Optimizing your drive!

Commisioing guide

Harmonic Filter RHF-Active
Software configuration guide

Marine

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General Industry

Data Center

Version 2/2023

Content

1. Important Information

1.1 About the manual

This commissioning guide shall ensure help the commissioning of a REVCON RHF-Active and explains the individual functions of the RHF-Active software and parameters. Commissioning of active filter should be handled by an electrical engineers with experience in active filter commissioning and they should have solid experience working with harmonics.

1.2 Terms and definitions

Filter module
For „Filter module REVCON RHF-Active“ the term „Filter module“ will be used.

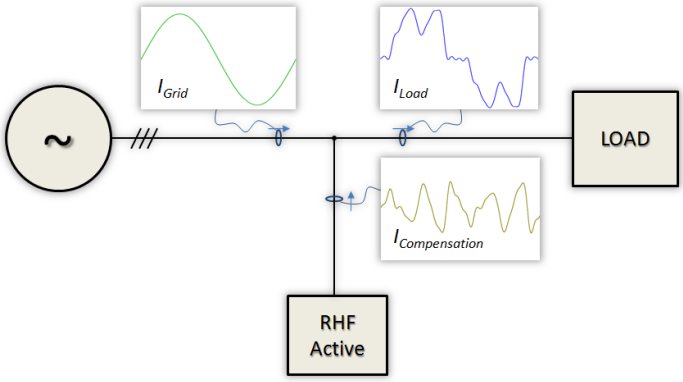
Drive controller
For the frequency inverter which is used together with the power feedback unit in the following the term „Controller“ is used

Drive system
For a drive system with harmonic filter, power feedback units, controller and other components of the drive system in the following the term „Drive system“ is used.

1.3 Working principle – RHF-Active

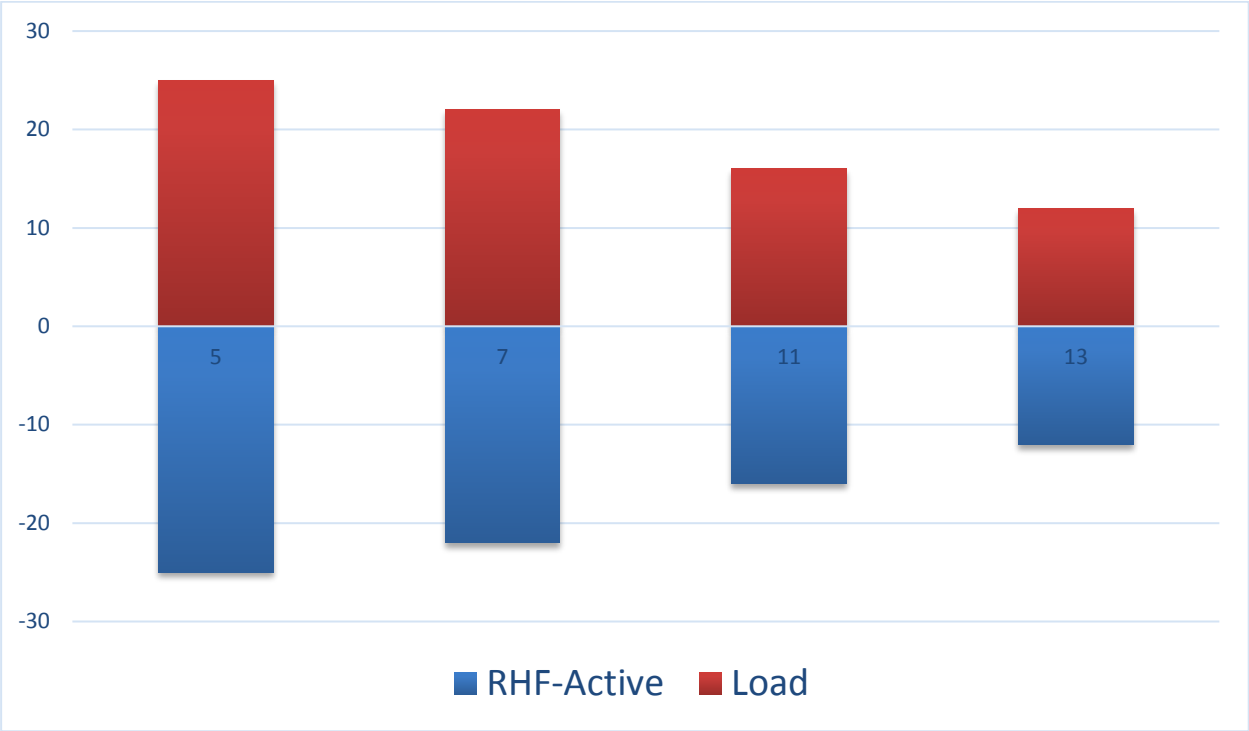
In order to commission the active harmonic filter, a good understanding of the working principle is mandatory.

The following picture is showing the basic topology and the working principle of the RHF-Active.



Active Harmonic Filters are parallel filter circuits injecting harmonics into the supply. These Harmonics have phase shift of 180° compared to the harmonics in the system. Therefore, the injected Harmonics are eliminating the Harmonics seen from the mains supply.

The following picture helps to verify the principle.



The result of the above shown harmonics is 0. The harmonics from load side are compensated by the RHF-Active injected harmonics. As a result, harmonics upstream of the RHF-Active will be low.

The RHF-Active will inject a harmonic current of same amplitude and frequency, but reverse angle into the connection point. Therefore, the theoretical result of the THDi upstream of the RHF-Active is 0%, assuming that the filter is sized for the full THC (Total Harmonic Current).

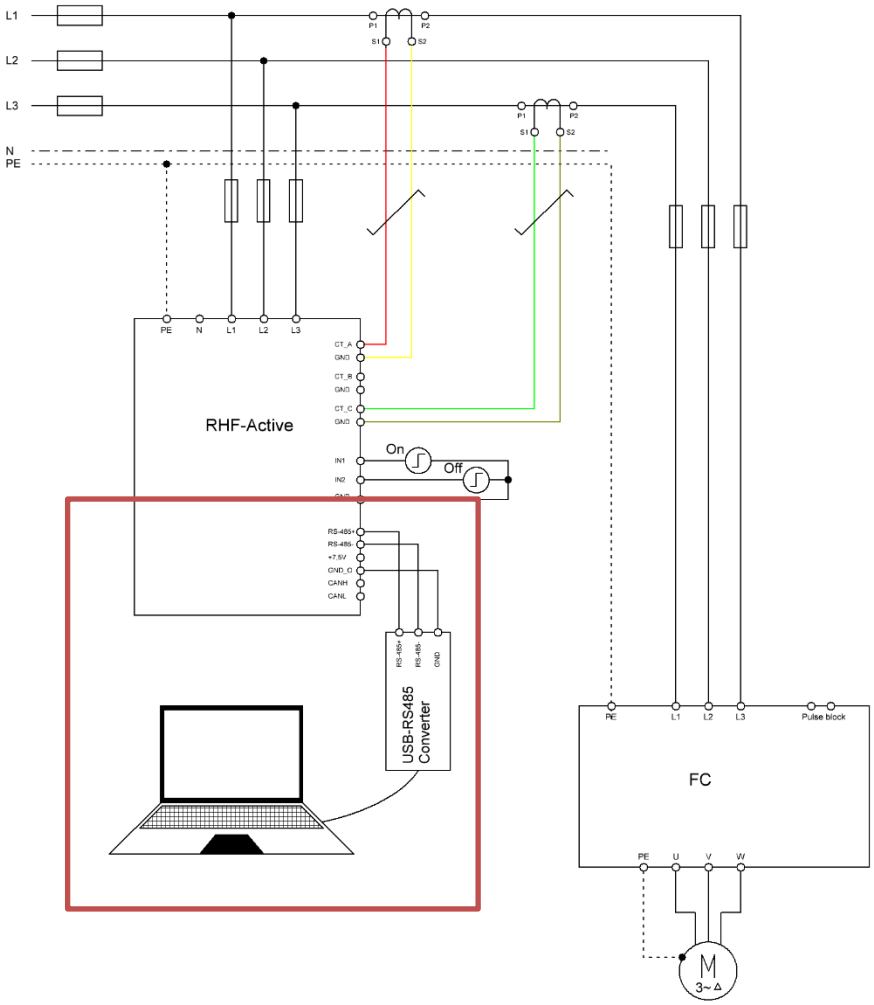
Nevertheless, the expected result is depending on many different factors such as:

- Grid-Load-Resonances - resonance frequency can typically not be fully eliminated.
- Measurement deviation – The true harmonic amplitude and angle is not the same as the measured harmonic content (reduced by high accurate measurement).
- Filter accuracy – Even though the RHF-Active is based on the most accurate hardware topology, 100% accuracy is not possible. Therefore, there is always a deviation between measured value and injected value.
- Load THDi value – The THDi is a ratio of harmonic current to fundamental current. When the Load THDi high, this will result in higher THDi result after compensation.

2. Connection

2.1 Required hardware

For connection of the RHF-Active, a RS485 to USB converter is required.



2.2 Software

For connection of the RHF-Active to the PC the latest RHF-Active PC software should be used.

