plugged, the simulator would only run Lithium-Ion battery simulation. Plugging two different license dongles is also possible and would allow switching between the simulation modes.

The license dongle is obtained by purchase directly from **EA Elektro-Automatik** or a qualified distributor. The procedure is as follows:

1) Order and purchase the license. After that the USB dongle is shipped.

2) Download the software from our website and install it.

3) Start using the software with any model from the compatible device series.

4.4   Conditions for remote control

The device you intend to run the battery simulation with can be in any of these control states of which some would prevent the simulation from running:

1) It's currently controlled via the analogue interface (where featured) and thus not controllable via digital interface.

2) It's in local state (display shows "Local") and thus locked from remote control in terms of writing to the device.

3) It's freely accessible. Then the PC can take over remote control.

4) It's currently controlled via another digital interface or it's in MENU mode

5) It's currently configured as slave of a master-slave system and controlled by a master device

If the situation is according to 3), the device will accept remote control commands and only then can be used with the simulator. Otherwise, only the actual values of voltage, current and power are read and displayed.

After the software start the device would normally be put into remote control, which could be denied by the device for the moment. If the reason of denial has been solved, it can later be put manually into remote control mode in the "**Device**" tab of the software (button "Remote on") or it will automatically enter remote control mode when starting the simulation.

4.5   General procedure

The battery simulation software always follows the same procedure:

1) Connect to the device.

2) Configure the battery simulation manually or load a previously saved configuration file.

3) Start simulation.

4) Stop simulation manually or let it run through until the end.

4.6   Essential facts

• The battery simulation can't run without any USB license dongle being plugged.

• The battery simulation can't run independently on the device, it requires the permanent connection to the PC and the software.

• The battery simulation runs for an undefined time, which primarily depends on the initial state of the simulated battery. It would only stop if any of these conditions becomes true:

 » the simulated battery has been discharged and the SOC has reached 0% (simulation of deep discharge is not supported)

 » the simulated battery has been discharged and the battery voltage has reached the threshold "Voltage lower cutoff limit"

 » the simulated battery has been charged and the battery voltage has reached the threshold "Voltage upper cutoff limit"

 » the battery current, in charging or discharging mode, has reached the "Current cutoff limit (fuse)"

 » a device alarm has occurred

 » another current limit has been reached (see „4.8 Battery types")

 » a temperature limit has been reached

4.7 Limitations of the software

- The software can run only 1 instance
- The simulation can't be controlled via the analog interface (pin REM-SB)
- The software can't be controlled by external commands (command line etc.)

4.8 Battery types

With date August, 2020 the software can simulate two battery types with following specifications and limits:

	Lithium-Ion	Lead-Acid
Nominal voltage	3.7 V	12 V
Nominal capacity	20…80 Ah	35…140 Ah
Upper voltage limit	4.2 V	16 V
Lower voltage limit	2.75 V	10.5 V

5.   Graphical user interface (GUI)

After being connected to a compatible device, the main window will appear. It's separated into two parts.
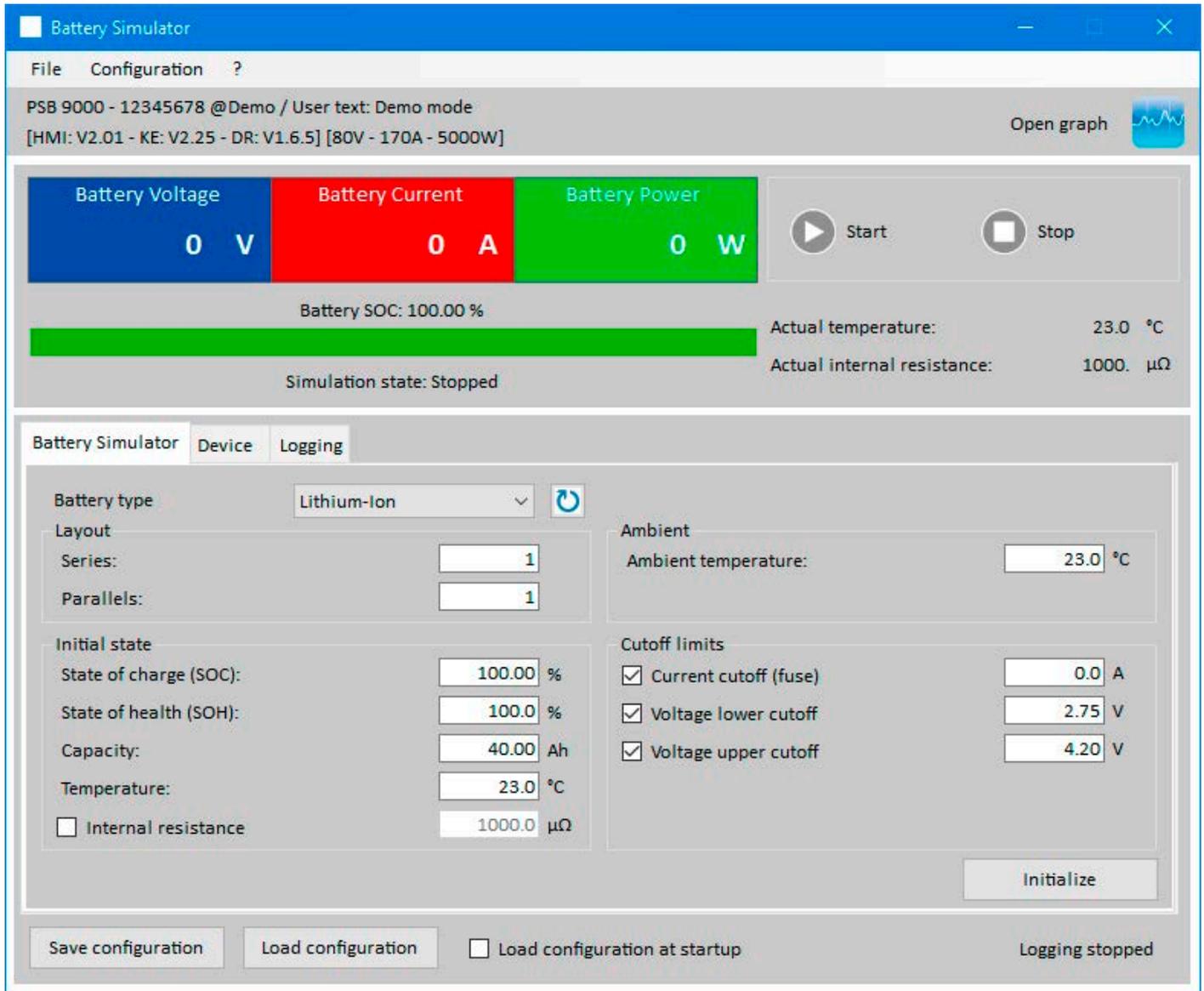

