

USER MANUAL



cSLSi-24-75-(WK) cSLSi-60-70-(WK)
cSLSi-24-110-(WK) cSLSi-60-100-(WK)
cSLSi-24-140-(WK) cSLSi-60-140-(WK)



SLSi-60-240-(WK) SLSi-60-360-(WK)



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Contents

1 General Information.....	3
1.1 Delivery.....	3
2 Safety Instructions.....	4
3 Electrical Connection.....	5
3.1 Motor Connection.....	5
3.2 Battery Connection.....	5
3.3 Servo Interface (Setpoint Specification).....	6
3.3.1 cSLSi.....	6
3.3.2 SLSi.....	6
3.4 Serial Interface.....	7
3.4.1 cSLSi.....	7
3.4.2 SLSi.....	7
4 Cooling and Mounting.....	8
5 Signaling via LEDs.....	9
5.1 cSLSi.....	9
5.2 SLSi.....	9
6 Configuration via SLS-Windows-Monitor.....	10
6.1 Status Window.....	11
6.2 Trace Memory.....	13
6.3 Parameters.....	14
6.4 Help Functions and Options.....	17
6.4.1 Signal Curve Live.....	18
6.4.2 Offset Servo Input.....	19
6.4.3 Operation Point Live (Paid Option).....	19
6.4.4 U-/I-Vector Representation Live (Paid Option).....	21
6.4.5 Control Panel (Paid Option).....	22
6.4.6 Activate Options.....	23
6.5 Signal Curve.....	23
6.5.1 Current Profile (Paid Option).....	26
6.6 Firmware Update.....	27
6.7 Exit.....	27
7 Technical Data.....	28
7.1 cSLSi.....	28
7.1.1 cSLSi-24-xxx.....	28
7.1.2 cSLSi-60-xxx.....	29
7.2 SLSi-60-xxx.....	30
8 Recycling.....	31
9 Warranty, Returning the Product.....	31
10 EG-Declaration of Conformity.....	32
10.1 cSLSi-24-75.....	32
10.2 cSLSi-60-xxx.....	33
10.3 SLSi-60-240 SLSi-60-360.....	34
11 FAQ (frequently asked questions).....	35

1 General Information

The SinusLeistungsSteller (SLS) is shipped in completely potted form. Silicon cables of adequate cross-section are brought out of the cSLSi potting, on the DC-side (battery) and AC-side (motor) for electric contacting. The SLSi contacts are realized by M8-screw terminal blocks.

The potting has the task to insulate electrically and to protect the sensitive internal parts from moisture, dirt and mechanical influences from outside.



The SLS are *not* "plug&play"!

All SLS must be tuned for the type of motor or drive train on which they will be used. Therefore other motors can not be used until proper parameters are loaded on the SLS, which are suitable for the new motor.

1.1 Content of Delivery

cSLSi:

- cSLSi
- user manual

SLSi:

- SLSi
- user manual
- 5 x screw (M8)
- 5 x ring washer (M8)
- 5 x serrated lock washer (M8)
- plug for the servo connection (PHOENIX CONTACT MC 1,5/4-ST3,5)

2 Safety Instructions



- **All constructional variants of the SinusLeistungsSteller (cSLS, cSLSi, SLSi) must not be used in the man-carrying area! We hereby explicitly prohibit such use!**
This does not include applications for testing and research purposes, which were reviewed and approved by us (IBZ) in written form.
If the buyer/user performs such application, using one of our controllers without our written consent, this will be at his own risk! We do not accept liability on our part, for damages that might occur directly or indirectly!
- When being installed in machines, the intended operation of the SLS is forbidden, until it has been ensured that the machine meets the machinery directive and EMC directive.
- During operation the SLS may have unprotected contacts as well as hot surfaces.
- Assembly and commissioning must be carried out by qualified personnel. Qualified personnel in the sense of the general notes of safety are persons, who are familiar with setting up, assembling, starting up and operating this device or possess the corresponding knowledge within their field of work.
- All SLS are allowed to operate only with an appropriately sized current fuse for reasons of safety.
- It is necessary to maintain a safe distance from all movable parts when connecting motor and source with the SLS, because the motor can accidentally start up due to incorrect operation or electric defect. A starting electric motor can cause serious injury. It is important to ensure that no property damage or personal injury occurs when commissioning the controller.
- The controller has to be protected against electrostatic discharges in order to avoid damage.
- A damaged controller (e.g. due to moisture, mechanical or electrical influences) must never be used, otherwise it may result in controller failure.
- The controller is designed for operation with batteries. If operated via a power source, this source must be able to sink eventually generated currents and must have a galvanic insulation to the grid.
- Extending DC- or motor-cables can influence the EMC characteristics and possibly requires an adjustment of controller parameters. Extending or shortening the cables is carried out at your own risk!

3 Electrical Connection

3.1 Motor Connection

Connect the 3 motor phases to the 3 phase connections of the SLS! The assignment of the connections initially does not matter. A possibly wrong direction of rotation can be fixed later by interchanging two of the three phases (or by activating the "Change Direction" parameter in the SLS-Windows-Monitor).

3.2 Battery Connection

Connect the power source in the following order with the SLS!



Make absolutely sure that the voltage is in the permitted range, no reverse polarity exists and nobody is located within the dangerous area of the motor! In any case use the existing precharge function to turn the controller on (internal precharge circuit of the cSLSi, external [AVS2](#) or [EBS](#))! Especially when the controller is operated near its maximum DC-voltage. Turning the device on via a mechanical switch generates excessively high charging currents in the electrolytic capacitors and in addition produces dangerous over-voltages that may result in permanent controller damage! A in this way damaged controller carries the risk of a battery short-circuit along with the risks of a possible electric arc!

First connect the minus pole of the SLS with the minus pole of the voltage source. Then precharge the input capacitors of the SLS (with the internal precharging circuit or an external [AVS2](#)). Only after the steps above are followed connect the positive pole of the source with the positive pole of the SLS. **When using a battery supply the use of a appropriately dimensioned fuse is mandatory – for applications dedicated to safety, we recommend in addition the use of a [EBS](#).** The SLS is ready as soon as the green LED lights up.

If operated via power source, this source must be able to sink generated currents (alternatively a small battery for buffering, which is connected parallel to the power source can be used). The parameter for the regenerated current must also be adjusted in the SLS-Windows-Monitor to ensure that no dangerous voltage increase occurs at the SLS input capacitors (and DC-source) – e.g. at a regenerated current during slow down of a inertia.

3.3 Servo Interface (Reference Signal Specification)

Selecting a reference signal is possible via an externally connected PWM signal. For example a Sollwertgeber ([SG2](#)) is able to produce this signal.

3.3.1 cSLSi

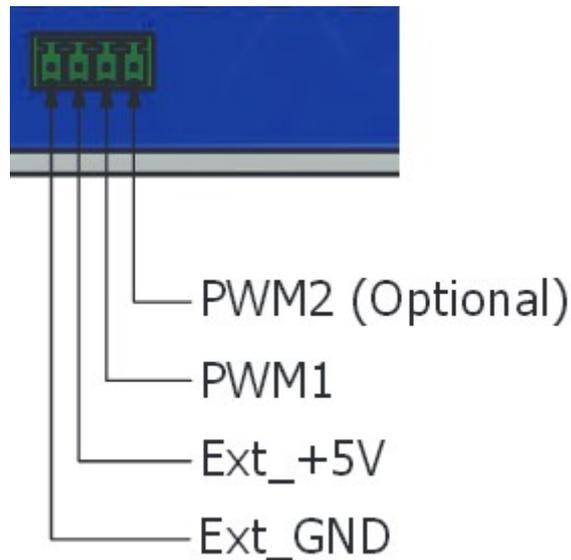
The cSLSi 3-pin connector is assigned as follows:

brown	GND
red	+5V
orange	signal

The +5V has to be supplied to the SLS from the outside, because the internal optocoupler needs also to be supplied.

3.3.2 SLSi

The SLSi reference signal is supplied via the included 4-pin connector. The pin assignment is shown below:



picture 3.1: SLSi servo input

(The PWM2 signal is reserved for future enhancements)

3.4 Serial Interface

The SLS-Windows-Monitor can access the controller through the serial interface. This makes it possible e.g. to change limit values and store them non-volatile in the SLS, exchange complete parameter sets or display the SLS status "live". This way internally recorded trace data can be read out and displayed graphically.

The connection between the PC and SLS should be as short as possible – specifically the USB-cable. If you need to extend the interface cable, extend to the RS232-side of the USB-Seriell-Interface (USI). The risk of ground-loops is prevented by the realized galvanic insulation through the USB-Seriell-Interface (**USI**). **Therefore do not use other interfaces that does not have the necessary galvanic insulation!**

The software-protocol is identical for all SLS.

Basically, the response message is seen after sending a command. Only after receiving the response, a new command can be send. The communication can only be initiated by the host. The settings of the serial interface are 115kBd, 1 start bit, 8 data bits, 1 stop bit, no parity.

3.4.1 cSLSi

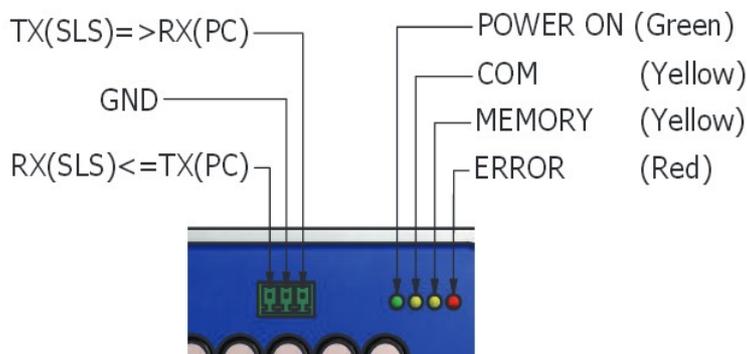
The cSLSi has a serial connection implemented via a female connector, in a 2,54mm grid with round 0,5mm pins. The pin marked on the cable, points towards the LEDs.



picture 3.2: cSLSi serial / LED

3.4.2 SLSi

The SLSi has a serial connection input realized via the 3 pin connector, next to the 4 LEDs.



picture 3.3: SLSi serial / LED

4 Cooling and Mounting

Both cSLSi and SLSi are available with a water cooling option. (-WK).

Without water cooling the aluminum potting is used as a heat sink and as a interface for external, larger heat sinks. 4 through-holes can be used for mounting. You will find the exact dimensions in the respective installation drawings located on our homepage.