This can be downloaded from www.revcon.de or requested from info@revcon.de

During download of the software, please ensure your antivirus software is not changing the name or delating the exe file: “RHF-Active-SiC.exe”. Execute this exe to start the software. The following Login for easy access can be used:

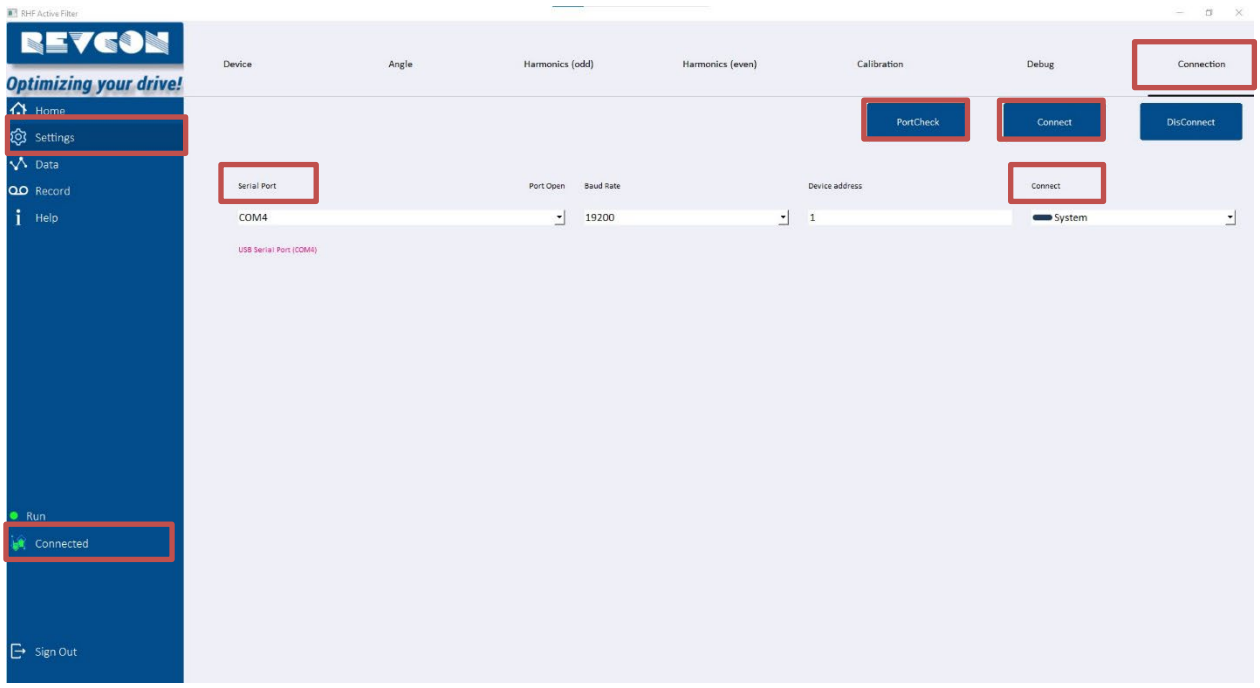
Login: 01
Password: 010101

Higher access level can be requested from REVCON.

NOTE: While entering values in the RHF-Active configuration software, the values must be confirmed by pressing enter! Without this step, the value will not be written into the RHF-Active.

2.3 Connection – PC to filter module

For connection of the RHF-Active to the PC the latest RHF-Active PC software should be used. In order to establish the connection to the filter module. Got to: “Settings” → “Connection”

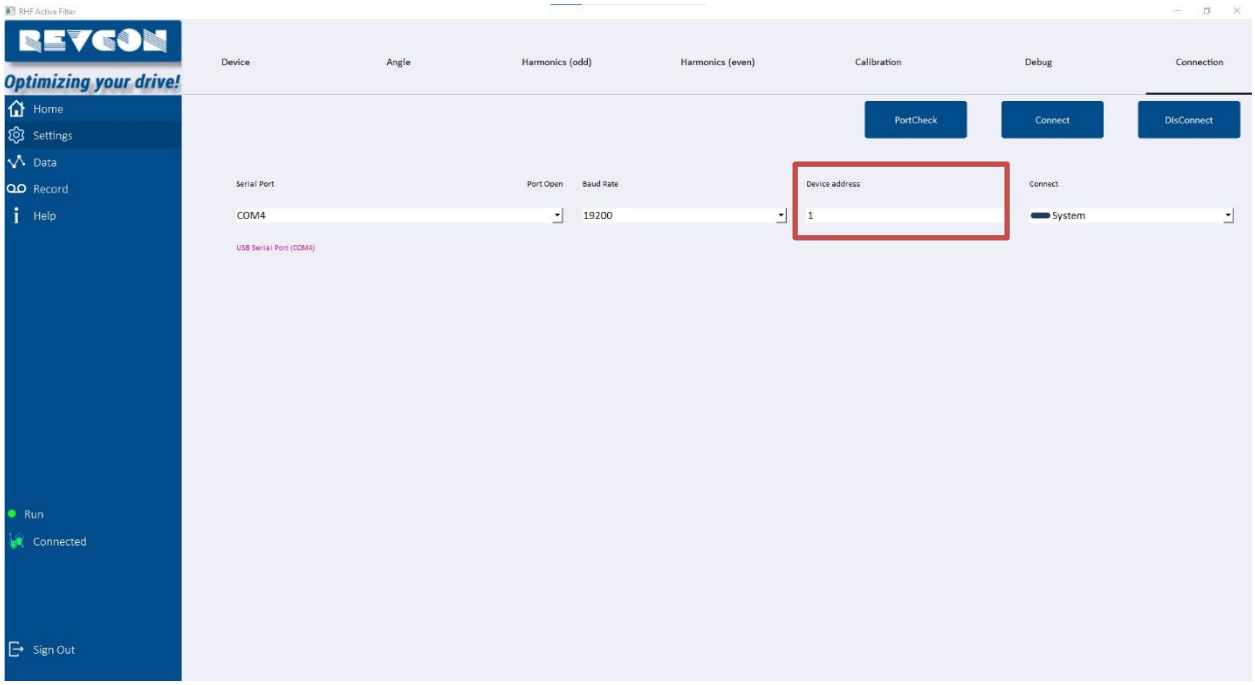


1. “Port Check”
2. Choose correct “serial port”
3. “Baud rate” should be set to 19200
4. “Connect” with either individual filter or system level (see chapter parallel connection)
5. Press “Connect”
6. Verify: “Disconnected” turns to green “Connected”

2.4 Connection – Parallel setup

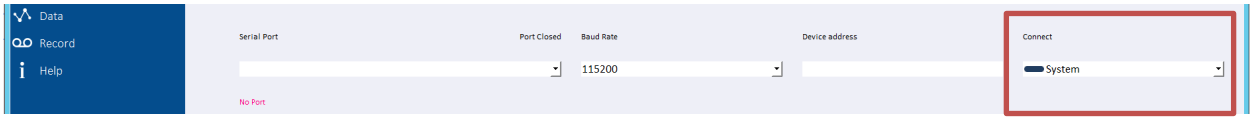
RHF-Active filters rated >55A are constellation of parallel setups. When ordered this way the filters will be set for parallel operation by factory. Settings can be changed in system level. If the compilation of active filters are changed, it can be necessary to follow the parallel setups.

Step one: Configure the MOBDUS address.



1. Connect RS485 connector to device 1 of your setup (other filters must not be connected)
2. Connect to filter as described in previous chapter.
3. Add “1” into “Device address”. Press enter.
4. Disconnect RS485 connector from device 1.
5. Connect RS485 connector to device 2 of your setup (other filters must not be connected)
6. “Connect” to filter.
7. Add “2” into “Device address”. Press enter.
8. Proceed for required number of parallel units.

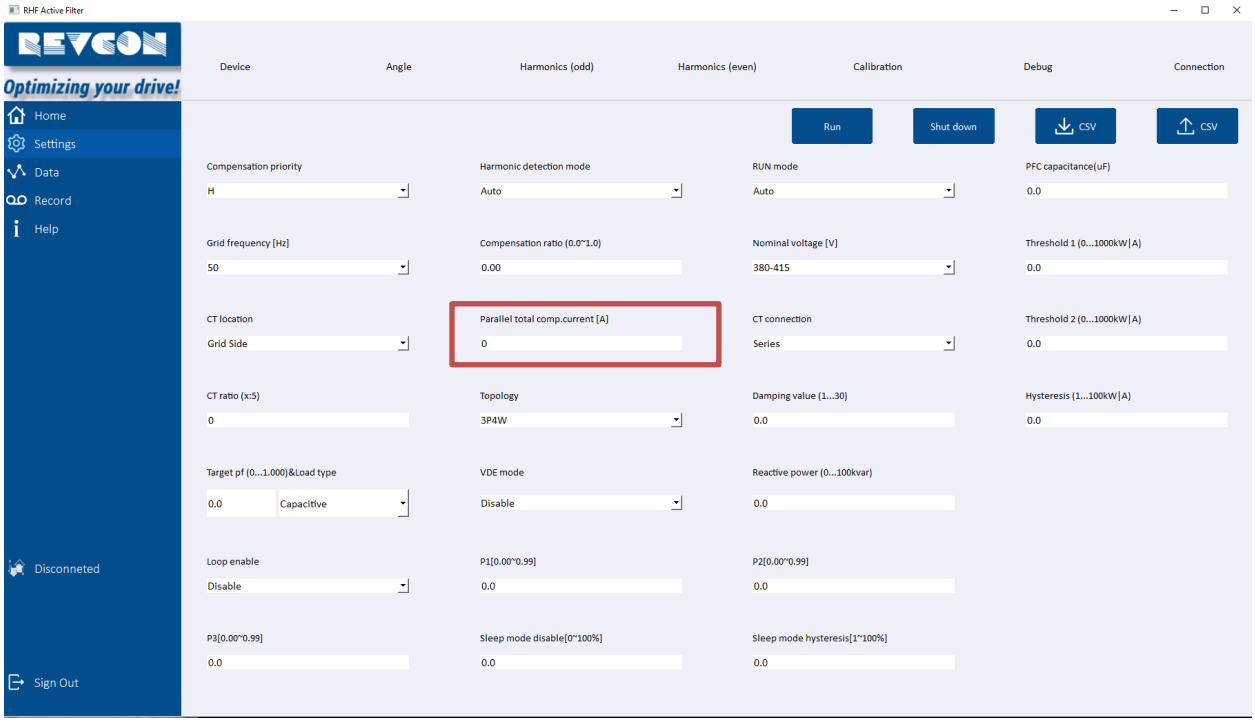
After these steps, all filters can be connected via RS485 connection. Individual filters can be addressed by using the filter selection menu.