Figure 2 - Main window

In the upper part it shows simulation related values and also the control for start and stop. For further details see below sections.

In the lower part there are three registers (tabs), for further details also see sections below. Overview:

Tab	Description
Battery Simulator	All setup for the simulation
Device	Manual device control, including: • Remote control on/off • DC output on/off • Set value adjustment • Enter the "Settings" app to configure some settings on the device, same as on the HMI It also shows some extra status information
Logging	Configure and start/stop the logging feature

5.1 Menu & Configuration

Menu item	Description
File	
Close	Closes the software immediately
Configuration	Opens the „**Configuration**" window where you can do settings for the software itself, such as the UI language
Tab „General"	Temperature unit — Switch between temperature display in °C or °F
Tab „General"	Device interface — This is used to select the interface to connect the device. Choices: USB (COM port) or Ethernet. For Ethernet, it requires to enter a valid, PC accessible IP that is currently assigned to the device either manually or by DHCP. The port setting must match the one in the menu on the HMI.
Tab „Language"	Switch GUI language between English, German, Russian and Chinese
?	
Help	Opens this help file (PDF)
About	Opens a small windows with information about the software

5.1.1 GUI language

In tab "Language" you can switch the language of the GUI between English, German, Russian and Chinese. The change is applied immediately after closing the Configuration window.

5.2 Status area

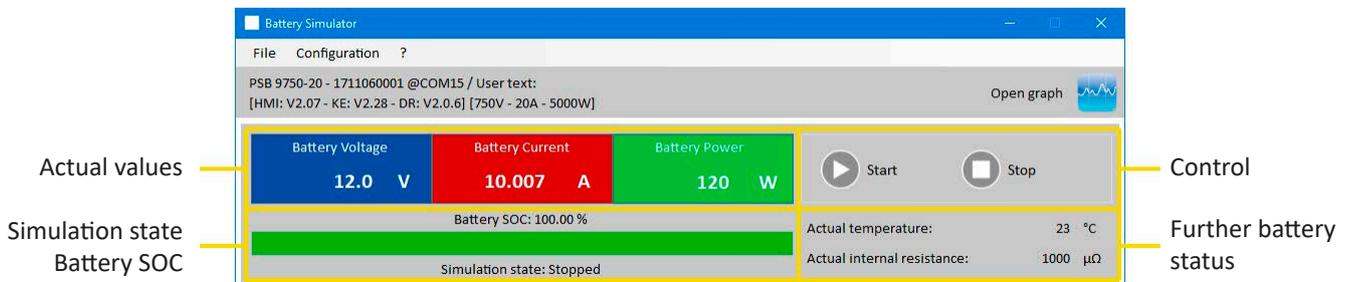The upper part of the main windows is used for status display and also control.

Figure 3 - Status & control

5.2.1 Actual values

Similar to the value coloring on the device's display, the actual values are separated from each other, being labeled accordingly to what they show.

Refreshing of these values is cyclic. High CPU load can, however, delay cyclic refreshing. Especially if there are multiple softwares running. The value format shall always match the format on the display of your device(s). Due to the internal translation from per cent values to real values the last digit can be different. This also applies for data recording (i.e. logging, see below).

