User guide to

EA Power Control

Version: 2.23 or higher

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:
    - » EL 3000 B
    - » EL 9000 B / EL 9000 B HP / EL 9000 B 2Q
    - » EL 9000 DT / EL 9000 T
    - » ELM 5000
    - » ELR 9000 / ELR 9000 HP
    - » ELR 10000 2U - 4U
    - » PS 2000 B TFT (only the 2020 models with color display)
    - » PS 3000 C
    - » PS 5000
    - » PS 9000 1U
    - » PS 9000 2U
    - » PS 9000 3U
    - » PS 9000 T
    - » PS 10000 2U - 4U
    - » PSB 9000 / PSB 9000 Slave
    - » PSB 10000 2U - 4U
    - » PSBE 9000
    - » PSBE 10000 3U/4U
    - » PSE 9000 3U
    - » PSI 5000
    - » PSI 9000 2U - 24U
    - » PSI 9000 DT
    - » PSI 9000 T
    - » PSI 9000 WR / PSI 9000 WR Slave
    - » PSI 10000 2U - 4U
- 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 supply and electronic load devices 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 Power Control is a Windows™ software to remotely control one or multiple units of compatible power supplies and/or electronic loads. This happens via digital interfaces only. Currently 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 Power Control**, at least one compatible device should be connected to the PC. If the device is connected via USB cable, it requires a USB driver to be correctly installed and running. The installed USB device can be found in the Windows Device Manager, in section "Ports (COM & LPT)". Example:
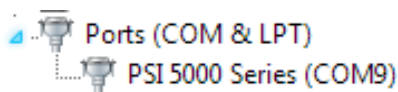
> *The driver file is usually installed on the system only once. In case a new device is connected the first time or a known device is connected to a different USB port of the PC, the device will be installed again. New devices will be assigned an unused and unreserved COM port.*

3.1 Installation of the software

The installation of the software is done via a standard installer setup. The installation requires administrator permissions. During installation you can select additional packages, if not already installed, which are required by the software to run correctly:

- Microsoft .NET Framework 4.5.2 or newer
- USB driver (not required for devices which are used via Ethernet only)

> *If there is trouble running or even starting the software, it's recommended to repeat the installation with the packages of Microsoft .NET and Visual C++ Runtime marked.*

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

Windows 7: ⊞ **-> All programs -> EA Power Control**

Windows 10: ⊞ **-> E -> EA Power Control**

4. 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 any of the other available languages. Also see section «7.4.1 GUI language» for that matter.

5. Software start / Search for devices

After the start of the software it can automatically search for connected, compatible devices on COM and Ethernet ports. Which of both are included in the search can be defined in "Configuration" . This makes it possible to spare searching for COM port devices if only Ethernet connection is used or vice versa.

The search can be repeated anytime with by double-clicking the **Search for devices** icon, as long as the access to the main window isn't blocked

After the search, detected and compatible devices are listed in the device list (**Devices**) as icons. The icons are captioned with the series name and the COM port resp. assigned IP they are connected to, as well as the user text (if not empty).

Example with 1 detected device:
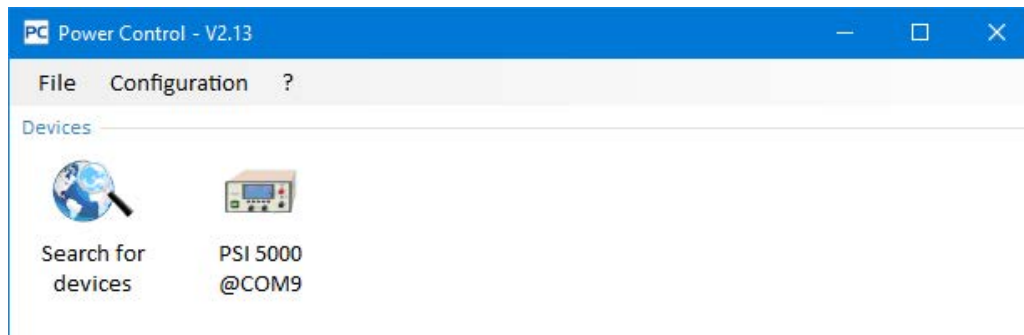
Figure 1

> In case a device is connected to the PC with two interfaces at the same time, USB has priority. The device is then listed only once as connected via COM port.

If there are no devices found, the device list will be empty:
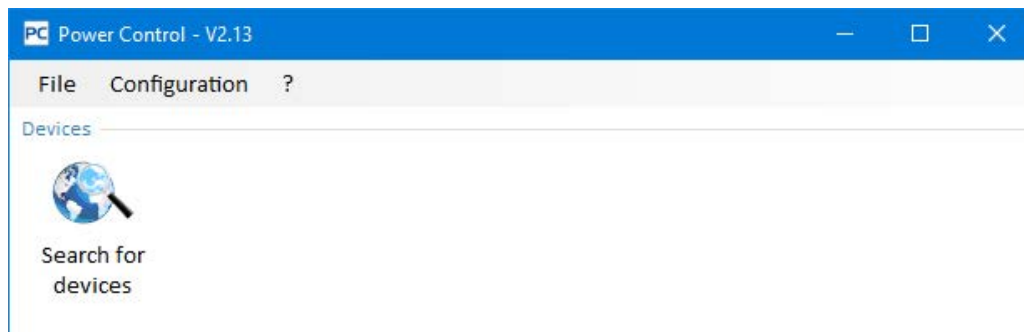
Figure 2

There are several reasons why a device isn't detected by the search:

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

- If the device shall be controlled via Ethernet:
  a. The Ethernet port which is set on the device doesn't 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 IP which has been assigned to the device manually or by DHCP isn't within the search range as defined in "Configuration".
  d. The PC's network adapter can't access the device's IP due to wrong settings

6.   Conditions for remote control

The device you intend to use in remote control can be in different control states:

1) It's currently controlled by 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 it.
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

If the situation is according to 3), the device will accept remote control commands (write access). Otherwise, only the actual values of voltage, current and power are read and displayed (resistance is calculated). In order to set the device into remote control, any other external control or local state has to be canceled manually at the device. Afterwards, it can be set to remote control with button "Remote on" in the app **Terminal** (see below). Details about device states can be found in the user manual of the device.

6.1   Controlling multiple units at once

Since version 1.52 of this software there are two separate ways to control and monitor multiple devices:

- Control and monitoring in separate windows, one for each unit (feature included)
- Control and monitoring in one window with app **Multi Control** (not free of charge, optional)

Both ways work differently. The separate handling in single windows for each unit is only recommended for a small number of devices, let's say up to 5. When wanting to control and/or monitor even more units, the overview would be lost with that many windows open at the same time. This is what to use **Multi Control** for, which offers the option to have up to 20 units of different devices in a clear overview in a single window. One of the primary functions of **Multi Control** is to set values or status of output/input on the selected device at the same.

> *The feature "Multi Control" is included in EA Power Control since version 1.52, but can't be used without prior installation of a license key which isn't free of charge. For more information refer to «12. License management» and «13. App „Multi Control"». For test and preview of the Multi Control app and other features you may request a one-time 14-day trial license. See «12.1 Trial license».*

Single window operation mode allows for up to 10 devices at once. This can be achieved by opening the any control app for every unit and switch between the windows. Those windows can be arranged at will on the PC screen. All units and windows work separately, there is no interconnection. More details below.

> *Remote control or even just monitoring devices on their actual values requires constant communication. The more devices are controlled/monitored, the more communication traffic will be generated and depending on the overall load of the PC with background tasks and other software running, EA Power Control might slow down because of too little CPU time. This can result in delayed response to buttons clicks or delayed refreshing of actual values and status.*

7. Graphical user interface (GUI)

7.1 Main window

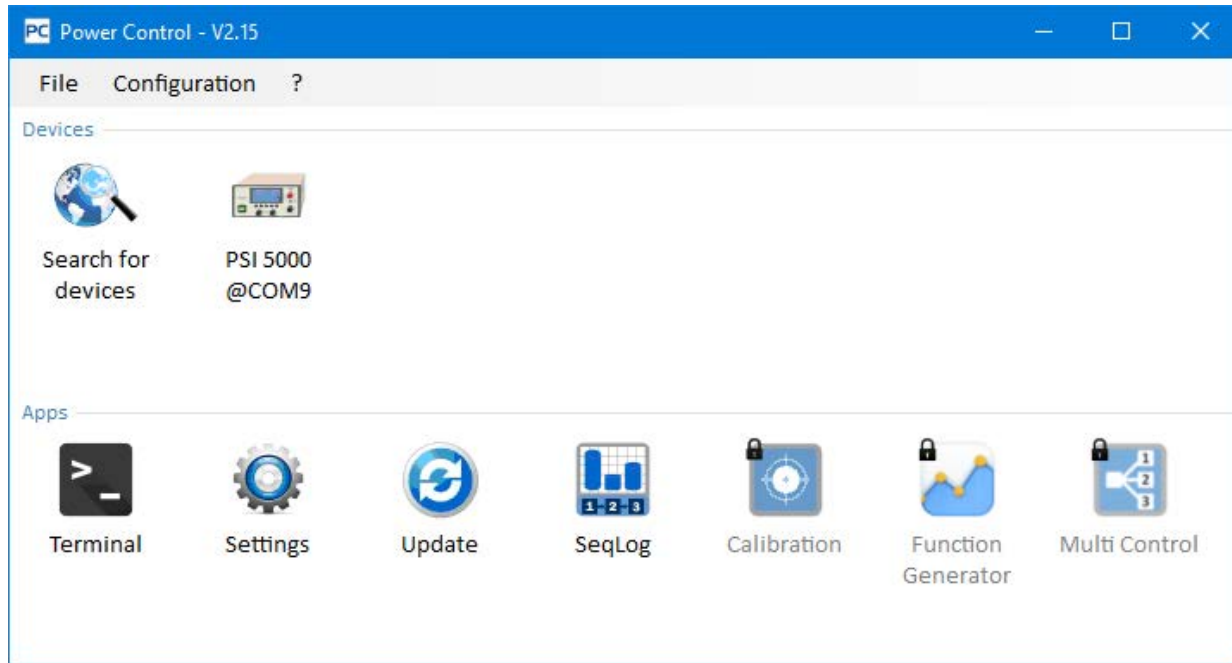After the start and search for devices (if search on start is activated), the main window will appear:

Figure 3

The windows is separated into two parts:

Devices	This part will list the detected devices as icons. In case more devices were detected than would fit in one row, the window will be expanded. The max. number of devices in the list can be 20. The software supervises the devices and in case the connection to a device is lot, probably due to the device being switched off again, the device will also be removed from the list after a short time. After re-establishing the connection again, the device list isn't automatically refreshed.
Apps	This part will show the available apps (short for: application). Every app offers a set of distinct features. More apps can be installed for use within this software, once available.

App overview:

App name	Functional description	Multiple instances?
Search for devices	After double-click, it will start searching for compatible devices on the selected interfaces. This is also used to refresh the device list. During the search a small windows is opened in front.	-
Terminal	This app is the control application for the devices. It opens a window in which actual values, set values, protection thresholds and status are shown. It can be opened up to 10 times for any 10 devices from the device list. Furthermore, there is direct access to almost every device feature by using commands in SCPI language (except for PS 5000 series) or ModBus protocol, plus for a simple scripting, which already allows for playing long command sequences.	Yes, up to 10
Settings	Opens a window for comfortable access to device settings as they can be set up in the MENU of the devices. For series which don't have a setup menu, like PS 5000 and PSI 5000, this is the only way to access certain settings related to the device operation.	Yes, up to 10
Update	Opens a window in which device firmware can be comfortably updated. Updates require to load a special update file (*.upd), which can be obtained from the manufacturers website or upon request.	No
SeqLog	Opens the sequencing and logging window. See «9. App „SeqLog" (Sequencing and Logging)» for more information.	Yes, up to 10
Calibration	Unlockable feature (licensed, upon request). Guides re-adjustment procedure as part of a calibration. This can be come necessary for several reasons. Further utilities are required to perform the re-adjustment.	No
Function Generator	Unlockable feature (license with costs). Opens a window for devices of series which feature a function generator or sequence generator. More details in «14. App „Function Generator"».	Yes, up to 10
Multi Control	Unlockable feature (license with costs). See «13. App „Multi Control"». Allows for the control and monitor of up to 20 devices of same or different type at the same time and in one window, along with synchronous setting of values and status	No

7.2 Handling in the main window

The handling of the software, concerning the use of the device icons and app icons, can be done in two ways:

- By double-click
- By drag 'n drop

7.2.1 Handling by double-click

If you double-click an app icon it displays a device list in form of a context menu from which you can select a device to start the app for.
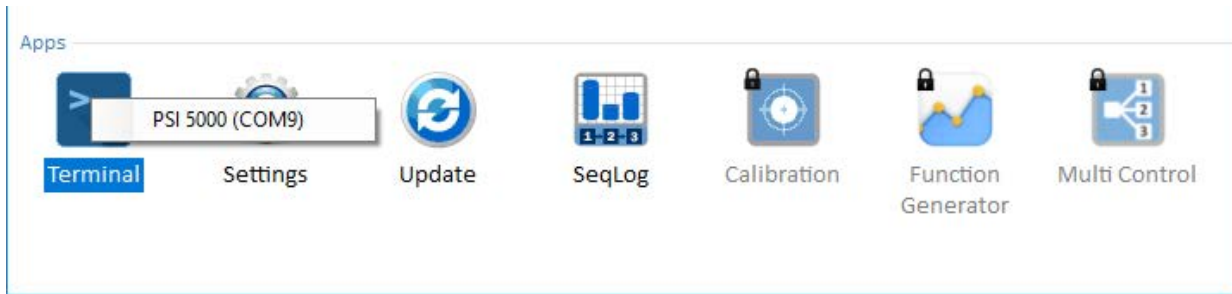
Figure 4 - Open apps by double-click

7.2.2 Handling by drag & drop

In order to open an app for a device from the device list, you can simply click the device icon, hold the mouse button and drag the icon onto the wanted app and then drop it. Unless the current situation disallows opening the app, it will be started. Otherwise it should pop up a message about why the app couldn't be started.
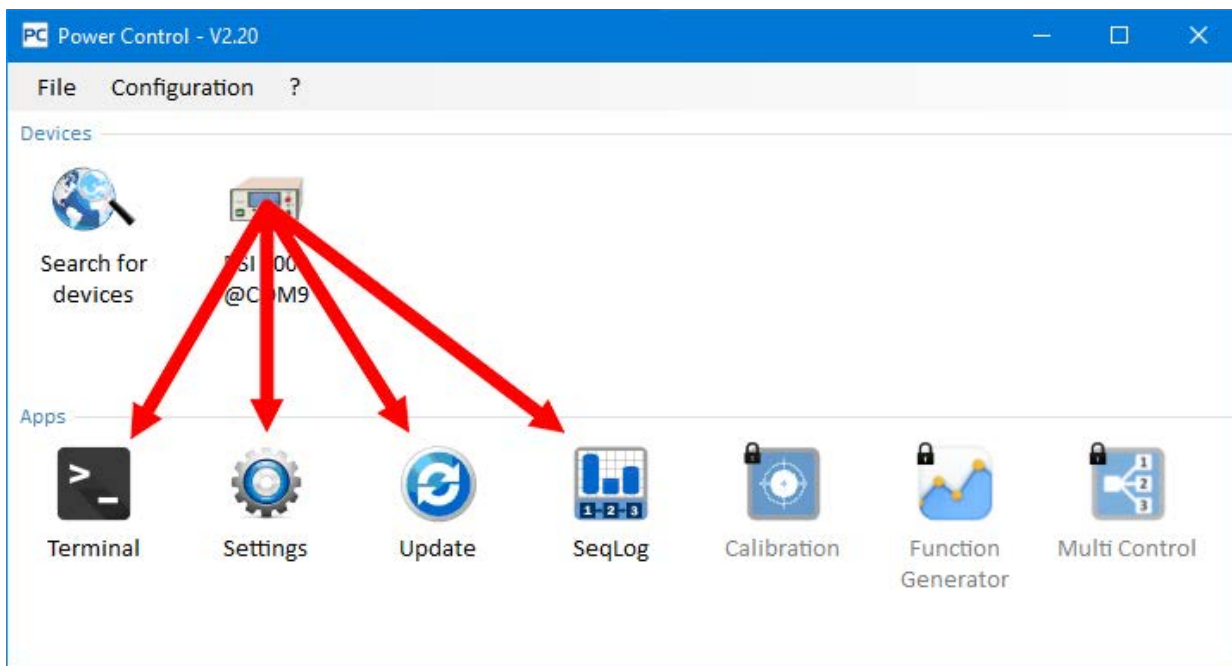
Figure 5 - Open an app by drag & drop

7.3 Show device related information

In the device list you can right-click the device icons one to make a window pop up with device information.

Example:
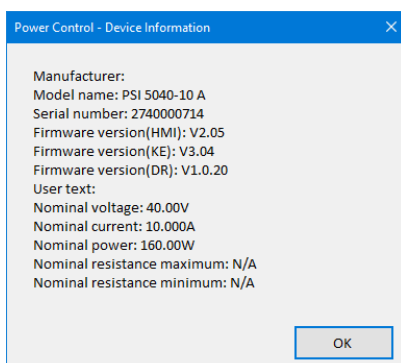
In the example with a PSI 5000 series power supply it becomes clear, that this device doesn't feature resistance mode (R mode). You can also see that the unit has no user text assigned (yet). The user text is intended to be used to distinguish multiple identical devices.

7.4 Menu & configuration

Menu item	Description
File	
Close	Closes the software immediately, no matter what other windows are still open yet.
Configuration	Opens the **Configuration** window where you can set device communication related settings and/or settings for the software itself
Tab „General"	The checkmarks in this tab enable or disable the support of device connection via USB or LAN interface in this software. When using either one of them, disabling the other can have positive impact on the performance of the software. Default setting: both enabled *Note: as long as both are disabled, search for devices can't find anything!*
Tab „USB"	Here you can choose to include (=checkmark set) the search for USB devices during the startup of the software. If no USB shall be used, it's recommended to turn off both, this settings and the global interface USB setting in tab "General". This decreases search time. In case the global interface USB setting is enabled and this parameter is disabled, you can still start searching for USB devices with app "Search for devices". Default setting: enabled
Tab „LAN"	This tab is used to define the IP search range and the port for devices connected via Ethernet. The search range is limited to the last octet. The default port 5025, such as it's default on the devices with Ethernet socket, can be changed at will, but only devices matching this port settings can be found within the IP range. You can furthermore choose to include (=checkmark set) the search for Ethernet devices during the startup of the software. If no Ethernet shall be used, it's recommended to turn off both, this settings and the global interface Ethernet setting in tab "General". This decreases search time. In case the global interface Ethernet setting is enabled and this parameter is disabled, you can still start searching for Ethernet devices with app "Search for devices". Default setting „Search at startup": disabled Default port: 5025 (also see device manual) Default IP range: 192.168.0.2 … 192.168.0.100
Tab „Language"	Switch GUI language between English, German, Russian and Chinese
Tab „Format"	Settings for the read/write format of the various log files and sequence files: US = CSV file format (comma as column separator) as commonly used in US American Excel or similar tools Standard = CSV format (semicolon as column separator) as commonly used in Europe In this windows you can also deactivate the recording of physical units in the log files (default is: "Activated") in order to have MS Excel (or similar tools) to interpret the values in the CSV as numbers and not as text.
Tab "Software update"	Since version 2.19, the software can find updates online by contacting a download server, if internet connection is available. It could then update itself automatically, which can be determined in this tab. Alternatively, it would only notify the user so a manual update can be triggered.
Tab "Other"	Further software related settings: "Connection attempts" = Number of attempts to reconnect to a device to which the connection seems lost before it's actually removed from the list of devices "Device ping (ms)" = Interval to ping a device for presence
?	
Help	Opens this help file (PDF)
About	Opens a small windows with information about the software and manufacturer details
Enable debug log	For internal use only. Do not enable debug mode, as this will slow down the software more or less, depending on the number of devices used in parallel.
Load patch file	This is used to load updates for **EA Power Control** itself, such as new and other example sequence files or a newer version of this help document.
License Management	This window is used to give an overview about installed licenses and unlocked, extended features. It can also be used to order a license or renew it, as well as install a license code to unlock new functions. See«12. License management».
Enable Demo mode	Switches demo mode on and off. In demo mode the software emulates two non-existing devices (1x ELR 9000, 1x PSB 9000) which you can use to open the different app windows and have a preview.
New in this version	Open a window that lists what's new and changed in this version

7.4.1 GUI language

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

8. App „Terminal"

The app **Terminal** is the main control application window for devices. It can be opened several times for up to 10 devices, in order to control the device separately and sort of in parallel. There is no link or connection between these windows.

The window is used to control the device state (remote, on/off) by mouse clicks, while values have to be entered via keyboard. Copy and paste is possible.
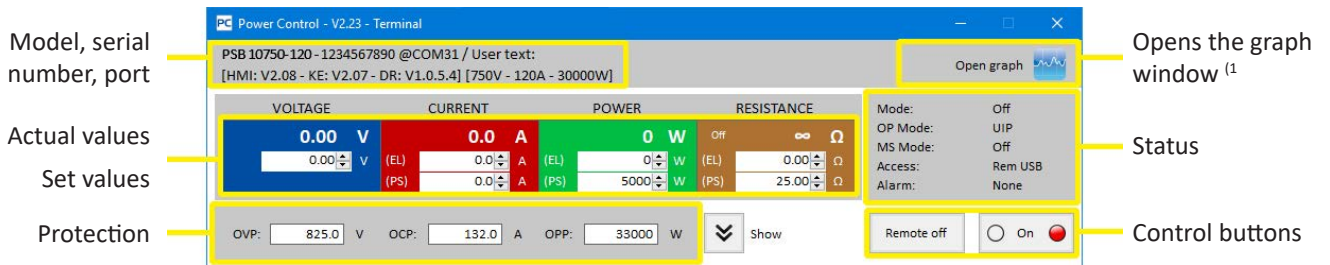

Figure 6

The upper part of the windows is for actual values, set values, protection thresholds and status.