Changes performed in “System” Level will result in changes on all connected filters. Changes performed in 1-16 will result in changes on the equivalent filter with the corresponding Modbus address 1-16.

Step two: Configure individual filters for parallel operation:

In order to run RHF-Active in parallel, the individual filters must be set to the correct total compensation current connected (“Parallel total comp. Current [A]”).
This setting can be done in system mode.



E.g.

RHF-Active 220-480-50/60-20-A is an active filter for 220A. This is a compilation of 4 x RHF-Active 55-480-50/60-20-A. The Total “Parallel total comp. Current [A]” is: **220**.

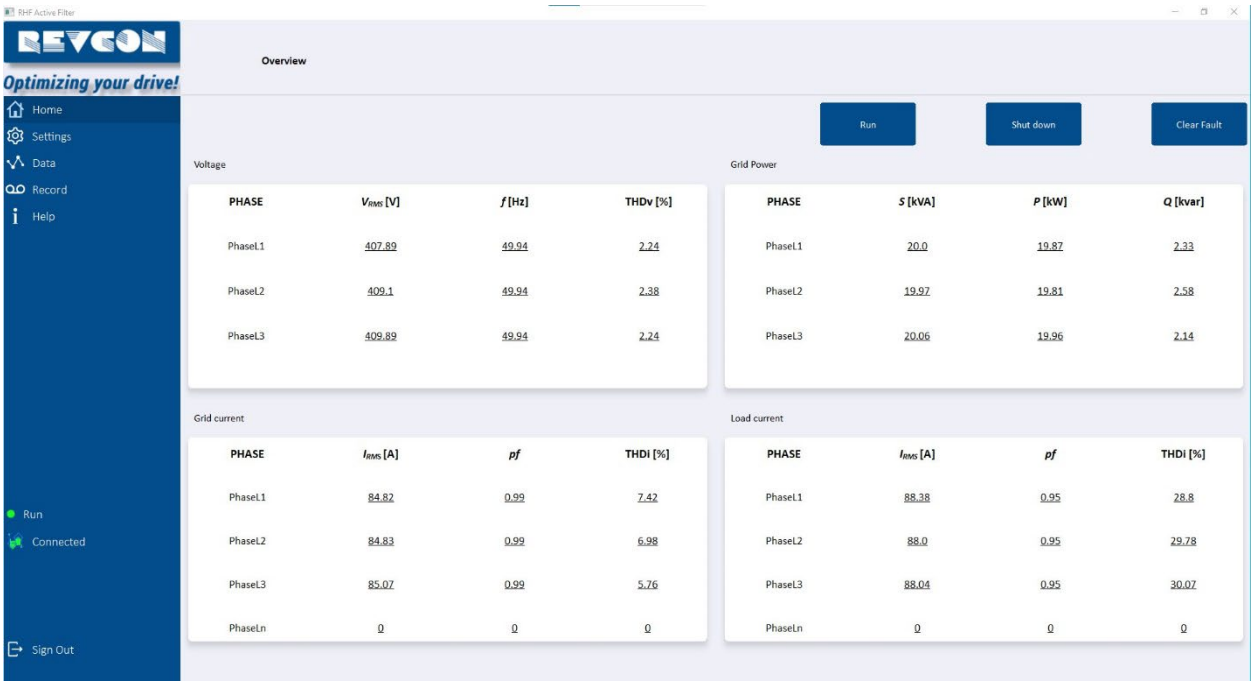
RHF-Active 70-480-50/60-20-A is an active filter for 70A. This is a compilation of 1 x RHF-Active 55-480-50/60-20-A and 1 x RHF-Active 15-480-50/60-20-A. The Total “Parallel total comp. Current [A]” is: **70**.

RHF-Active 350-480-50/60-20-A is an active filter for 350A. This is a compilation of 2 x RHF-Active 150-480-50/60-20-A and 1 x RHF-Active 100-480-50/60-20-A . The Total “Parallel total comp. Current [A]” is: **350**.

3. Home

3.1 Home page

The first page of the RHF-Active is “Home” This page gives an overview of considered interesting values, such as “Voltage”, “Grid Power”, Grid current” and “Load current”

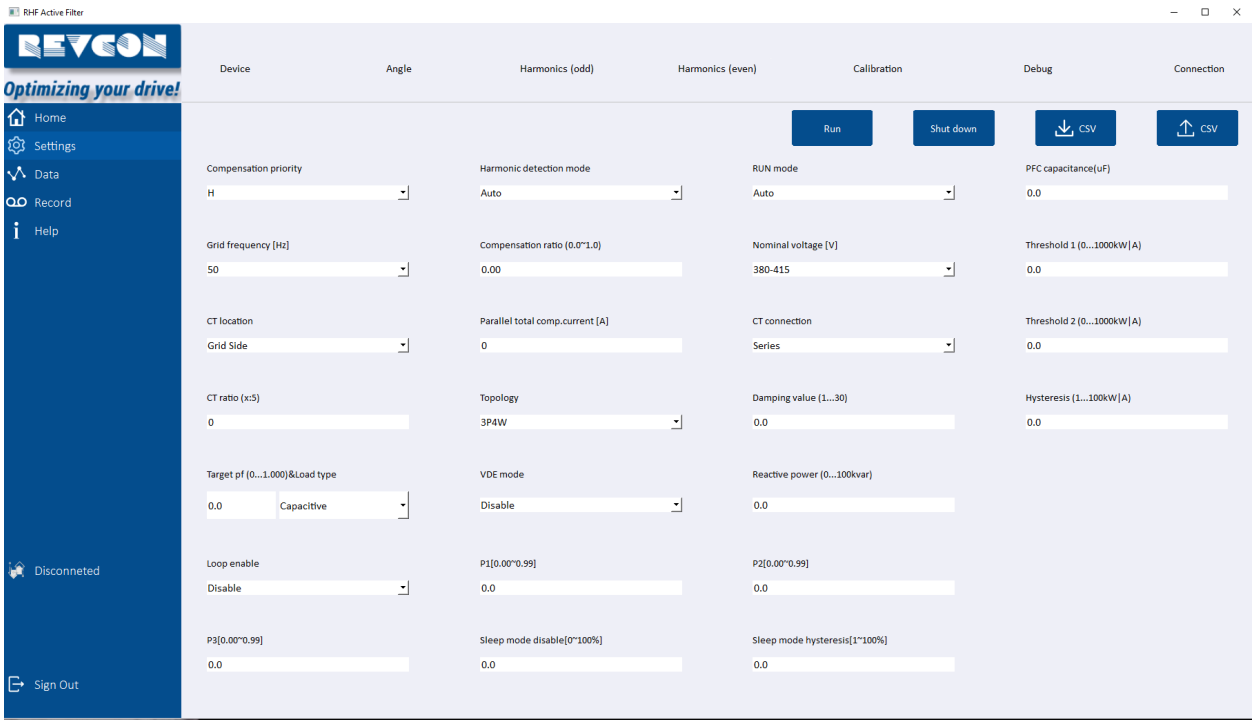


Run	Set the unit into operation
Shut down	Turn of operation
Clear fault	Delate fault (e.g. after EPO – Emergency Power Off).