During assembly, several points have to be considered:

- 1. Do not attempt to open the SLS or apply additional tooling!** Electronic components found directly under the protective potting could be damaged. Intruding moisture can damage the electronics, interfere with their function and result in permanent damage.
- 2. Avoid all forces and bending moments acting from outside the controller!** Contacts or heat sinks exposed to external forces or bending moments can lead to cracks at the transition of the potting compound, whereby the intruding of moisture is possible.
- 3. Fix the DC and AC-lines near the SLS!** The SLS can not absorb any external forces or vibrations of heavy and long leads. Therefore ensure strain relief is existing on the actual contacts!
- 4. Use thermal *paste* to achieve a good heat transfer between aluminum potting and external heat sink – do not use thermal *compound*!** The SLS can be significantly damaged (bending moments!) during a necessary disassembly of the heat sink, when using thermal compound and lead to permanent damage. Therefore the warranty expires when using thermal compound and attempting disassembly.
When using thermal paste, please make sure to **slowly** tighten the screw to the cooling plate of the SLS in order to give the paste enough time to spread evenly. Only use the amount of paste that is absolutely necessary! Remove the screw during disassembly and then pull the aluminum potting with a slight turning motion to the side. Never lift off the heat sink (e.g. with a screw driver)!
- 5. Operate the SLS only with enough external cooling (heatsink or fan) up to its limits!** Rapid change from "cold" to "warm" or vice versa leads to mechanical stresses and possibly to cracks on the potting transition.

5 Signaling via LEDs

5.1 cSLSi

The cSLSi indicates its status via 3 LEDs:

- **LED green:**
continuously ON: Internal powerup-self-test completed successfully. SLS is ready.
flashing: Loss of EEPROM-information (reload the *.SLC parameter file)
- **LED yellow:**
Data logger is active (short pulses, when data is being saved)
Communication via the serial interface is active (short pulses)
- **LED red:**
continuously ON: SLS in failsafe (under-/overvoltage or overtemperature shutdown)
pulses: SLS operates in derating (undervoltage, overvoltage, overtemperature)

5.2 SLSi

The SLSi indicates its status via 4 LEDs:

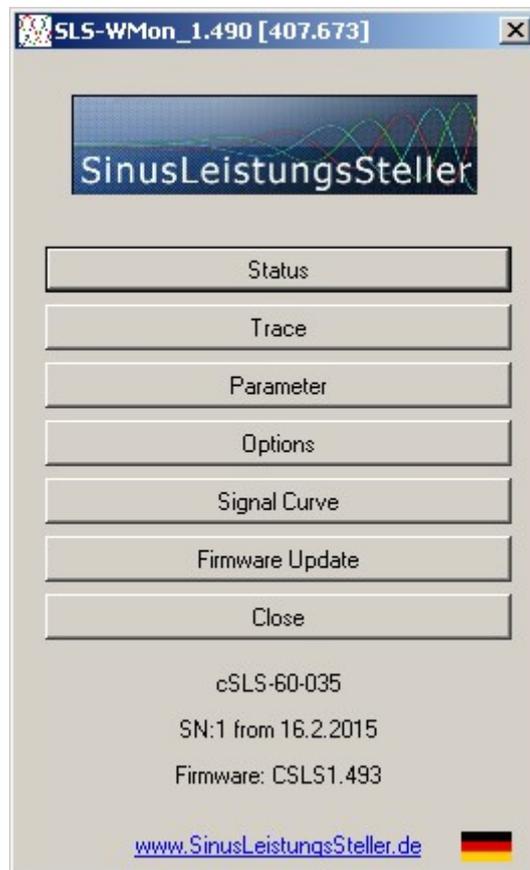
- **LED green:**
continuously ON: Internal powerup-self-test completed successfully. SLS is ready.
pulses: Loss of EEPROM-information (reload the *.SLC parameter file)
- **LED yellow1:** Data logger active (short pulses, when data is being saved)
- **LED yellow2:** Communication via serial interface is active (short pulses)
- **LED red:**
continuously ON: SLS in failsafe (under-/overvoltage or overtemperature shutdown)
pulses: SLS operates in derating (undervoltage, overvoltage, overtemperature)



The "failsafe" state protects the SLS-hardware and battery. This state can only be reset via power cycle (separating the SLS from battery for at least 30 seconds).

6 Configuration via SLS-Windows-Monitor

The SLS have a series of parameters, which define the operational behavior and enable the control. The settings are managed via SLS-Windows-Monitor.

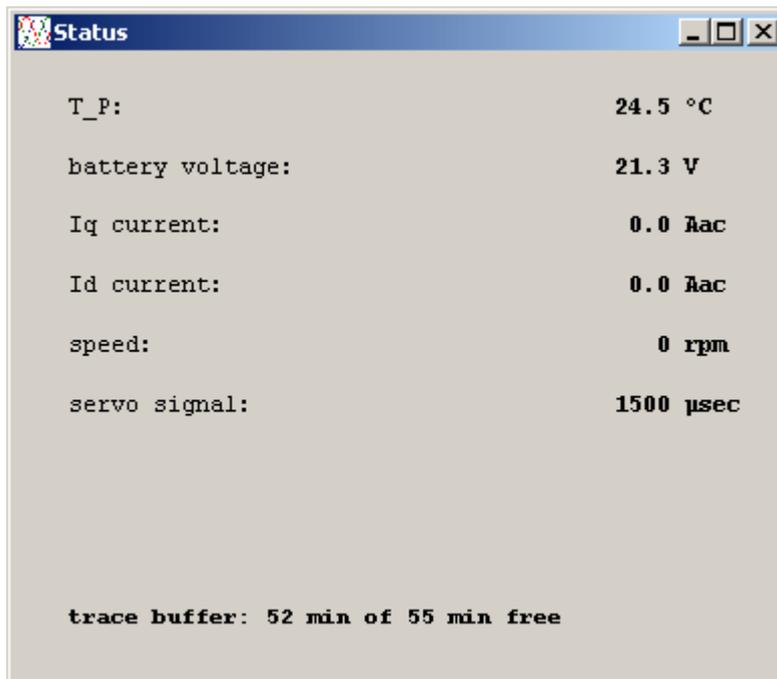


picture 6.1: main menu of the SLS-Windows-Monitor

The main-menu offers sub-menus, which are explained below. The main-menu also contains important information regarding the version of the SLS-Windows-Monitor. Further type, serial number, firmware-version of the connected controller as well as a direct link to the SLS-homepage. By clicking the country flag (right-bottom in the main-menu), the SLS-Windows-Monitor language can be changed (currently English and German).

6.1 Status Window

The status window displays the actual operation values of the SLS live.



picture 6.2: status window

- T_P: Temperature of the power module in °C.
- T_E: Temperature of the capacitors (only for SLSi) in °C.
- battery voltage: DC-voltage in Volt, measured by the controller.
- Iq current: The torque current in A_{ac}. (It is not the DC-current from the source, but the current in the motor phases!)
- Id current: The magnetizing current in A_{ac}.
- speed: The motor speed in RPM (revolutions per minute).
- servo signal: The µs-values, imported via servo interface.
- trace buffer: Information about the internal trace-memory.
 - If the ring buffer is not active, the remaining free trace-memory will be displayed.
 - If the ring buffer is active, the buffer time is displayed. For very small trace intervals (< 100ms) a limitation of the buffer cycles is necessary, to prevent excessively frequent writing. Max. 10 cycles are possible in this case. Already completed cycles will be displayed.

Possible error messages are displayed between the speed and the trace memory status:

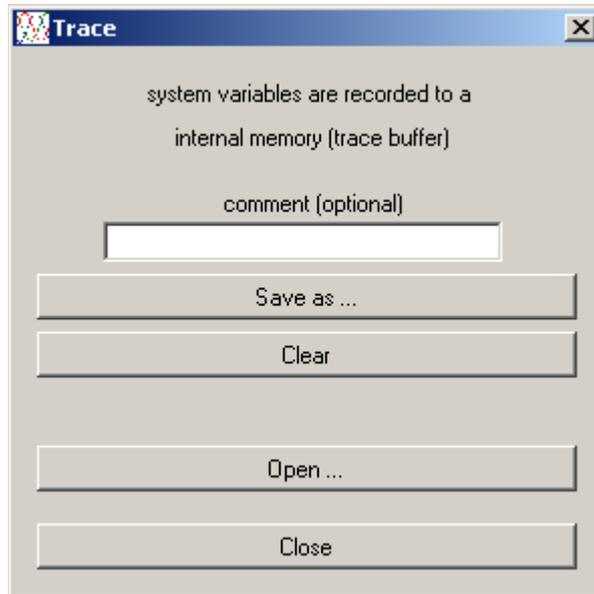
- **SwitchOff OverTemp:** The maximum temperature (100°C) has been exceeded. The SLS stops further operation. The power supply must be disconnected in order to fix the error.

Attention! Give the SLS enough time to cool down!

- **CutOff MaxTemp:** The SLS has derated the reference to zero(both for speed and current). For resetting the error, set the reference to neutral and give the SLS enough time to cool down.
- **Limit MaxTemp:** The SLS is in temperature derating mode. The speed and current are constantly derated with increasing temperature until a thermal balance is achieved.
- **SwitchOff OverVolt:** The max. allowed voltage on the DC-input of the SLS was exceeded. Operation is not possible anymore. The error cause must be fixed. To solve the problem, the SLS must be restarted and it must be ensured that the error does not occur anymore. An excessively high voltage can damage the SLS permanently!
- **SwitchOff UnderVolt:** The input voltage is too low for a safe operation or the battery is empty. The SLS voltage needs to be increased or the battery must be recharged.
- **CutOff MaxVolt:** The maximum allowed SLS operating voltage is reached. The current regeneration is derated to 0%. A further increase in voltage is prevented. With battery operation, the final charge voltage is reached.
- **CutOff MinVolt:** The minimum SLS operating voltage is reached. The SLS does not provide additional motor current. The target speed is derated to 0.
- **Limit MaxVolt:** The overvoltage derating is reached, the current regeneration reduces until no further voltage increase occurs. The battery is approaching the end charge voltage.
- **Limit MinVolt:** The undervoltage derating started. The motor current and speed are reduced gradually, until no further decrease in voltage occurs. The battery approaches its final discharge voltage.
- **FailSave_Stop - Switch SLS off - on!:** The SLS disabled itself. The controller must be restarted. The error cause has to be removed.
- **LoadLess_Flt:** This error occurs when the load is too low. Dependent on the speed a minimum load can be set using the option "current profile". If the min. load is not reached, the SLS turns off.
- **OvrSpd_Flt:** The rotation speed exceeds the set limit. The device shuts down for reasons of safety.
- **I_Offset_Flt:** The SLS offset-current-measurement is too big. A new start-up is required.
- **ZeroSpd_Flt:** The minimum speed was not reached after a start command.
- **Retry_Flt:** Even after several starting attempts no successful start was possible. A completely new start attempt must be initiated.
- **Phaseloss_Flt:** The synchronization to the rotating field was lost. A commutation is not possible, the motor must be restarted.