In order to remote control any other function of the particular device, the upper part can be revealed by clicking the "Show command" button. The tabs for SCPI command language (except for PS 5000 series) and ModBus protocol offer predefined selections of commands which can be sent to the device by clicking the "Send" button.

8.1 Actual values
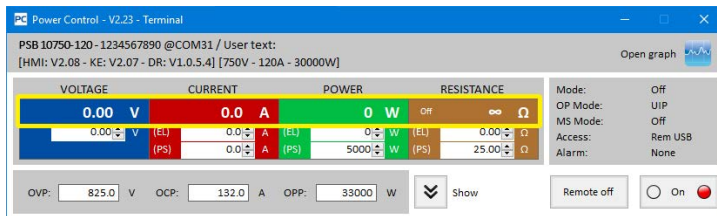
Similar to the value coloring on the devices with color TFT display, the actual values are separated from each other. In the single fields, they are located at the top (big digits). The colored area always shows at least three actual values. With electronic loads, it also shows actual resistance.

Refreshing of actual values is cyclic. High CPU load can, however, delay cyclic refreshing. Especially if there are multiple Terminal windows open. The value format doesn't always match the format on the display of your device(s), primarily regarding decimal places. 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 influenced by any operation on the device (manual or via analog interface). They are always available, even if the device isn't in remote control by EA Power Control.*

8.2 Set values
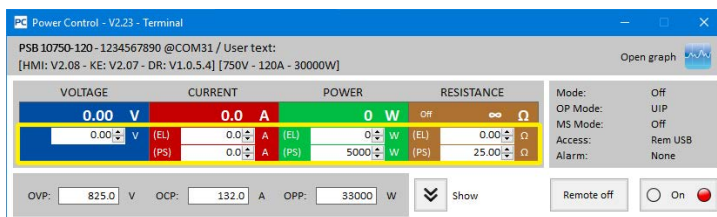
The lower parts of the colored areas show the set values (smaller digits). Those are input boxes, which are enabled for putting in values via keyboard after the device has been switched to remote control via any digital interface. This can happen from within the Terminal window by using button "Remote on" or the corresponding command.

After the input boxes have been enabled, they turn white and you can enter values either by typing or by copy & paste.

The allowed range of value per input box is identical to what the device allows on the front panel for manual use. The adjustment range of a set value is by default 0...102%, which can be narrowed by the so-called adjustment limits (here short: Limits). These can be defined manually in the MENU of the device or via **EA Power Control** in app **Settings**. In case, any value you enter is too high or too low, it's not accepted and the former value will be displayed again.

The brownish area for RESISTANCE is only showing actual and set values if resistance mode is activated. This can be done in the **Settings** app or with the small On/Off button in the area.

> *Set values are only submitted to the device after pressing key ENTER or RETURN as confirmation.*

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1) Only available with app „Multi Control" unlocked. Also see «13. App „Multi Control"» and «12. License management»

8.3 Protection thresholds
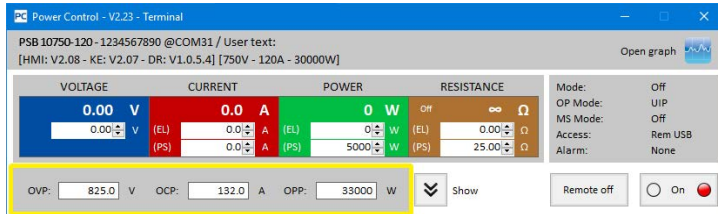
The so-called protection thresholds are display boxes and input boxes. There are only enabled for entering values while the device is in remote control via digital interface.

Remote control condition is displayed in the status area by parameter **Access:**. After the input boxes have been enabled, you can enter values either by typing or by copy & paste.

The allowed value range per input box is identical to what the device allows to adjust on the front panel for manual use. The adjustment range of a protection threshold always is 0...110% of the related nominal value. In case, any value you enter is too high or too low, it's not accepted and the former value will be displayed again.

> *Set values are only submitted to the device after pressing key ENTER or RETURN as confirmation.*

8.4 Status
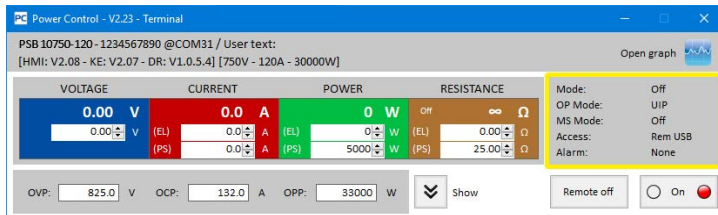
The status area shows a copy of the device status as indicated on the device's display. There can be slight differences between series. For example, a PSI 5000 device only shows **Remote** in the display, no matter if remotely controlled via analog or digital interface. The status area clearly shows the type of interface in charge (see below).

Status indicators:

Mode: Displays the condition of the DC output/input as "OFF" while it's off and while it's switched on, the actual regulation mode (CC, CV, CP, CR) is indicated here. For details about regulation modes please refer to the device manual.

OP Mode: Indicates with **UIR** that resistance mode (where featured) or normal mode **UIP** is active.

MS Mode: Shows the status of master-slave mode (where featured) with:
 N/A = Device doesn't feature „Master-Slave"
 Off = Master-Slave (MS) is available, but deactivated at the moment
 Slave = Master-Slave (MS) is available, device is set as Slave (remote control not possible)
 Master = Master-Slave (MS) is available, device is set as Master (remote control possible)

Access: Shows the access to the device via interface as available for remote control with **Free** or while the device is in remote control, the type of interface in charge (**Rem** = remote control).

Alarm: Shows the last device alarm of the device. Some device alarms switch off the DC output/input and have to be acknowledged before the device can be used again. In such a situation, the button ON/OFF below the status area changes to **ACK alarm**. It has be used to clear the alarm condition and to enable the ON/OFF button again, but only after there is no alarm present anymore.

> *Statuses are only read from the device(s) and are influenced by any operation (manual or via analog interface). They are always indicated, even if the device isn't in remote control by EA Power Control.*

8.5   Commands

The app window can reveal an extra part by clicking on the "Show command" button. This allows the user to directly access the device with commands in either ModBus or SCPI (where featured) protocol/language format, in order to query other information from the device or to access functions which are not available in the upper window part.
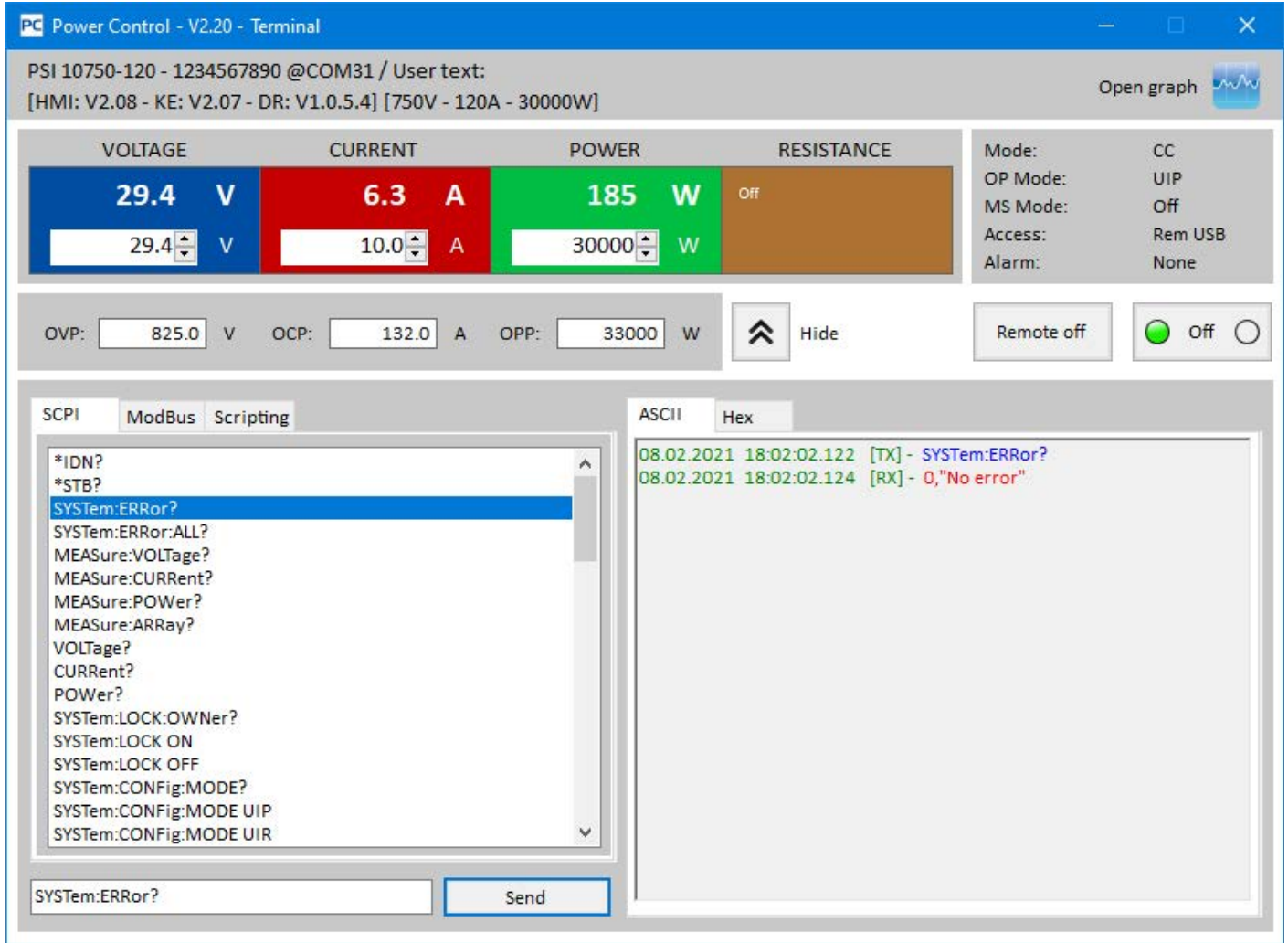

Figure 7 - Direct commands

The tabs "SCPI" and "ModBus" both offer a selected set of commands to choose from and send by click on the "Send" button. Further SCPI commands can be directly typed into the input box (see external documentation "Programming Guide ModBus & SCPI", which is also delivered with the device on CD or USB stick), while further ModBus commands can be created in tab "Custom" by selecting registers and function codes according to ModBus RTU standard, even for Ethernet connection, because the software doesn't use ModBus TCP messages and port for communication. Manually entering messages in ModBus TCP and sending them isn't going to work.

All commands sent and answers received in the selected mode are logged with time stamp in the window part on the right-hand side. The example screenshot above shows that SCPI command *IDN? has been sent to a PSI 10000 device and the device responded after a few milliseconds.

While SCPI is a text based command language it's logged in the ASCII tab, ModBus is a binary format and thus logged in the Hex tab.

8.5.1   Limitations

- The log doesn't record all commands in parallel in the ASCII and Hex tabs
- When switching between tab "SCPI" and tab "ModBus", the input mode for the command input box also changes, meaning that typing a SCPI command while ModBus mode is selected won't result in correct transfer and execution and vice versa, if SCPI mode is active

8.6 Scripting
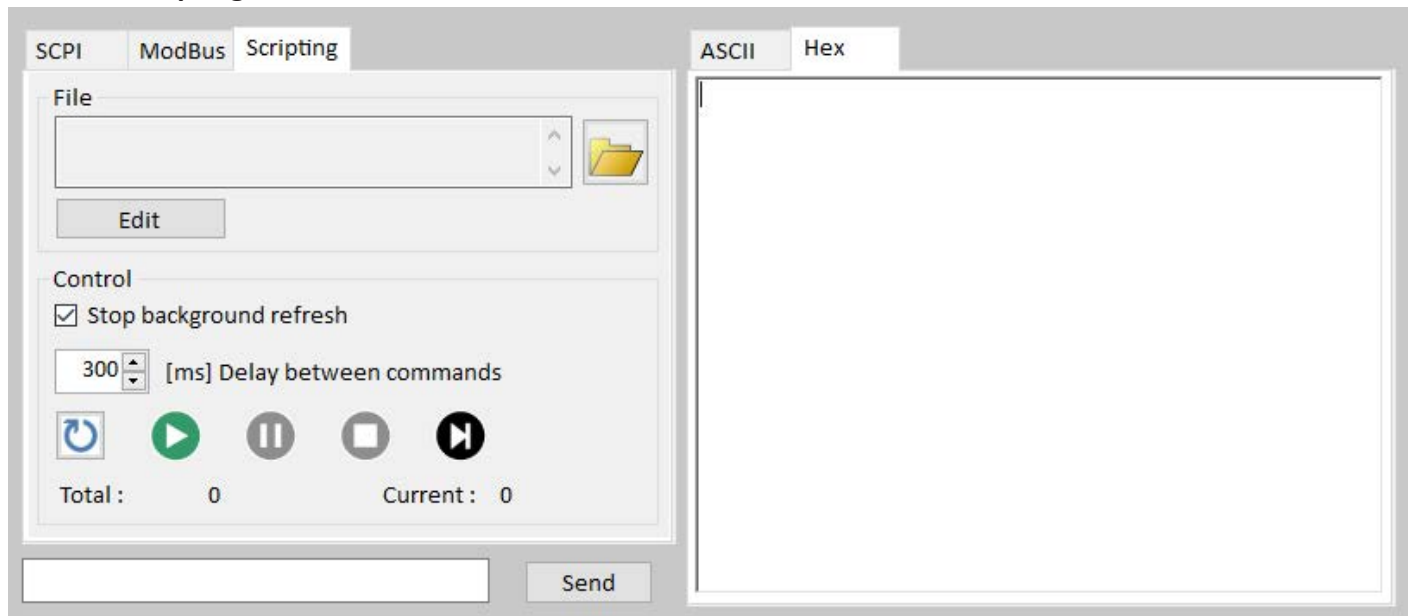
New since version 2.09 is a scripting processor feature in the **Terminal app** window (lower part). It allows to run simple script files, containing either SCPI (ASCII text) or ModBus RTU message (binary format written as ASCII text).

> ⓘ *Mixing both protocols isn't supported. The detection of the protocol used in the script is done when parsing the frist command in the first line of text. It means that if the 2nd line was a ModBus command it would be treated as SCPI, sent as string and cause a communication error. Vice versa, the same happens when detecting ModBus first.*

The scripted commands plus all responses from the device under control will be written into the log window. The log history can be exported for later analysis (right-click into log window).

Following restrictions and specifications apply:

- The script file isn't checked for plausibility of values or the commands, only the supported concatenation of up to 5 SCPI commands in one line is checked
- The adjustable **Delay between commands** (15 - 1000 ms), applies to all script lines as a global delay; in order to extend the global delay beyond its limit, a WAIT xxxx command can be inserted (see below)
- The script would stop after the last processed line, unless infinite repetition has been activated which runs until manually stopped.
- The script file can't contain mixed command lines in SCPI and ModBus RTU protocol format
- The delay of WAIT commands adds to the global delay , i. e. WAIT 1000 with a global delay of 500 would result in ~1500 ms delay for a step
- The global delay can't be adjusted while scripting is running, only in PAUSE or STOP

8.6.1 Script file format for "Terminal" app

In previous versions of the software the script file was required to named *.csv, but since version 2.23 the software also supports to load *.txt files. Inside the file all must be text, with semicolons as separators for commentaries or concatenated SCPI commands. This would already match the format of a CSV file exported from an european or german Windows/Excel, in case the script was created and/or edited in Excel and then exported. No matter what the selected file type is, clicking the **Edit** button will open the default Windows app for it.

When working with Excel or a similar tool and when using more than one column, an exported CSV would either have the columns separated by comma (US default) or semicolon. The comma isn't accepted by the software, so depending on the system settings of the PC Excel may not be the right choice as script editor tool or it must be set up to export the format as required.

Until **version 2.22**, a script file could only have up to 2 columns: one for the command and one for an optional commentary. Since **version 2.23** this has been extended so that now up to 5 SCPI commands could be concatenated in one line, sp there can be up to **6 columns** now.

> ⓘ *When creating a script file with more than one column in Excel and saving as CSV file format you should check if in a viewer (Notepad or similar) the required separator is saved as semicolon.*
>
> *When saving the same script as text file (*.TXT) it will result in an invalid script, because no separators are inserted by Excel.*

8.6.1.1   Example for a script with SCPI commands until version 2.22

In MS Excel or similar tools the separator is invisible, but when viewing the file in a text editor, it would look like this or when creating it directly in the text editor, it must have this format when optional commentaries are added:

*IDN?;Query device type and serial number

SYST:LOCK ON;Activate remote control

VOLT?;Query voltage setting

The scripting, when started, would execute one set command and two queries. All three commands plus the responses would show up in the log window. Due to the script containing all SCPI commands, the software would detect ASCII format and automatically switch to the ASCII tab.

8.6.1.2   Example for a script with SCPI command since version 2.23

Since version 2.23 scripts can be extended when using SCPI commands. It allows for up to 5 commands per line, same as the device would support it when directly accessing the device with SCPI. The commentary would still be in the last column, when used, which here can be column 2 to 6. Another requirement is that the commentary now has to have three hashtags (###) as prefix, because else it would consider the three commentaries in the script from «8.6.1.1» as SCPI command, also count them as such, and simply send them to the device. It means that older scripts from before version 2.23 must be revised. The example script from in the new format for version 2.23:

*IDN?;###Query device type and serial number

SYST:LOCK ON;###Activate remote control

VOLT?;###Query voltage setting

Examples for the extended format with up to 5 concatenated SCPI commands as support since version 2.23:

Full command set	Description
VOLT 10;CURR MAX;POW MAX;###Write set values	Sends three commands for three set values at once
VOLT 10;CURR MAX;POW MAX;RES MAX;MEAS:ARR?	Sends five commands at once which define four set values and queries actual values which, in this case, would not yet represent the just defined set values

8.6.1.3   Example for a script with ModBus RTU commands

When using ModBus RTU messages, written in ASCII letters and numbers and with or without commentaries, the only difference between version 2.22 and 2.23 of the software is the now required three hashtags (###) in front of the optional commentary.

In MS Excel or similar the separator is invisible, but when viewing the file in a text editor, it would look like this:

00 03 00 01 00 14 15 D4;###Query device type

00 05 01 92 FF 00 2D FA;###Activate remote control

00 03 01 F4 00 01 C5 D5

The **bytes** in the ModBus message must be separated with a **blank** (space), else the script is denied. The example script above, when run, would execute one set command and two queries. All three commands plus the responses would show up in the log window. Due to the script containing all ModBus commands, the software would detect binary format and automatically switch to the Hex tab in the log window.

8.6.1.4   The WAIT command

Apart from regular SCPI commands or ModBus RTU messages in the script, an extra command WAIT xxx command can be inserted as step at any position and as often as required. It serves to extend the global delay. The xxx is for 0 to 2^{32} milliseconds. Example of a script with ModBus message format and WAIT command

00 03 00 01 00 14 15 D4;###Query device type

WAIT 500

00 05 01 92 FF 00 2D FA;###Activate remote control

00 03 01 F4 00 01 C5 D5

8.6.2   Options

Since version 2.10 there is one option to tick/untick **Stop background refresh**. When checked and as soon as the scripting is started, it would halt the usually running background communication which fetches actual values and status for the displays in the upper window part. This can be useful to achieve a more accurate timing of message steps in the script.

8.6.3   Display and control

The scripting tab only has two displays:

Total: the total number of valid commands in the script file
Current: the currently processed step number

The controls use familiar symbols for

Start/run the script processing (after a valid script file has been found)

Pauses the scripting run after the current step; the scripting can be continued later with the next step

Stops scripting after the current step; when starting again with Start button, the scripting will be processed from the beginning

Allows to perform single (manual) steps, either directly from the start of the script (this button is clicked instead of play button) or when paused; after a manual step, the script could also be continued to run automatically by using the Start button

Activates/deactivates script repetition after last step; with this setting activated, the script would never stop automatically
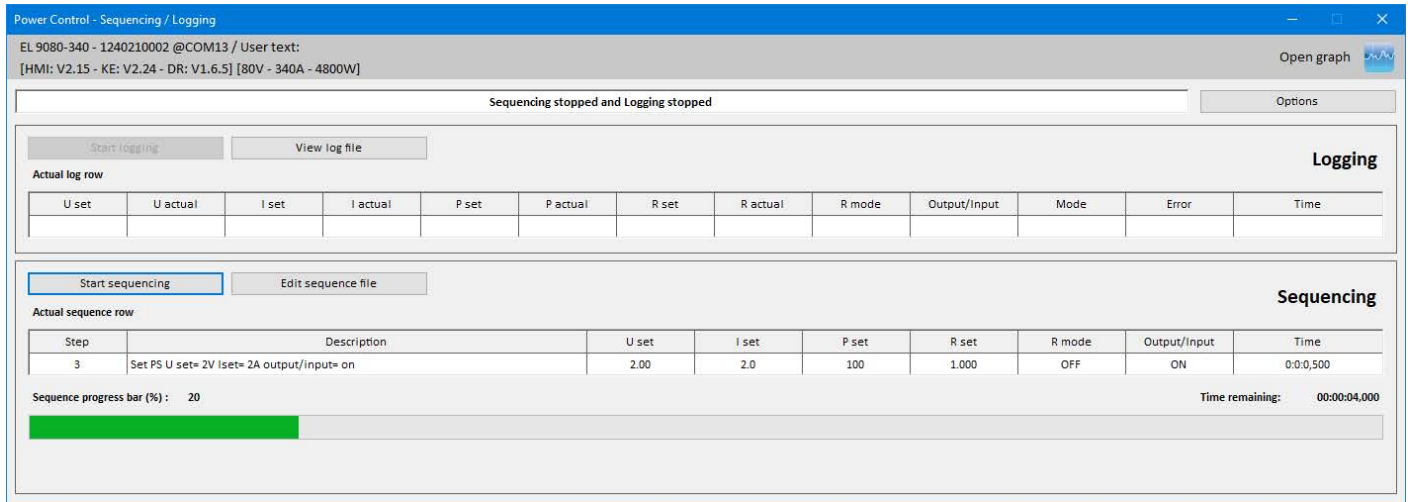
9.   App „SeqLog" (Sequencing and Logging)

Figure 8

A very important feature of **EA Power Control** is the ability to process sequence files (here: Sequencing) and to record device data (here: Logging). A sequence is a set of rows with set values and a time x, which are stored in a text file of type CSV.