4. Settings

4.1 Settings – Device

The Device settings are mayor function paramaters of the RHF-Active. It is recommended that these paramters are only changed while RHF-Active is “Shut down”



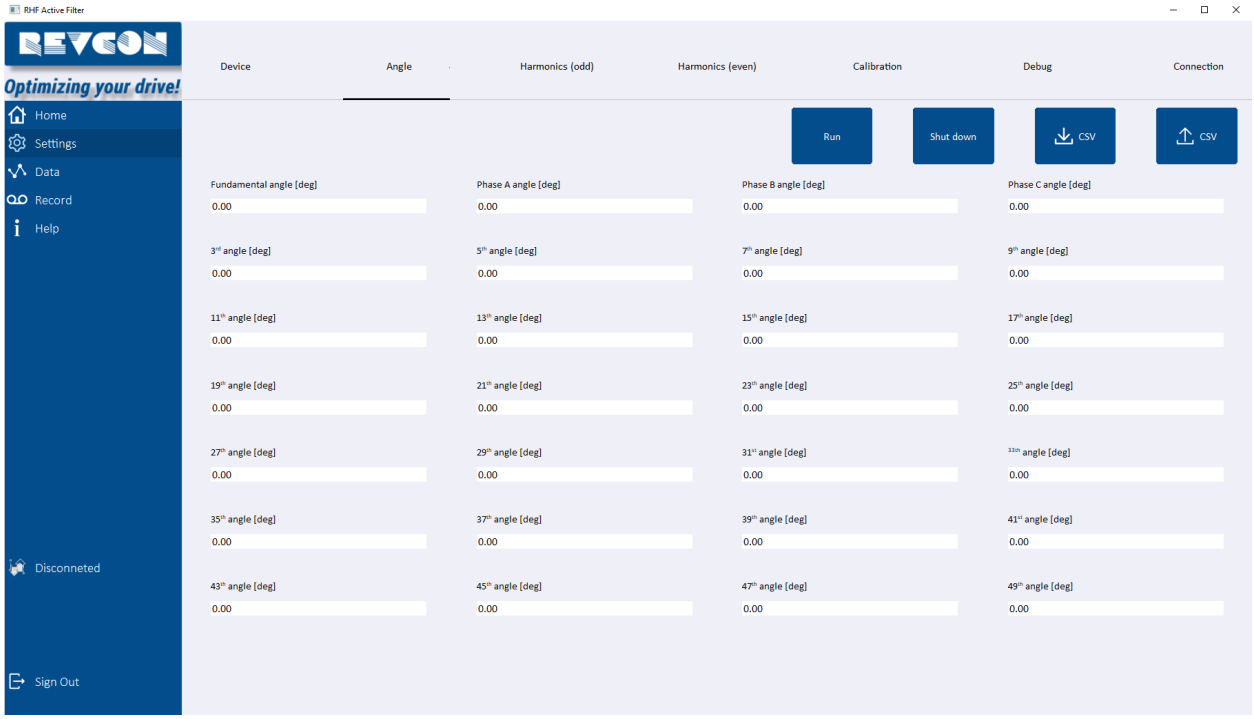
Run	Set the unit into operation
Shut down	Turn of operation
↓ **CSV**	(download) - Saves the current parameters into a CSV to be stored on PC.
↑ **CSV**	(upload) – Uploads a CSV parameter list into the machine.
Compensation Priority	**H**: Harmonic mitigation only **HR**: Harmonic mitigation and fundamental reactive current (Priority Harmonics) **HRU**: Harmonic mitigation, fundamental reactive current, and current unbalance (1. Priority Harmonics 2.Priority fundamental reactive current) **Self aging**: For factory use only!

Harmonic detection mode	This parameter changes the algorithm of the harmonic compensation mode. Auto mode should be preferred. **Auto:** optimum setting of individual harmonics will be searched by the filter. Individual settings for individual harmonics will be used as max values. **Manually**: Harmonics will be mitigated in accordance to the individual harmonics settings. **Completely**: All harmonics will be mitigated independent of the individual harmonics settings
RUN mode	**Auto**: Filter starting automatically when connected to power supply. Recommended setup after commissioning for most applications. **Manually**: Filter can be started via PC software “Run” or by external signal on In1. (10-24V high to start, 0V to Stop)
PFC capacitance	The RHF-Active can be used, as a hybrid system for reactive power compensation on fundamental current (I1). In this mode, the RHF-Active controls additional passive PFC equipment. The value entered corresponds to the individual capacity of the passive PFC circuit in µF.
Grid frequency	Grid frequency is detected by the software and can be changed individually by this parameter. Will be reset after power of.
Compensation ratio	Limitation of harmonic mitigation. Can be used to move the priory for harmonic mitigation in **HR** and **HRU** mode.
Nominal voltage	Grid voltage is detected by the software and can be changed individually by this parameter. Will be reset after power of.
Threshold 1	Threshold for RHF-Hybrid setup. This will close the NO1 or NO2 contact at the specified kW value. This is used to bypass and close the filter circuit in the RHF passive filter via contactor.
CT Location	**Grid side**: closed loop control. CT are located upstream of the filter **Load side**: open loop control. CT are located downstream of the filter (recommended!)
Parallel total comp. current	Value of total active filter connected in parallel (same CT signal)
CT connection	CT Connection for parallel operation of several RHF-Active with one CT Signal. **Series**: CT´s are in series (recommended!) **Parallel**: CT´s are connected in parallel (not recommended!)
Threshold 2	Threshold for RHF-Hybrid setup. This will close the NO1 or NO2 contact at the specified kW value. This is used to bypass and close a second filter circuit in the RHF passive filter via contactor.
CT ratio	Ratio of CT (x:5). E.g. CT: 200A to 5A, enter **200**
Topology	**3P4W**: For setups with 3 phase supply and neutral. **3P3W**: For setups with symmetrical 3 phase supply.
Damping Value	Damping of current controller. Recommended: “10” for 3P4W system. “30” for 3P3W system with VFD typical spectrum. “20” for 3P3W system with EC Fan or slim DC bus drive spectrum. Lower value corresponds to less damping in the compensation.

Hysteresis	Hysteresis for the open and close of the Threshold 1 and 2 in order to avoid frequent open and closing of the contact.
Target pf	Target for reactive current compensation. Can be set Capacitive or Inductive. (leading or lagging current)
VDE mode	VDE Mode can be enabled if active filter is used with REVCON Regen unit in order to reach the VDE-AR 4105
Reactive power	Reactive Power settings for VDE Mode in kvar
Loop enable	Not used. Default: Disable
P1	Not used. Default: 0.0
P2	Not used. Default: 0.0
P3	Not used. Default: 0.0
Sleep mode disable	This value will disable the sleep mode. Filter will start operation once the initial value is reached. The parameter is linked to the CT ratio. E.g. CT ratio is 200 and sleep mode disable is **10**%. The filter will start operation at 20A nominal load current.
Sleep mode hysteresis	Offset in % from sleep mode disable. E.g. CT ratio is 200A and sleep mode disable is 10%. Sleep mode hysteresis is set to **5**%. Filter will start operation at 20A, and turn of at 10A.

4.2 Settings – Angle

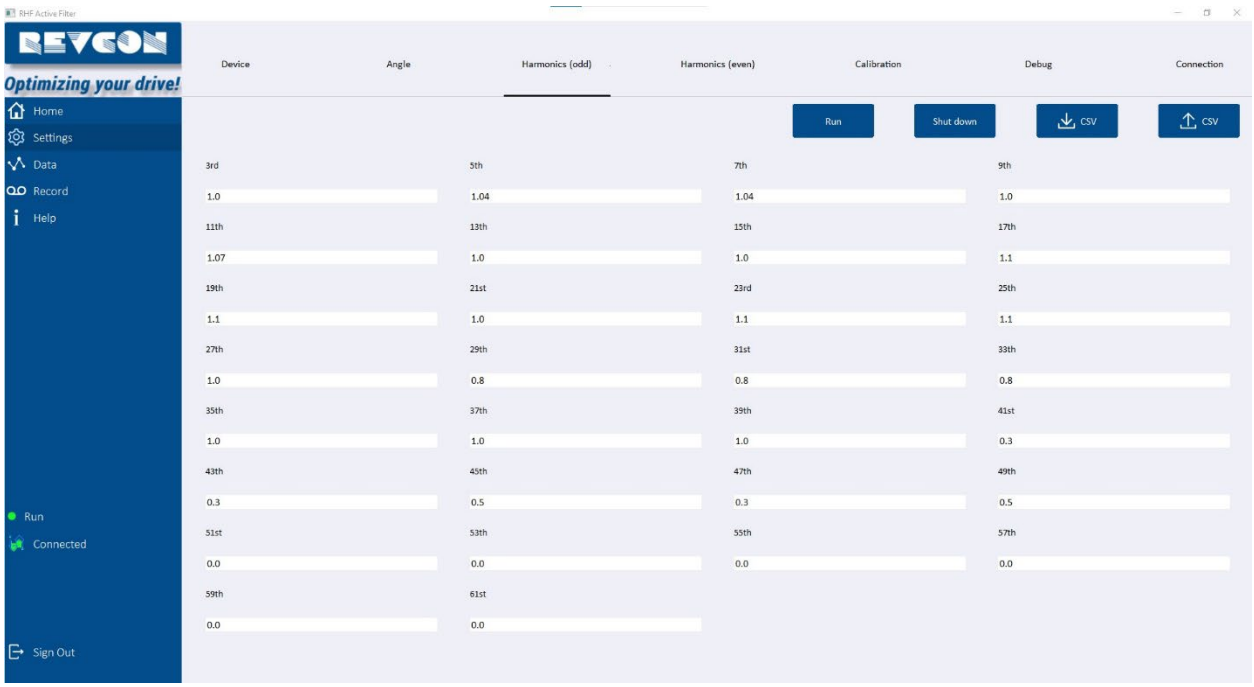
The RHF-Active is injecting harmonics of opposite angle, compared to the measured value. Deviation between measured value and injected value can be adjusted in the “Angle” settings. Values are referring to degree (2.20 correspond to an offset of 2.2° (injection angle 180°+2.2°)). Negative values are possible. These settings can be changed during operation on the RHF-Active.