> • *Actual values are only read from the device(s) and are always available, even if the device is not in remote control.*
>
> • *While the simulation is stopped the area "Battery Voltage" will always show the voltage on the DC terminal, even when the DC terminal is switched off, because the voltage may come from an external source.*

5.2.2 Status 1

Battery and battery simulation status share two areas. The left-hand area shows the current simulation state, **Charging** or **Discharging** that is, and the battery state of charge (SOC) in per cent and also as green bar.

Before the simulation is started, the SOC value will be identical to the one in the setup below, but will change during runtime. The SOC usually decreases when discharging is simulated and increases while charging.

5.2.3   Status 2

Battery and simulation status share two areas. The right-hand area shows the simulated battery temperature and the calculated internal resistance.

Before the simulation is started, the indicated battery temperature will be identical to the one in the setup below, but will change during runtime. Same for the internal resistance.

5.2.4   Control

Control, i. e. manual start and stop of the simulation, is done via two buttons in the upper part of the main window.

After the start of the software the **Start** button is locked until the simulation has been initialized (**Initialize** button).

Following rules for control:

- Battery simulation could be interrupted by a device alarm or disconnection, but can be continued later
- You can manually **Stop** anytime and then continue the test (**Start** button)
- The simulation would only start from the very beginning when resetting the test to its start conditions with button **Initialize**
- The **Start** button will be locked until initialization

5.3   Tab "Battery Simulator"

The lower part of the main window, specifically tab "Battery Simulator" is most important. There you set up your simulation parameters. The sum of all settings can be saved in configuration profiles (CSV file) and loaded at will. The latest saved set of settings can also be loaded automatically, if option "Load configuration at startup" is checked.
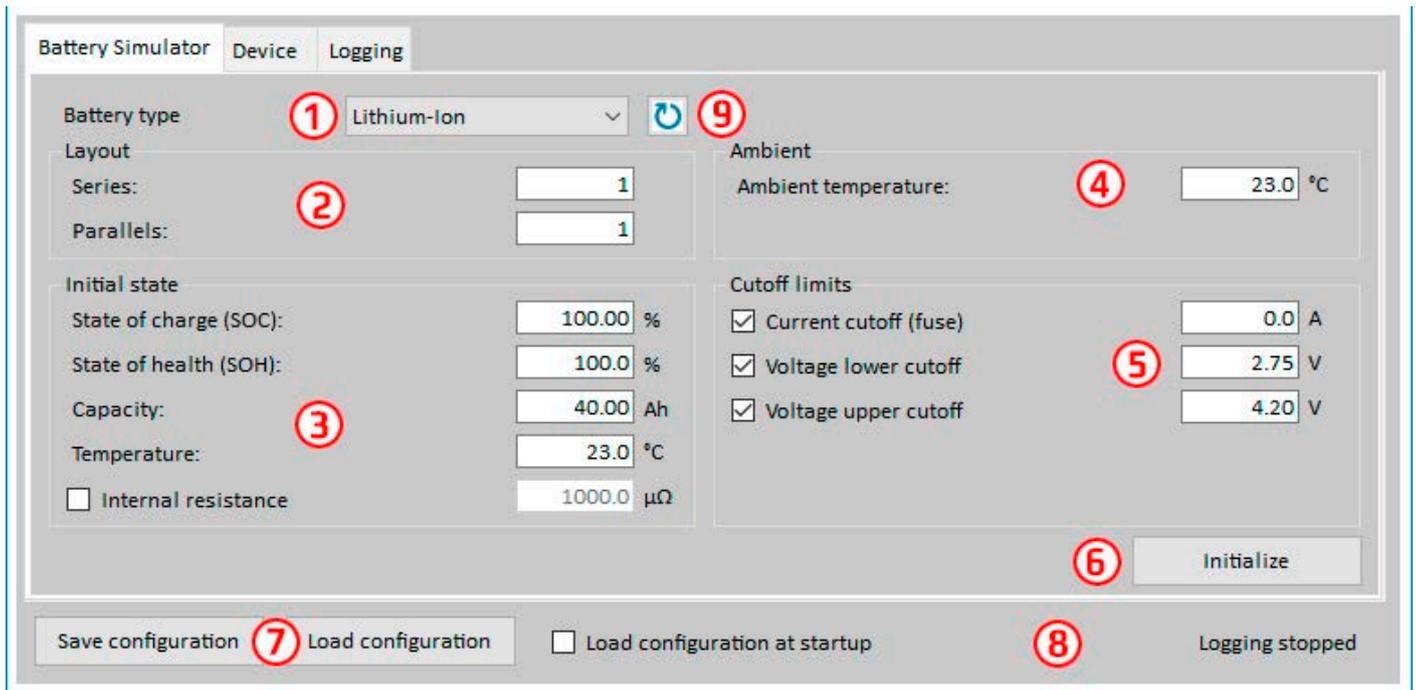
Overview:

Figure 4 - Battery Simulator tab

Nr	Parameter	Description
1	**Battery type**	This selector is usually locked to the battery type defined by the license on the USB dongle. It means, the software will detect the kind of license and automatically select the battery type. Only if two different license dongles are plugged to the same PC, this selector will be unlocked.
		With date August, 2020 and when unlocked, it selects the simulated battery type between **Lead-Acid** and **Lithium-Ion**. The selection affects the adjustable range of parameters **Capacity**, **Internal resistance**, **Voltage lower cutoff** and **Voltage upper cutoff**.