The software reads these sequence files row by row and send the values and status from the currently processed row to the device, then waits for a certain time to achieve the period until the next step is processed. The period range is 100 ms…99 h:59 m:59 s with a step width of 100 ms.

Logging works similar, but vice versa. In selectable intervals (same definition as for sequencing), the software reads actual values and statuses from the device and writes them step by step into a log file of CSV format. The total recording time and number of recorded entries is limited to a max. number of continuous log files of 1000.

> *Since version 2.03 of this software you can select the CSV file format in "Configuration". The default setting is "Standard" and lets the software accept/create CSV with semicolon as separator and as used in Germany and Europe. US users should thus select "US" to use CSV files which are compatible to american standards. The setting applies to both, sequencing and logging. It means, that with setting "US" and when trying to load a CSV file with european format, a format error would pop up.*

> Important! Sequencing of EAEPS Power Control is different to what you can do with the sequences of the arbitrary generator as featured in series ELR 9000, EL 9000 B and PSI 9000. Sequence file processing always sends the next values as entered in the sequence file and thus the device can't generate ramps to have a linear rise or fall between two set values.

Logging and sequencing are configured in the **Options** window, which can be accessed from the **SeqLog** app window. For both features it's required to select a separate file for **EA Power Control** to work with. Both, the sequencing and the logging file, are also set separately for every unit used with sequencing & logging. It's not possible to record data of multiple devices into one log file at this point. Doing so is only possible in «13. App „Multi Control"».

The log file doesn't contain information to uniquely identify for what device it was created. Thus it's very important to use file names which clearly assign a file to a device, perhaps by including the same user text in the file name.

For Sequencing you have to select an existing sequence file, which is checked for validity after every selection. The sequence file format is defined (see below) and shown by an example file which is included in the installation and which is the default sequence file when opening the SeqLog app the first time. Sequence file in arbitrary number can be created outside of **EA Power Control**, with popular tools like Excel, other CSV tools or even text editors.

9.1   Sequencing

Sequencing requires to select a sequence file for a device, which is tested for compatibility. In case there are errors in the file they are pointed out in a pop-up window. The installation of this software includes an example sequence file (attention, european CSV format!) in path "C:\Users\Public\Documents\EAPowerControl\seqlog\example_sequence_file.csv" which is preselected after in the software. You can use this file as a start and edit it according to your requirements.

Editing can be done outside of **EA Power Control** or started from within the app window "SeqLog" or the "Options" window.

Before the start of sequencing the file is checked again in order to cover unnoticed external editing. Basic rules:

- All set values (U, I, P and R [2]) must match the nominal values of the device for which the sequence file is going to be opened. If you just open a sequence which was originally made for a 200 V model for an 80 V model, a single voltage value in any row which exceeds 80 V will cause rejection of the file.
- Time values have a recommended minimum of **200 ms. It's possible to use lower values, but stable operation can then not be assured anymore.** It depends on many factors, like number of devices running sequencing in parallel or what interfaces are in use. What will work properly can only be elaborated by the user with the on-location setup. The maximum time value is 99h 59m 59s 999ms.
- A single sequence file can be opened for multiple identical devices to have parallel sequencing, as long as the nominal values match. This is true for models PS 9080-170 and PSI 9080-170, even if the PS model doesn't feature resistance mode, but would not be true for ELR 9080-170 and PSI 9080-170, because they have a different nominal power.
- The app **SeqLog** can be started multiple times for up to 10 devices. For every device, a separate sequence file can be selected. It's not possible to start Sequencing in all open SeqLog windows at once. For this, app **Multi Control** can be used. See «13. App „Multi Control"».
- After a valid sequence file has been opened and the device is in remote control, sequencing can be started in the app window **SeqLog**. The current processed step is copied from the sequence file to the lower part of the window. The progress bar indicates progression of one cycle of the sequence file. A countdown shows the remaining time of the sequence (number of repetitions x total time of all rows in the sequence file), while a repetition counter counts the number of repetitions, unless repetition was set to "Endless loop".

Following applies additionally:

- Sequencing either stops automatically at the end of a sequence resp. if the desired number of repetitions has been reached or because of device alarms like OV.
- Sequencing can't be paused. Every start after a stop, no matter if manually or due to a device alarm, will start the sequence file all over
- Logging can be started and also stopped automatically with sequencing. There are separate settings in the "Options" window, in tab "Logging".
- Logging can only be started, no matter if manually or automatically, if a log file has been defined, which must be completely accessible for the software, i.e. not locked.
- Paths and file names of sequence and logging files, once selected and assigned for a specific device, are stored in an INI file and recalled the next time the device if detected by search for devices.
- When opening a sequence file for a device which doesn't feature resistance mode, the entries in columns "R set" and "R mode" are shown as "N/A" (not available)

Tips for sequenced operation:

- With the start of sequencing, the DC output/input of the device can be switched on or off and values are set as defined by the 1st sequence row. This can lead to unexpected voltage steps on the DC output of a power supply. To avoid this you might want to add another row as 1st row where the voltage set value is 0 and the DC input/output is set to off.
- With power supplies only: the voltage setting of in a sequence row can be very different to the voltage setting of the previous or next row. In such a case, where the voltage has been set in the previous row to much higher than in the current row, the voltage would have to sink first, which can take more time than defined for the current row, depending on the load. This can even result in the next row not working as expected regarding voltage level and period of step.

---

2) Adjustable resistance, also called R mode, isn't available with every device series. In order to find out if your device features R mode, refer to the device manual.

9.1.1 Settings for Sequencing

> ⓘ The settings for sequencing are per device. It means, the software distinguishes devices by their serial number and restores the settings after the next start.
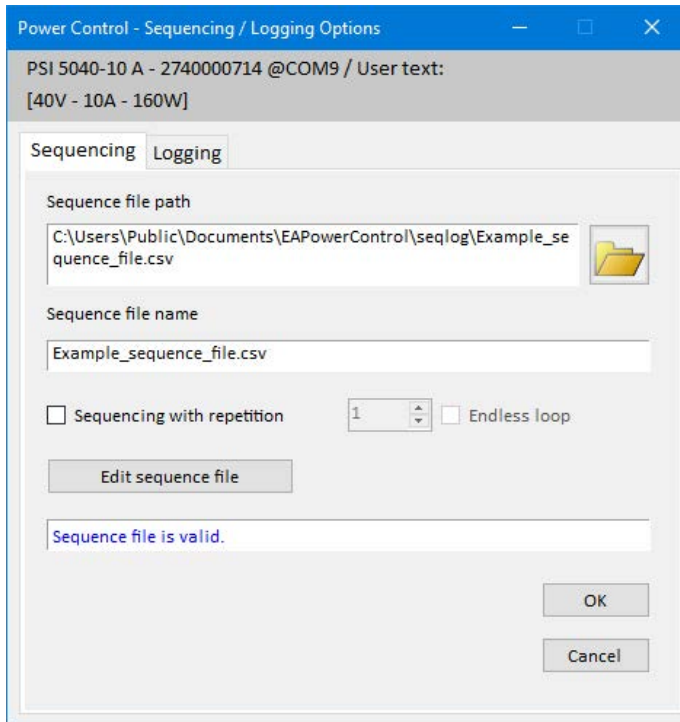

Figure 9

> ⓘ In case this windows shows "Sequence file is invalid" (in red), even if all values in your loaded CSV are correct for the device, it may have to other reasons:
>
> 1. Wrong CSV format used in the file (the format regarding comma or semicolon as column separator must match the setting in the configuration, see section «7.4», setting "Format").
>
> 2. The sequence requires a different number of columns. For example, the sequence file for a bidirectional power supply device requires more columns with values than for every other series. Also see the example sequence files which were installed along the software installation in the public user folder

Element	Description
Sequence file path	The button with the folder icon opens a dialog to select a sequence file of type CSV, which must contain data in a certain format, as explained below. By default, an example sequence file is given here. Default selection: example_sequence_file.csv
Sequence file name	Separately shows the name of the sequence file
Sequencing with repetition	Enables repetition of the entire sequence after it has been completely processed. You can set a certain number of extra rounds. Range: 1...65500. The additional option "Endless loop" will repeat the sequence infinitely, until manually stopped or due to a device alarm. Default setting: both disabled
Edit sequence file	Tries to start the application (if there is any) which is assigned to open CSV files, in order to open the sequence file in edit mode. It's required to save the changes and close the file in the external application to be able to use the file for Sequencing.

9.1.2 The sequence file format

The sequence file has to be in file format CSV, which determines a specific value separator format. This format can be selected in the **Configuration** window between "US" (separator = comma) or "Standard" (separator = semicolon). Files with the opposite format would then be neglected.

Since the implementation for support of bidirectional device series there is an extended file format which must be loaded for those kind of devices. Standard sequence files would be rejected as "invalid". There is an example file installed in the public user folder of Windows (in c:\users\public\documents\EAPowerControl\seqlog) after the installation of **EA Power Control**. It's named example_sequence_file.csv. It illustrates the required layout of the sequence file. We recommend to store the example sequence file as template for any new sequence file to be made.

The sequence file is built like this (example shows the extended format for PSB series):

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Step	Description	U set (V)	I set (A)	P set (W)	Output/Input	Hour	Minute	Second	Millisecond	R mode	R set	I set EL (A)	P set EL (W)	R set EL
2	1		0	1,2	101	ON	0	0	0	900	ON	1	1	100	10
3	2		1	1,3	102	OFF	0	0	0	900	OFF	2	2	200	20
4	3		2	1,4	103	ON	0	0	0	900	ON	1	3	300	30
5	4		3	1,5	104	OFF	0	0	0	900	OFF	2	4	400	40
6	5		4	1,6	105	ON	0	0	0	900	ON	1	5	500	50
7	6		5	1,7	106	OFF	0	0	0	900	OFF	2,2	6	600	60
8	7		6	1,8	107	ON	0	0	0	900	ON	2,4	7	700	70
9	8		7	1,9	108	OFF	0	0	0	900	OFF	2,6	8	800	80

The sequence file format has to follow these rules (with format extension changes from 02/2018):

- Row 1 is used as headline and must not be used as 1st sequence step.
- The texts in columns A and B are not required, but are intended to help describing (column B) and counting (column A) the steps
- All values in columns C thru E, unless left empty - which is allowed -, must not exceed the corresponding nominal values of the device which the file is opened for, else the sequence is rejected and the software will pop up an error list. Example: you create a sequence file for an 80 V model and in one row you define 50 V. This sequence file could not be loaded for a 40 V model.
- Columns G thru J must only not be empty and must only contains number.
- Column K is only checked for validity if the sequence is loaded for a device which features resistance mode. Entries in this column can be empty or contain the string OFF (=resistance mode UIR not active) or ON.
- Column L is only checked for validity if the sequence is loaded for a device which features resistance mode. Entries in this column can be empty or if they're not empty, the must contain a value which has to be within the minimum and maximum resistance definition for the particular device model.
- Extended format: Columns M thru O (red frame) are only required for any PSB 9000 and PSB 10000 series device, they belong to sink operation mode, which is additional for this series

9.2 Logging

Device data can be recorded at almost any time, also while the device isn't in remote control. It means, it's possible to control a device via its analog interface, where featured, and record data through a digital interface in **EA Power Control**, to do logging that is.

Logging can be started manually by pressing a button or automatically along with Sequencing, if the related option is enabled and a log file has been defined. The **Options** windows offers the necessary settings.

Following generally applies for Logging:

- Logging can be started anytime if a log file has been defined and set up for the particular device.
- In case Logging is started automatically with Sequencing, it also can be stopped anytime manually or it stops automatically once Sequencing stops or if "Stop Logging on error" is enabled and an error occurs.
- The **Options** window gives the choice to either create a new log file or open one for reuse.

> ⚠️ Attention! Be careful with record mode "Overwrite" when opening existing files from disk! Previously recorded data is lost if the setting is "Overwrite" and Logging is started the next time.

- If Logging is automatically started with Sequencing and the log interval matches the time values in the sequence file, the device has to receive and set the values of the current sequence row first. Afterwards, the device can be read by Logging to record the updated values. This will cause the log file to have at least one row offset regarding the set values and related actual values. The bigger the log interval, the bigger the time difference between sequence file row and corresponding log file row.
  - » Example: the time values in the sequence file are all 1 s, the log interval also is 1 s. Sequencing and Logging are started simultaneously. In row 5 it defines a voltage value of 30, which will cause a power supply to set 30 V as soon as row 5 is processed. In the same moment, the log file receives an entry in row 5, but probably a different actual value, because the 30 V are not yet set. So the log file will record the actual value corresponding to 30 V at least one row later.
- Older Excel versions which might still be in use and probably also similar tools can have a max. row limit of 65536 per sheet. In order to record beyond this limit, the software will create an overflow file once 65500 rows have been reached. The overflow file will be added _001 in the file name. This number is a counter which can go up 999, so that after recording 1000 log files, logging will automatically stop and the software will pop up a message.
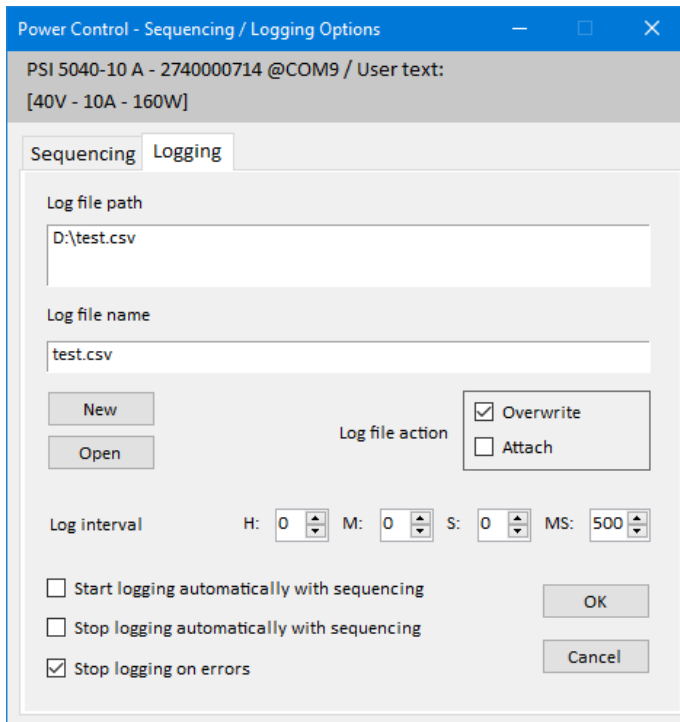
9.2.1 Settings for Logging

Figure 10

Element	Description
Log file path Log file name Button „New" Button „Open"	These are used to define path and file name of the log file. You can either create a new file with "New" button or open an existing one with "Open". Mind the option "Log file action", especially when opening existing log files where data shall be attached at the end!
Log file action	Selects the record mode for the log file between "Overwrite" and "Attached". Caution! With "Overwrite" chosen, previously recorded data is overwritten every time you start Logging again, no matter if manually or automatically with Sequencing. Default setting: "Overwrite"

Log interval	Defines the time between two log file entries of a logging session. This value can't be changed while logging is running. Adjustable range: 100 ms...99 h 59 m 59 s in 100 ms steps or a multiple of it.
	Default value: 500 ms
Start logging automatically with sequencing	If this setting is enabled and there is a log file defined, a new logging session is started automatically every time sequencing is started with the corresponding button. The selected log file action also applies! You may stop logging manually at any time else it will continue until stopped by an event, or automatically if the other setting „Stop logging automatically with sequencing" is enabled, too.
	Default setting: disabled
Stop logging automatically with sequencing	If this setting is enabled and logging has been started either manually or automatically with sequencing (see other setting „Start logging automatically with sequencing"), it can stop automatically with sequencing, no matter what reason made sequencing stop (reached end of sequence file, end of repetitions, device alarm).
	Default setting: disabled
Stop logging on error	Normally, logging would continue logging during device alarm situations where the DC input/output of the device is switched off and the actual values are all zero (except for voltage on an electronic load). Then the log file would be filled with zeros. You can enable this settings to avoid logging to continue recording values during errors/alarms.
	Default setting: disabled

10.   App „Settings"
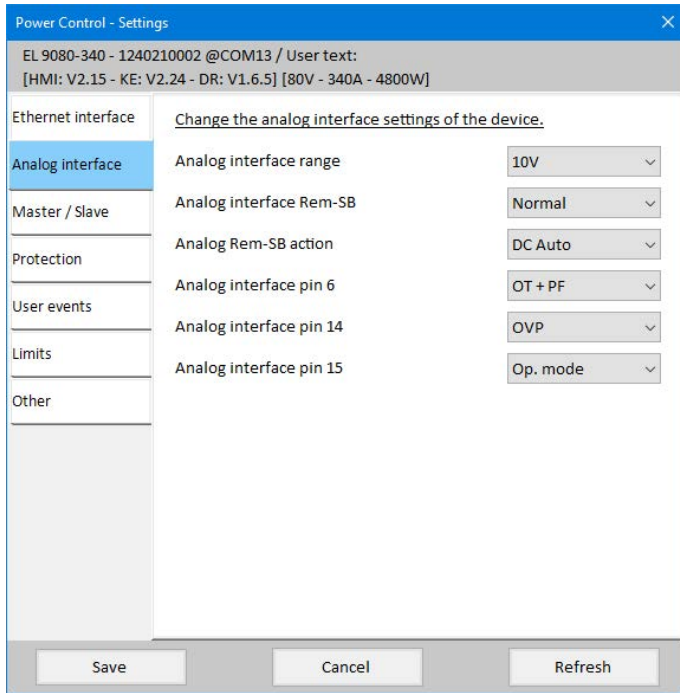
Figure 11

The app **Settings** offers you to adjust device related parameters and settings as they are also available in the setup menu of your device. In order to save the changes the app requires remote control. In case the app can't switch the device into remote control, it won't even open the window.

> ⓘ *The settings in this app are usually updated with every new software release, at least if any new setting comes to any series. Should you not find a specific setting, it's usually going to be in the next release.*

Some device series do not even have a setup menu, such as PS/PSI 5000. For these, this settings window is the only way to access some extra settings, such as the effective voltage range (0…5 V or 0…10 V) of the analog interface (PSI 5000 only). Not all available setting is supported by all device series. Unsupported items will be greyed out.

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

11.   App „Update"
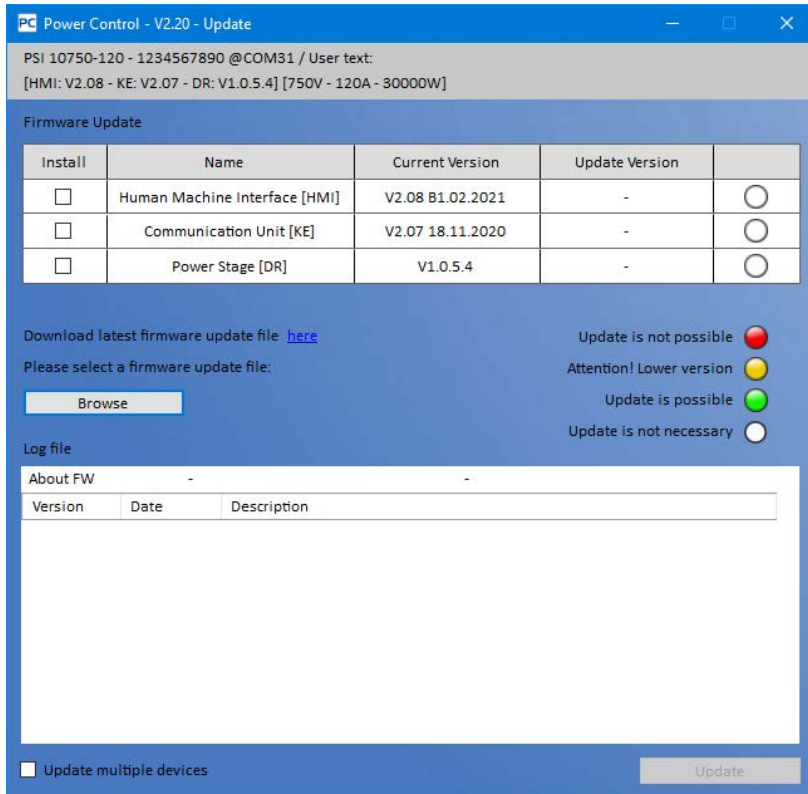
Figure 12

This app is used to update firmware of micro-controllers inside a device, as well as the firmware of the CAN interface module IF-AB-CAN, which is supported since **EA Power Control** version 2.15. This part of the software is considered as an update tool for current device series. In order to update any supported device, you first need to download an update file (firmware_updates.upd) from our website or obtain it from us upon request. The file will always contain the most recent firmware versions. Rule of thumb:

Only install updates on your device if absolutely necessary or after you have been requested to do so!

Further facts you should be aware of before installing firmware updates:

- Firmware updates can only be done via USB line or, in case of the HMI component, from USB stick
- Installing updates can fail due to several reasons, for example because of a supply blackout. Depending on which component was being updated while the interruption occurred, the device can be recovered or has become unusable. Recovery is partly possible, but not in every situation. In such a case contact our support staff.
- Do not downgrade your device, i.e. install an older version than currently installed, unless you are definitely requested by us or we agreed to it as the only solution. The software will ask for permission to do the downgrade. Upgrading to a newer version after a downgrade should be possible without restrictions.
- It might happen that particular models of a compatible device series or a device of a series yet unknown to your currently installed version of **EA Power Control** can't be updated by this app. In such a conflict situation, the software should pop up a message.