Run	Set the unit into operation
Shut down	Turn of operation
↓ CSV	(download) - Saves the current parameters into a CSV to be stored on PC.
↑ CSV	(upload) – Uploads a CSV parameter list into the machine.
Fundamental angle	Angle offset of fundamental angle compensation.
Phase A angle	Angle offset of complete signal measured via L1.
Phase B angle	Angle offset of complete signal measured via L2.
Phase C angle	Angle offset of complete signal measured via L3.
3rd angle	Angle offset of 3rd harmonic for L1-L3.
n angle	Angle offset of n harmonic for L1-L3.
25th angle	Angle offset of 7th harmonic for L1-L3.

4.3 Settings – Harmonics (odd)

The RHF-Active is injecting harmonics of same amplitude as measured value. Deviation between measured value and injected value can be adjusted in the “Harmonics (odd)”.
Values are referring to a factor of the individual harmonic amplitude (1.05 correspond to compensation of 105%). This setting is used to fine-tune the performance of the RHF-Active. These settings can be changed during operation on the RHF-Active.



Run	Set the unit into operation
Shut down	Turn of operation
↓ **CSV**	(download) - Saves the current parameters into a CSV to be stored on PC.
↑ **CSV**	(upload) – Uploads a CSV parameter list into the machine.
3rd	Compensation of the 3rd harmonic order as a factor. Values from 0.00-1.10 are allowed. (0-110% compensation current).
n	Compensation of the n harmonic order as a factor. Values from 0.00-1.10 are allowed. (0-110% compensation current).
61st	Compensation of the 61st harmonic order as a factor. Values from 0.00-1.10 are allowed. (0-110% compensation current).

4.4 Settings – Harmonics (odd/even) – fine-tuning harmonics

In order to achieve the best possible performance, fine-tuning of individual harmonics is recommend. The following procedure can be used:

1. Install PQ-Analyser upstream of the RHF-Active.
2. Start RHF-Active and view result in bar graph mode.
3. Identify harmonic content on 5th Harmonic on PQ analyser or start with 3rd Harmonic if relevant content (e.g. in 3P4W system)
4. Add +0.01 to the corresponding harmonic value in the RHF-Active software.
5. Review the result:
    a. If harmonic content is less than before, move on to step 6.
    b. If harmonic content is higher, move on to step 8.
6. Add +0.01 to the corresponding harmonic value in the RHF-Active software.
7. Review the result:
    a. If harmonic content is less than before, repeat step 6.
    b. If harmonic content is higher, insert previous value and move on to step 12.
8. Add -0.01 to the corresponding harmonic value in the RHF-Active software.
9. Review the result:
    a. If harmonic content is less than before, move on to step 10.
    b. If harmonic content is higher move back to initial value and move on to step 12.
10. Add -0.01 to the corresponding harmonic value in the RHF-Active software.
11. Review the result:
    a. If harmonic content is less than before, repeat step 10.
    b. If harmonic content is higher, insert previous value and move on to step 12.
12. Repeat steps 4-11 with next odd harmonic order until all harmonics are within the considered limits.

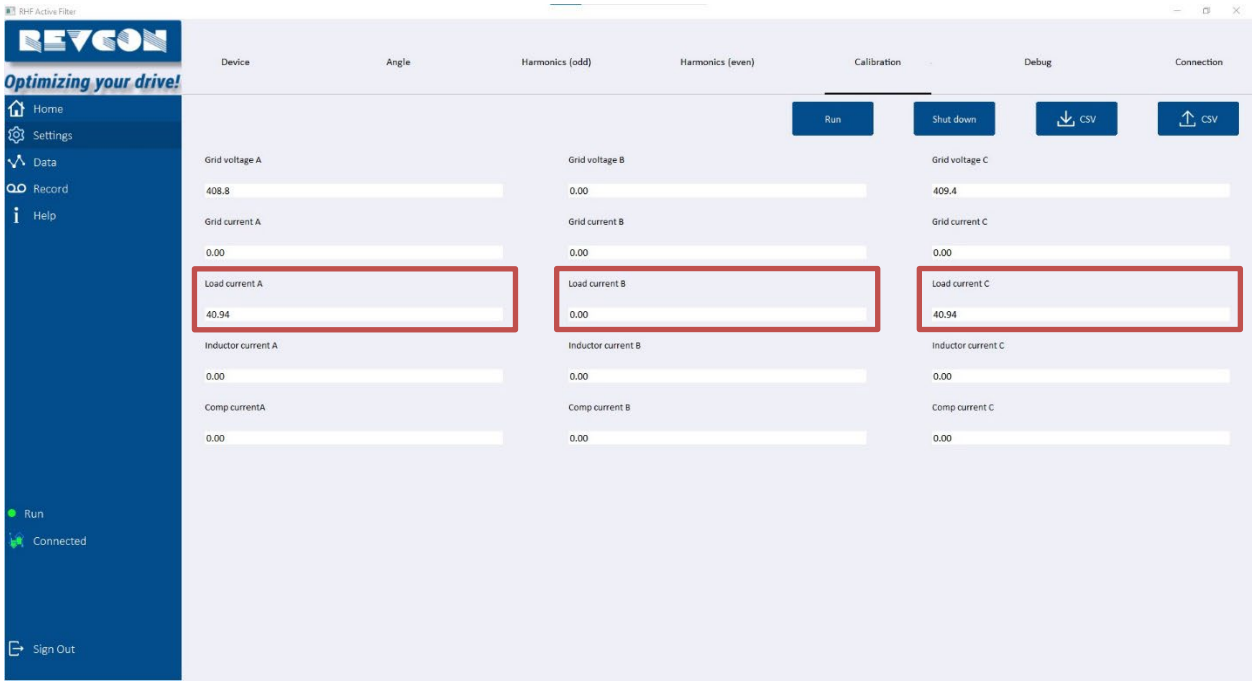
4.5 Settings – Harmonics (even)

The RHF-Active is injecting harmonics of same amplitude as measured value. Deviation between measured value and injected value can be adjusted in the “Harmonics (even)”.
Values are referring to a factor of the individual harmonic amplitude (e.g. 1.05 correspond to compensation of 105%). This setting is used to fine-tune the performance of the RHF-Active. These settings can be changed during operation on the RHF-Active. Even order harmonics may be caused by unbalance in the load. For symmetrical load, compensation of the even order harmonics should not be required and settings of 0.00 is recommended.

Run	Set the unit into operation
Shut down	Turn of operation
↓ **CSV**	(download) - Saves the current parameters into a CSV to be stored on PC.
↑ **CSV**	(upload) – Uploads a CSV parameter list into the machine.
2nd	Compensation of the 2nd harmonic order as a factor. Values from 0.00-1.10 are allowed. (0-110% compensation current).
n	Compensation of the n harmonic order as a factor. Values from 0.00-1.10 are allowed. (0-110% compensation current).
60th	Compensation of the 60st harmonic order as a factor. Values from 0.00-1.10 are allowed. (0-110% compensation current).

4.6 Settings – Calibration

The RHF-Active is injecting harmonics of same amplitude as measured value. Deviation between measured value and injected value can be reduced by proper calibration of the CT. This step is made in the factory, but in some occasions, this may be necessary on site.

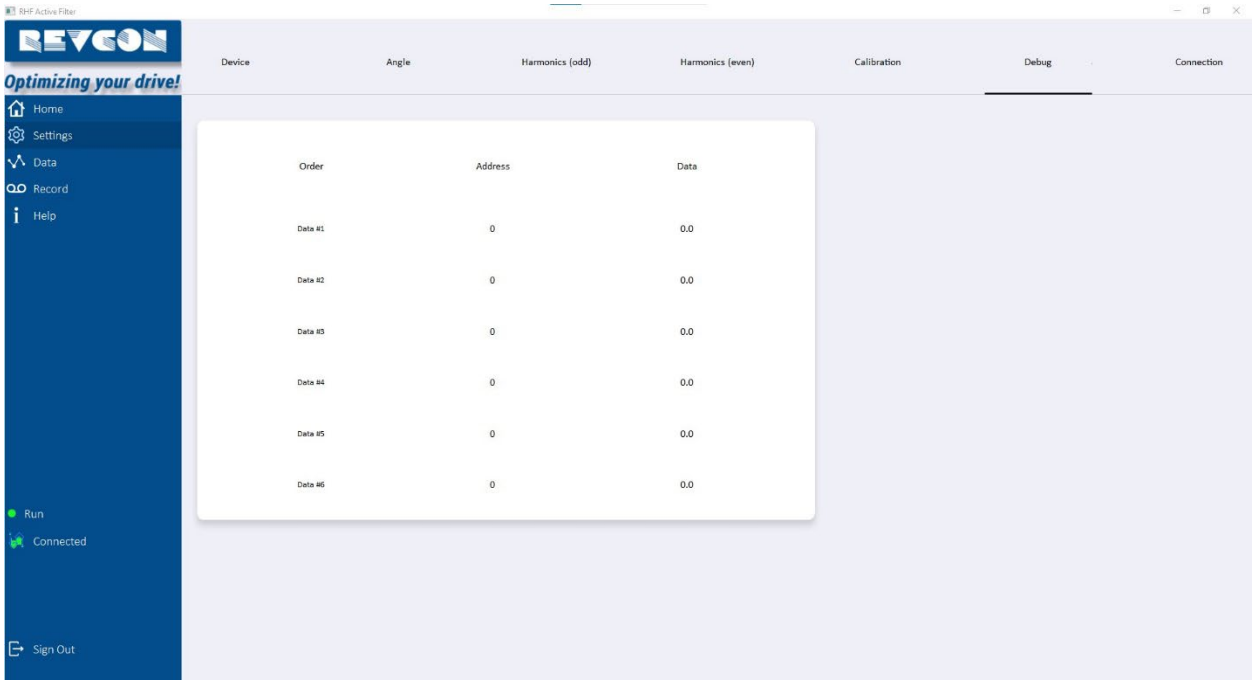


For calibration, a very stable load current through the CT is required. The load should be between 60-80% if the nominal CT load. Calibration of other than “Load current A/B/C” should only be made in the factory. The calibration is made by the following steps:

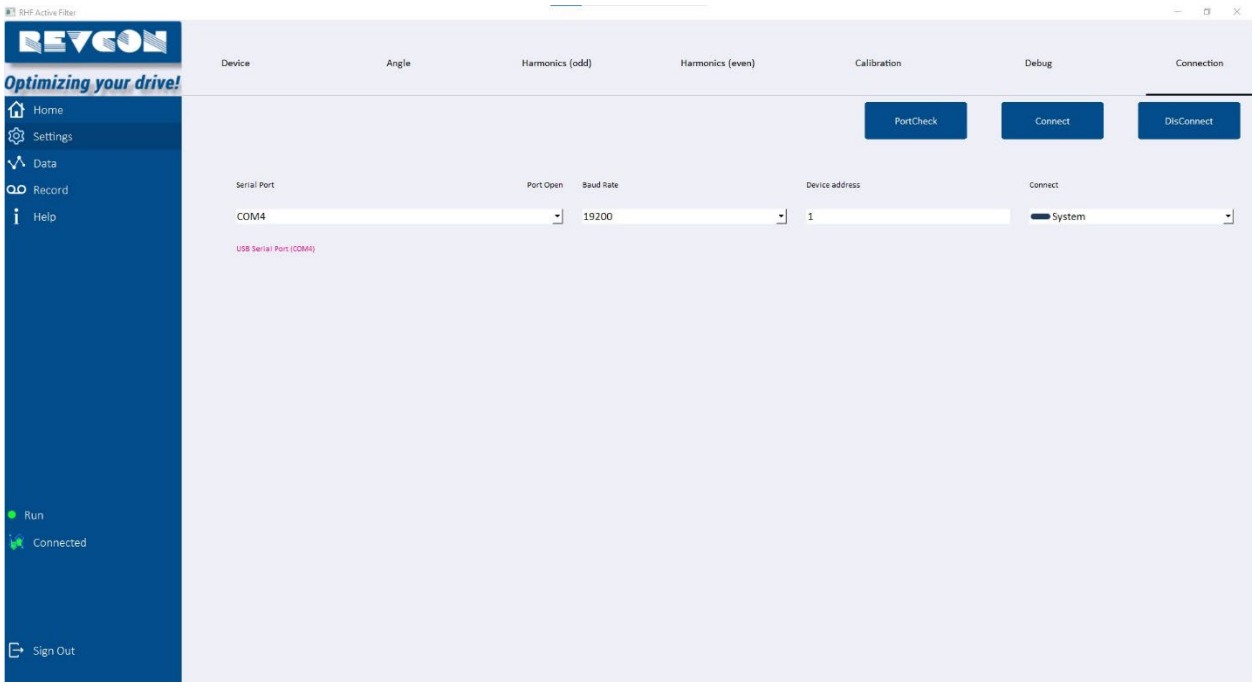
1. Turn off the RHF-Active
2. Install PQ analyser or other accurate current measurement with detailed I_{RMS} calculation. Measurement should be in the same position as the CT connected to the RHF-Active.
3. Compare “load current” I_{RMS} (Home) and measured current by the measurement device connected (I_{RMS}).
4. If a relevant deviation was found. Calibration may be required. Please note that all fine-tuning of the RHF-Active filter will miss-tuned after the next step.
5. Enter the measured I_{RMS} value from L1 into “Load current A”.
6. Enter the measured I_{RMS} value from L2 into “Load current B” (required for 3P4W only / 3 CT connected only).
7. Enter the measured I_{RMS} value from L3 into “Load current C”.
8. Compare “load current” I_{RMS} (Home) and measured current by the measurement device connected (I_{RMS}).
9. If a relevant deviation was found. New Calibration may be required. Repeat step 5-8.
   Remark: Often the current changes with time (due to variation of mains voltage, temperature etc.). Therefore this action is time critical. It is recommended to enter the measured current immediately into the RHF-Active.

4.7 Settings – Debug

The Debug page can give information on different MODBUS RTU address. This page is currently reserved for factory use only.



4.8 Settings – Connection

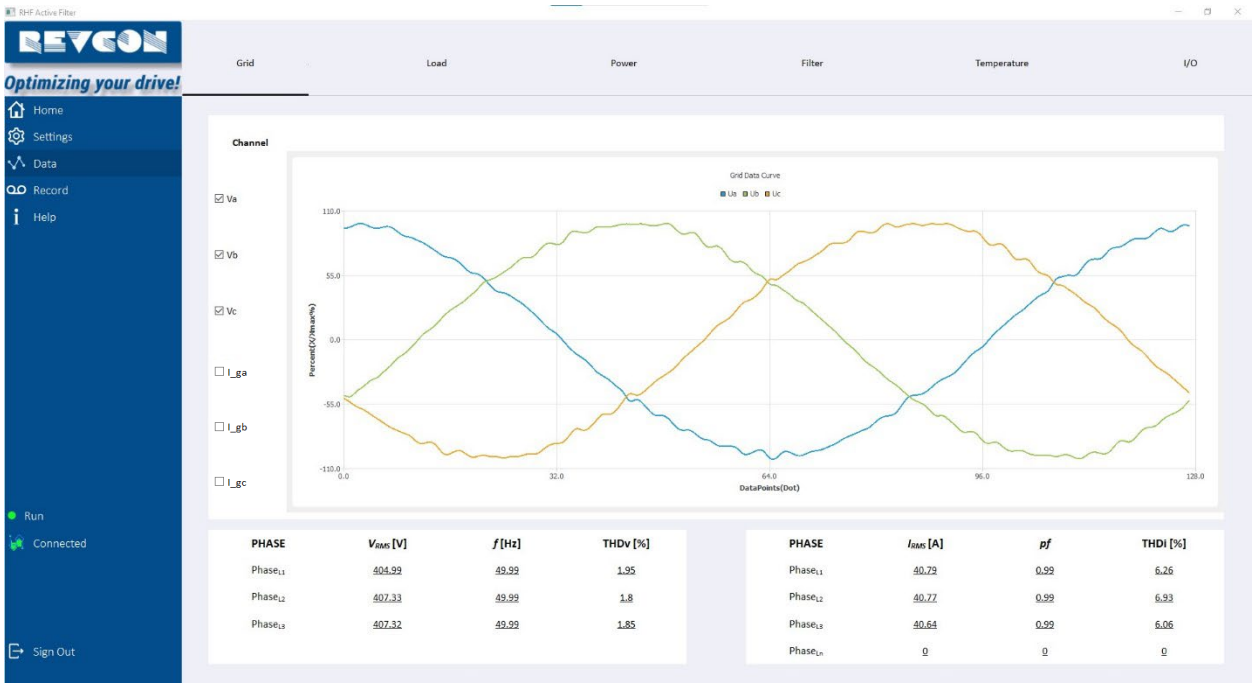


Port Check	Checks for available USB Devices.
Connect	Connects the PC Software to the RHF-Active if settings are correct.
Disconnect	Disconnects the PC Software to the RHF-Active.
Serial Port	Shows available USB Devices. Choose device corresponding to RS485-USB connector
Baud rate	Different available baud rates. Choose: **19200**
Device address	Setting for individual MODBUS Address of RHF-Active (See chapter 2.4 for details)
Connect (drop down menu)	Choosing between individual RHF-Active (1-16) or system level. During system level, several parallel RHF-Active will act as one device. (See chapter 2.4 for details)

5. Data

5.1 Data – Grid

The Data-Grid page is showing voltage current waveforms of the grid side. This individual current and voltage can be enabled and disabled using the check marks on the left side.



NOTE! For CT on load side, there is no measurements of the grid side current. The grid side current should only be considered as a pproximation of the true current waveform.