6.2 Trace Memory

The SLS trace memory can be read or deleted in the trace memory menu. Saved *.SLT-files can be viewed.



picture 6.3: trace memory window

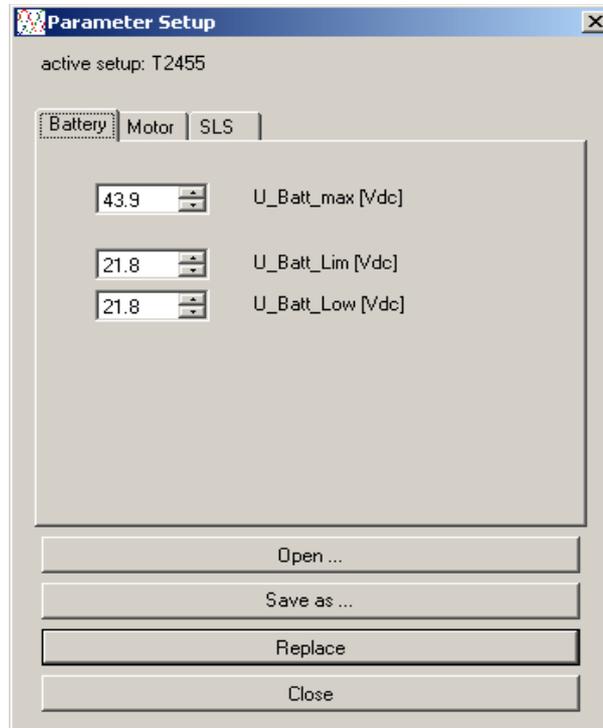
- **Save as ...**: reads the internal trace memory of the SLS, displays the content graphically and stores it on the hard disk. In addition it is also possible to enter a comment for the trace file, which is then stored and displayed on the chart.
- **Clear**: deletes the trace memory in the SLS.
- **Open ...**: a trace file stored on the hard disk (*.SLT) is opened and displayed.
- **Close**: the trace memory-window will close.



The trace files can also be opened directly by double click e.g. from the Windows-Explorer.

6.3 Parameters

The active SLS parameters can be edited in the parameter menu, complete parameter-sets can also be opened and saved on the hard disk.



picture 6.4: parameter window / Battery

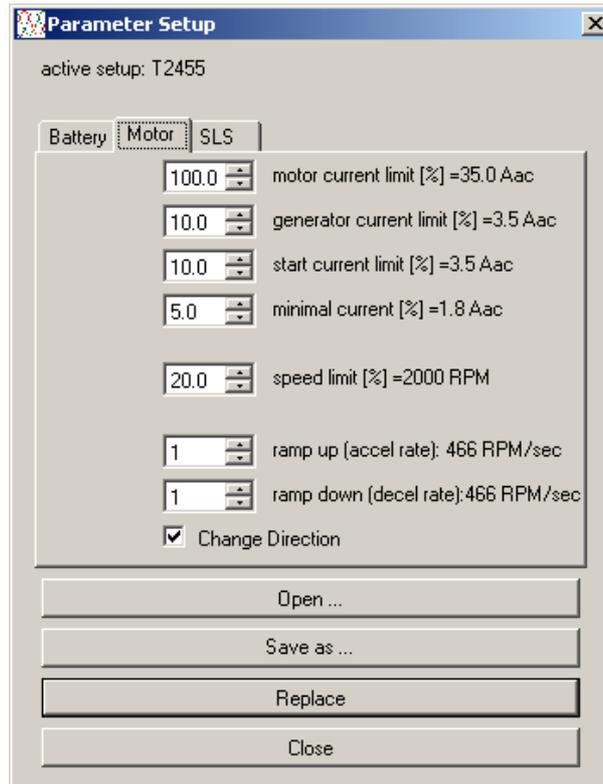
- **Open ...:** This button is used to load parameter files (*.SLC) from the disk. When a file is loaded the SLS-Windows-Monitor checks if it is compatible with the connected SLS. Finally, the parameters are updated into the SLS by clicking the "replace" button!
- **Save as ...:** The active parameter set is saved on the hard disk.
- **Replace:** The active parameter set is loaded to the SLS.
- **Close:** Closes the parameter menu.



Replacing the parameters will delete the trace memory!

Derating voltages can be changed in the "**Battery**" tab:

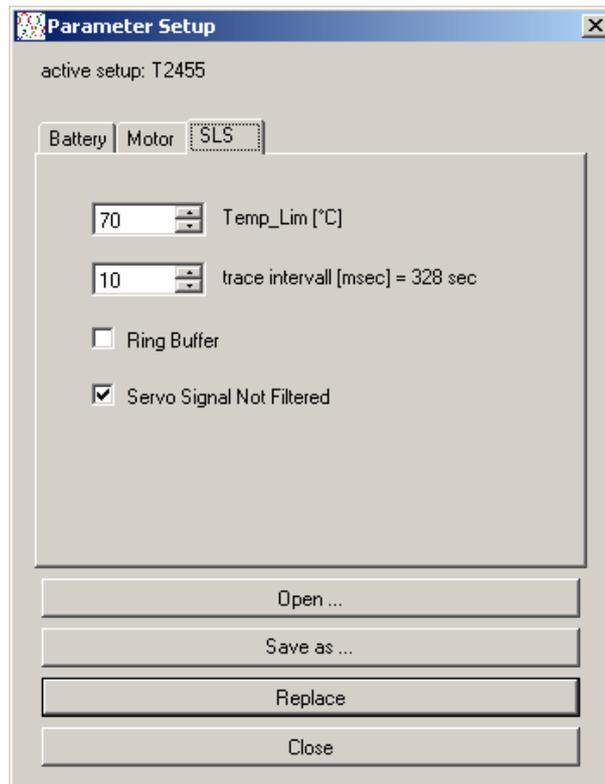
- **U_Batt_Max [Vdc]:** Specifies the max. DC-voltage on the SLS. For batteries this voltage corresponds to the final charge voltage. The SLS begins to derate regenerative current 1 Volt below this limit. If the voltage is reached this process stops.
- **U_Batt_Lim [Vdc]:** Sets the point at which the undervoltage derating begins. The speed and the motor current are reduced gradually up to U_Batt_Low.
- **U_Batt_Low [Vdc]:** At this voltage, rotational speed and motor current are derated to 0. For batteries this voltage corresponds to the final discharge voltage.



picture 6.5: parameter window / Motor

The tab "**Motor**" allows a few changes regarding the motor parameters:

- **motor current limit [%]**: Indicates the maximum motor current in % based on the current released in the data set. The released current is displayed in A_{ac} . 100% corresponds to the current released in the data set.
- **generator current limit [%]**: This feature allows to set the max. generated current.
- **start current limit [%]**: This parameter allows to define the current during start-up ("Open Loop"). **Attention!** Please change only after consultation and in small steps.
- **minimal current [%]**: The minimum current is only important in torque mode. This feature allows to set a min. required current for secure operation.
- **speed limit [%]**: The maximum rotation speed can be set via the speed limit. 100% corresponds to the speed released in the data set.
- **ramp up (accel rate)**: The acceleration rate is active in the speed controlled mode. This feature allows you to set the size of the speed change. A big value will rapidly accelerate the motor. Additionally a calculated value of the speed change is displayed in RPM/sec.
- **ramp down (decel rate)**: The same as the acceleration rate with the difference that this parameter defines how fast the rotation speed is reduced.
- **Change Direction**: This function allows to reverse the rotational direction – it is the same as interchanging two motor phases.



picture 6.6: parameter window / SLS

The derating temperature, the trace memory and the evaluation of the servo signal can be changed in the "**SLS**" tab:

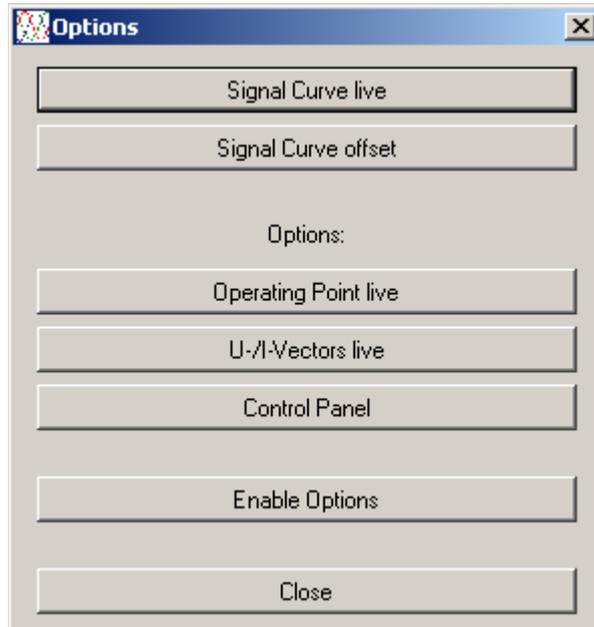
- **Temp_Lim [°C]**: This parameter defines when the temperature derating begins. In the area between Temp_Lim and 90°C will be derated. In practice, this threshold should be between 65°C and 75°C.
- **trace-interval [msec]**: This function adjusts the interval in which the SLS saves data to the trace memory. Values of 10ms up to 10000ms(10s) are possible. The maximum number of cycles is restricted to 10 cycles for trace intervals between 10 and 99ms, in order to limit write-cycles to trace memory, if ring buffer is activated.
- **Ring Buffer**: The trace memory will be configured as a ring buffer.
- **Servo Signal Not Filtered**: Setting this checkbox causes the servo signal to be processed directly (i.e. without filtering). If filtering is active, this function allows to bridge over possible short interferences in radio communications.



The trace memory will be deleted if the settings are changed by pressing the "**Replace**" button!