2	Layout	Multiple batteries in series (=string), parallel or in a matrix connection (serial/parallel combined) can also be simulated. Battery voltage and current will be scaled accordingly. **Series**: number of batteries in serial connection. The single battery voltage is multiplied with **Series** **Parallels**: number of batteries or battery strings in parallel connection. The single battery current and capacity is multiplied with **Parallels**. Adjustable range: 1...400 > *The practical result of the settings here depends on the device type you are using. For instance, 100 Lithium-Ion batteries in series can only be simulated correctly if the power supply can at least provide or sink a voltage of 420 V.* Example of a matrix: 5 Lead-Acid batteries with 12 V in series form a string, 4 strings in parallel form a matrix. Every simulated battery has a capacity of 80 Ah. The matrix results in a total capacity of 320 Ah and a total battery voltage of 60 V.
3	Initial state	> *All values in group "Initial state" and group "Cutoff limits" are always related to <u>one battery</u>!* Defines the initial state of the simulated battery. **SOC**: state of charge in per cent. A fully charged battery is considered as 100%, while 0% state of charge corresponds to a fully discharged battery. "Discharged" corresponds to approx. 2.5 V discharging end voltage with a Lithium-Ion battery and for a 12 V Lead-Acid battery this level is approx. 10.5 V. **Capacity** = defines the capacity of one simulated battery in **Ah**. Ranges: • Lead-Acid = 35...140 Ah • Lithium-Ion = 20...80 Ah **Temperature** = defines the initial temperature of the battery body within -10 ... 45 °C (14...113°F). Typically and like with a previously not used battery, this is supposed to be the same value as the ambient temperature. **Internal resistance**: activating this input box will lock the input boxes for **SOC** and **Temperature** and also resets their values because the initial internal resistance is only valid for an SOC setting of 100% and a battery temperature of 23°C (73.4°F). Vice versa, deactivating the resistance input will unlock the other two again. Adjustment ranges: Lead-Acid 3000...6000 µΩ, Lithium-Ion 1000...2000 µΩ **State of health (SOH)**: defines a factor in percent which affects the truly available battery capacity which will lower constantly while the ag of a battery increases. An SOH of 100% represents a brandnew battery.
4	Ambient	Ambient temperature, adjustable within -10 ... 50 °C (14...122 °F)
5	Cutoff limits	Defines several limits which can cause the simulation to stop automatically when reached. **Current cutoff limit (fuse)**: threshold for charging or discharging current, can be considered like a circuit breaker in line with the battery, except that it doesn't physically cut the simulated battery from external loads/sources. Once the threshold is reached, an OCP alarm is triggered and the test will stop. Range: 0...110% of device current rating **Voltage cutoff upper limit**: upper battery voltage limit for charging. Can be used to stop the simulation before or after reaching 100% SOC, which would normally not stop the simulation. **Voltage cutoff lower limit**: lower battery voltage limit for discharging. Can be used to stop the simulation before reaching an SOC of 0%. Ranges for both voltage limits: see „4.8 Battery types"
6	Initialize	This button initializes, i. e. resets the test conditions to an initial state defined from all parameters in the window. It's required to initialize the simulation every time... a) ...before a new simulation is started, else the last simulation would be continued. b) ...any parameter has been changed, else the new setting wouldn't submit.
7	Save/load config-uration	Can be used to save the current configuration, i. e. all settings in the "**Battery Simulator**" tab into config files (*.csv) or load from such. The checkmark next to "Load configuration at startup" activates automatic loading of the most recently saved config file. If there is no config file, default values are set. > *We recommend to include the battery type in the file name for clear distinction. If only one license dongle is present, let's say one for Lead-Acid, a configuration file for Lithium-Ion could not be loaded and vice versa.*
8		Logging status

| 9 | | Refreshes the drop down selector by re-checking for plugged dongles. If the dongle type has changed, the selector will also change automatically. If a second dongle with a different license has been added, the selector will be unlocked. |

5.4   Tab "Device"

This tab is actually not required for the simulation and its setup, but can become important in case the set values of current and power are not set up correctly and could interfere with the simulation at some point. However, outside of a simulation the power supply could be controlled from here for other purposes.