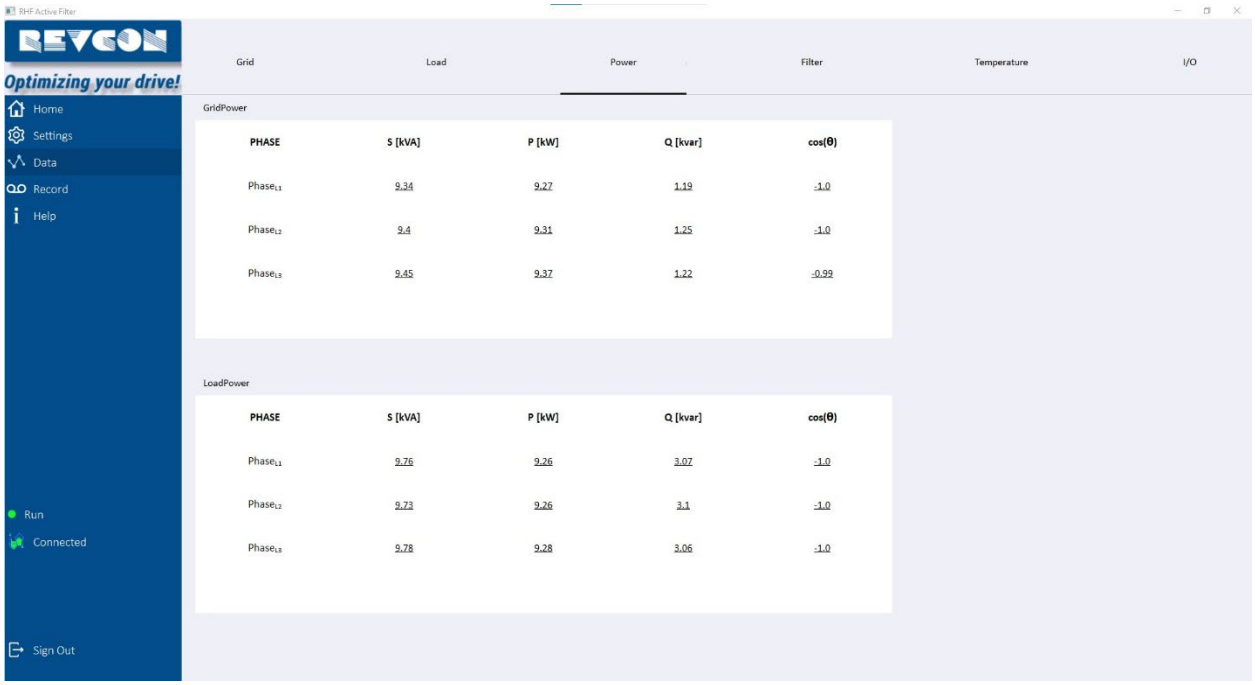
5.2 Data – Load

The Data-Load page is showing voltage current waveforms of the load side. This individual current and voltage can be enabled and disabled using the check marks on the left side.

NOTE! For CT on grid side, there is no measurements of the load side current. The current should only be considered as approximation of the true current waveform.

5.3 Data – Power

The Data-Power page is showing load side and grid side apparent power, power, reactive power and cos(φ) (displacement factor).



NOTE! For CT on load side, there is no measurements of the grid side current The values for grid side should be considered as approximations only.

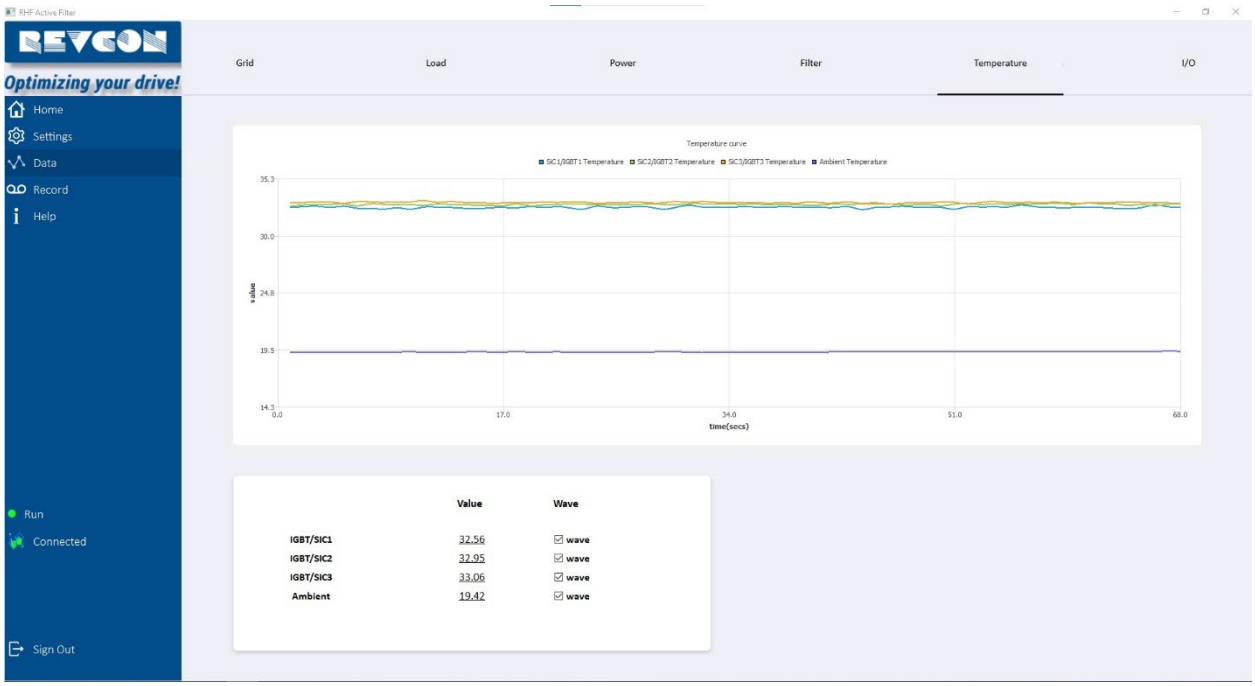
NOTE! For CT on grid side, there is no measurements of the load side current. The values for load side should be considered as approximations only.

5.4 Data – Filter

The Data-Filter page is showing voltage current waveforms of the RHF-Active. This individual current and voltage can be enabled and disabled using the check marks on the left side. This page is also showing the DC Bus voltage which can be used to indicate errors.

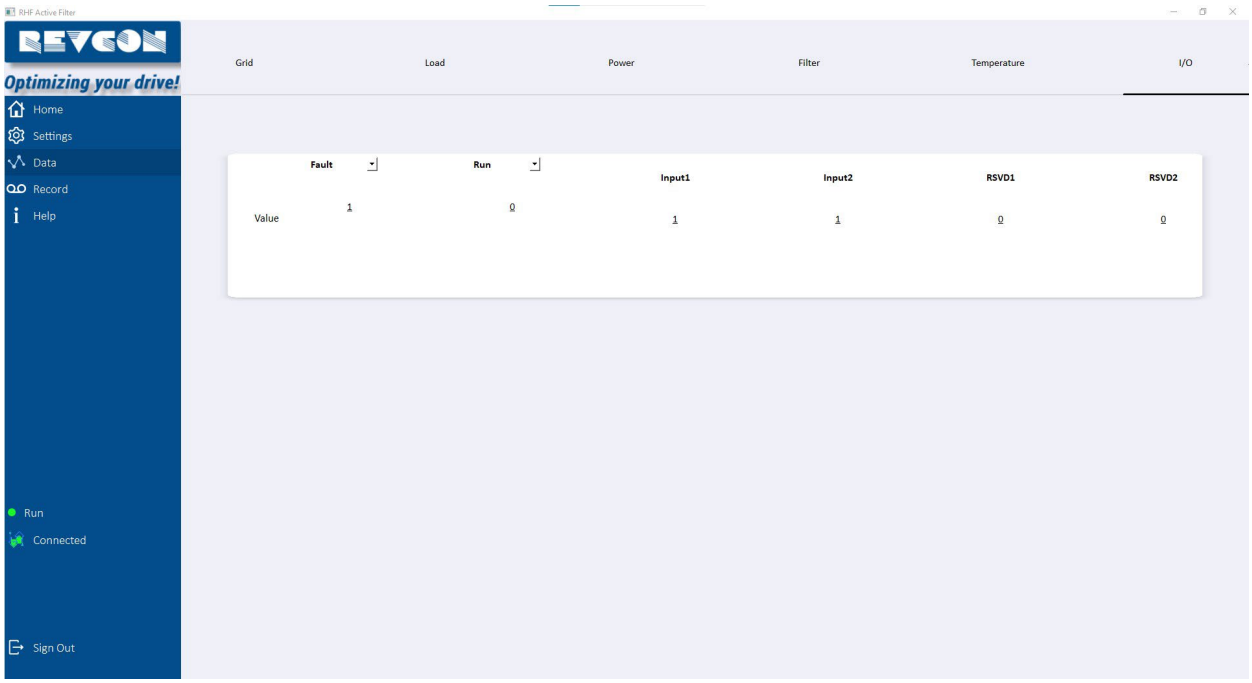
5.5 Data – Filter

The Data-Temperature page is showing the individual SiC and ambient temperature. These individual temperatures can be enabled and disabled using the check marks.