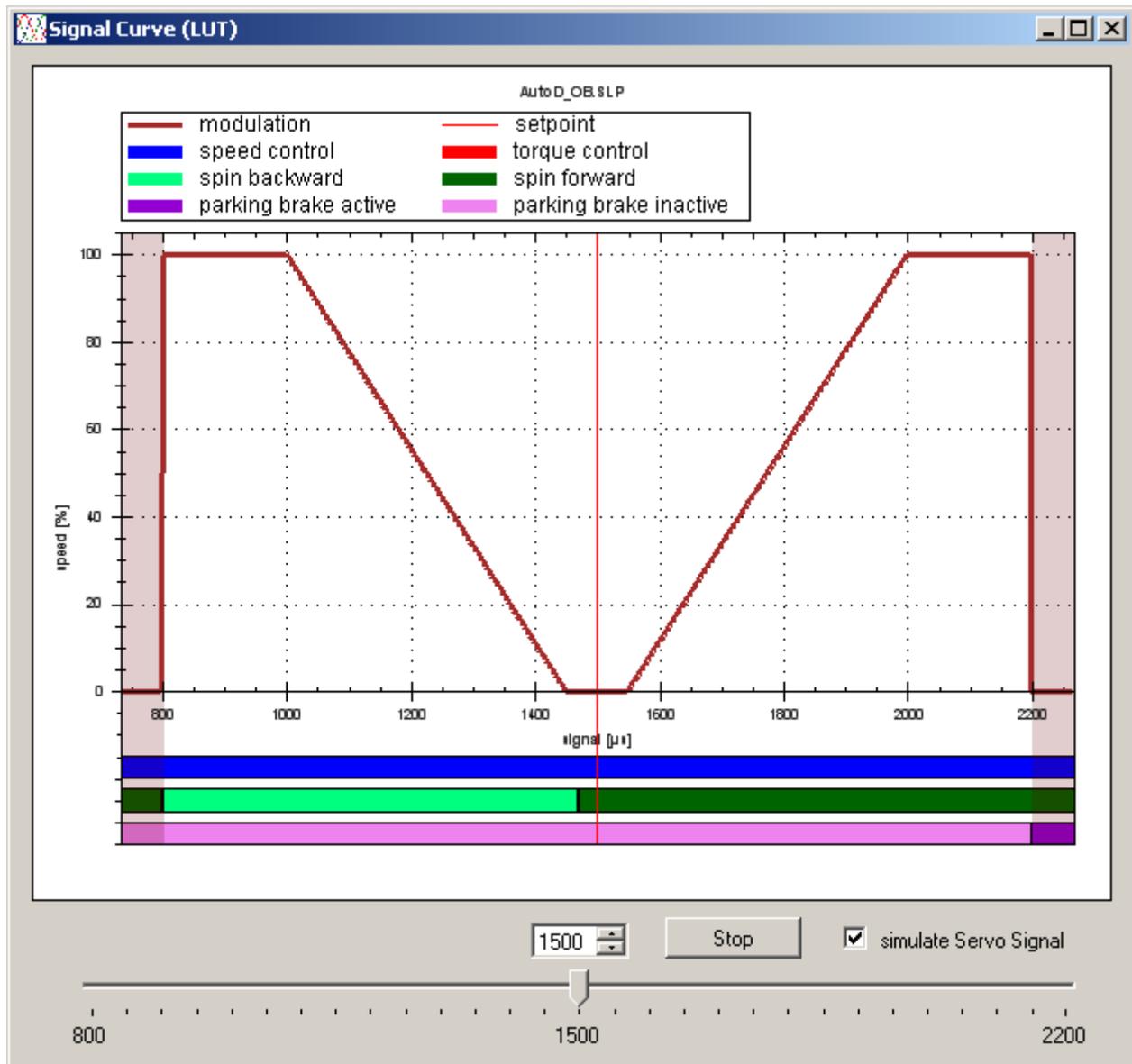
6.4 Additional Functions and Options

Useful functions and (chargeable) options are summarized in this menu. The options can be activated by requesting a activation code. See point 6.4.6 for more information. Not activated functions are displayed in gray.



picture 6.7: additional functions and options

6.4.1 Signal Curve Live



picture 6.8: example of a signal curve

The loaded signal curve can be displayed in the SLS-Windows-Monitor. The present operating point within the signal curve is displayed with a vertical red cursor. This way the signal curve can be checked for correct function.

It is also possible to override the external servo signal and to specify the μ sec signal directly. To enable check the box "simulate servo signal". To change the value, use the slider or enter the numerical value directly.

6.4.2 Servo Signal Offset



picture 6.9: servo signal offset

The servo input has a galvanic insulation via an optocoupler. Slight differences can occur in the evaluation of the pulse width due to manufacturing tolerances. This is e.g. not desirable in the synchronous operation of several controllers. The offset can therefore be adjusted in the range of +127 - 127µsec. By **Save**, the previous offset in the SLS is replaced.

6.4.3 Operation Point Live (Chargeable Option)

The SLS in combination with the SLS-Windows-Monitor offers the function to display the **motor characteristic $I_{ac}=f(n)$ dynamically** together with the current operating point (displayed as a red dot). The limits set for AC motor current, AC generator current and speed are displayed simultaneously including the hardware related maximum currents. The limitations are shown dynamically: The motor limit changes for example with the DC-voltage level.

Derating limits will also be displayed, if the controller operates in derating mode. This may be the case with overvoltage, undervoltage or overtemperature.

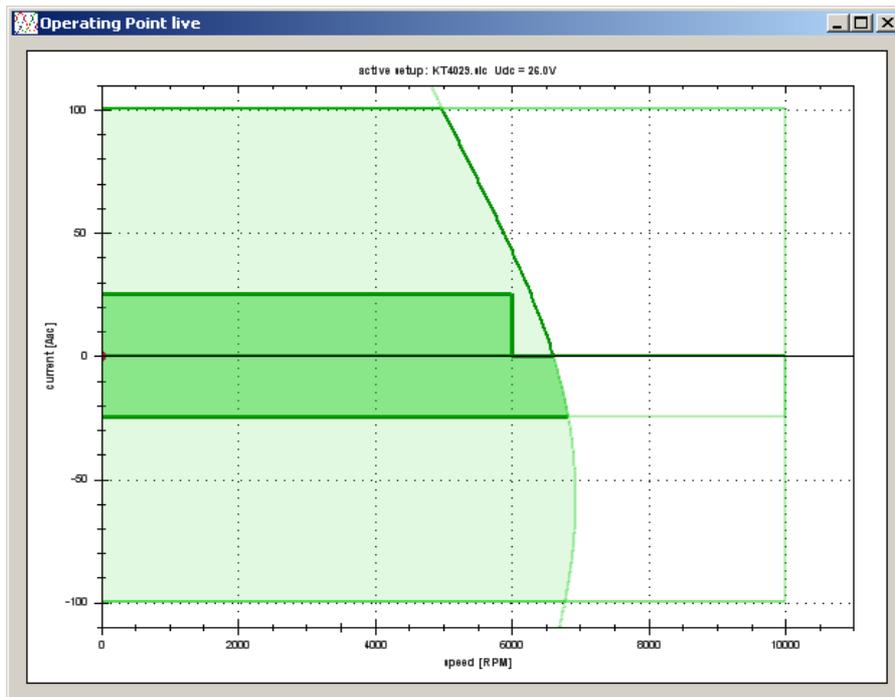
The motor characteristic, on the next page is calculated at a DC-voltage of 26Vdc. On the motoric side max. +25A_{ac} are enabled, on the generatoric side max. -25A_{ac}. The user however, can enable up to +/-100A_{ac}. The default setting for the speed limit is 60% of 10.000rpm (=6.000rpm).

The area enabled as "active" will be displayed in dark green and the possible range (not yet enabled) as a light green area. Displayed are only the two right quadrants; the two left quadrants result by reflection at the origin and are displayed in the area of the right quadrants.

The curved boundary towards high speeds originates from the motor constants and the DC link-voltage. It represents the given limit without field weakening ($I_d=0$). Exceeding this limit in motor mode ($I_{ac} > 0$) is not possible.

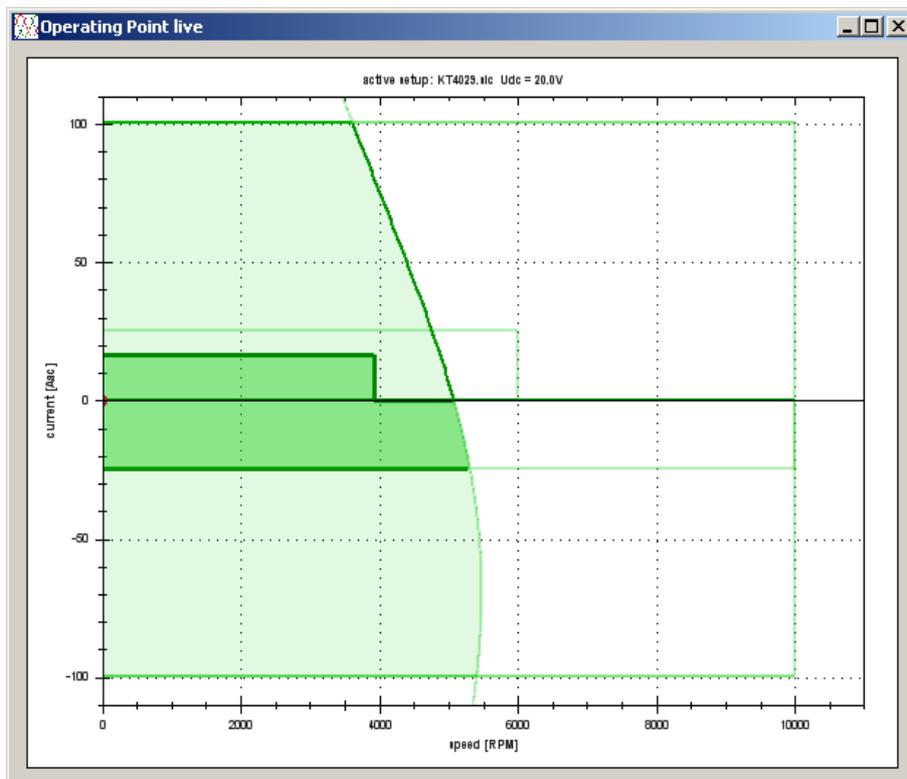


In the generator mode ($I_{ac} < 0$) however, this limitation can be exceeded by over-speed. Since uncontrollable high currents can flow from the SLS due to diode commutation, an operation outside these limit must be avoided!