In the window of the **Update** app you can open the update file via button **Browse**. The file is first checked for validity and later the winodw will show information in the log file box about the firmware history of the above selected component (HMI, KE, DR or the CAN interface) in the "Firmware Update" table. Along with the information in the log window the list also displays the firmware versions, as installed in the device, and the update versions, as contained in the update file. There is furthermore a traffic light telling you if an update is

- permissible (green)
- not required (white)
- refused (red)
- permissible, but not recommend, i. e. it would be a downgrade (yellow)

Normally, you should only install updates on components with **green** light.

The user can decide to update every component or just one. The selection is done by manually ticking a check mark in the list view, in column **Install**. Components not check-marked here will be skipped during the update process.

After enabling at least one component for update and clicking button **Update**, the update will start and do the rest automatically until finished. This can take a couple of minutes. Make sure the device is permanently powered during this time.
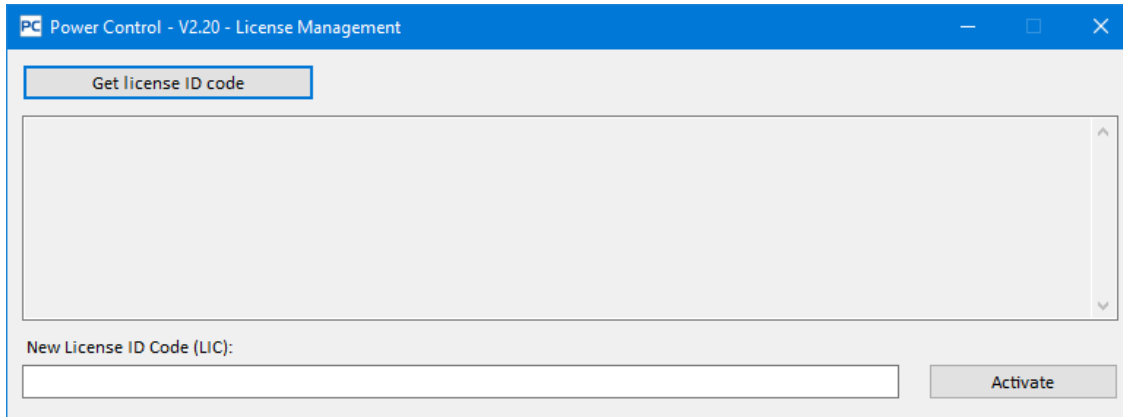
12. License management

Figure 11 - License manager

The software contains a license manager. It's used to install optionally obtainable license codes to unlock extended features in the software. Those extended features are not free of charge. The license code can be purchased together with a device (which is supported by this software) or later. The license is tied to the PC on which it shall be installed.

There is furthermore the option to request a one-time trial license code to test the extended feature for a period of 14 days, starting from the day of trial license generation.

Questions & answers:

What to do before requesting a full or trial license code?

First, gather information about the unlockable features by calling our sales department or visiting our website or reading this document. Most important topic: does you device support any of the unlockable features? If one or multiple of these features are of interest for you, download the most recent version of **EA Power Control** from our website and install it. In the help menu there is an option to enable a demo mode which allows to have a view into every app. If you want to test the software first, there is a free 14-day trial option available for which you can request a trial license. See section «12.1 Trial license».

If you have decided to order the full license, you can request a quote from our sales department before actually starting to obtain the license code. With date 10/2021 following features can be unlocked (all at once, not separately):

Feature name (App)	Included since version	Short description
Multi Control	1.52	App for parallel and synchronous control and monitoring of up to 20 devices in one window. For details about this feature refer to «13. App „Multi Control"». Note: the license for this app includes the **Function Generator** app and the **Graph**
Function Generator	2.03	App for the remote control of the function generator as featured by some series or the sequence generator of ELR 5000 series. Once the license code for **Multi Control** is installed, this app is automatically unlocked. For more details about this app refer to «14. App „Function Generator"».
Graph	2.03	App with a graphical visualization of set values and actual values, screenshot feature and data recording. Once the license code for **Multi Control** is installed, this app is automatically unlocked. For more details about this app refer to «15. The Graph». The app can't be started directly from the main window, but only from within other windows, such as **Terminal**.
Calibration	2.15	Re-adjustment of calibration values for DC output/input related values. Since version 2.20 this app requires to be unlocked by a licence code which isn't available for end users.

How to obtain a full or trial license?

Open the license manager in **EA Power Control** via menu "**?** -> **License Management**" and in the manager click on **Get License ID Code**. This will open another window with some information. Click on the displayed e-mail address (blue link) to open your default e-mail software and to send a request mail for a quote and/or other information. In case you want to obtain the 14-day trial license code please explicitly say so in the e-mail, otherwise it's assumed you want to obtain the full license. For this, you must also add the proof of purchase by attaching the receipt to the request e-mail.

How to install a license code?

After reception of the license (as e-mail, text form), which is tied to a specific PC and it unique computer ID number (short: CID), compare the CID of the PC you are going to install the license on with the CID in the license code e-mail. The CID of the current PC is displayed in the "Get License ID code" window. Access it via menu **? -> License Management -> Get License ID code**. In case the compared CIDs didn't match, the PC may be the wrong one or the CID has changed in between. Then read below at "What to do if the license should suddenly become invalid?".

After successful comparison, close the window and either type the license code into the text box "New License ID Code (LIC)" or copy & paste it from the e-mail. If the license code is accepted, the license will be installed and the corresponding features unlocked. The license manager windows will show the status as often as you open it. One license code can unlock multiple extended features.

> ⚠️   Save the e-mail with the license code for later use in a secure and easy to find location or print it.

Can a license be transferred to a different PC?

No. But there is a multi-license package available. Please contact out sales team for advice on how to proceed or a quote. This is especially required in case a PC with an installed license suddenly fails and becomes unusable or the license was only installed on the PC for temporary use and test and that PC is going to be forwarded to the end user.

What to do if the license should suddenly become invalid?

It may happen that a license suddenly becomes invalid, for example because the PC configuration has changed and its computer ID (short: CID) too. In such a case, please first compare the current CID with the one in the e-mail you should have received after purchasing the license. The current CID is shown to you when accessing the menu **? -> License Management** and then by clicking on "Get License ID Code".

     a. If both CIDs are identical, simply install the license again. See above at "*How to install a license code?*"

     b. If the CID has changed, please request a new license code. You can do this by sending us an e-mail which should contain the new and old CID and the proof of purchase. We will then generate a new code and mail it to you

12.1   Trial license

For previewing and testing purposes there is the option to request a14 day trial license. It unlocks the full functionality.

Getting and installing the trial license is done the same way as with the full license, but the trial will expire 14 calendar days after being created (not 14 days after being installed). Within the test period the program will notify you upon every start. Once it's expired, the software will notify a last time and after that the apps **Multi Control**, **Function generator** and the **Graph** are locked again. Installation of a full license during the trial period or after will overwrite the trial license.

You may request a trial license once for every PC. The procedure is the same, via the license manager window and the "Request trial licence" button. In the small window which shows the CID there will be a blue link that when clicked generates an e-mail to send the CID. Add your trial license request there.
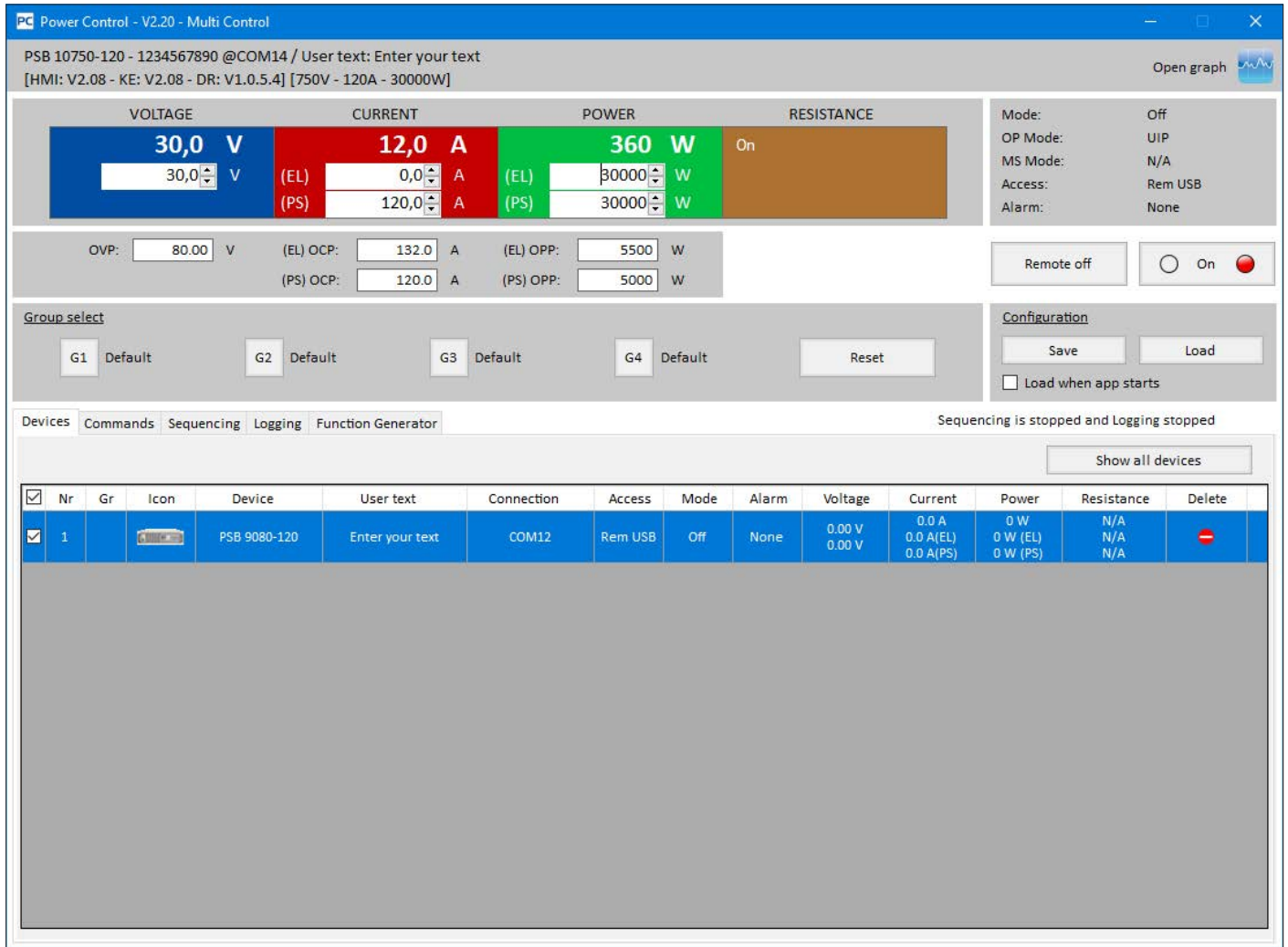
13.   App „Multi Control"

Figure 12 - Multi Control main view

The app **Multi Control** is featured since version 1.52 of **EA Power Control**. After the first installation of this software, the app is locked. To unlock it, an optionally purchasable license has to be installed. For more information about getting a license and unlocking the app refer to «12. License management».

This app can be used to control and monitor up to 20 devices of identical or different model and type at once and in one window. The first 20 devices recognized by **EA Power Control** are listed in this window to access them for remote control without the need to switch to app **Terminal**. The device list can be managed by deleting devices from it resp. insert them again, as long as they are still connected to the PC.

13.1   Limitations

- The app can manage, access and control up to 20 devices. In case a higher number is directly connected to the PC or accessible via a network, a rule applies to first list USB devices according to their incrementing COM port number, then list Ethernet devices according to their incrementing IP
- When using sequencing, only one sequence file can be selected and used. Furthermore, it can only be started if the set values in the loaded sequence don't exceed the ratings of the selected units.
- The function generator remote control feature can be used for one or multiple selected units which feature a function generator or sequence generator. In case the selected units
  - » are of different type, not all functions can be used for all units and doing so could lead to error messages popping up
  - » have different ratings, the input boxes for values are limited to the lowest rating of all of the selected units.
  - » don't all feature a function generator, loading a function will be aborted with an error message.
- Devices to which the connection has been lost can't be inserted automatically into the device list again
- A configuration via app **Settings** can't be written to multiple devices at once
- The list of devices will be immediately when running a function (function generator, where featured) on at least one of the listed devices

13.2 Functions in the app window

13.2.1 Upper window area
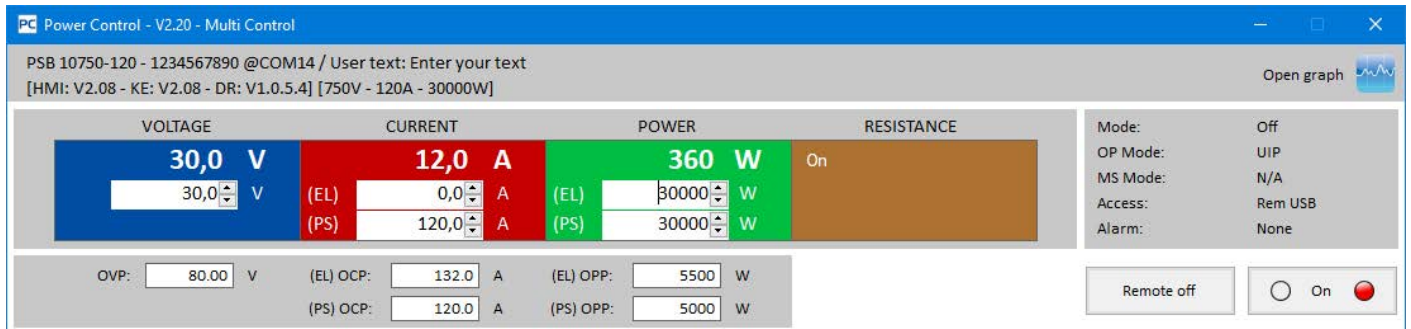
The upper window area always shows the actual and set values, as well as status of one currently selected device from the device list (blue, single device selection). This window part is identical to the upper window part of app **Terminal** (see «8. App „Terminal"»).

13.2.2 Central window area

The middle part of the window is used to manage groups of devices. Every of the max. 20 devices can be assigned to any of the four groups, while every group can have a max. of 20 devices. The actual assignment to a group is done in the device list (see below at Tab "Devices"). The buttons are used to select devices which are assigned to a particular group. "*Select*" here means to put the checkmark next to the devices in column 1 of the device list. It works the same way the other way round when deselecting groups.

All actions after group selection, like setting status (input/output on/off) or values, are applied to the selected devices only. It means you can assign different set values to every group. General rules:

- A device from the device list can only be assigned to one of the four group or none
- The group configuration isn't stored automatically, but you can do this manually (button "Save config.") and then let the software load the last save configuration automatically when opening the app
- Devices, which have been stored in a group configuration but are now disconnected, are listed in the device, but are greyed out and can be deleted manually or are cleaned up when using button "Show all devices"

Area "Group select"

Buttons **G1 – G4**	Select/deselect one or multiple device groups
Button **Reset groups**	Deletes all device assignments to all groups, deselects all groups
Group names	The text next to the group buttons G1 - G4, the group name, can be changed to your custom name when double-clicking on them

Area "Configuration"

Button **Save config.**	Saves the current group configuration into a configurations file (*.ini). Different groups configurations can be loaded and saved this way, while the most recently used configuration could be loaded automatically at app start-up by ticking the option "Load config. at app startup"
Button **Load config.**	Loads any formerly save group configurations file (*.ini) from storage and also set the most recently loaded file to load for option "Load config. at app startup"
Option **Load config at app startup**	When activated, this option will try to load the most recently saved or loaded group configurations file from storage when starting this app

13.2.3 Lower windows area

Tab **Devices**
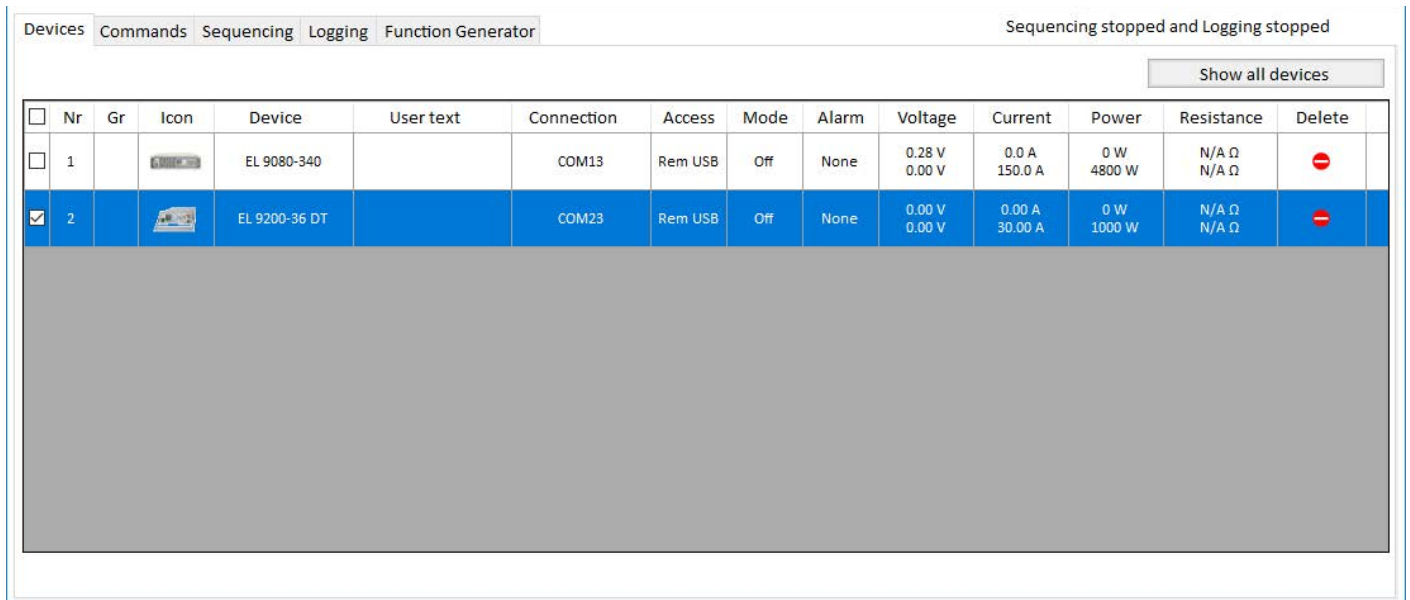
After starting the app **Multi Control**, it will list all known devices in this overview. This list can later be modified by deleting unnecessary units or refreshing. General rules for this list:

- In case the connection to any device on the list drops, it will be detected and grayed out, but can also be cleared from the list by clicking "Show all devices"
- Devices, which have been deleted from the list with a button click into column "Delete", but are still connected and online can be put into the list again by clicking on "Show all devices" or by repeating the search for devices

In the device list you can…

- select one device (one row marked blue), in order to have the upper window show its values and status
- select one or multiple devices by setting the check-mark in order to
  - » send values and/or status almost[3] synchronously to these devices
  - » run parallel Sequencing on them
  - » run parallel functions on them or at least configure functions
- assign one or multiple devices to device groups, in order to
  - » quicker select certain device types
  - » send different settings (values, status) to different groups
- delete (hide) devices from the device list
- undelete (unhide) formerly deleted devices again
- run the app "Settings" for the selected device, in order to adjust operation parameters

In the device list, at least one device row is selected and marked blue. The values and status of this device will be shown in the upper part of the window for direct access. Clicking another device switches the display. The device list show a lot of information in compact view:

Column	Column title	Information in the column
1	-	Check mark for selection of single or multiple device for group action
2	Nr	Incrementing position number for the device in the list
3	Gr	Group assignment (G1 - G4, empty when no group)
4	Icon	Device icon like in the main window, used for easier device type recognition
5	Device	Device name
6	User text	Show the user text you probably have given the device
7	Connection	Interface identifier (COM port or IP)
8	Access	Status of remote control: free/local = not in remote control, remote = in remote control
9	Mode	Status of the DC input/output of the device
10	Alarm	Last alarm (copy from device display)
11-14	U, I, P, R	The three resp. four actual values (upper) and the set values (lower) which are currently in effect on the selected device
15	Delete	This column is used to delete, i. e. hide a device from the list

3) Due to the nature of the supported interfaces (USB, Ethernet) it's physically not possible to send a command to all units at exactly the same time. Instead the same command is sent to all selected devices subsequently, with the shortest possible delay

Tab **Commands**
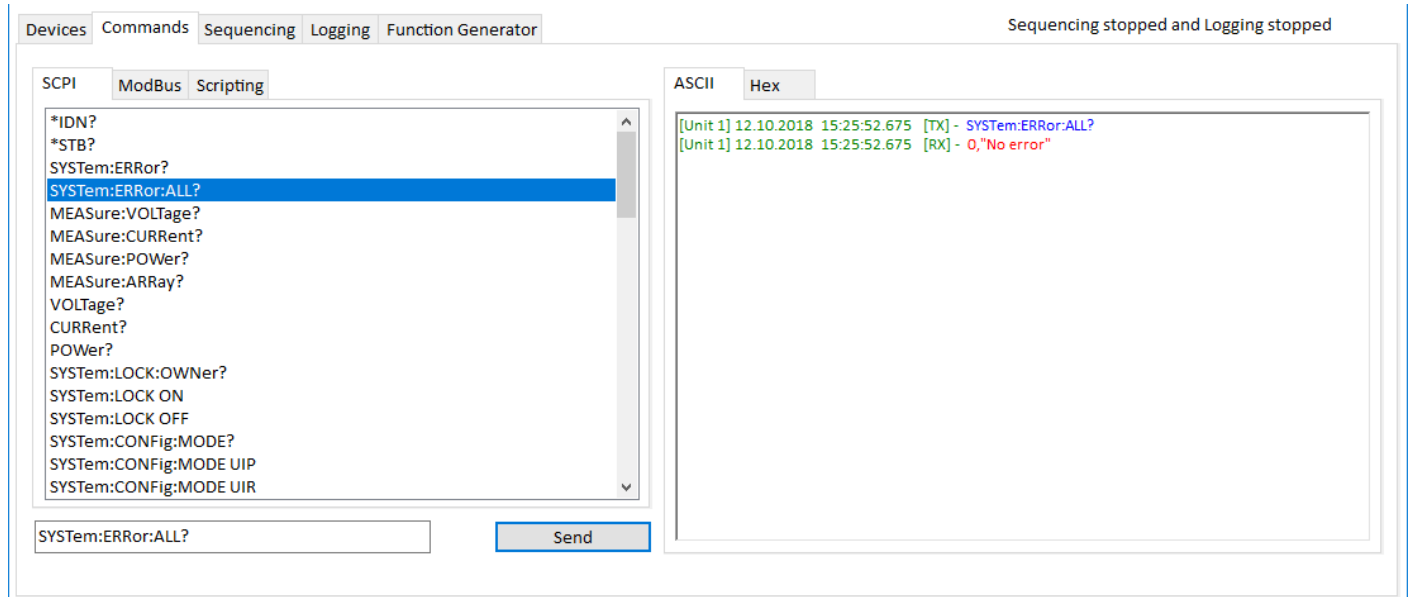
Similar to single device control in the app **Terminal** (refer to «8.5 Commands»), you can control further functions or query information which are not available in the device list or upper window part.