5.6 Data – I/O

The Data- I/O is showing the status of the input and output relay. The Function of the output relays can be changed in these settings. Output relay is suitable for 2A/250V AC or 3A/30V DC. Input signal is considered low for 0-3V, high for 10-24V)



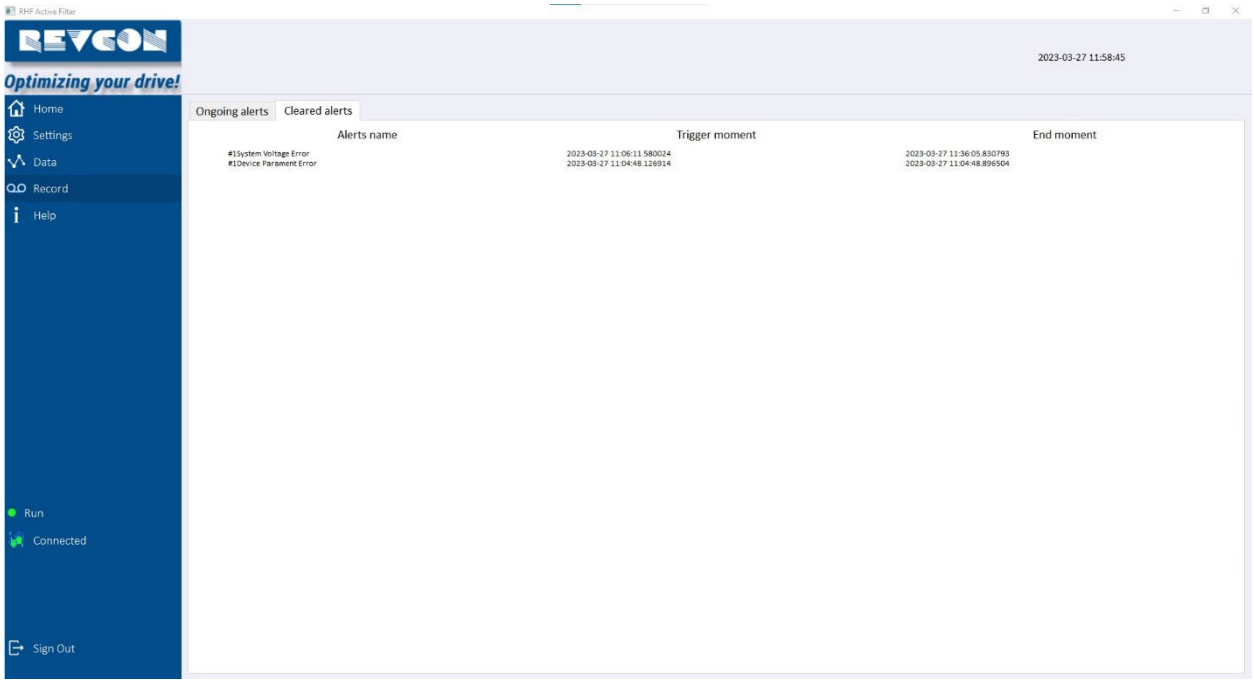
NO1 (dropdown 1)	This relay is by default set to fault. **Fault State**: this NO1 relay, will open in case of alert or power failure. **Threshold 1:** NO1 Relay will close when the power threshold set in parameter “threshold 1” is reached. This is used for hybrid harmonic filter.
NO2 (dropdown 2)	This relay is by default set to Run. **Run**: This signal must be used in combination with NO1 – Fault - signal only in accordance to the table below: NO1 - Fault / NO2 - Run Power Failure: 0 / 0 Standby: 1 / 1 Run: 1 / 0 Failure: 0 / 1 **Threshold 2:** NO2 Relay will close when the power threshold set in parameter “threshold 2” is reached. This is used for hybrid harmonic filter.
Input1 – IN1	This signal is used for controlling the filter operation (RUN) **High**: will turn unit into run - **Low**: shut down This function is only active for run mode: “Manually”

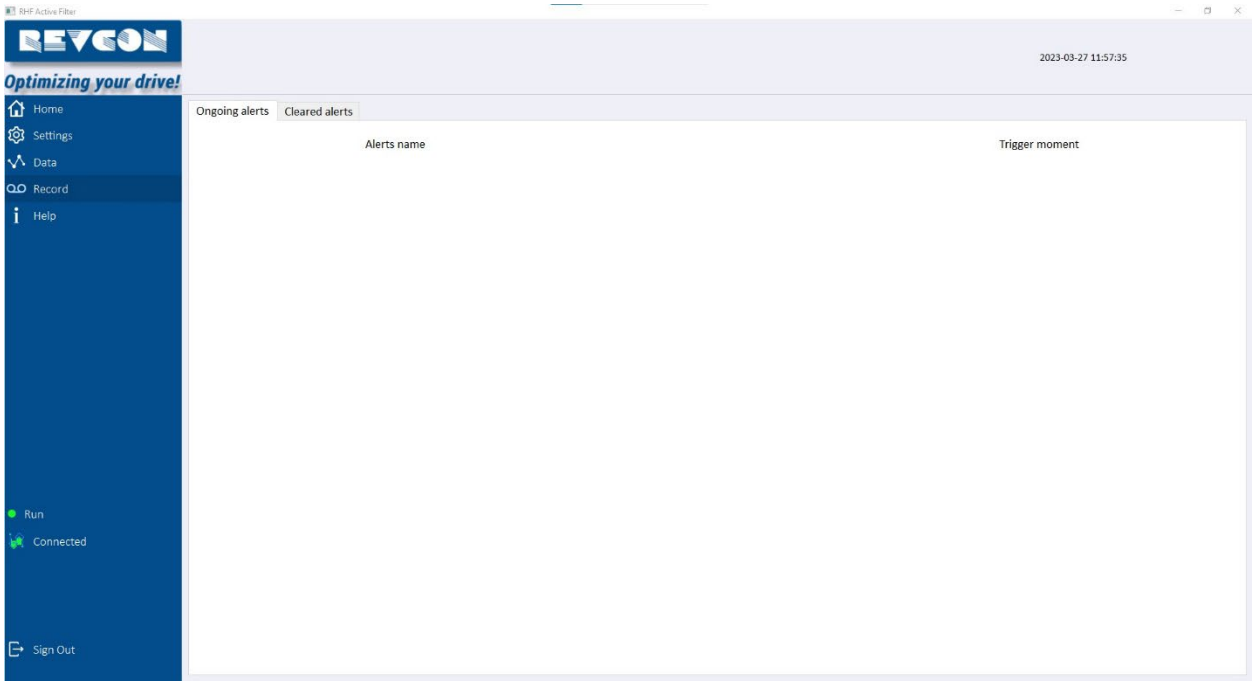
Input2 – IN2	For different grid conditions, different parameter settings can be used (.g. Generator during power shut down). **Low**: Primary parameter are set **High**: Secondary parameter are set In order to set secondary parameter, the input must be high during setup. It´s not recommended to change the settings during operation of the RHF-Active (shut down).
RSVD1	Reserved for future purpose
RSVD2	Reserved for future purpose

6. Record

6.1 Record - Ongoing/cleared alerts

This page is showing ongoing and cleared alerts. Note that the cleared alerts are stored only in the PC software. Disconnecting from the device will lose this date.





6.1 Possible alerts and troubleshooting

Alert	Possible fault	Troubleshooting
'Inverter Short Error'	1.MOS tube damaged 2.The drive circuit is damaged	Power off. Factory repair
'DC Voltage Error'	1. Bus voltage error, which may be due to resonance or high grid voltage	1. Check the value of bus voltage 2. Check for resonance 3. Check if 3P3W or 3P4W selection error. 4. Voltage sampling circuit failure Shut down and wait for the bus voltage to return to normal. Then restart.
'Epo'	Check EPO contacts	Disconnect EPO and clear fault
'Inverter Current Error'	The harmonic detector detects the resonance point	1. Adjust the compensation rate of resonance point 2. Adjust active damping coefficient
'System Frequency Error'	Check the voltage frequency and voltage sampling waveform	1. If the power grid is restored, RHF-Active will automatically clear the fault; 2. If the power grid is normal and the sampling waveform of the equipment is incorrect, it is necessary to check the voltage sampling circuit
'DC Difference Value Error'	1. Check the DC-Bus voltage 2. 3P3W or 3P4W selection error.	1. If both positive and negative buses have different voltage, it may be caused by resonance. After eliminating resonance, restart to return to normal. 2. If the voltage of one bus is close to 0V, it is necessary to shut down and send for factory repair.
'Supply Power Error'	Check whether the LED light is on	Factory repair of the auxiliary power supply
'System Voltage Error'	Check the grid voltage waveform	1. Wait for the power grid to return to normal 2. If it´s a voltage sampling fault, factory repair is required.
'U3Comm Error'	Check whether the input and output dry contacts can be used normally	1. Factory repair.
'Fan Error'	Check whether the fan does not work	Replace the fan with a new one
'CtrlSoftware Version Error'	Check software version	Upgrade the correct software

'Inverter Over Temprature'	Check power and ambient temperature or radiator temperature	1. Wait until the temperature returns to normal, then restart the RHF-Active 2. Temperature sampling failure. Factory repair
'CT Set Error'	Check the actual current and CT value	1. Set the correct CT transformation ratio 2. Replace the appropriate CT. 3. If the fault is caused by inrush current, it can be ignored
'Device Parameter Error'	1. When setting the CT in grid side, the full compensation mode is not allowed; 2. When grid voltage is 480V.it can only be used in 3P3W mode; 3. The parallel capacity must be greater than the rated capacity of RHF-Active	Reset relevant parameters according to the three rules described on the left
'Over Load'	Check for resonance	1. Wait for five minutes and the fault will be cleared automatically, or power off and restart 2. Sampling circuit fault. Factory repair