picture 6.10: operation point at 26Vdc

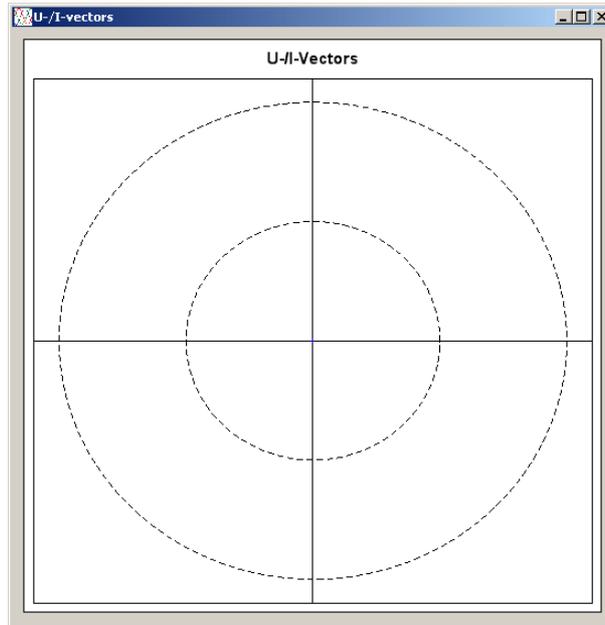
The following picture shows the same motor with reduced input voltage (20Vdc). In this case the input voltage is in the derating area between **U_Batt_Lim** and **U_Batt_Low**. The input power is thereby reduced to avoid a too deep battery discharge. The limitations of the enabled (motoric) operational area will be further derated and the current operating point adjusted downwards. The generator area on the other hand is not restricted.



picture6.11: operation point derated

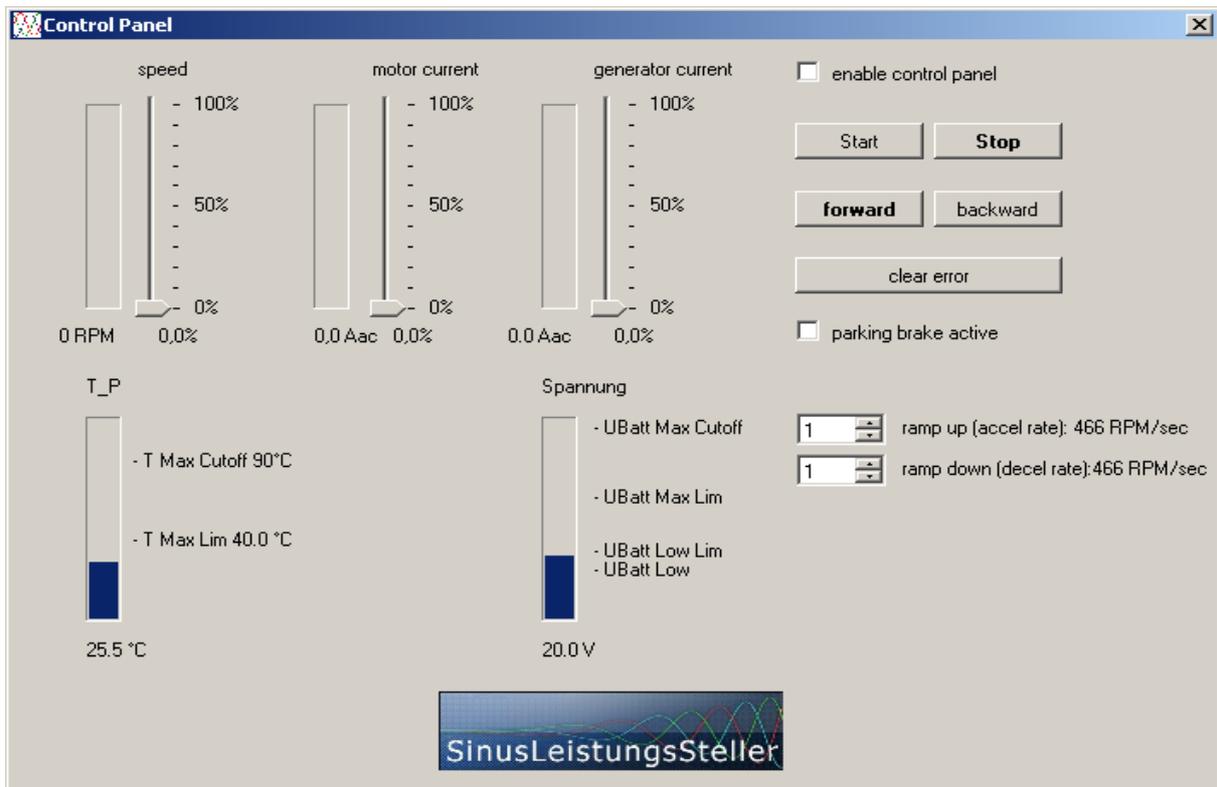
6.4.4 U-/I-Vector Representation Live (Chargeable Option)

(The vector representation of current and voltage is currently still in a beta version. This will be completed in the future.)



6.4.5 Control Panel (Chargeable Option)

The control panel is used to control and set the reference values of the SLS via the serial interface.



picture 6.12: control panel

3 sliders are located in the control panel window. They can specify e.g. the target speed. Currents necessary to reach this target value must be enabled in advance via the corresponding motor current-slider. If the preset current is high enough, the SLS will be in speed controlled mode, otherwise the controller operates in torque controlled mode. The position of the slider represents the reference value, the bar on the left shows the actual value. Reference and actual value are displayed with the corresponding numerical value: the reference value in percent, the actual value in real units.

The control panel is enabled by checking the box **enable control panel**. The buttons **start** and **stop**, start or stop the motor. **forward** and **backward** select the rotational direction. Direct reversal is not possible at this moment.

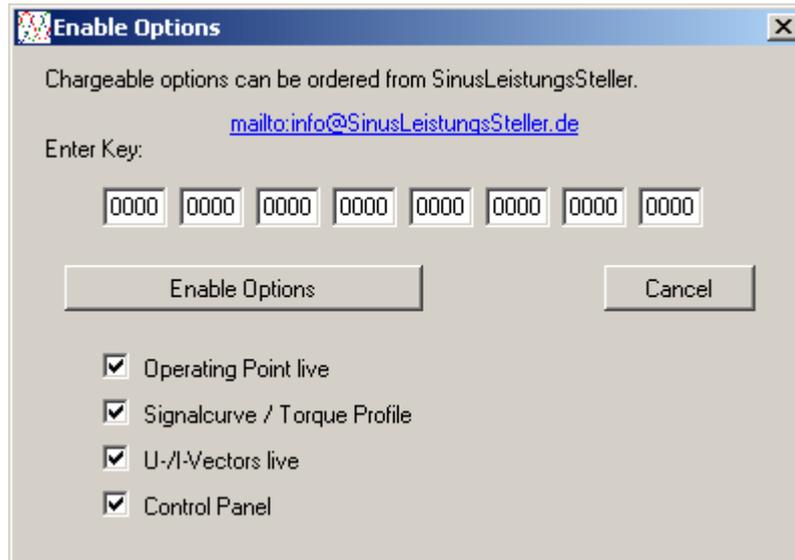
The **clear error** button resets all errors displayed in the status window.

Checking the box **parking brake active** means that the motor is blocked during standstill (by shorting the 3 motor phases to ground/GND).

The remaining bars in the lower half of the window, display the actual values for temperature and DC-voltage together with the corresponding limits. T_P stands for the power module temperature. The SLSi displays in addition the capacitor temperature T_E also with its limits.

It is also possible to temporarily override the deceleration and acceleration rate. After disabling the control panel, the values in the data set will be taken again.

6.4.6 Activate Options



picture 6.13: activate options

With this feature, options can be unlocked afterwards. Already activated options are marked as such. Keys for one or more options can be ordered here info@SinusLeistungsSteller.de. The options are bound to the controller hardware by the serial number, therefore we need the number and information about the exact type of the SLS. The current price list can be found on the SLS website: <http://www.sinusleistungssteller.de/preise.html>

6.5 Signal Curve

The servo signal (in μs) is translated into reference signal via a (configurable and reloadable) characteristic curve. This signal curve represents a powerful tool to adjust the motor to different requirements.

So this curve can be used to operate the SLS in **speed- or torque-control**. The **rotational direction** (forward/backward) can be adjusted to the servo input range (e.g. aligning a potentiometer in center position). It can also be determined whether the motor is inhibited (parking brake) or free to rotate in the neutral range. With activated **parking brake**, the 3 motor phases are short-circuited through ground and inhibited by the induced short-circuit currents during rotation. However not completely blocked.



The motor must not be driven mechanically during active parking brake, since the currents will not be limited and this could damage the SLS hardware in extreme cases!

A new signal curve can be generated by the user within the SLS-Windows-Monitor. Complete signal curves can be generated according to individual needs using linear connected steps. By inserting a sufficient number of such steps, nonlinear relationships can also be approximated.

A file with the extension *.SLP is generated when saving a new created signal curve: This file contains the actual signal curve in binary form. A target value is assigned for each μs -value of the servo signal in accordance with the piecewise linear specification. The SLS generates reference values for internal control during runtime on the basis of the characteristic signal curve. The file also contains steps in a kind of vector format. This way, the signal curve can be edited and changed.

The name of this file can be freely chosen by the user. However, it should not exceed 8 characters to avoid confusion, since the SLS stores only the first 8 characters.

Example of a signal curve:

The **rTQ_vDZ.SLP** signal curve is shown on the following page. In order to explain the possible functions of the SLS.

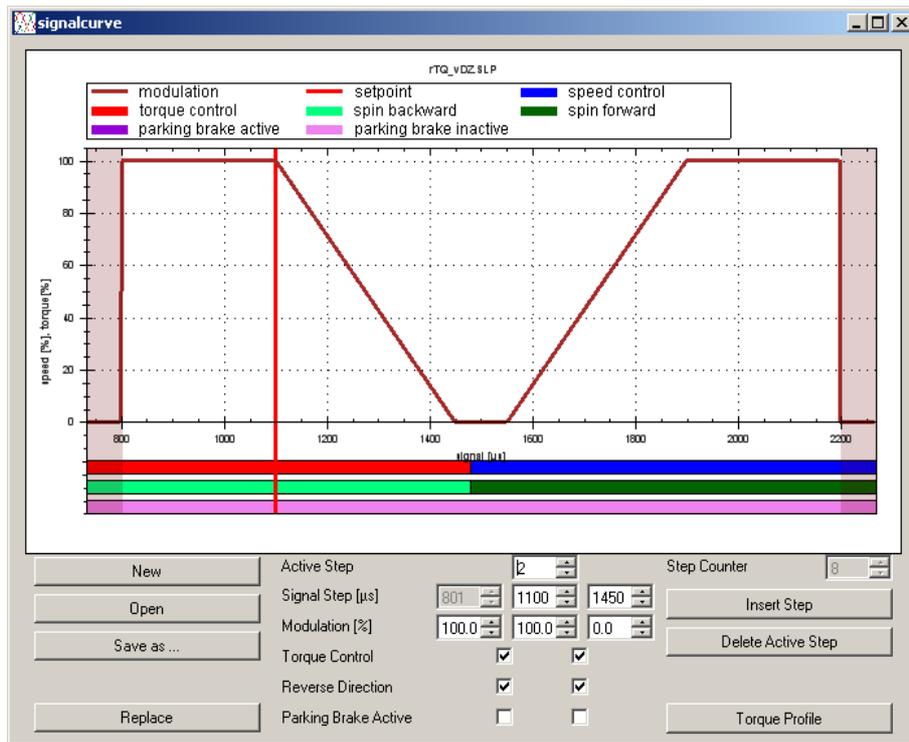
The signal curve specifies torque-control to be activated for the reverse direction („rTQ“) and speed control for the forward direction („vDZ“ means: “vorwärts DrehZahlregelung”). Servo values from $800\mu\text{s}$ up to $1450\mu\text{s}$ are assigned to the "reverse" direction and servo values from $1550\mu\text{s}$ up to $2200\mu\text{s}$ to the "forward" direction. The range in between ($1451\mu\text{s}$ up to $1549\mu\text{s}$) is marked as "neutral" by setting all values to 0% (direction and control-mode are not relevant in this area).