Furthermore, the tab shows additional status and allows for manual control of the device in terms of switching the DC output on or off, activating or deactivating remote control or adjusting device related settings. Manual control also offers the option to acknowledge, i. e. clear a device alarm (OVP, OCP etc.). Overview:
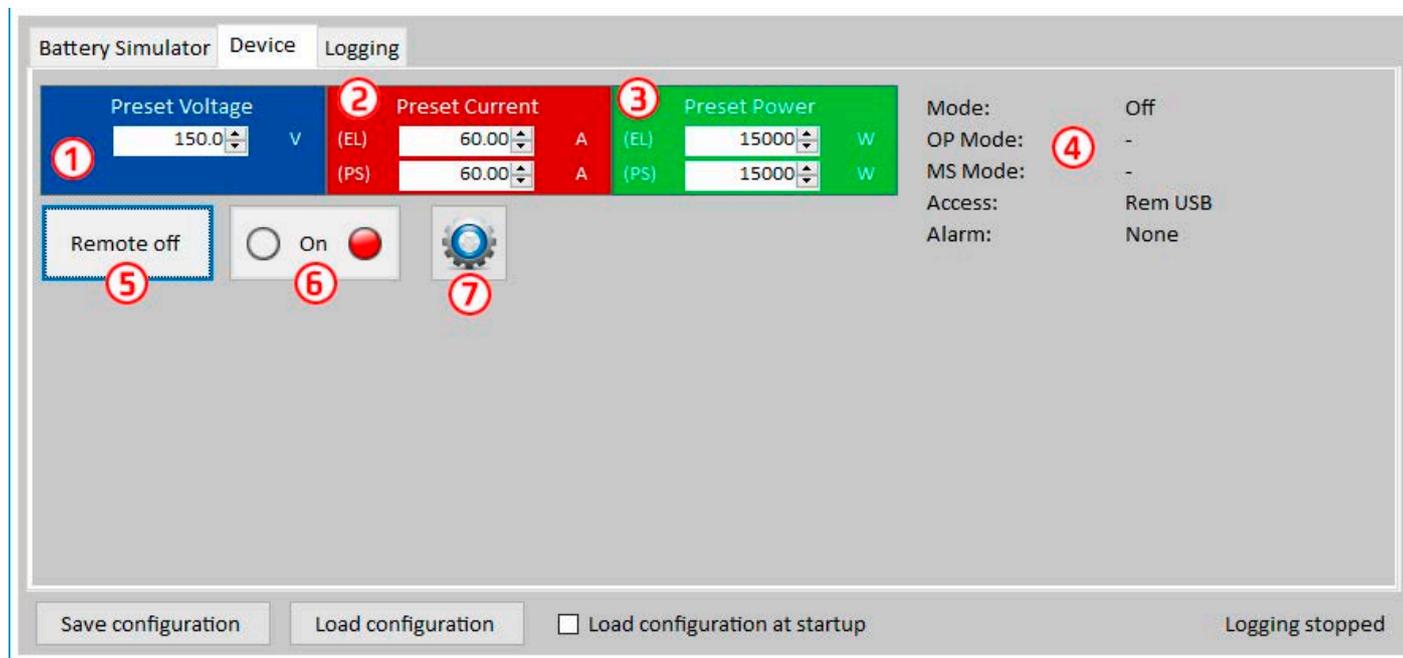

Figure 5 - Manual device control in tab "Device"

Nr	Parameter / Button	Description
1	Preset Voltage	Global voltage setting. Will be overwritten during the simulation.
2	Preset Current	Global current setting, set to maximum by default. PSB series devices show two separate values here for sink and source mode. The global limit defines at which current level the simulation current is clipped. It only limits the current, contrary to the setting "Current cutoff limit (fuse)", which will stop simulation when reached. This requires to set the cutoff limit lower than the global current limit.
3	Preset Power	Global power setting, set to maximum by default. PSB series devices show two separate values here for sink and source mode. The global limit defines at which power level the simulation current and voltage are clipped.
4		Additional status from the power supply (also refer to the user manual of the device for details): **Mode**: regulation mode (CP, CV, CC) **OP Mode**: always UIP (resistance mode = off), because the simulation forces UIP mode **MS Mode**: shows if the device you run the simulation with is a part of a master-slave system **Access**: name of the interface currently being used for remote control **Alarm**: shows the latest alarm, if any, until cleared or "None"
5	Remote on Remote off	Used to switch manually between remote control on or off. Remote control is automatically activated upon start of the software.
6	On/Off	Used to switch the DC output manually on or off, also to clear/acknowledge alarms. Condition "on" is indicated by the green LED, off by the red one. The DC output is automatically switched on or off with start and stop of the simulation.
7	Settings	Opens the **Settings** app. It allows to adjust some device related parameters like on the HMI.