The difference here is that the selected command can be sent to one device or group, resulting in as much responses as devices are currently selected when querying something. In order to connect responses in the log window to devices, the entries are prefixed with the device's user text (unless not given). The figure above shows it with [Unit 1].

For more details about the subtab **Scripting** refer to «13.6 Scripting in Multi Control».

Tab **Sequencing**
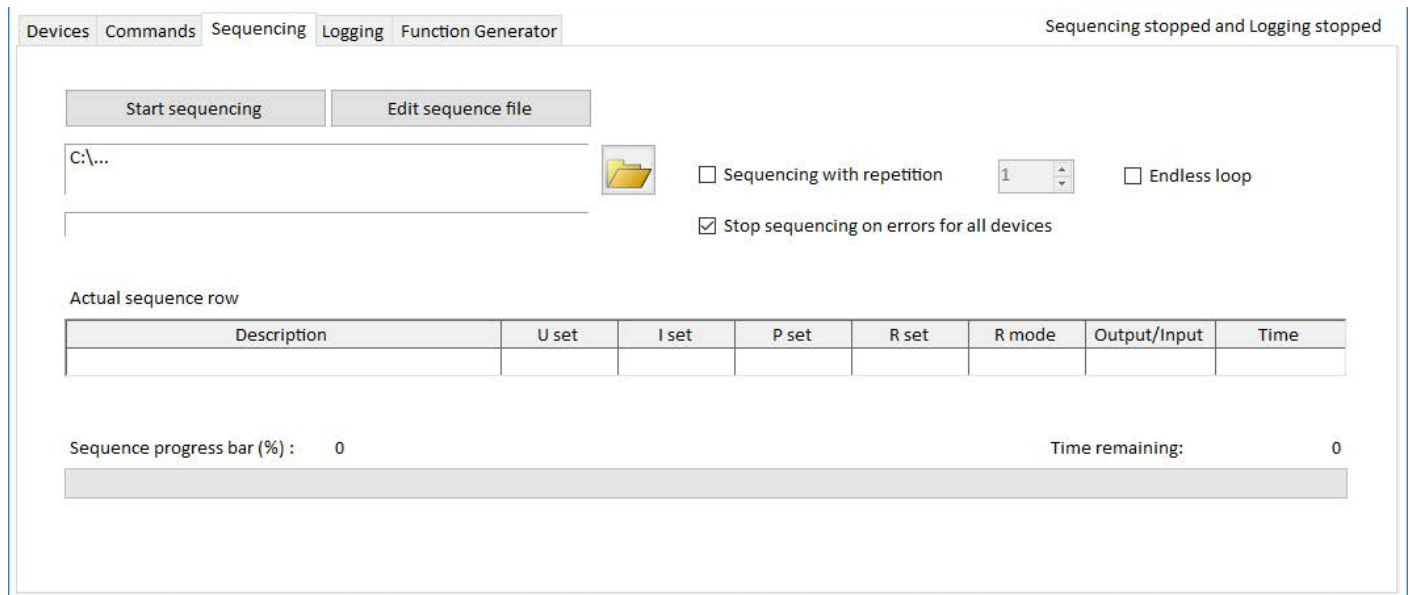
The sequencing action in this tab is very much the same as in the app **SeqLog** for single device control (refer to «9. App „SeqLog" (Sequencing and Logging)»), but with some differences:

- The sequence file will be applied to all currently selected devices at once
- The sequence file will be checked for compatibility to all currently selected devices

Tab **Logging**

Logging in **Multi Control** is available since version 2.02. The logging is basically the same as with the app **SeqLog** for single units. Also see «9. App „SeqLog" (Sequencing and Logging)».

The only difference is the log mode, which makes it possible to decide whether the log data of the devices is recorded into separate log files or one:

Option	Effect
One file for all devices	For each selected device from the device list there will be one row of data recorded with every logging interval. Thus there can be up to 20 rows with the same time stamp.
	The data in the log file can be filtered and analyzed using either the serial number or user text (unless empty), which both are also recorded for every unit.
One file for each device	This option will either automatically create a new log file for every selected device in the folder set in "Log file path" or use existing one(s). The files have a specific naming scheme like < serial_number >_<user_text>_log_<counter>.csv. Explanation:
	<user_text>: the user definable text which is stored in the device
	<serial_number>: of the device
	<counter>: 001...999, will be counted up as soon as the number of rows in a log file exceeds 65500, like when logging with app **SeqLog**

For log mode "One file for each device" it furthermore applies:

- If the user text of a device is empty, the log file name will be shorter
- The selected log file path folder is checked for file already existing from previous log actions and in case they match the selected devices from the list, they are used for logging and with the selected log file action, instead of creating new ones
- When selecting one or multiple additional units in the device list while logging is running, the logging isn't started subsequently for these units
- When deselecting one or multiple additional units in the device list while logging is running, the logging is stopped immediately for these units, while it keeps running for the other units
- In case the connection to one or multiple units drops while logging is running, the logging is stopped for those while it keeps running for the rest

For log mode "One file for all devices" it furthermore applies:

- When selecting one or multiple additional units in the device list while logging is running, the logging is started subsequently for these units. The log data is then added in the log from that moment on
- When deselecting one or multiple additional units in the device list while logging is running, the logging is stopped resp. paused immediately for these units
- In case the connection to one or multiple units drops while logging is running, the logging is stopped for those while it keeps running for the rest
- The log file format isn't identical to the log files created by those device series featuring a front USB port with USB logging feature

<u>Tab **Function Generator**</u>
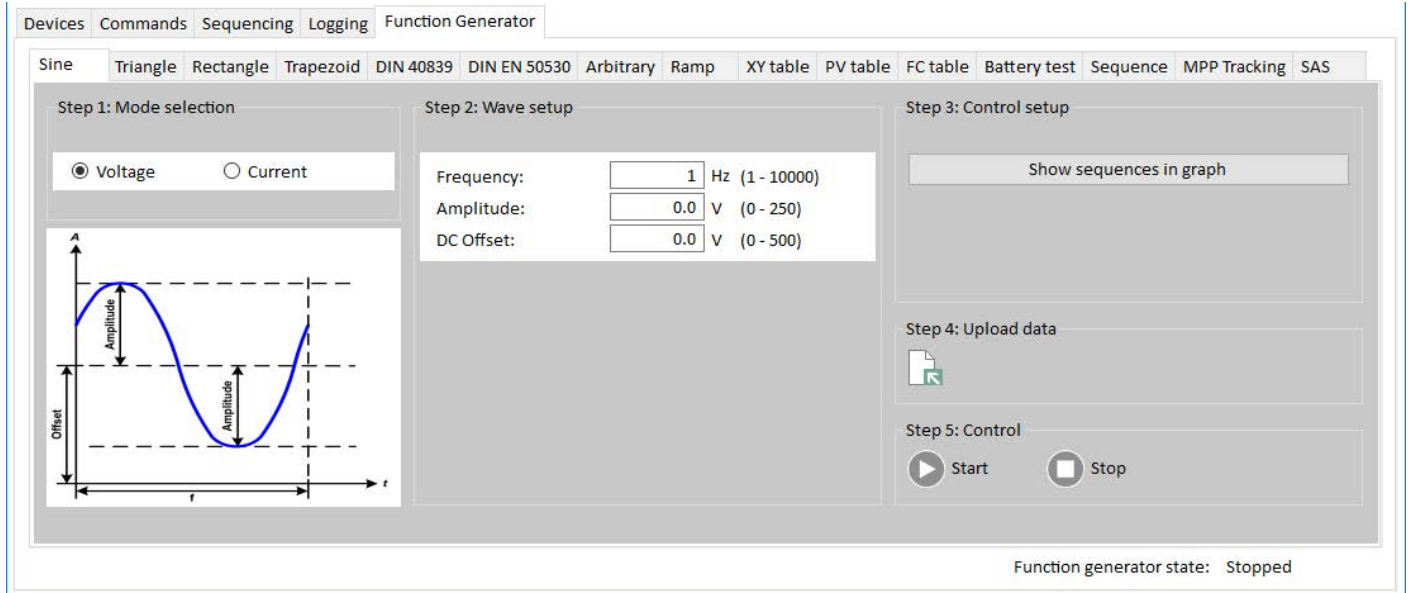
Most functions in this tab are set and handled the same way as in the app **Function Generator**. Also see «14. App „Function Generator"». But there are a few additional features only available in the function generator in **Multi Control**, because they require multiple units to run. These are:

- **SAS** (Solar Array Simulation, available since version **EA Power Control** 2.12, see section «13.3»)
- **MPPT Flow Control** (available since version **EA Power Control** 2.11, see section «13.4»)

There are also a few additional rules for the use of the function generator in **Multi Control**:

- The tabs of the single functions are always accessible, even if only one device is currently selected and that one device doesn't feature a function generator
- When selecting different device types at the same time, the tab will show all functions which would be available on the control panels of the single devices. Every function could be configured, but only loaded if it was one which is featured by all selected devices. Otherwise loading is aborted with an error message. For example, the battery test isn't supported by power supply devices. Hence it's recommend to group only devices of same type and also check what functions are featured by the device series
- Values, as you can enter them in the various input boxes and which are related to set values (U, I, P) on the devices, are limited to lowest of the ratings of the selected device. Example: you selected two devices, one with 60 V rating and one with 40 V. Then all input boxes related to voltage would only accept to enter max. 40.

13.2.3.1   Context menu

There is a context menu (right-click) in the device list to perform extra actions for a single device or multiple selected devices:

Menu item	Parameter	Effect
Open in	Settings	Opens app **Settings** for the device in the selected row. Also see «10. App „Settings"»
Set group	G1, G2, G3, G4, None	Assigns the device in the selected row to a group (G1...G4) resp. revokes an assignment (none).
Send command	ACK alarm	Alternative method to clear an alarm (row marked red)
Set group for all marked devices	G1, G2, G3, G4, None	Assign devices with check mark to a group resp. revoke assignment
Set values for all marked devices		Set values of U, I, P and R to all devices with check mark
Try to connect		Tries to re-connect with a disconnected device (greyed out). If successful, the device can be used again.
Start/stop sequencing for all marked devices		Starts or stops Sequencing, depending on the current status, the same was as when using button „Start Sequencing" in tab „Sequencing". Also see <u>Tab „Sequencing"</u>.
Start/stop logging for all marked devices		Starts or stops Logging, depending on the current status, the same was as when using button „Start Logging" in tab „Logging". Also see <u>Tab „Logging"</u>.

13.3 Function "SAS" (Solar Array Simulation)

13.3.1 Introduction

This function is implemented since version **2.12** of **EA Power Control**. It extends the feature set of the simple PV simulation by the definitions of norm paper EN 50530. Together with a set of power supplies (single units or masters of master-slave systems), it can simulate an array of various solar modules/panels with different characteristics. Thus it's possible to configure the test setup differently for each power supply. The sum of settings can be save with the "Save config." feature and loaded again after the next start.

The sole purpose of SAS is to measure data about the MPP tracking of solar inverters and to rate their tracking efficiency.

Further information about what SAS is, does and what's its benefit is can usually be found in external documentation, such as application notes.

13.3.2 Series supporting SAS

- PSI 9000 2U-24U
- PSI 9000 WR, PSI 9000 WR Slave
- PSI 9000 3U Slave
- PSI 10000
- PSB 9000 (from firmware KE 2.25)
- PSB 10000

13.3.3 Control elements in the SAS window

Nr.	Description
1	**Device selection**. Lists all devices you selected in the device list, excluding incompatible ones. Every device can be selected one by one from the drop-down field to configure it or, after the configuration is done, the settings of any device can be applied to all other units as well, if option "Apply same settings for all devices" is enabled.
2	**XY curves windows**. Opens up to three different pop-up windows with an XY graph showing real-time calculated an UI, UP or efficiency curve of the currently selected unit. The efficiency curve would thus only all results after the test has finished. When switching to a different unit, these pop-up windows don't switch as well. They must be reopened manually to show the curve of the next unit etc.
3	**Configuration tabs**. The test can basically run in two parts, static and dynamic tracking, whereas static runs first. In the tabs, the test steps can be enabled and disabled, so that static and dynamic tests can also run standalone. More details below.
4	**Device test status**. Show test run status in form of a time counter and a progress bar.
5	**Device measurements**. Shows some measured and calculated data related to the MPP (maximum power point), as comparison. The ratio between calculated MPP and measured MPP determines the tracking efficiency.
6	**Run control**. Starts the function run or manually stops it, contrary to the default, when it would stop automatically at the end. After any form of stop, the function can only be repeated from the very beginning
7	**Create report.** After the function has stopped, this button can save a report in form of a CSV file on PC. It will contain an overview about all devices (models, serial numbers etc.) involved in the last test, plus the results from the static and dynamic test part for every device.

13.3.4 How it works

The SAS function always works in two parts, a static test and a dynamic tracking test (MPPT). Both use check-mark buttons to enable or disable a test part, so that only static, only dynamic or both are possible, whereas when using both parts, static will always run first. During the test run the windows refreshes data shown in area (5) and after it has stopped, a report can be created for every unit in the drop-down list. The last result data is furthermore stored automatically for every device, so that when opening **Multi Control** again and going into **SAS**, the last data is still available. As an additional feature, one of the options allows for automatic saving of extra result data from every unit to PC.

> *Only specific series support the SAS function (see section «13.3.2»). Unsupported series are filtered, so that the drop-down list in the SAS window may not contain all devices you selected in the device list tab.*

Setup and run of the SAS function always follows the same steps:

1) Selection of any number of compatible units from the device list tab by putting a check-mark

2) Switch to **Function Generator** tab and in there, to **SAS** tab.

3) Select a device from the drop-down list to configure it for the static, dynamic or static + dynamic test (further explanations below)

4) Repeat the same for all other devices OR choose to use the same settings for all by putting a check-mark in the **Options** tab. This will use the settings applied for the currently selected device for all other devices in the drop-down.

5) Run the function (6).

6) If favored, create a test report file (7). This file will summarize the result data from the tables in the static and dynamic test of all involved devices. This file is saved in the same public user folder where other files will also be stored in.

13.3.5 Configuring the test parts

SAS has two test parts, a static test part called "EN 50530 Static" and a dynamic test part called "EN 50530 Dynamic". Both are configured separately.

13.3.5.1 Configuration for "EN50530 Static"

The static test part only tests one fixed MPP (maximum power point) which is defined by the values Umpp (min, nom, max) and Impp, plus the panel technology. Value Umpp requires two edge values and a regular which should be close to each other. The defined MPP is then shifted by applying varying irradiance in selectable per cent steps (see image above). This goes along a new PV table calculation for every step which also calculates the next MPP. After shifting the MPP, the solar inverter would start to track and find a new MPP, which is measured and displayed together with the calculated MPP on the right side in area "Device measurement results". The ratio between calculated MPP and the measured MPP is then used to rate the inverter efficiency, which is depicted in per cent in table for every Umpp.

The technologies "cSI" and "Thin film" have no adjustable parameters which are thus only shown. The settling and testing times are adjustable, but set to default value from the norm. Definition:

Settling time: time to wait before every step. A step is, for example, to go from Umpp (min) to Umpp (nom)

Testing time: total time to dwell on the next MPP (step). It adds to the settling time.

Example: let's say rows 5%, 25%, 75% and 100% in the table are activated. Every row would process three MPP settings for Umpp(min), Umpp(nom) and Umpp(max), with the selected irradiance. The settling time is 300 seconds, the dwell time is 600 seconds. The total test time for the static test part would then be 4 x 3 x (300 + 600) = 10800 seconds or 3 hours.

13.3.5.2 Configuration for "EN50530 Dynamic"

The dynamic part has extended features compared to the static part. It runs similar to the day trend ET curve in the EN 50530 PV function (see user manual of series supporting this function). It requires to load a CSV file from hard drive, which can hold up to 50 rows of configuration data. This data is then listed in the table (see figure above). Any number of rows loaded from the file can be activated to be used in this test part. In this windows, you would also define an MPP, which would later be shifted in the test run by the factors in the table, such as irradiation (in W/m²), ramp up time, dwell time etc. The temperature, like used in simulation modes ET and DAY ET, can't be varied here.

The total time required by the dynamic part is determined from the number of cycles and time values in the table. Visualization of the MPP trend in the dynamic test part:

(1) One cycle of a table row. The period results from (ramp up time + dwell time high + ramp down time + dwell time low) * cycles.

(2) Ramp up time

(3) Dwell time high

(4) Ramp down time

(5) Dwell time low
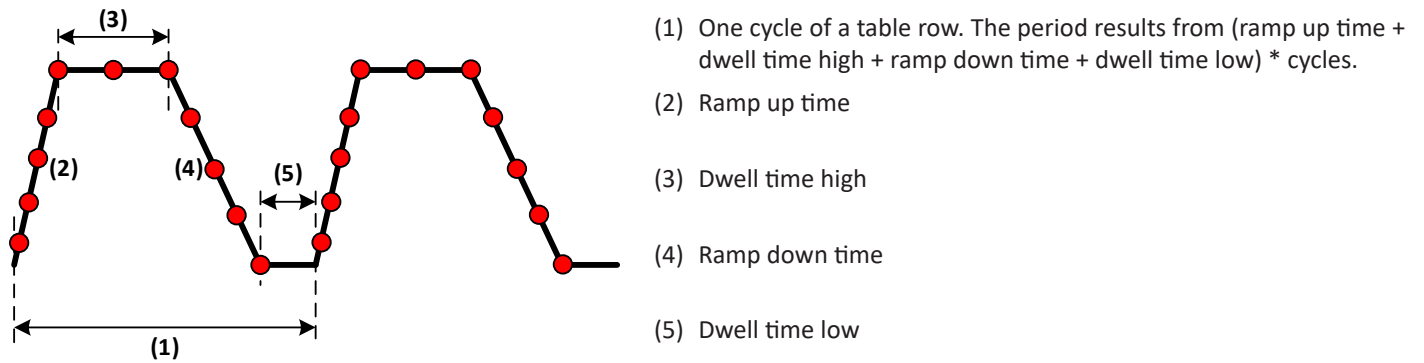
Format of the configuration file:

- Text format (CSV), columns separated either by comma or semicolon (the file format must match the selection in the global configuration of **EA Power Control** in configuration window, tab "Format")
- Up to 50 rows plus 1 header row
- 7 columns, defined as this from left to right:

Column header	Description	Value range
Irr from (W/m²)	Irradiation trend over time (rising/falling ramp, shown in combined form in the table in the SAS app window)	1...1500
Irr to (W/m²)		
Cycles	Number of cycles to process the same row. A value > 1 causes the test to repeat the trend defined by ramp and dwell times and by the irradiation	1...2^32
Ramp up (s)	Ramp up time in seconds in which the irradiation changes in the defined range "from-to"	1...1500
Dwell high (s)	Dwell time at the end of the rising ramp (defined by the "to" value of irradiation")	1...2^32
Ramp down (s)	Ramp down time in seconds in which the irradiation changes in the defined range "from-to"	1...1500
Dwell low (s)	Dwell time at the end of the falling ramp (defined by the "from" value of irradiation")	1...2^32

13.3.6 Options

All options are not activated by default. They are saved automatically and apply for all units involved in the SAS test.

Option	Meaning
Stop test for all devices upon error	In case of an error, such as a device alarm (OT, OVP) or connection drop, the test would automatically stop for the particular device. This option can be used to stop the test for the other device as well.
Save raw test data for all devices	The test run gathers a lot of data, partly displayed on screen, partly available for save as a file by clicking a button (**Create report**), as kind of a summary. This option enables to save more and raw data for every device in separate files, sort of as a log, which allows for deeper analysis
Apply setting to all devices	The test setup, i. e. configuration in the tabs **EN 50530 Static** and **EN 50530 Dynamic**, is by default done for every device separately and will be automatically stored. But this option allows to submit the configuration of any unit for all others, which makes the most sense when having a strain of identical units with identical E.U.T/D.U.T.
Run static test in UI mode	The default mode it ET (see EN50530 function description in the user manual of your device for details), where the default values E = 1000 W/m² and T = 25°C are used. The SAS function would then calculate per cent values from E and T, as defined in the table for the static test. This option switches the simulation mode to UI where the PV curve calculation isn't based on E and T, but on the U_{OC} and I_{SC} values which are internally derived from U_{MPP} and I_{MPP} via the fill factor settings defined by technology selected in the **EN50530 Static** tab.
Run static test in power mode	By default, the MPP is defined by setting up I_{MPP} and U_{MPP}. The power input box in the **EN50530 Static** tab is locked and the value only calculated. This option switches to MPP definition by voltage and power, so that the current would be calculated instead.

13.3.7 Function run, control and analysis

After the configuration is complete or when Multi Control has been started for a set of already **SAS** configured devices which would load the last configuration automatically, the test can be started (6). It runs in parallel for all devices, always consisting of the static and dynamic test part. Due to different device types and configurations the test time can vary pretty much from unit to unit.