Border areas less than $800\mu\text{s}$ or greater than $2200\mu\text{s}$ will be interpreted as a missing servo signal and will lead to the immediate shutdown of the motor.

For security, the firmware does not start the motor, if the SLS is turned ON with a servo position outside the neutral range. To start the motor after a power-cycle (or for error deletion after a failed start attempt) the servo signal must first be adjusted to the neutral position.

Of course, it is also possible to set the entire range exclusively for one direction or one control-mode. The neutral range would then be in the top or bottom range.

The absolute values for 100% speed or torque are stored together in the SLS parameter-set and can not be changed within the signal curve.



picture 6.14: example of a signal curve

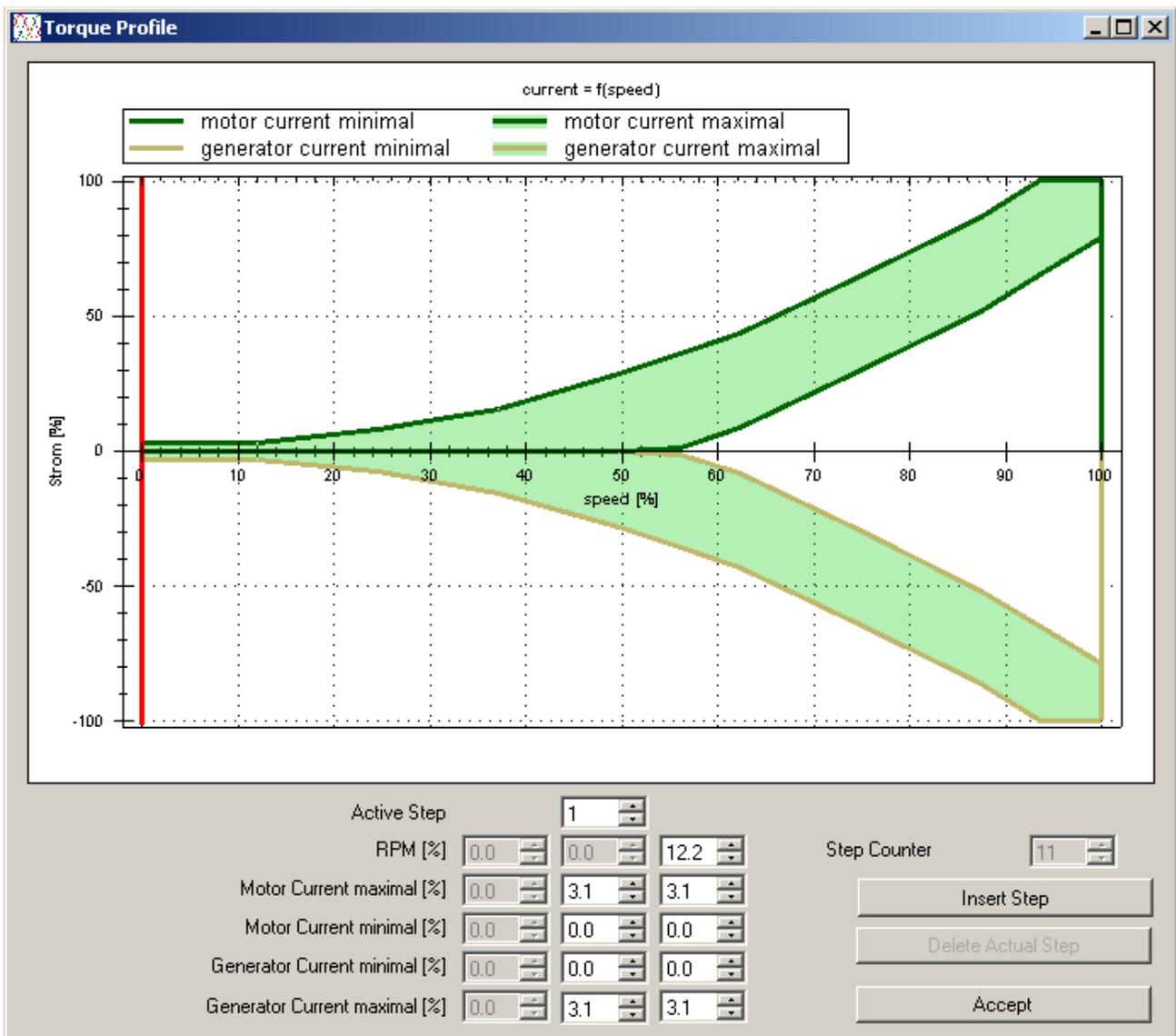
- **New**: A new (empty) signal curve opens.
- **Open**: An already existing signal curve can be opened from the hard drive.
- **Save as...**: The currently displayed signal curve will be saved to the hard disk.
- **Replace**: The currently displayed signal curve is transferred to the SLS.
- **Insert Step**: A new step will be inserted between the current and the next step.
- **Delete Active Step**: Deletes the selected step.
- **Torque Profile**: With this button you will enter the current profile window (more information in the next section).

Select the active step via the top numerical box ("Active step"). The active step is marked as a vertical red line extending the entire diagram. The individual steps are numbered from left to right.

Below the selected steps, the settings for **this** step (middle column), for the previous (left column) and for the next step (right column) are displayed. A step can be moved with the coordinate information (Signal Step / Modulation).

Further settings are for the areas between two neighboring steps. These are "torque-control", "reverse direction" and "parking brake". The corresponding check boxes are arranged accordingly in between the steps.

6.5.1 Torque Profile (Chargeable Option)



picture 6.15: example of a current profile

The enabled current in % can be adjusted via the actual speed using the optional current profile. The motor current is plotted upwards in positive direction, the generated current downwards in negative direction. All entries are absolute values (without sign).

The maximum number of steps in this case is 32. There are different curves possible for motor and generated current. Both for the maximum as well as the minimum currents.

- **Insert Step:** A new step will be inserted in between the active and the next step.
- **Delete Actual Step:** Deletes the selected step.
- **Accept:** The entries are applied, the window is closed. Attention! The current profile has not been transmitted to the controller yet. Only when clicking **replace** in the signal curve window, the current profile is transferred (along with the signal curve).

Select the active step via the top numerical box ("Active Step"). The step is marked as a vertical red line extending the entire diagram. The steps are numbered from left to right.

Below the selected steps, the settings for **this** step (middle column), for the previous (left column) and for the next step (right column) are displayed. A step can be moved with the coordinate information (RPM / current).

The max. speed (100%) corresponds to the maximum speed, which was stored in the parameter-set for 100%. The motor current and generated current corresponds to the current which has been saved in the parameter-set for 100%.

When the motor current approaches the upper limit, given by the current profile (motor current maximum), the speed is derated. When the motor current approaches the lower limit, given by the current profile (motor current minimum), the controller shuts down, with the error message "Loadless_Flt".

When the generator current approaches the upper limit, given by the current profile (generator current maximum), the speed increases accordingly! When the generator current approaches the lower limit, given by the current profile (generator current maximal), the controller shuts down with the error message "Loadless_Flt". The motor is released.

6.6 Firmware Update

If required, the SLS can be updated via the option **firmware update**.

There are two different versions at this moment:

- cSLS and cSLSi require the variant **cSLSxxxx.BIC**
- SLSi needs the variant **SLSxxxx.BIC** (without "c")

Based on the connected hardware, the SLS-Windows-Monitor automatically detects which firmware version can be loaded. Always make sure that the latest firmware is in use. We provide updates for download on our homepage: www.SinusLeistungsSteller.de/SWdownload.html

6.7 Exit

All windows, opened by the SLS-Windows-Monitor will be closed by the "exit" button. The program terminates.

7 Technical Data

7.1 cSLSi

7.1.1 cSLSi-24-xxx

	cSLSi-24-xxx		
	min	typical	max
Input voltage	8Vdc		26Vdc (max. 6S LiPo)
Output current (Note 1)	0A _{ac}		cSLSi-24-75: 75A _{ac} cSLSi-24-110: 110A _{ac} cSLSi-24-140: 140A _{ac}
PWM-frequency (Note 2, 3)	8kHz		60kHz
+5V at the servo input	3,3V	5,0V	7,0V
Voltage at the PWM-input low-level			1,0V
Voltage at the PWM-input high-level	3,3V	5,0V	7,0V
PWM High time	800μs		2200μs
PWM Low time	100μs	20ms	50ms
Timeout if no reference => motor stops		0,3s	0,5s
Environmental temperature during operation	0°C		50°C
Storage temperature	0°C		70°C
Dimensions		82 x 59 x 37 mm 102 x 59 x 43 mm (with option -WK)	
Weight with 20cm cable (6 mm ²)		370g 470g (with option -WK)	

7.1.2 cSLSi-60-xxx

	cSLSi-60-xxx		
	min	typical	max
Input voltage	16Vdc		60Vdc (max. 14S LiPo)
Output current (Note 1)	0A _{ac}		cSLSi-60-70: 70A _{ac} cSLSi-60-100: 100A _{ac} cSLSi-60-140: 140A _{ac}
PWM-frequency (Note 2, 3)	8kHz		60kHz
+5V at the servo input	3,3V	5,0V	7,0V
Voltage at the PWM-input low-level			1,0V
Voltage at the PWM-input high-level	3,3V	5,0V	7,0V
PWM High time	800μs		2200μs
PWM Low time	100μs	20ms	50ms
Timeout if no reference => motor stops		0,3s	0,5s
Environmental temperature during operation	0°C		50°C
Storage temperature	0°C		70°C
Dimensions		82 x 59 x 43 mm 102 x 59 x 49 mm (with option -WK)	
Weight with 20cm cable (6 mm ²)		370g 470g (with option -WK)	

7.2 SLSi-60-xxx

	SLSi-60-xxx		
	min	typical	max
Input voltage	16Vdc		60Vdc (max. 14S LiPo)
Output current (Note 1)	0A _{ac}		SLSi-60-240: 240A _{ac} SLSi-60-360: 360A _{ac}
PWM-frequency (Note 2, 3)	8kHz		60kHz
+5V at the servo input	3,3V	5,0V	7,0V
Voltage at the PWM-input low-level			1,0V
Voltage at the PWM-input high-level	3,3V	5,0V	7,0V
PWM High time	800µs		2200µs
PWM Low time	100µs	20ms	50ms
Timeout if no reference => motor stops		0,3s	0,5s
Environmental temperature during operation	0°C		50°C
Storage temperature	0°C		70°C
Dimensions		150 x 89 x 43 mm 170 x 89 x 53 mm (with option -WK)	
Weight		880g 1150g (with option -WK)	

Note 1: Continuous operation at high currents might require additional external cooling.