5.4.1 Tab "Logging"

The software features a logging function. Logging records data, such as actual values, battery resistance, temperature and more to a text file (*.csv). The recorded data can be used to analyze the simulated battery and also the application the simulated battery was used in. Overview:
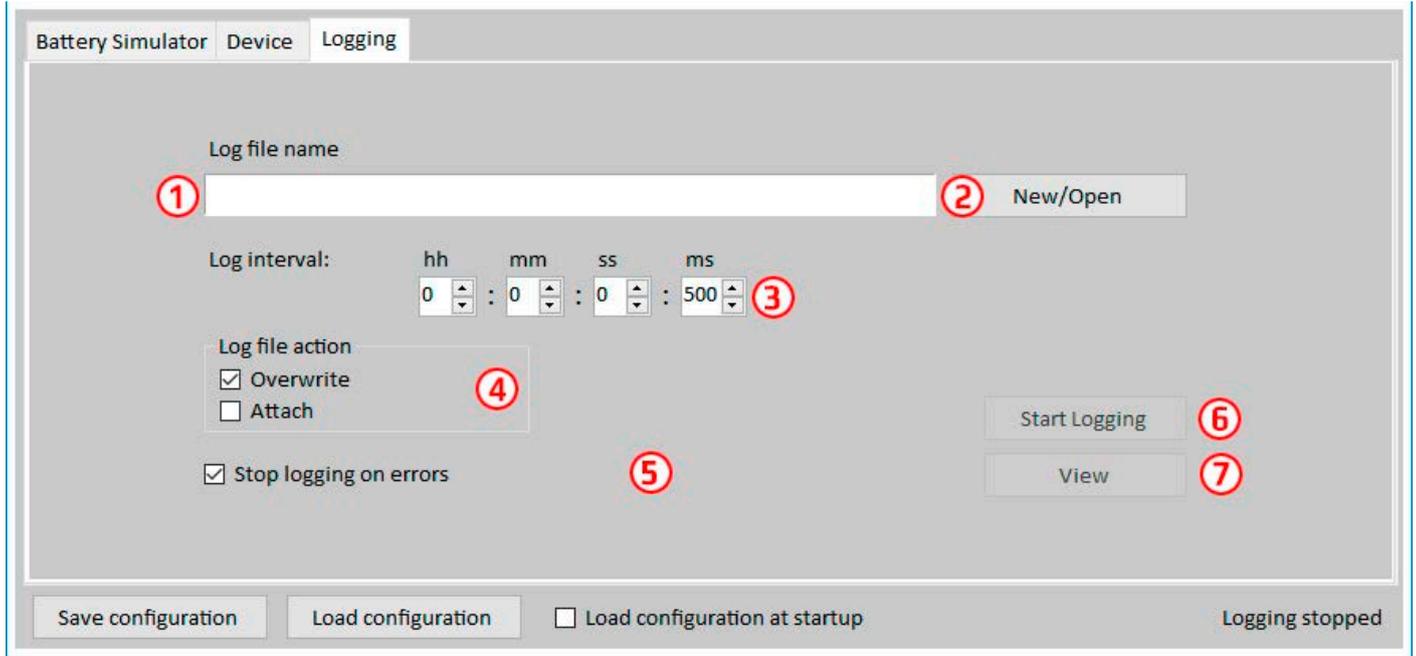

Figure 6 - Control elements in tab "Logging"

Nr	Parameter / Button	Description
1	Log file name	Path to a new or existing CSV file on your favorite storage media
2	New/Open	Creates a new log file or opens an existing one, also sets the path for (1)
3	Log interval	Set the time to wait before the next log file entry is written. Range: 500 ms ... 99h:59m:59s,900ms
4	Log file action	Defines whether already existing data in the selected log file is overwritten (default) or new data from next run is appended
5	Stop logging on errors	By default, logging would continue even if the device is disconnected or a device alarm occurs. From this moment, the recorded data would be all 0, so it's recommended to enable this feature. The alarm causing the stop should be recorded in the last row, so that the alarm type and time of occurrence can be found.
6	Start logging	Starts logging manually and anytime, as long as a valid log file has been selected. Turns into "**Stop logging**" afterwards, for manual stop
7	View	Opens the log file for viewing

5.4.1.1 Log file format

The log file created from the logging feature stores all simulation related information in rows and columns. The file format is CSV, which stands for "comma separated value" and means that values or texts in columns use a comma as column separator. This is valid for those countries which use the english number format (dot as decimal separator) and is thus saved in the original CSV format when the software is set to English language. In all other languages the CSV file is saved in the european format where the comma is the decimal separator and the columns are separated by semicolons. Depending on the format in the CSV, there can be differences in the value representation after the file has been opened in a software which can read such files.

File overview:

Columns:

Battery voltage = Simulated battery voltage (in V)

Battery current = Actual current from the device (in A)

Battery power = Simulated battery power (in W), calculated from the simulated battery voltage and the actual battery current

Output/Input = DC output/input condition

Device mode = Regulation mode (CV, CC, CP)

Error = last device error (OCP, OVP etc.)

Time = Time stamp, taken from PC's clock

SOC = Battery's state of charge (in %)

Temperature = Simulated battery temperature (in °C)

Internal resistance = Simulated internal battery resistance (in µΩ)

General:

- Logging starts only upon manual action, i. e. clicking the **Start Logging** button
- Logging either stops upon manual action (**Stop Logging**) or, if activated, on errors. This is activated by default, because else the log file might contain a lot of useless data entries
- Logging data can be added to an already existing log file, but only if mode **Attach** is activated; default is **Overwrite**

6. Battery simulation

6.1 Introduction

The purpose of the software is to simulate a real Lead-Acid or Lithium-Ion battery as close as possible. Because a battery can be a source or sink of energy, the simulation can only be fully realized with a bidirectional power supply, such as one of PSB 9000 series.