The **SAS** window would always show the measured data and test status of the device currently selected in the drop-down list. In order to see data and status of other units, it requires manual switching.

The test would usually stop after a determined time which results from the sum of settings in the configuration, but could also be stopped by an error (alarm, connection lost) or manually anytime (stop button, (6)). The latter means to stop the test for all devices at once.

At the end of the test, i. e. when all devices have run through, the test results can be read from the **SAS** window or be saved as a summary to a file ("Create report", (7)). The file would then contain the same results as shown in the tabs **EN 50530 Static** and **EN 50530 Dynamic**, but for all SAS test involved devices at all.

13.4 MPPT Flow Control

ⓘ	*In order to basically use MPP tracking your device must generally support this function and may also require a firmware update.*

MPP Tracking is one of functions recently added to some device series and supported in **EA Power Control** since version 2.10. It has been extended in version 2.11 by a feature called "MPPT Flow Control". The extension is only available in **Multi Control**'s function generator. This extension is configured in an extra tab labeled "Options", under the **MPP Tracking** function tab in the function generator.

The purpose of the flow control is have two MPP tracking test, i. e. **MPP3** and **MPP4**, run automatically after each other in an infinite loop. This automated run comes with some extra rules:

- The flow control feature has to be activated in the "Options" tab (put checkmark)
- In order to correctly run this extended MPP tracking, it's required to...
    - » Configure mode MPP3 completely and correctly in tab **MPP3 (Fast track)**
    - » Configure mode MPP4 completely and correctly in tab **MPP4 (User curve)**
- Mode MPP3 always runs first, followed by MPP4
- The extended test is started with the control elements in the MPP3 tab. Once MPP3 is done, **EA Power Control** will automatically load the configuration data for MPP4 into the device and start the MPP4 test part.
- Mode MPP3 requires to setup a max. running time
- The flow control of MPP3->MPP4 repeats infinitely until stopped, but can be paused at a specific time of day and for a specific duration

13.4.1 Flow control settings

Nr.	Description
1	**Activate/deactivate flow control**. This activates or deactivates flow control. In deactivated state, modes MPP3 and MPP4 run as usual, i. e. separately. This setting isn't saved automatically, but can be saved manually in the global configuration using the "Save config." button. When activating flow control a special situation is in effect which requires a specific sequence of steps. See «13.4.2».
2	**Step 1 period**. Step 1 will always be MPP3. This mode normally runs without a time limit until manually or otherwise (alarm) stopped. This period setting defines how long MPP3 will run in every cycle.
3	**Pause Flow control and Logging**. The flow of MPP3->MPP4 repeats infinitely until manually or otherwise stopped, so it could run for a very long time. In order to have a nightly rest period or a time window to reconfigure something, a pause can be defined for a specific time of day and a specific period. This causes the test to stop immediately memorizing the current mode and elapsed time of MPP3 to continue after the pause. If the current mode before the pause was MPP4, it will restart after the pause, because it can't continue from somewhere in the middle. Logging will also pause.
4	**Disable logging for MPP4**. By default, an activated logging would run in the background logging data all the time, even if nothing happens. Since mode MPP4 gathers its own result data and saves it to a file, the logged data during MPP4 may be useless or double, so you may decide to deactivate logging for the MPP4 cycle.
5	**Save MPP4 results automatically.** Same as when using the "normal" MPP tracking function, where you run MPP4 once and receive a full set of result data, this can be done here as well. When activated (put checkmark), the result data would then be saved automatically to the given path, except for the drive being full. There are, however, differences: • Every repetition of MPP4 creates one file with result data for all involved devices in it. In order to distinguish the blocks of result data inside the file from each other, the serial number of the particular device is inserted above the result data • Every finished cycle of MPP4 will create a new result data file with date and time in the file name

13.4.2 Procedure

Using the flow control extension requires a specific procedure for configuration and control. Given that all devices are correctly set up on their DC inputs/outputs, do the following:

7) In tab **Options** activate flow control and configure all related settings according the test requirements or load a configuration file.

8) In tab **MPP4 (User curve)** configure the test part for MPP4

9) In tab **MPP3 (Fast track)** configure the test part for MPP3

10) Start the tracking function (tab of MPP3)

11) Stop the test when finished

The test would not stop automatically, except for device alarms or connection drops.

13.5 Function "Sandia"

This function was already available in the function generator app since version 2.12, but now since 2.13 it's also available in Multi Control. It means, it can now configure and run the PV simulation according to **Sandia** on multiple units at once. Configuration and use of the function is the same as for a single device. For details about Sandia refer to section «14.1 Function "Sandia"».

It's recommended to only use and select identical device models for Sandia, i. e. ones with same voltage and current rating.

Differences in the simulation run with multiple units:

- After the start, the simulation runs on every selected device in parallel, but autonomously. The control in the Sandia windows is merely for start and stop.
- If any device experiences an alarm situation, it will stop the test, but the other devices will continue. The alarm condition can be read from the status area in the Multi Control window and in the device list you can find the particular device.
- Once an alarm has been cleared from any unit, the simulation can be restarted by selecting the particular device and run the simulation from the Sandia window. Later, when the simulation shall be stopped for all units at once, they have to reselected in the device list before.
- The simulation is only started after all selected devices have received the table data. Depending on the number of units, there can be a noticeable delay.

13.6 Scripting in Multi Control

Scripting in **Multi Control** is basically the same as in **Terminal** app. For details about using Scripting and the scripting file format refer to «8.6 Scripting». Since version 2.23 of the software there is a new feature which makes scripting in Multi Control a little different, more flexible.

The difference to **Terminal**: for the assignment of a command line to one or multiple devices out of selected group of devices it supports to put a marker, a token (here: -->) which, in combination with a text, assigns the command line to a specific device or multiple devices. That marker would be ignored in **Terminal**. More below. The said text is the so-called user text that is determined by the user and written into a device, for instance in the **Settings** app.

13.6.1 Rules

- **Multi Control** allows for control of several devices, even different models at once by sending command lines in a script to all selected devices, except the command line is marked to be written to one device only or a specific number of devices
- When a command line contains the marker for device assignment, followed by one user text that is currently not set for any of the selected devices, the software will pop up a message and script could not run as expected; with more than user texts per line and at least one of them being valid, the script could run
- It's possible to set the same user text for multiple devices would cause the software to send a command line to multiple devices while it only has one user text after the marker
- The markers for assignment (-->) and the one for comments (###) can be combined in one line
- Multiple user texts after the assignment marker can be concatenated by the "&" symbol which makes it the "user text separator" and thus the "&" should not be in any of the actual user texts
- Up to 20 user texts per command line can be concatenated
- Invalid characters in user texts: &

13.6.2 Examples for command lines with device assignment

Full command line	Description
VOLT 10	Sends then command VOLT 10 to all selected devices
VOLT 10;-->Unit 1	Sends then command VOLT 10 to all devices which match the user text "Unit 1" (not case sensitive)
VOLT 10;-->Unit 1&Unit 2	Sends then command VOLT 10 to all devices which match the user text "Unit 1" or "Unit 2" (not case sensitive)
VOLT 10;CURR MAX;POW MAX;###Set UIP-->Unit 5	Combines three SCPI commands in one line and sends them to one or several devices within the group of selected devices which have the user text "Unit 5" set. The comment is optional and won't show somewhere else

14.   App „Function Generator"
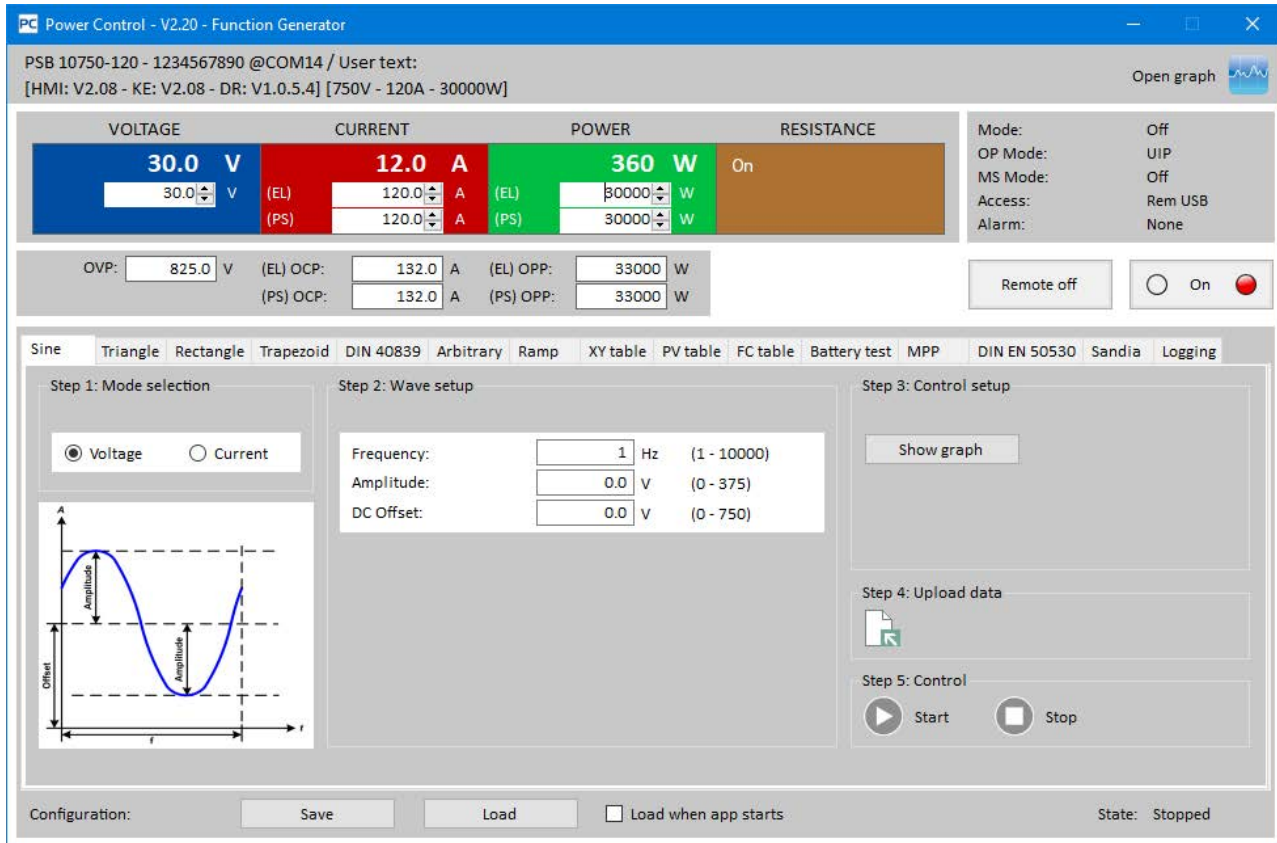
Figure 13 - Function generator app window

After the first installation of the software the app is locked. To unlock it, an optionally purchasable license has to be installed. For more information about how and where to get a license and unlocking the app refer to «12. License management». In case you already have a valid license for app **Multi Control** installed, the **Function Generator** app is automatically unlocked.

The **Function Generator** app is a representation of the manual operation of the function generator on the control panel (HMI) of those device series featuring a function generator or sequence generator, which are:

- ELR 9000 / ELR 9000 HP / ELR 10000
- EL 9000 B / EL 9000 B HP / EL 9000 B 2Q
- EL 9000 T / EL 9000 DT
- ELM 5000 (ELR 5000)
- PSB 9000 / PSB 10000
- PSI 9000 (including all sub series) / PSI 10000
-

For unsupported series the app won't start or pop up a notification.

The single functions and their parameters etc. are described in the device manual and are not explained further herein. The following things are different or additional to manual control on the HMI:

- When starting the app, the set values of voltage and current are reset to zero for safety reasons. In order to run the function correctly, you need to set these values, plus power, as required for the application
- The setting for functions Sine, Triangle, Rectangle, Trapezoid, DIN 40839, Battery test, PV table, FC table and Ramp can't be loaded from the device into the app window
- All parameters in any of the functions are not saved automatically by the app nor transmitted automatically to the device. You need use the "Save config." button in order to save the settings or load them into the device with the button in area "Step x: Upload data"
- The app ignores activated resistance mode (**UIR** in status area) at first, but automatically switches it off when eventually loading the configured function data into the device

14.1 Function "Sandia"

The name "Sandia" comes from the US american institution "Sandia National Laboratories". It developed a photovoltaics test function similar to the one from european norm EN 50530. It works with less factors and thus less options to play around with, but at the same time it's simpler and easier to handle.

This Sandia function is pure software, embedded into **EA Power Control** since version 2.12. Contrary to the purpose of EN 50530, Sandia isn't intended to measure and rate the tracking efficiency of solar inverters, but to rate the overall efficiency of energy generation in solar plants, i. e. the combined system of solar module(s) and inverter. Further information about Sandia and its test mechanism can be found in official documentation from Sandia National Laboratories.

14.1.1 Overview and control elements

Nr.	Description
1	**Configurations tabs.** These are used to enter the test parameters from which the PV curve will be calculated. Variation of the fill factor (FF) is optional, else the Sandia defaults it to 0.78. If FF use is activated, the software will ignore Uoc and Isc parameters and instead calculate both from Umpp, Impp and the FF. Tab "Advanced" even allows for the integration and variation of additional factors into the table calculation, such as temperature. All these affect the resulting PV curve. See section «14.1.2».
2	**Calculate table**. After entering all parameters, the PV table data, which represents the PV curve, is calculated by clicking this button. This doesn't happen automatically and may take a few seconds.
3	**Save table to file**. This is an option to save the calculated table data to a CSV file on a storage media for later analysis or visualization in a different software.
4	**Show the table**. After the calculation, in order to verify the curve results as expected, it can be visualized in an XY diagram.
5	**Upload**. Before the test can actually start, it's required to upload the table data to the device. This is done by clicking this button
6	**Start/Stop**. Manual start or stop of the function run. An XY generator based function would not stop automatically, only in case of a device alarm.

14.1.2 Configuration

By default, only 4 parameters are required to set up this PV function (tab **Basic**): Uoc (open circuit voltage), Isc (short-circuit current), Umpp/Impp (voltage/current in the maximum power point). Additionally, there is a fill factor which can be activated and which defines the ratio of Uoc to Umpp, as well as of Isc to Impp. In case it's activated, only Umpp and Impp are required to be defined and the rest is calculated. The resulting Uoc, Isc and Pmpp are displayed in tab "Calculated results".

Tab "Advanced" offers some additional parameters to enable and configure. Definitions and ranges:

Name	Located in tab	Range	Default value	Unit
Uoc / Umpp (panel voltage)	Basic	$0...U_{Nom}$ of the device	-	V
Isc / Impp (panel current)	Basic	$0...I_{Nom}$ of the device	-	A
Fill factor	Basic	>0...1	0.78	-
Irradiance reference value	Advanced	>0...1500	1500	W/m²
Irradiance	Advanced	>0...1500	1500	W/m²
Temperature reference value	Advanced	-40...80	50	°C
Temperature	Advanced	-40...80	50	°C
Beta (temperature coefficient)	Advanced	-1...<0	-0.38	-

14.1.3   Control

After configuring all necessary parameters the table has to calculated before it can be uploaded to the device. Table calculation doesn't happen automatically, so you have to trigger it by clicking the corresponding button. Calculation can fail and will then be reported on screen. One possible reason to fail could be a voltage value which is too low, even if the adjustable range starts at 0. The same value could lead to a positive result with a different device model. So it can't be predetermined which values would be OK and which wouldn't. To verify the calculated PV curve is OK it's recommended to view it in the XY diagram.

After the calculation, the table can either be directly uploaded to the device (button in Step 3) in order to start the test, or the curve resulting from the table data can be viewed or the table data could be stored to a file for other purposes. Once the table has been uploaded, the control button Start/Stop will be unlocked and the PV simulation can be started immediately. During the test run only output voltage and power set values are adjustable, which are global limits able to affect test results, so it's recommended to set the output voltage to at least as high as Uoc, ideally before the test is started, and the output power to at least the calculated power of the MPP, but better to the product of Uoc * Isc.

14.2   Function "DIN EN 50530"

This function is mostly identical to the equally named function as available on the HMI of select series. For details about this function, its setup and use please refer to the user manual of the device. This section is only intended to describe additional features.

14.2.1   Simulation mode "U/P"

Additionally to the simulation modes as also available on the HMI of your device, **EA Power Control** features this mode since version 2.17. It allows for a different method to impact on the MPP compared to simulation mode U/I. With U/P mode, the user only enters a per cent value which is factor for the current in the MPP. Input example:

The value "Pmpp (100%)" in Step 3 is simply calculated from the in Step 2 given MPP values Umpp and Impp. Value "Umpp" is variable during the simulation, but only in Step 3 part and only in this simulation mode. Value "Percentage" is also variable during simulation and is the main factor to focus on, as it moves the MPP on the Y axis of the PV curve by varying the current (Impp) in per cent of the current value given in Step 2. Example: if "Impp" would have beeb defined as 120 A in Step 2 and either before or during the simulation is running you would set the "Percentage" to 50%, the simulation would start with 60 A or change to 60 A.

14.2.2   Simulation mode "DAY U/P"

Additionally to the day trend simulation modes DAY ET and DAY UI, as also available on the HMI of the device, **EA Power Control** features since version 2.19 the mode **DAY U/P**. This is derivate of mode DAY U/I, but in this mode values for current and power in the MPP are loaded. The layout of the DAY UP data file is identical to the one for DAY UI, it's only that the current values (3rd column) are replaced by plausible power values. The device would still work internally in DAY UI mode, but **EA Power Control** would calculate the necessary current values from the voltage and power values in the table, before uploading the data to the device.

However, there is another new feature. Basically, the device supports to load 100,000 points or indexes for a day trend simulation. In case less are actually loaded, the data could also be multiplied which turns out as sort of extension or repetition of the simulation. An example: let's say you have an index table with 800 value sets, called indexes. These form a full day trend. When loading this table, it only uses 800 out of the possible 100,000 indexes. Let's also say you wanted to repeat the simulation 8 times with the same data. This could be achieved by either duplicating the 800 existing indexes seven times in the same table or let the software do it. The value "Cycles" defines how often the loaded day trend data is run through or repeated. The 800 indexes would fit 125 times into the capacity of 100,000. Setting 8 cycles would result in 6400 indexes to be uploaded to the device.

The value "Max. index" can be used to limit the number of indexes to be uploaded to the device. In case you have loaded the example table with 800 indexes and only wanted to run 720 of them, you could define it here.

The button "Show graph"will open a window with an XY diagram that plots the resulting day trend curve from the loaded and or extrapolated values sets. The curve is zoomable.

There are furthermore buttons to load the day trend curve data from the device and store them into a file. The software will translate the downloaded current values into power values so the saved file in the same format as the loaded file and can be used again later.

> 🛈 *Uploading a high number of indexes can take a significant amount of time. For example, uploading 50,000 indexes take more than 10 minutes. However, the upload can be canceled anytime and the indexes uploaded so far can be used in the simulation.*

14.3 Function "Battery test"

This function is mostly identical to the equally named function as available on the HMI of select series. For details about this function, its setup and use please refer to the user manual of the device. This section is only intended to describe additional features.

14.3.1 Mode "CP" (constant power)

Contrary to the HMI of the device where the battery test can either run in constant current mode (CC) or in constant resistance mode (CR) here constant power (CP) is can additionally be activated. This mode is limited to the so-called "Dynamic test" which in the current version of this software is only available with series PSB 9000 and PSB 10000. CP has to be activated explicitly, same like CR, and also separately for the test parts "Charging" and "Discharging". After activation the power set values becomes accessible, also separately for both test parts.

When running the dynamic battery test in CP, the software will permanently calculate the charging/discharging current from the battery voltage and the given power set value to keep the power constant. It means, that the values "Discharging current" and "Charging current" have to overridden, so they're not accessible anymore once CP has been activated.

14.3.1.1 Limitations

- The power may not be held constant anymore if the calculated current would exceed the maximum current as rated for the particular device or there is an adjustment limit (I-max) which is lower than the rated current.

14.3.2 Log file format

The log file format has been modified and improved in version 2.21 and now also covers the dynamic test mode with PSB series. Furthermore, when switching logging mode "Append" the log file will also write a full new header, as shown in rows 1-4 in the example view below, with all necessary values for every new test start. This can help to verify and sort out test results later.