Note 2: The PWM-frequency is set and fixed during tuning.

Note 3: Small motor-inductances require a higher PWM-frequency. By this, more switching losses occur and this may result in a reduction of possible motor current.

8 Recycling

Electric components must not be disposed with household waste but have to be disposed according to local environmental regulations!

National and local disposal regulations have to be respected.

You can also send the SLS back to the manufacturer for disposal.

9 Warranty, Returning the Product

Warranty is governed by our terms and conditions, which are viewed here:
www.sinusleistungssteller.de/AGB_IBZ.pdf

Returning the product to us (for whatever reason) requires our prior consent.

To accept warranty the **original invoice** is required, with information visible for date of purchase and dealer.

Further we need a written error description with precise indication of the error itself and the circumstances in which the error occurred.



10 EU-Declaration of Conformity

10.1 cSLSi-24-75

EU Konformitätserklärung
EU Declaration of Conformity

1.	Gerätetyp/Produkt <i>Apparatus model/Product</i>	SinusLeistungsSteller
2.	Name und Anschrift des Herstellers <i>Name and address of the manufacturer</i>	Ing.-Büro Rolf Zimmermann Industriestr. 7 D-97297 Waldbüttelbrunn
3.	Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller. <i>This declaration of conformity is issued under the sole responsibility of the manufacturer.</i>	
4.	Gegenstand der Erklärung <i>Object of the declaration</i>	cSLS-24-75, cSLSi-24-75
5.	Der oben beschriebene Gegenstand der Erklärung erfüllt die einschlägigen Harmonisierungsrechtsvorschriften der Union. <i>The object of the declaration described above is in conformity with the relevant Union harmonisation legislation.</i>	
	RICHTLINIE 2014/30/EU DES EUROPÄISCHEN PARLAMENTS UND DES RATES vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit	
	<i>DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility</i>	
6.	Angabe der einschlägigen harmonisierten Normen, die zugrunde gelegt wurden, einschließlich des Datums der Norm, oder Angabe anderer technischer Spezifikationen, für die die Konformität erklärt wird, einschließlich des Datums der Spezifikation: <i>References to the relevant harmonised standards used, including the date of the standard, or references to the other technical specifications, including the date of the specification, in relation to which conformity is declared:</i>	
	DIN EN 61000-6-2; VDE 0839-6-2:2006-03 Elektromagnetische Verträglichkeit (EMV) Teil 6-2: Fachgrundnormen – Störfestigkeit für Industriebereiche (IEC 61000-6-2:2005); EN 61000-6-2:2005	
	DIN EN 61000-6-4; VDE 0839-6-4:2011-09 Elektromagnetische Verträglichkeit (EMV) Teil 6-4: Fachgrundnormen – Störaussendung für Industriebereiche (IEC 61000-6-4:2006 + A1:2010); EN 61000-6-4:2007 + A1:2011	
7.	Nicht zutreffend. <i>No applicable.</i>	
8.	Zusatzangaben <i>Additional information</i>	
	—	
	Untersignet für und im Namen von: <i>Signed for and on behalf of:</i>	Ing.-Büro Rolf Zimmermann Industriestr. 7 D-97297 Waldbüttelbrunn
	Ort und Datum der Ausstellung: <i>place and date of issue</i>	Waldbüttelbrunn, 21.08.2014
	Name und Funktion <i>name, function</i>	Ingenieurbüro Rolf Zimmermann Industriestraße 7 D-97297 Waldbüttelbrunn Tel. 0931/7801103-0 Fax -8
		Rolf Zimmermann Dipl.-Ing.(FH), Inhaber

10.2 cSLSi-60-xxx

EU Konformitätserklärung <i>EU Declaration of Conformity</i>	
1. Gerätetyp/Produkt <i>Apparatus model/Product</i>	SinusLeistungsSteller
2. Name und Anschrift des Herstellers <i>Name and address of the manufacturer</i>	Ing.-Büro Rolf Zimmermann Industriestr. 7 D-97297 Waldbüttelbrunn
3. Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller. <i>This declaration of conformity is issued under the sole responsibility of the manufacturer.</i>	
4. Gegenstand der Erklärung <i>Object of the declaration</i>	cSLS-60-70, cSLSi-60-70 cSLS-60-100, cSLSi-60-100 cSLS-60-140, cSLSi-60-140
5. Der oben beschriebene Gegenstand der Erklärung erfüllt die einschlägigen Harmonisierungsrechtsvorschriften der Union. <i>The object of the declaration described above is in conformity with the relevant Union harmonisation legislation.</i>	
RICHTLINIE 2014/30/EU DES EUROPÄISCHEN PARLAMENTS UND DES RATES vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit	
<i>DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility</i>	
6. Angabe der einschlägigen harmonisierten Normen, die zugrunde gelegt wurden, einschließlich des Datums der Norm, oder Angabe anderer technischer Spezifikationen, für die die Konformität erklärt wird, einschließlich des Datums der Spezifikation: <i>References to the relevant harmonised standards used, including the date of the standard, or references to the other technical specifications, including the date of the specification, in relation to which conformity is declared:</i>	
DIN EN 61000-6-2; VDE 0839-6-2:2006-03 Elektromagnetische Verträglichkeit (EMV) Teil 6-2: Fachgrundnormen – Störfestigkeit für Industriebereiche (IEC 61000-6-2:2005); EN 61000-6-2:2005	
DIN EN 61000-6-4; VDE 0839-6-4:2011-09 Elektromagnetische Verträglichkeit (EMV) Teil 6-4: Fachgrundnormen – Störaussendung für Industriebereiche (IEC 61000-6-4:2006 + A1:2010); EN 61000-6-4:2007 + A1:2011	
7. Nicht zutreffend. <i>No applicable.</i>	
8. Zusatzangaben <i>Additional information</i>	--
Unterzeichnet für und im Namen von: <i>Signed for and on behalf of:</i>	Ing.-Büro Rolf Zimmermann Industriestr. 7 D-97297 Waldbüttelbrunn
Ort und Datum der Ausstellung: <i>place and date of issue</i>	Waldbüttelbrunn, 21.08.2014
Name und Funktion <i>name, function</i>	Ingenieurbüro Rolf Zimmermann Industriestr. 7 D-97297 Waldbüttelbrunn Tel. 0931/7801103-0 Fax -8 Rolf Zimmermann Dipl.-Ing. (FH), Inhaber

10.3 SLSi-60-240 SLSi-60-360

EU Konformitätserklärung <i>EU Declaration of Conformity</i>	
1. Gerätetyp/Produkt <i>Apparatus model/Product</i>	SinusLeistungsSteller
2. Name und Anschrift des Herstellers <i>Name and address of the manufacturer</i>	Ing.-Büro Rolf Zimmermann Industriestr. 7 D-97297 Waldbüttelbrunn
3. Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller. <i>This declaration of conformity is issued under the sole responsibility of the manufacturer.</i>	
4. Gegenstand der Erklärung <i>Object of the declaration</i>	SLSi-60-240 SLSi-60-360
5. Der oben beschriebene Gegenstand der Erklärung erfüllt die einschlägigen Harmonisierungsrechtsvorschriften der Union. <i>The object of the declaration described above is in conformity with the relevant Union harmonisation legislation.</i>	
RICHTLINIE 2014/30/EU DES EUROPÄISCHEN PARLAMENTS UND DES RATES vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit	
<i>DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility</i>	
6. Angabe der einschlägigen harmonisierten Normen, die zugrunde gelegt wurden, einschließlich des Datums der Norm, oder Angabe anderer technischer Spezifikationen, für die die Konformität erklärt wird, einschließlich des Datums der Spezifikation: <i>References to the relevant harmonised standards used, including the date of the standard, or references to the other technical specifications, including the date of the specification, in relation to which conformity is declared:</i>	
DIN EN 61000-6-2; VDE 0839-6-2:2006-03 Elektromagnetische Verträglichkeit (EMV) Teil 6-2: Fachgrundnormen – Störfestigkeit für Industriebereiche (IEC 61000-6-2:2005); EN 61000-6-2:2005	
DIN EN 61000-6-4; VDE 0839-6-4:2011-09 Elektromagnetische Verträglichkeit (EMV) Teil 6-4: Fachgrundnormen – Störaussendung für Industriebereiche (IEC 61000-6-4:2006 + A1:2010); EN 61000-6-4:2007 + A1:2011	
7. Nicht zutreffend. <i>No applicable.</i>	
8. Zusatzangaben <i>Additional information</i>	--
Unterszeichnet für und im Namen von: <i>Signed for and on behalf of:</i>	Ing.-Büro Rolf Zimmermann Industriestr. 7 D-97297 Waldbüttelbrunn
Ort und Datum der Ausstellung: <i>place and date of issue</i>	Waldbüttelbrunn, 21.08.2014
Name und Funktion <i>name, function</i>	Ingenieurbüro Rolf Zimmermann Industriestraße 7 D-97297 Waldbüttelbrunn Tel. 0931/7801103-0 Fax -8 Rolf Zimmermann Dipl.-Ing.(FH), Inhaber

11 FAQ (frequently asked questions)

Our FAQs are updated frequently. The latest version can be found here:
www.sinusleistungssteller.de/SLS_FAQ.pdf .