Together with this software, the PSB can be considered as a battery with variable parameters, such as:

- Battery voltage
- Battery capacity
- Battery temperature
- Internal resistance
- State of charge

Based upon a single Lead-Acid battery with 12 V nominal voltage or a Lithium-Ion battery with 3.7 V nominal voltage any multiple of these battery voltages can be simulated, always within the limits of the power supply device, but up to a maximum of 400 batteries in series and/or 400 batteries in parallel. This means the max. battery voltage can be 1480 V for Lithium-Ion in discharging mode and for Lead-Acid it could be even up to 4800 V. All this can only be realized within the technical specifications of the PSB model and thus is limited to what the device can do.

The simulation has some advantages over a real battery. You can...

1) define the battery's initial state of charge (SOC). With a real battery this is usually unknown.
2) define an odd or untypical battery capacity.
3) define any ambient and battery temperature within -10 to +50 °C (14 to 122 °F).
4) charge and discharge the simulated battery without any risk while real batteries can be destroyed by deep discharging or overcharging.
5) save a lot of time as no charging is required before using the simulated battery as source. The power supply can simulate a fully or partly charged battery anytime.
6) quickly swap batteries and reconfigure the simulated battery to completely different specifications without physically disconnecting and connecting anything.

6.2 Limitations

Compared to a real battery, there are some battery characteristics which can't be simulated:

- **Short-circuit current and short-term overcurrent capacity**. A battery can deliver an almost unlimited current for a certain amount of time. The power supply will always limit its output and input current.
- **Presence of battery voltage.** The voltage of a battery is always present, while a power supply's DC output is switched on or off. Switching it on requires some time for the voltage to rise (soft start, ca. 150 ms). The output voltage of a power supply can furthermore drop very much when it enters current limitation (CC) or power limitation (CP). The voltage drop is inversely proportional to the current increment.
- **Battery temperature sensing**. There is no way to provide the simulated battery body temperature as analog value, like when having any kind of thermal sensor, as often used with battery chargers. Though the temperature of the simulated battery increases while charging, it's only a digital value on the user interface (UI) of a software.

6.3 Running a simulation

The simulated battery can either be source to any DC load, which is considered as **discharging**, or it can be sink to any external DC source, which is considered as **charging**. The simulation will automatically switch to charging mode as soon as the external voltage is higher than the simulated battery voltage and will switch back to discharging mode when the external voltage sinks below the battery voltage or if there is no voltage at all, which means that discharging mode is the default mode without anything connected to DC.

Starting a new simulation run consists of basically two steps:

1) Configuration
2) Initialization and start

After everything has been set up in tab "Battery simulator", the simulation is first initialized by pressing button **Initialize**. This will unlock the **Start** button. Next, button **Start** would then be clicked to start the simulation. After a stop by any reason there are two options:

- You can continue the interrupted simulation by simply pressing **Start** again or
- You can reset and start a new simulation by first pressing **Initialize** and then **Start**

During the simulation run, the UI will refresh the upper status part (also see sections 5.2.2 and 5.2.3) continuously. The SOC, the battery state of charge, will additionally be indicated as progress bar. Once the simulation is running, you would normally stop using the software and switch focus to the application where the simulated battery is part of.
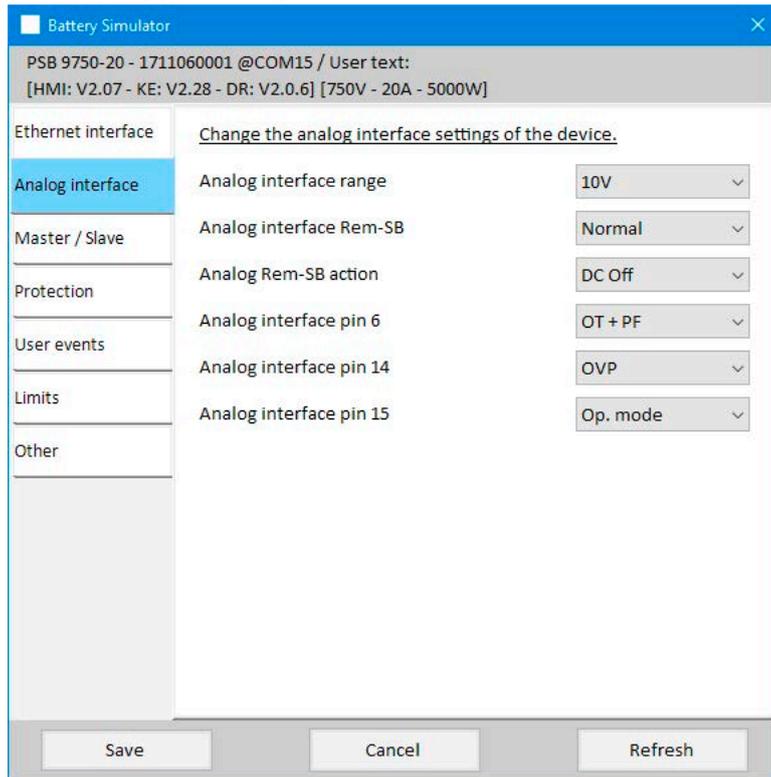
7. Further features

7.1 App „Settings"

Figure 7 - Example screenshot of app window "Settings"

The app **Settings** is started from within tab **Device** and offers you to adjust device related parameters and settings as they are also available in the setup menu of your device. Contrary to manual operation on the front panel (i.e. HMI) of the device, the app requires remote control. In case the app can't switch the device into remote control, it won't open the window.