Since there are several test modes with different setting, not all values in the header are filled. The unused ones are marked as "N/A" (=not available). Example log file from test mode "Static discharge":

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Date	Mode	Charging voltage	Charging current	Charging end current	Dynamic discharging t1	Dynamic discharging t2	Discharging end voltage	Discharging current 1	Discharging current 2	Charging power	Discharging power	Discharging resistance	Charging time	Discharging time	Rest time1	Rest time2	Test cycles
2	05.05.2022	static discharge	N/A	N/A	N/A	N/A	N/A	0V	0A	N/A	N/A	1500W	N/A	N/A	N/A	N/A	N/A	N/A
3																		
4	U battery	I battery	P battery	R actual	Ah	Wh	Regulation mode	Alarm	Time	Phase								
5	0,00V	0,000A	0W	N/A	0,00	0,00	CC	None	10:18:46.960	Discharging								
6	0,00V	0,000A	0W	N/A	0,00	0,00	CC	None	10:18:47.965	Discharging								
7	0,00V	0,000A	0W	N/A	0,00	0,00	CC	None	10:18:48.978	Discharging								
8	0,00V	0,000A	0W	N/A	0,00	0,00	CC	None	10:18:49.989	Discharging								
9	0,00V	0,000A	0W	N/A	0,00	0,00	CC	None	10:18:51.001	Discharging								

Legend:

Value	Belongs to test mode	Description
Mode	-	Selected test mode which has been logged
Charging voltage	Static charge, Dynamic test	Output voltage of the charger when charging, must be higher than the actual battery voltage
Charging current	Static charge, Dynamic test	Current limit for charging, should be set as defined for charging by the battery manufacturer in the technical data sheet of the battery
Charging end current	Static charge, Dynamic test	Charging end current to stop the charging at
Dynamic discharging t1/t2	Dynamic discharge	Pulsed discharging. Duration for setting discharging currents 1 and 2
Discharging end voltage	Static discharge, Dynamic discharge, Dynamic test	Discharging end voltage to stop discharging at
Discharging current 1/2	Dynamic discharge, Dynamic test	Pulsed discharging between two current set values 1 and 2; test mode "dynamic test" uses current 1 for phase "Discharging"
Charging power	Static charge, Dynamic test	Power limit when charging
Discharging power	Static discharge, Dynamic discharge, Dynamic test	Power limit when discharging
Discharging resistance	Static discharge	In case CR mode has been activated for discharging test mode, this will show the defined resistance set value
Charging time	Static charge, Dynamic test	Maximum time for charging or the charging phase
Discharging time	Static discharge, Dynamic test	Maximum time for discharging or the discharging phase

Value	Belongs to test mode	Description
Rest time 1/2	Dynamic test	Rest times between the test phases
Test cycles	Dynamic test	Defined number of test cycles
U battery	all	Battery voltage as measured at the DC output of the device
I battery / P battery	all	Current/power consumed from or supplied to the battery
Ah / Wh	all	Capacity/energy consumed from or supplied to the battery
Regulation mode	all	Regulation mode of the power supply at time of log entry, depends on the phase and the battery test parameters
Alarm	all	Shows if there was a device alarm, which usually stops the battery test, and also what kind of alarm
Time	all	Absolute time stamp
Phase	all	Switches during test mode "Dynamic test" between "Charging" and "Discharging" to mark the phase and for other modes it just states the test mode

14.4 Function "Automotive"

For quality and durability tests of electric and electronic car components, the german car manufacturers have developed specialized test standards with a number of test procedures that all require a voltage source. Our device series and their wide model range cover almost all test requirements already. Specifically, the test standards **LV 123**, **LV 124** and **LV 148** are implemented in this function. More details about these standards and their test procedures can be found on the Internet or in the standard papers.

The function offers a varying numbers of test procedures for the three standards. All of them define a certain test voltage progression, forming a curve. The required curve points are calculated by the software from the parameters defined in the standard papers. The resulting test curve can also be saved or loaded, which allows for modifications to the curve if necessary. The curves either run on the internal arbitrary function generator or the software would continuously send voltage set values to the device in the calculated interval. Curves loaded from a file don't need calculation anymore.

14.4.1 Restrictions

- It requires a source device (PSI 9000, PSB 9000, PSI 10000, PSB 10000)
- Not every model of a supported series can run every test, as the tests require different voltages ranges
- The standards also demand a certain slew rate, a specific voltage per millisecond slope, which not every model can achieve, even when it's capable of supplying the required voltage range
- The software only calculates the test curve, the required voltage points and controls the run; the user is required to do the validation if and what model is suitable for a specific test procedure

14.4.2 Overview and control elements

Nr.	Description
1	Choses a standard out of three (selector: **Mode**), then a specific **Test**, plus for LV 123 as additional setting a **Voltage range**
2	Used to **Calculate** the curve for the selected test setup. The calculated curve data will be filled into the sequence point editor under "Step 2". The number of resulting curve points and also the resulting total test time vary from procedure to procedure and are defined in the standard papers. Contrary to other functions like **Sine** which are solely based on the arbitrary generator the number of sequence points here can be much higher and if they result as >99, the arbitrary generator isn't used.
3	Sequence point editor. The depiction of data here is the same as with other functions, because some test procedures use the arbitrary generator. Some of the parameters (start frequency, angle etc.) are not used for these automotive tests and remain zero. The calculated sequence point data can be edited here at will.
4	These buttons allow to save or load the calculated data in form of a CSV file that has the same format as with other functions, only may contain more then 99 sequence points. The lefthand button is only enabled for test procedures which need less than 100 sequence points.
5	The values here are automatically set when calculating data, but not all when loading a file. If there is the need to run more than 1 cycle, it can be changed here before starting. The **Show graph** button will generate a graph from the calculated or loaded data and show it in a separate window. The graph also visualizes the total test time.
6	**Start/Stop**. Manual start or stop of the function run. The function never starts automatically, but stops when either at the expected end or when a communication problem with the device or a device alarm occurs.

14.4.3   Handling

Selection and control consist of a few steps, which are almost the same as the numbering in the above overview and given that the suitable device model has already been determined:

1) Select a test procedure under **Step 1: Mode selection** or load one from a file in **Step 2: Sequence setup**.

2) If a test procedure/curve has been selected and not loaded, click the **Calculate** button. This will calculate and transfer all necessary test point data into **Step 2: Sequence setup** where the data is displayed as sequence points of an arbitrary function. The calculation results in a different number of points, from 5 to over 3000. After this the highest calculated point will be shown, like nr. 2081 from procedure LV148_E48_06A.

3) If necessary, modify the values under **Step 3: Control setup**.

4) Should the number of calculated or loaded sequence points be > 99, the function cannot run in the arbitrary generator and so the **Upload** button is locked. Otherwise click the Upload button to transfer the curve points to the device

5) Optional: view the function run in a graph window which also gives you a hint about the total test time (the x axis displays the time in units of 1 or 10 ms, so that a curve ending at 20,000 with axis caption "Time[10ms]" will run for 200,000 ms).

6) Run the function.

The test runs fully automatic and as long as the total time defines, unless any of the below listed stop condition comes into play.

14.4.3.1   Stop criteria

- User: Manual stop by stop button in the software or by leaving remote control mode on the HMI
- Technical: Interruption in the communication line between control unit and device
- Device: any device alarm, such as OVP, that would switch off the DC output
- Natural: end of test reached

### 14.4.4   Overview about the available tests

14.4.4.1   LV 123
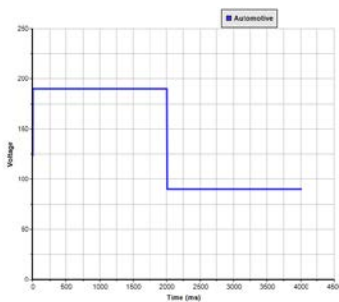
Name: lv123_unlimited_op_cap_hv_1
Voltage: 90-190 V
Duration: ca. 3x 4 s
Sequence points: 4
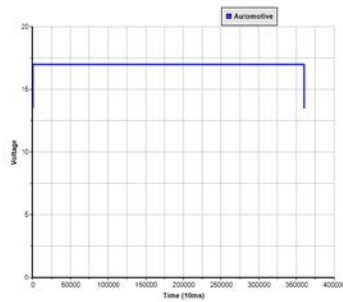Power supply model: from 200 V rated voltage
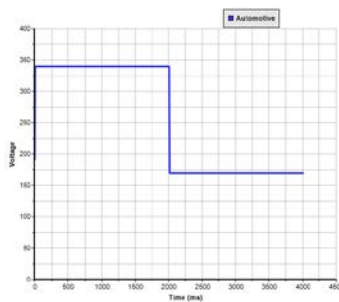
Name: lv123_unlimited_op_cap_hv_2a
Voltage: 170-340 V
Duration: ca. 3x 4 s
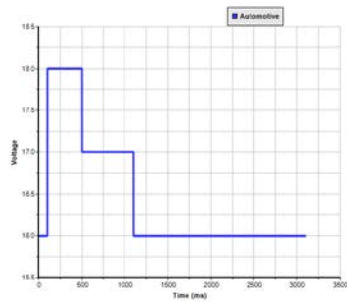Sequence points: 4
Power supply model: from 360 V rated voltage
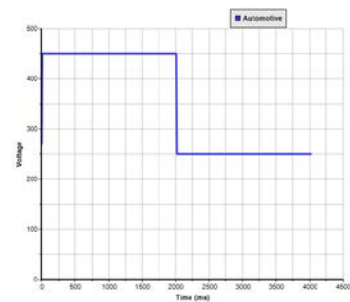
Name: lv123_unlimited_op_cap_hv_2b
Voltage: 250-450 V
Duration: ca. 3x 4 s
Sequence points: 4
Power supply model: from 500 V rated voltage
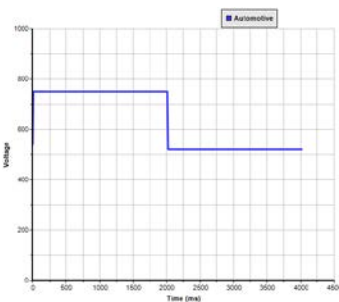
Name: lv123_unlimited_op_cap_hv_3
Voltage: 520-750 V
Duration: ca. 3x 4 s
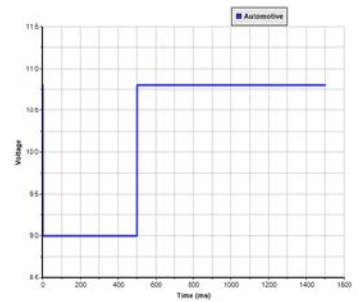Sequence points: 4
Power supply model: from 750 V rated voltage
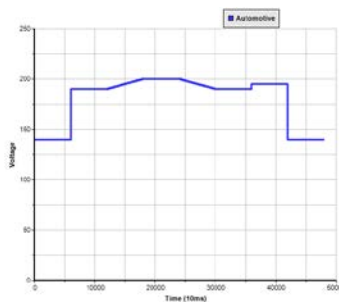
Name: lv123_upper_limited_op_cap_hv_1
Voltage: 140-200 V
Duration: ca. 3x 480 s
Sequence points: 11
Power supply model: from 200 V rated voltage
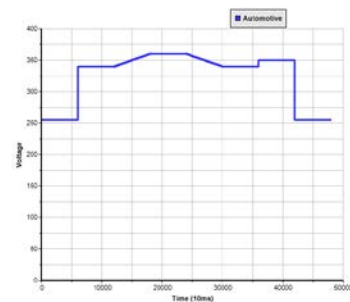
Name: lv123_upper_limited_op_cap_hv_2a
Voltage: 255-360 V
Duration: ca. 3x 480 s
Sequence points: 11
Power supply model: from 360 V rated voltage
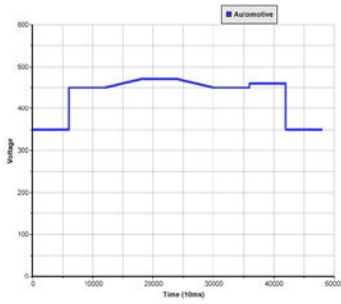
Name: lv123_upper_limited_op_cap_hv_2b
Voltage: 350-470 V
Duration: ca. 3x 480 s
Sequence points: 11
Power supply model: from 500 V rated voltage
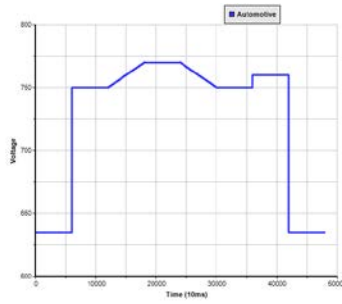
Name: lv123_upper_limited_op_cap_hv_3
Voltage: 635-770 V
Duration: ca. 3x 480 s
Sequence points: 11
Power supply model: from 920 V rated voltage
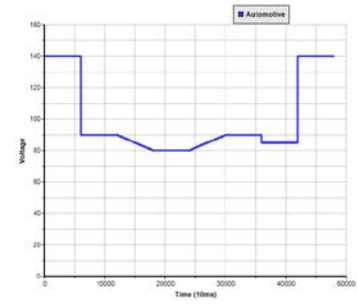
Name: lv123_lower_limited_op_cap_hv_1
Voltage: 90-140 V
Duration: ca. 3x 480 s
Sequence points: 11
Power supply model: from 200 V rated voltage
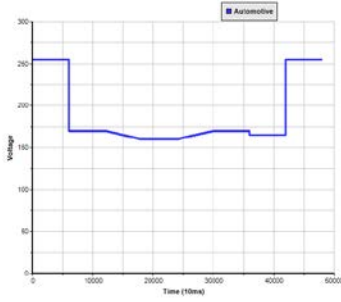
Name: lv123_lower_limited_op_cap_hv_2a
Voltage: 160-255 V
Duration: ca. 3x 480 s
Sequence points: 11
Power supply model: from 360 V rated voltage
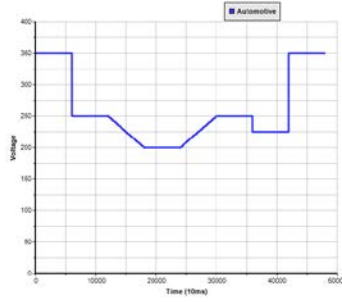
Name: lv123_lower_limited_op_cap_hv_2b
Voltage: 200-350 V
Duration: ca. 3x 480 s
Sequence points: 11
Power supply model: from 360 V rated voltage
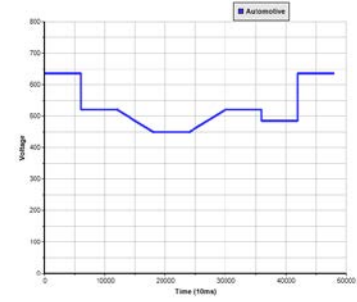
Name: lv123_lower_limited_op_cap_hv_3
Voltage: 450-635 V
Duration: ca. 3x 480 s
Sequence points: 11
Power supply model: from 750 V rated voltage
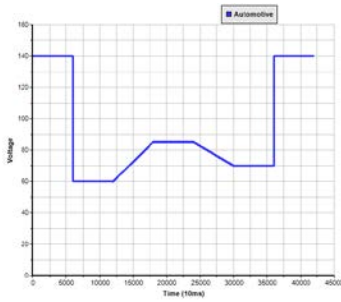
Name: lv123_highly_limited_op_cap_hv_1
Voltage: 60-140 V
Duration: ca. 3x 420 s
Sequence points: 9
Power supply model: from 200 V rated voltage
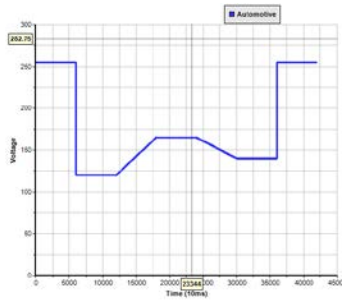
Name: lv123_highly_limited_op_cap_hv_2a
Voltage: 120-255 V
Duration: ca. 3x 420 s
Sequence points: 9
Power supply model: from 360 V rated voltage
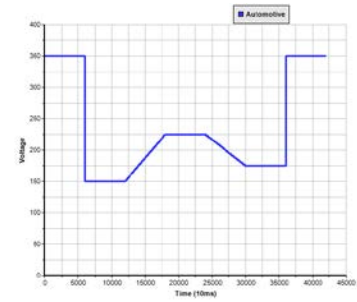
Name: lv123_highly_limited_op_cap_hv_2b
Voltage: 150-350 V
Duration: ca. 3x 420 s
Sequence points: 9
Power supply model: from 360 V rated voltage
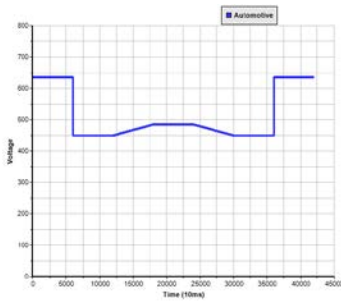
Name: lv123_highly_limited_op_cap_hv_3
Voltage: 450-635 V
Duration: ca. 3x 420 s
Sequence points: 9
Power supply model: from 750 V rated voltage
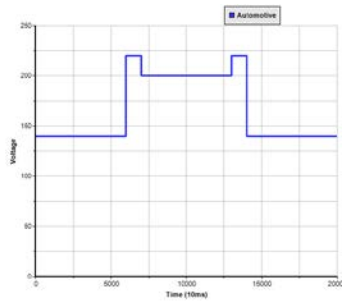
Name: lv123_overvoltage_hv_1
Voltage: 140-220 V
Duration: ca. 200 s
Sequence points: 9
Power supply model: from 360 V rated voltage
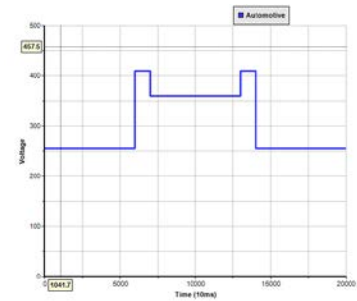
Name: lv123_overvoltage_hv_2a
Voltage: 255-410 V
Duration: ca. 200 s
Sequence points: 9
Power supply model: from 500 V rated voltage

Name: lv123_overvoltage_hv_2b
Voltage: 350-500 V
Duration: ca. 200 s
Sequence points: 9
Power supply model: from 500 V rated voltage
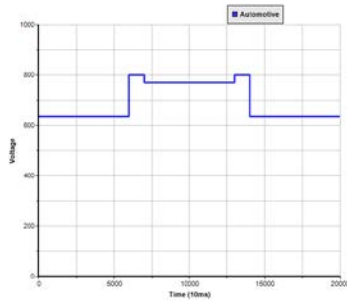
Name: lv123_overvoltage_hv_3
Voltage: 635-800 V
Duration: ca. 200 s
Sequence points: 9
Power supply model: from 920 V rated voltage
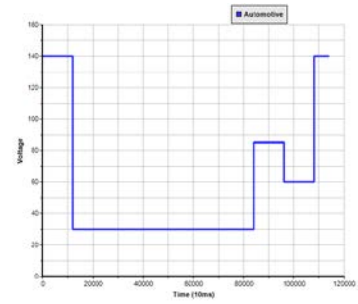
Name: lv123_undervoltage_hv_1
Voltage: 30-140 V
Duration: ca. 2x 1140 s
Sequence points: 9
Power supply model: from 200 V rated voltage
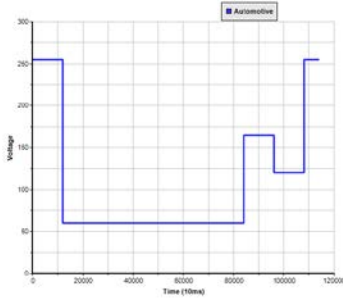
Name: lv123_undervoltage_hv_2a
Voltage: 60-255 V
Duration: ca. 2x 1140 s
Sequence points: 9
Power supply model: from 360 V rated voltage
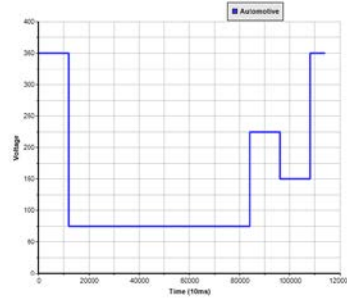
Name: lv123_undervoltage_hv_2b
Voltage: 75-350 V
Duration: ca. 2x 1140 s
Sequence points: 9
Power supply model: from 360 V rated voltage
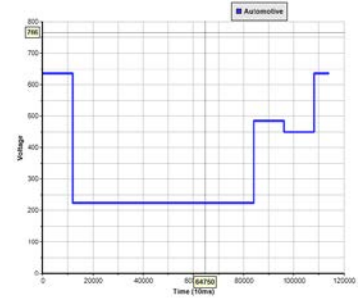
Name: lv123_undervoltage_hv_3
Voltage: 225-635 V
Duration: ca. 2x 1140 s
Sequence points: 9
Power supply model: from 750 V rated voltage

14.4.4.2   LV 124

Name: lv124_e01
Voltage: 13,5-17 V
Duration: ca. 3602 s
Sequence points: 5
Power supply model: from 60 V rated voltage

Name: lv124_e02
Voltage: 16-18 V
Duration: ca. 3x 3 s
Sequence points: 7
Power supply model: from 60 V rated voltage