Question: *Why must a SLS be tuned on a motor?*

Answer: All cSLS/SLS operate according to the principle of field-oriented control. The basic idea of the field-oriented control is to achieve an ideal orientation of the current and voltage vectors, which will result in best efficiency. For this, the controller simulates a model of the real motor or drive. For this simulated model, motor parameters are necessary, which have to be measured first and saved afterwards in the SLS parameter-set. One of the most important parameters are the number of pole pairs, the winding resistance and the inductances of the motor phases.

Question: *What happens, if the SLS parameters are not suitable for the motor?*

Answer: Of course, the SLS must be able to compensate some deviations in motor parameters, which may occur due to unavoidable temperature rise of the motor windings or manufacturing tolerances. On larger deviations, the efficiency drops, the motor might start badly or not at all (all SLS operate sensorless!). If wrong parameters (the simulated model does not fit), the control- loops for current and speed could become unstable, which may lead to permanent damage of the controller in extreme cases. Always make sure that the loaded parameter-set matches on the motor in use!

Question: *What does the tuning procedure look like? What is required? How long does it take? What are the costs?*

Answer: The tuning has to be performed in our laboratory and is basically divided into two steps:
1. Determination of the motor parameters and tuning in loadless mode (basic-setup). In the simplest case we need only the motor. You have to send us the motor for the duration of the tuning process. The operation under load must then be tested by the customer by gradually increasing the load itself.

2. Tuning the motor with load (load-optimized-setup). For this, two identical motors would be ideal to build a motor generator pair: so that we can set and measure any operating point. Only one motor with the later intended load (e.g. propeller) would also be possible – the tuning optimization then refers only to this operating point.

The determination of the parameter-set needs about 4-8 hours of work, the hourly fee amounts to EUR 75,- (+ VAT.). We also offer additional tuning tasks (e.g. creating a optimal signal curve or creating a current profile optimized for your system etc.)

Question: *Does each motor (same type) require to be tuned individually ?*

Answer: No. Every motor *type* needs to be tuned, not every motor *device*. The tuning must be done only once, as long it is the same type of motor (identical model and the same winding scheme!). The additional costs will be charged only once. You can use this parameter-setup to any number of identical drives.

Question: *Why is there no way for the user to tune a new motor himself?*

Answer: Determining the motor parameters requires special measurement devices, theoretical background and experience. Because these requirements are not met by all customers (with regard to possible damages caused by mismatching), we generally reserve the right to determine the setup of new motors. The measured motor-specific parameters (R, L, Kv, etc.) and the settings for current and speed control remain covered in the background and can not be changed by the user. Based on this basic-setup (or load-optimized-setup), the user can change numerous parameters (e.g. current-, voltage- and temperature-limits) and adjust them to his needs.

Question: *Can a SLS only be used with the motor it was matched for?*

Answer: The parameter-set must **always** match on the motor connected to the SLS! But the user can switch the parameter-set to another parameter-set and operate the SLS with another suitable motor. All parameter-sets can be read entirely from the SLS and saved on the PC in form of a file. You will need our [USB-Seriell-Interface \(USI\)](#) to change/replace parameter-sets and a installation of the SLS-Windows-Monitor. The [USI](#) is also required to read trace data or load firmware-updates and is in most cases already available or a worthwhile investment. The SLS-Window-Monitor can be downloaded for free from the [Download-Area](#) on our homepage.

Question: *Which types of motors can be operated with the SinusLeistungsSteller?*

Answer: All 3-phase motors that match the basic concept of a permanent-magnet synchronous motor (PMSM, BLDC). It makes no difference whether it is an inrunner or outrunner. Ideal (but not mandatory) is a sine induced voltage - if the voltage differs from pure sine, efficiency slightly drops. Due to the sine-commutation, there are restrictions on the maximum field frequency: it should not exceed a maximum of 1.000Hz (= 60.000rpm field). For motors with very small winding inductance, the PWM-frequency must be increased in order to keep the current ripple small. As a result, additional losses occur (increased switch-losses!), this leads further to a derating of the max. allowed AC-current of the controller. Further, separately excited synchronous motors and induction motors can not be operated with the cSLS/SLS at this moment.

Question: *Are the cSLS/SLS really safe at partial load?*

Answer: Yes, absolutely! The full AC-current, indicated on the name-plate can be used in all partial load situations. Exceeding this maximum current is practically impossible, since the real AC-currents are measured and limited – this way overload is impossible. The cSLS/SLS has less losses in partial load than in full load, for which the cSLS/SLS is designed. Primarily the AC-currents are responsible for the losses of the cSLS/SLS – not the speed nor the converted power! A derating of the max. allowed AC-current may be necessary for motors with small inductance, but applies in this case for all load situations.

Question: *Is the SLS also suitable for traction drives in vehicles?*

Answer: Yes, however with certain restrictions. The cSLS/SLS operates sensorless at this moment and does not support any hall-sensors, which are used for starts with full torque. However at sensorless operation, full torque is available only above a certain minimum speed. This restriction can be overcome by using a centrifugal clutch, which enables the torque-free motor start. Thus the cSLS/SLS with all its advantages is also suitable for traction drives.

Question: *Why is the AC-current specified on the name-plate and not the DC-current?*

Answer: The AC-current is the specification used in the industry. This is, because the AC-current can be translated directly into the torque if the motor constant is known. The DC-current together with the DC-voltage indicates only the input power – which is still dependent on the speed and does not provide any information about the actual operating point (speed, torque). Since the AC-currents are needed for the field-oriented control (i.e. they must be measured), the indication of the AC-current is obvious. The DC-current is not measured by the cSLS/SLS.

Question: *What are the advantages of sine-commutation towards block-commutation?*

Answer: The sine-commutation causes a absolutely uniform torque, a "smooth running" of the motor. ... one might demonstrate the difference by comparing round and hexagonal wheels - which would you like to have on your car? ;-)
Without torque ripple also the input power from the DC-power supply (battery or AC adapter) is uniform - thereby there is no length limitation of the DC-supply cables. The efficiency of the overall system is higher (especially in partial load) and there is no reactive power drawn from the supply. Finally an almost noise-free operation is possible with sine-commutation - the high-frequency "squeaking and squealing" of block-commutation is completely eliminated.

Question: *Is the operation via power supply(or battery with connected charger) possible?*

Answer: Principally: YES – because the cSLS/SLS does not “see” whether it draws its current from a power source or battery ;-)

If supplied by power supply it must be ensured that the cSLS/SLS does not regenerate current back (e.g. rapid braking of a inertia) or the power supply must be able to source and sink currents.

By using a not suitable power supply , cSLS/SLS and/or power supply can be damaged by over-voltage.

During battery operation with a connected charger, always make sure that the max. voltage of the cSLS/SLS is not exceeded. Some chargers produce very high voltage pulses (e.g. desulfation of lead-acid-batteries), which could damage the cSLS/SLS. Especially when the battery-pack consists of multiple, serial-connected 12V lead-acid batteries, which are recharged each with a separate 12V charger - this is where the pulses of the individual chargers can add-up to dangerous voltages! Disconnect the cSLS/SLS from the battery during recharge to keep the cSLS/SLS safe!

In any case use the existing precharge function to turn the controller on (internal precharge circuit of the cSLSi, external [AVS2](#) or [EBS](#))! Especially when the controller is operated near its maximum DC voltage. Turning the device on via a mechanical switch generates excessively high charging currents in the electrolytic capacitors and in addition produces dangerous over-voltages that may result in permanent controller damage! A in this way damaged controller carries the risk of a battery short-circuit along with the risks of a possible electric arc!

Question: *What information is required to send an offer, and find the best SLS for our application?*

Answer: We will gladly help you in choosing the right cSLS/SLS. In order to evaluate your application, we need further information (best case via eMail: info@SinusLeistungsSteller.de):

- A brief, general description of your application.
- Have you already selected a motor? If so, what type of motor?
- How is the motor supplied with energy? (by battery, AC-adapter, hybrid, fuel cell, etc.)
- Level of the DC-voltage (min, nom, max)
- Level of the maximum speed.
- Level power (nom, max, maximum time for Pmax)
- What kind of cooling (air-cooling, water-cooling)
- Is it a private or commercial application (estimated quantity p.a.)?
- Your residence and delivery address

Question: *Why do you deliver only within Europe? How can I get a SLS if I live outside of Europe?*

Answer: We do not want to deal with the enormous amount of "paperwork" that would arise for exporting products abroad. The EU-internal market makes it easier for us to deliver beyond the border of Germany to the neighboring EU countries. Everything beyond that, is done by a Germany-based import/export company. Unfortunately, this company does not work for free – so they need to be paid for their services. By request we will gladly provide a contact for you!

Question: *I did not found a dealer for SLS ...*

Answer: We distribute the cSLS/SLS exclusively ourselves. The cSLS/SLS is not "plug&play" and needs to be tuned on the motor (see above). This is very hard to accomplish by merchants.

Question: *Can the offered water cooling for cSLSi/SLSi be used with sea/salt water?*

Answer: No. A sea water resistant design would require a different aluminum alloy, but this would also mean a significantly worse thermal conductivity – the cSLS/SLS water cooling would therefore be too bad. We recommend a dual-circuit cooling system for applications permanently operating in seawater. The internal cooling circuit can operate with normal water (possibly with suitable antifreeze) and the heat can be dissipated via the outer cooling circuit (with sea water) to the sea.

Question: *I loaded an update from the download area into my SLS. Now the red LED is permanently ON after turning the device ON...*

Answer: No need to worry! Starting from firmware version 1.480, the red LED additionally indicates an invalid servo input signal. "Invalid" here means: out of range (800µs..2200µs, no Sollwertgeber connected) or immediately after turning ON: not in the neutral position of the signal curve stored in the cSLS/SLS (protection against unintentional start up after switching ON). Once you connect a valid reference signal (e.g. from [SG2](#)) and it is in neutral range, the red LED should turn OFF.

Question: *Is it really necessary to precharge the electrolytic capacitors, when turning ON the controller (before connecting the controller to the battery)?*

Answer: Hard switching can damage the SLS by over-current and over-voltage! In some cases, controllers failed, when they were connected to the battery without precharging the capacitors. We examined the occurring problem in detail (see [P03.pdf](#)) and conclude, that the use of the existing precharge options is mandatory.

You can use the precharge circuit integrated in the SLS ("thin red wire"), an external [AVS2](#) or our [EBS](#). We will not grant warranty for damages caused by turning ON without precharging!