Details about the settings in this window can be found in the device manuals, as they are identical to those described there.

8.   The Graph

The software features a graph, a windows with a plot area which draw multiple colored plots over time, representing actual values from the simulation. The data which is recorded this way can also be exported in several ways, for example as CSV file.

Overview:

Figure 8 - Graph window

Nr	Element	Description
1	**Show plots**	Deactivate/activate single plots on the drawing area. By default, all plots are activated. Via a context menu it also allows to change the plot colors. Switching any plot on or off doesn't affect the data recorded in the background and which can be saved to file. The file will always contain all data from all plots.
2	**Threshold to stop plotting**	Separately selectable/deselectable thresholds for the 6 plots to stop plotting upon reaching any. If several are selected, the first one to reach triggers the stop.
3	**Sample interval**	Time between two plotted values. Default interval is 500 ms, range is 100 ms...99h59m59s999ms
4	**Zoom**	Control elements for the plot area
5	**Graph control**	▶ Start ⏸ Pause ⏹ Stop
6		Graph plot area
7	**Measured values**	The plots in real values with minimum, maximum and average since plot start.

8.1   Handling

8.1.1   General

- All settings (plot color, interval time etc.) in the graph window are automatically stored and restored
- Plots can overlay each other when having identical values so that some may seem hidden
- The Graph plots in the so-called scrolling mode. It means, the plot area will always show plotted values of the last minute. Earlier plot data can be visualized by scrolling on the X axis to the left in Stop condition.
- The Graph records a maximum of 20,000 data points for every plot, after that the data will be overwritten from the beginning

8.1.2   Functions of the plot area

The Graph's plot area draws up to 6 plots at the same time from left to right. It also visualizes adaptable scales on the sides, plus a cursor and a time stamp. For the plot area, there are some options for customize the view.

Level 1	Level 2 / Description
Auto scale Y	The Y axis of the plot area is usually set up for the full range of a plotted value. For example, if the device has 5000 W of rated power, the scale for power would show from -5000 to 5000. When plotting low values, the resolution could be too coarse so the plot rests around 0. With auto-scale activated, all visible scales are automatically and permanently adapted to the values currently visible in the 1 minute frame.
Clear plot	Clears the plot area
Select background color	Default is **White**, with black scales and grid. Can be switched to **Black**, with white scales and grid
Select plot color	Allows to edit the plot colors
Show cursor value	This is activated by default. On every plot, there is a cursor showing the plot value at a specific time stamp. It can be used to read plotted values backwards in time, but also to read the precise value, since it's often not possible to read values from the scales.
Select plot type	By default, a plot is drawn by connecting two points by a straight line (plot type "Line"). Depending in the resolution of time (X axis) and scale (Y axis), the plot may look smooth or edgy. With plot type "Dot" the line between two points is not drawn and the particular plot would appear as a thread of rectangular dots. Plot type "Interpolated" calculates and draws intermediate points within longer sample intervals and connects them, which results in the same view as drawn with type "Line"

8.1.3   Data export

8.1.3.1   As image

Button "Save graph" exports the current Graph plot area anytime as an image file of either BMP or PNG format. You will only get a snapshot of the momentary plot view, which represents all your customized settings regarding plot color, plots visibility and scaling.

8.1.3.2   As file

When saving plot data to a file, you will get all recorded data since plotting start and for all six plots, no matter if they have been switched off or not. This action is triggered by button "Save data", which is only accessible while the Graph is stopped or paused.

The file is saved as text file in CSV format, with a headline and any number of rows between 1 and 20,000. The Graph records a maximum of 20,000 data points for every plot after every start. The actual recorded number is not indicated anywhere.

Every row of data in the file contains the sampled values of all six plots, without physical unit.

> ⓘ   *The format of the file exported from the Graph plotting area is different to the one you get from Logging!*

9. Trouble-shooting

9.1 Error "License dongle not found"

The battery simulator software is licensed software. The license comes in form of an USB stick, here called "dongle". It must be kept plugged as long as the simulator is in use. In case you see an error message "License dongle not found", you should check following, given that an USB dongle is plugged:

- Is the **CodeMeter service** running? You can check that in the "Services" panel as "CodeMeter Runtime Server". If not, start it and try again.
- Is the dongle listed in the **CodeMeter Control Panel**? This is a tool that is installed along with the dongle driver. If not, try to reinstall the driver and try again.