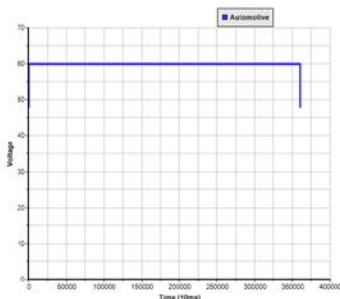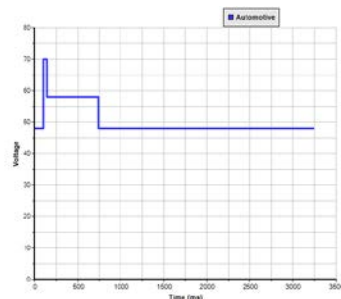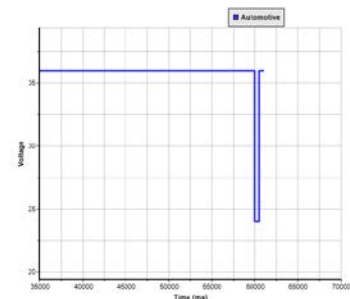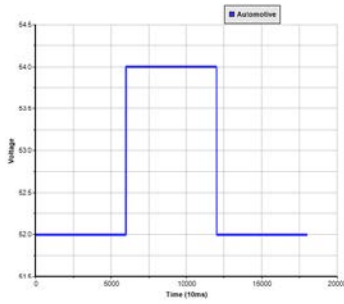Name: lv124_e03
Voltage: 9-10,8 V
Duration: ca. 3x 1,5 s
Sequence points: 5
Power supply model: from 60 V rated voltage
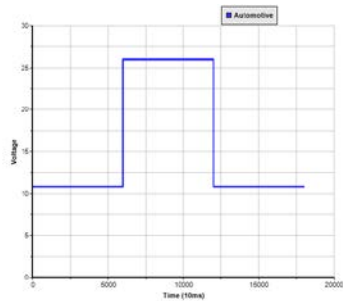
Name: lv124_e04
Voltage: 10,8-26 V
Duration: ca. 180 s
Sequence points: 5
Power supply model: from 60 V rated voltage
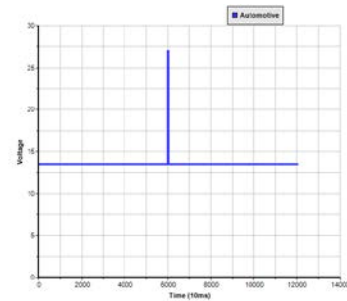
Name: lv124_e05
Voltage: 13,5-27 V
Duration: ca. 10x 120 s
Sequence points: 5
Power supply model: from 60 V rated voltage
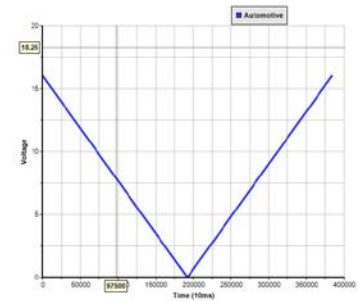
Name: lv124_e07
Voltage: 0-16 V
Duration: ca. 3841 s
Sequence points: 3201
Power supply model: from 60 V rated voltage
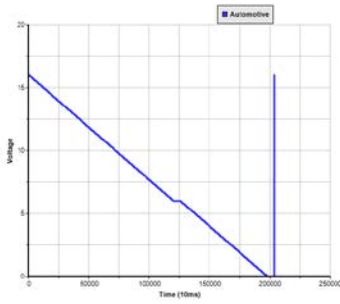
Name: lv124_e08
Voltage: 0-16 V
Duration: ca. 2040 s
Sequence points: 1612
Power supply model: from 60 V rated voltage
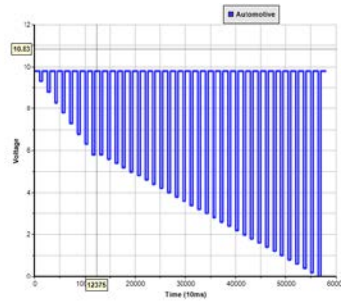
Name: lv124_e09
Voltage: 0-9,8 V
Duration: ca. 580 s
Sequence points: 77
Power supply model: from 10 V rated voltage
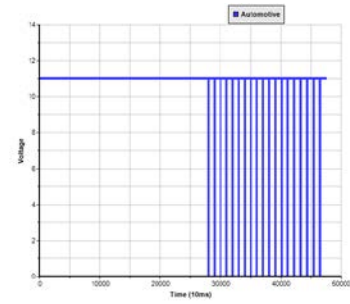
Name: lv124_e10
Voltage: 0-11 V
Duration: ca. 476 s
Sequence points: 93
Power supply model: from 60 V rated voltage
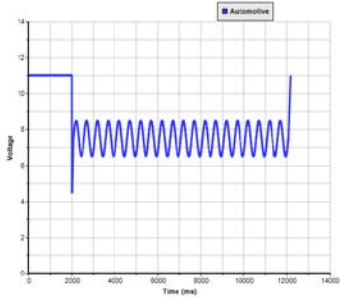
Name: lv124_e11_cold_start_normal
Voltage: 4,5-11 V
Duration: ca. 12 s
Sequence points: 6
Power supply model: from 60 V rated voltage
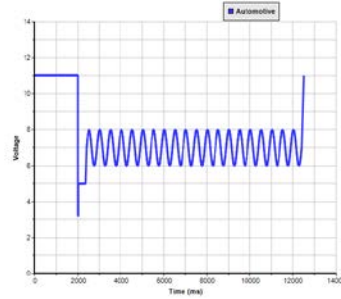
Name: lv124_e11_cold_start_severe
Voltage: 3,2-11 V
Duration: ca. 12 s
Sequence points: 8
Power supply model: from 60 V rated voltage
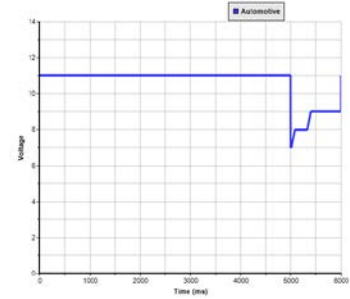
Name: lv124_e11_cold_start_short
Voltage: 7-11 V
Duration: ca. 6 s
Sequence points: 8
Power supply model: from 60 V rated voltage
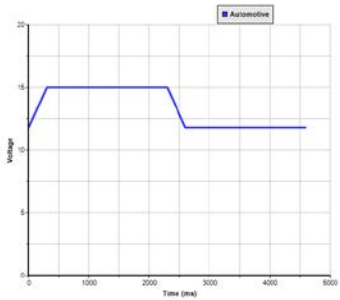
Name: lv124_e12_testcase_1
Voltage: 11,8-15 V
Duration: 4,6 s
Sequence points: 4
Power supply model: from 60 V rated voltage
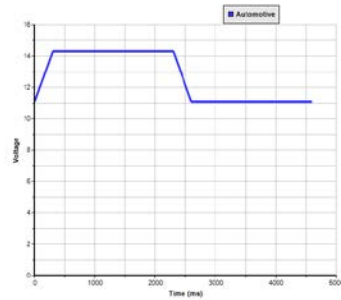
Name: lv124_e12_testcase_2
Voltage: 11,1-14,3 V
Duration: 4,6 s
Sequence points: 4
Power supply model: from 60 V rated voltage
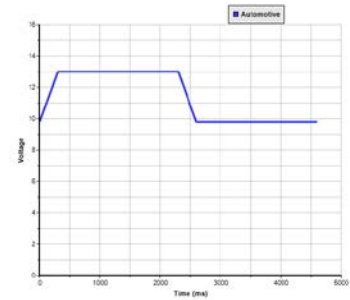
Name: lv124_e12_testcase_3
Voltage: 9,8-13 V
Duration: 4,6 s
Sequence points: 4
Power supply model: from 60 V rated voltage

14.4.4.3   LV 148

Name: lv148_e48_01a
Voltage: 48-60 V
Duration: ca. 3602 s
Sequence points: 5
Power supply model: from 60 V rated voltage

Name: lv148_e48_02
Voltage: 48-70 V
Duration: ca. 3,2 s
Sequence points: 7
Power supply model: from 80 V rated voltage

Name: lv148_e48_03
Voltage: 24-36 V
Duration: ca. 61 s
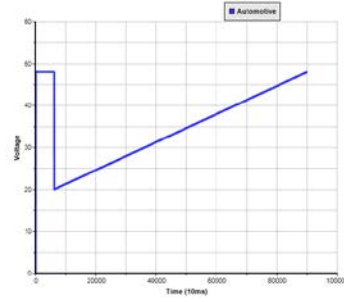Sequence points: 5
Power supply model: from 60 V rated voltage

Name: lv148_e48_04
Voltage: 52-54 V
Duration: ca. 180 s
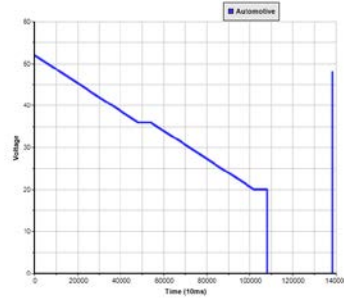Sequence points: 5
Power supply model: from 60 V rated voltage
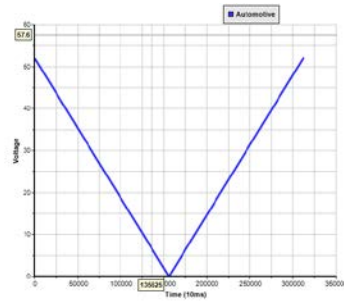
Name: lv148_e48_06a
Voltage: 0-52 V
Duration: ca. 3121 s
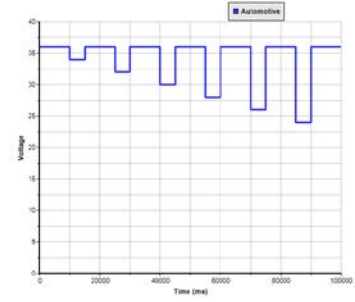Sequence points: 2081
Power supply model: from 60 V rated voltage
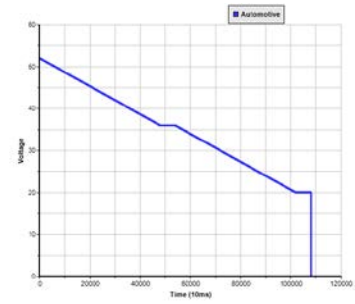
Name: lv148_e48_06b
Voltage: 0-52 V
Duration: ca. 1080 s
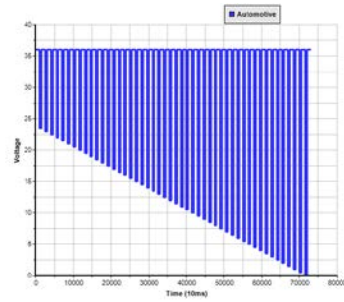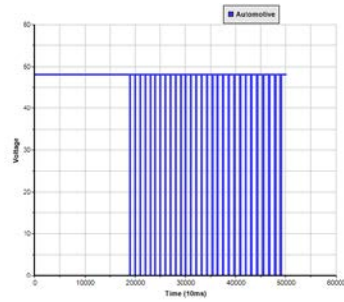Sequence points: 3203
Power supply model: from 60 V rated voltage

Name: lv148_e48_06c
Voltage: 20-48 V
Duration: ca. 901 s
Sequence points: 6
Power supply model: from 60 V rated voltage

Name: lv148_e48_07
Voltage: 0-52 V
Duration: ca. 1383 s
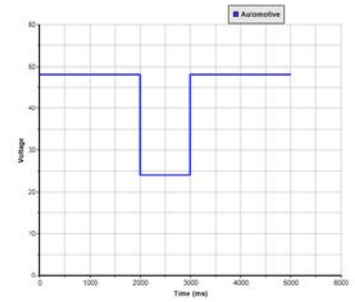Sequence points: 3205
Power supply model: from 60 V rated voltage

Name: lv148_e48_08_1
Voltage: 24-36 V
Duration: 100 s
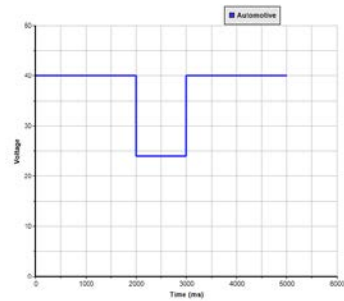Sequence points: 13
Power supply model: from 60 V rated voltage

Name: lv148_e48_08_2
Voltage: 0-36 V
Duration: 730 s
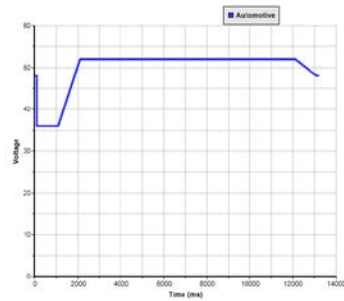Sequence points: 97
Power supply model: from 60 V rated voltage

Name: lv148_e48_09
Voltage: 0-48 V
Duration: 502 s
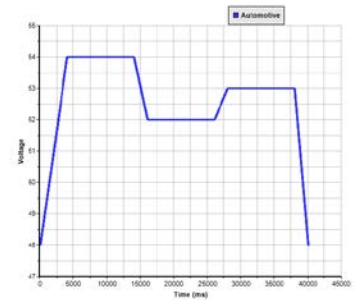Sequence points: 95
Power supply model: from 60 V rated voltage

Name: lv148_e48_10_normal
Voltage: 24-48 V
Duration: 5 s
Sequence points: 5
Power supply model: from 60 V rated voltage

Name: lv148_e48_10_severe
Voltage: 24-40 V
Duration: 5 s
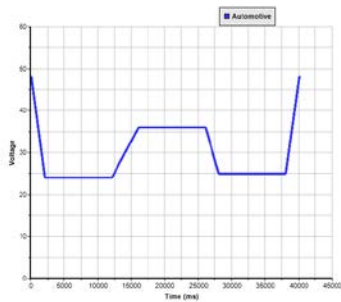Sequence points: 5
Power supply model: from 60 V rated voltage

Name: lv148_e48_15
Voltage: 36-52 V
Duration: ca. 13 s
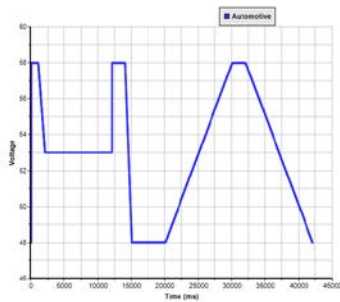Sequence points: 7
Power supply model: from 60 V rated voltage

Name: lv148_e48_16
Voltage: 48-54 V
Duration: 40 s
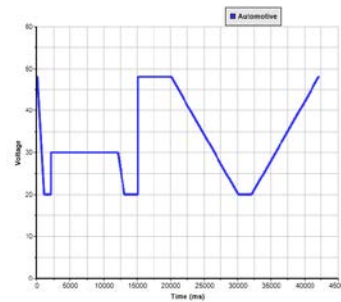Sequence points: 9
Power supply model: from 60 V rated voltage

Name: lv148_e48_17
Voltage: 24-48 V
Duration: ca. 40 s
Sequence points: 9
Power supply model: from 60 V rated voltage

Name: lv148_e48_18
Voltage: 48-58 V
Duration: ca. 42 s
Sequence points: 13
Power supply model: from 60 V rated voltage

Name: lv148_e48_19
Voltage: 20-48 V
Duration: ca. 42 s
Sequence points: 13
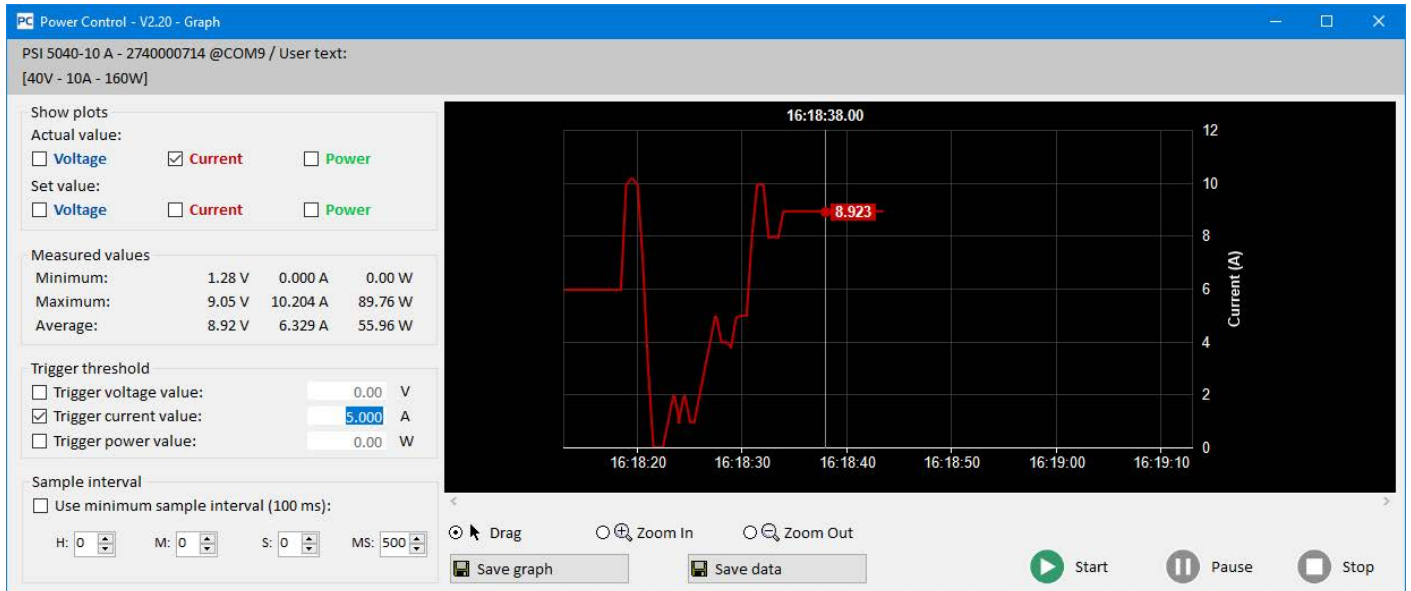Power supply model: from 60 V rated voltage

15. The Graph

Figure 14 - Graph window (default size)

After the first installation of this software, the app is locked. To unlock it, an <u>optionally purchasable license</u> has to be installed. For more information about getting a license and unlocking the app refer to «12. License management». In case you already have a valid license for app **Multi Control** installed, the Graph is automatically unlocked.

After unlocking the **Graph** by installing a license there will be a new button available in the app windows **Terminal**, **Seq/Log** and **Function Generator**:

It opens the graph window. The **Graph** records data in the background and visualizes it on the graph screen. It can show **up to 6 plots**. The recorded data (10000 samples with each plot) can be exported into a text file of CSV format (european or US format, can be selected in **Configuration**), similar to the one of the logging feature. Alternatively, the current graph screen can be saved as image.

The graph screen always shows a time range of at least 1 minute and a maximum time range of 10000 x sample interval. It means, with a sample rate of 1 s the zoomable and movable time range would be 10000 s etc.

15.1 Control elements

Area "Show plots"

The check boxes enable and disable the 6 available plots. The color here is the same as used for the plots on the graph screen, in order to see which plots represents which physical value. The graph has three vertical axes for U, I and P. The set values and actual values belonging to the same physical value use the same scale. Switching off a plot only makes it invisible on the graph screen, but the data for it's still recorded in the background, so that when switching it back on again, there will be no gaps and the recorded data of the plot is filled into the graph at once.

Area "Measured values"

The values in this area update with the every elapsed sampled interval. This area is only of informational value.

Area "Trigger threshold"

The check boxes here enable or disable separate trigger thresholds which can make the graph stop when reaching any of the enabled thresholds. It works both ways, either if a value is above the threshold and then falls or if it's below the threshold and then rises. After a stop has been triggered, the software will pop up a message. Once the pop-up is closed, the recording can be continued.

The threshold values only become valid if the entered value is confirmed by ENTER or RETURN key on keyboard or if you click with the mouse somewhere outside of the numeric field.

Area "Sample interval"

Defines the sample interval, i. e. the time after which the graph collects the next set of data (=sample) from the device to record it into plots. The default value is 500 ms, the minimum value is 100 ms and the maximum is 99 h 59 m 59 s 999 ms.

For using the **minimum interval of 100 ms** it's sufficient to tick the check box. This setting doesn't touch the adjusted sample interval, so that when deselecting the check box, the other sample interval instantly becomes effective.

Changing the sample interval while the graph is running will be effective after the momentary interval has elapsed.

Buttons "Drag", "Zoom in" and "Zoom out"

These three buttons are for use with the graph screen only. Once a function of those three has been selected by clicking the button, it can be used on the screen. As the button names say, the graph can be zoomed in or out, for instance to analyze a specific part and save images or show the entire record of max. 10000 samples. When zooming, the scales on the Y axes are adapted, so it can happen that plots gets out of the visible area. This can be compensated by dragging the visible area or zooming out again.

Button "Save graph"

This button can be used to save a snapshot of the graph area to an image file (PNG, JPG, GIF, SVG) or PDF on any storage media. It will save the entire graph area, including the scales.

Button "Save data"

With this button the samples, i. e. data recorded in the background (actual values of U, I, P) can be saved to a file at any time, even while the graph is running. The exported file format is similar to the log file of the logging feature, but only holds the three actual values plus a time stamp. The exported file can contain recorded samples up to the max. number of 10000.

Buttons "Start", "Pause" and "Stop"

These are used to control the graph run. After every first start or the next start succeeding a stop, the graph area is initialized according to the last settings of color and will be cleared. The graph then starts to plot the recorded samples. Button only pauses the graph from plotting, the data record is continued in the background, so that when continuing the plotting with , the graph plots all data recorded in the pause at once into the graph area and jumps ahead to the current time stamp. Stopping with button causes the plotting to end, with the max. last 10000 samples in memory, which then could be exported.

15.2   Context menu

The graph area offers a context menu which becomes accessible when hovering the mouse pointer over it. It's used to change the plot settings:

Menu entry	Function
Auto scale Y	Activates or deactivates the auto-scaling of the Y axes. When activated, the scales of the three vertical axes are dynamically adapted to the plot values in the visible graph area. When using this with very small values, the visual result can look unexpected.
Clear plot	Clears all plots and recorded samples in the memory. It can be considered as a reset. Can be applied during the graph run or in stop mode. Be careful with this function, as all recorded data will be lost.
Select background color	Selects the graph area background color between black and white. The graph grid, scales and captions are adapted as well
Select plot color	You can change the default colors of the plots here. The new color settings are stored and used the next time the graph window is opened.
how cursor value	Additionally to the plots the graph can show a vertical cursor along with a sample point on every of the 6 plots. When hovering the graph area with the mouse pointer, the cursor follows and shows the recorded value of the plot(s) at a certain time stamp.
Select plot type	For the 6 plots you can select the plot type between:

Dot = all recorded samples of the plot are shown in dot like form, with gaps due to the sample interval

Line = Default setting, draws straight lines between every sample point in order to achieve the look of a curve, depending on the zoom level

Curve fitting = similar to line mode, but rounded so the curve doesn't look so edgy when zooming in very deep |

15.3   Notes and limitations

- The graph isn't a measuring tool. The displayed and recorded values are read from the device and plotted to the graph area. Long-time recording can be done by setting a very long sample interval.
- The vertical axes of U, I and P are set to auto-scale mode by default. This can lead to weird display when working with very low values which fluctuate only a little so the auto-scaling zooms the scale. In such situations it's recommended to switch off auto-scale function and zoom in manually
- The graph window can't be opened independently, but only from within the app windows **Terminal**, **Seq/Log**, **Multi Control** and **Function Generator** and will also be closed together with them
- When running dynamic operations on the device, for example a function, the graph may not be able to keep up with the value progression on the DC input/output of the device. For example, when running a rectangular function with 1 s pulse and 1 s pause and having a sample interval of 1 s for the graph, the visual result would be a triangle. However, with the minimum setting of 100 ms the result would look like a rectangle showing a few "stairs" here and there. A better visual depiction could only be achieved using an oscilloscope.

16.   Demo mode

Since version 2.03 of this software includes a demo mode. It allows for the access to all app windows without having a real device of any compatible series connected to the PC, in order to have a look into the GUI especially of the licensed app "Multi Control". When enabling the demo mode, the software will create two dummy units for app testing. Of course, there are some limitations, such as it can't show reasonable values and status in the various app windows.

Enabling or disabling the demo mode is done in the help menu (also see «7.4 Menu & configuration»). Demo mode is furthermore only temporary until the program is terminated.