

# User Manual REFUset V3

REFU Elektronik GmbH



REFUset V3

**REFU Elektronik GmbH** 

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# **Table of Contents**

1	Ab	out this User Manual	5
	1.1	Symbols and Markup	5
	1.2	Warning Notices	5
	1.2.1	Layout of a Warning Notice	5
	1.2.2	Categories of Warning Notices	5
	1.3	Information	6
2	Sa	fety Information	7
	2.1	Qualified personnel	7
	2.2	Proper use of REFUsol-Products	7
	2.3	Disclaimer	7
3	Co	mpatibility Overview	8
	3.1	Inverter type compatibility	8
4	Co	nfiguration with REFUset	9
	4.1	System Prerequisites	9
	4.2	Preparatory Measures	9
	4.3	Description of Functions	9
	4.3.1	Grid-Interactive Functions	9
	4.3.2	Other functions	10
	4.4	Connection Set-Up Ethernet and RS485	10
	4.4.1	Ethernet	10
	4.4.2	RS485	11
	4.5	REFUset Main Window	13
	4.5.1	Initial Settings	13
	4.5.2	Password	13
	4.5.3	Main Screen	14
	4.6	File Menu	14
	4.7	Configuration Menu	15
	4.7.1	Ethernet-Configuration	15
	4.7.2	RS485	16
	4.7.3	Data logger	16
	4.7.4	Analog Inputs	17
	4.7.5	REFUlog	18
	4.7.6	Set time to computer time	19
	4.8	Extras Menu	19
	4.8.1	Reboot	19
	4.8.2	Error and event memory	17
	4.ð.3 7. o	Firmware-Opdate	20 20
	4.7 /. 10	Food in conditions	20 21
	4.10 /, 11	Power Ramn	21 22
	+. I I	Actual voltage monitoring	22 22
	<b>→.</b> 1∠		



5	Cont	tact	35
	4.15.9	Static Q with reduced active power	34
	4.15.8	Variable Q with reduced active power	33
	4.15.7	Q(U) characteristic	31
	4.15.6	Static Q	31
	4.15.5	Variable Q	30
	4.15.4	Cos φ (U) – characteristic	29
	4.15.3	Cos φ (P) - characteristic	27
	4.15.2	Variable cos φ	27
	4.15.1	Static cos φ	27
Z	4.15 R	Reactive Power	26
Z	4.14 P	Power Reduction	25
Z	4.13 A	Actual frequency monitoring	24

# 1 About this User Manual

These operating instructions form part of the product.

- $\Rightarrow$  Read the User Manual carefully before installing and using the product.
- $\Rightarrow$  Keep the operating instructions readily available with the device for the entire service life of the product.
- $\Rightarrow$  Provide all future users of the device access to the operating instructions.
- $\Rightarrow$  For more information on the device, troubleshooting, and options under: <u>www.refu-sol.com</u>

## 1.1 Symbols and Markup

V	Prerequisite
$\Rightarrow$	One-step instruction
1.	Multiple-step instruction
•	Bulleted list
Highlighting	Highlighting within a text
₩Ş	Result

## 1.2 Warning Notices

#### 1.2.1 Layout of a Warning Notice

WARNING TEXT	The type and source of danger are described here. $\Rightarrow$ Measures for avoiding the danger are shown here.
Example	
DANGER	<ul> <li>Death or severe injury due to high discharge current when opening the device.</li> <li>⇒ It is essential to ensure an earthing connection has been established prior to connection to the supply current circuit.</li> </ul>

#### 1.2.2 Categories of Warning Notices

There are three categories of warning notices.



DANGER	"DANGER" designates a safety notice, the disregarding of which will lead directly to death or severe injury!
WARNING	"WARNING" designates a safety notice, the disregarding of which can lead to death or severe injury!
	"CAUTION" designates a safety notice, the disregarding of which can lead to property damage or minor injury!

## 1.3 Information



## Note:

A **notice** describes information which is important for the optimum and costeffective operation of the equipment.

# REFUso/

# 2 Safety Information

## 2.1 Qualified personnel

The product/system related to this documentation may only be handled by **qualified personnel** for the respective scope of tasks in compliance with the documentation related to the respective scope of tasks, in particular the safety and warning notices contained in it. Qualified personnel is competent on the basis of their training and experience to detect risks and prevent potential threats while handling these products/systems.

## 2.2 Proper use of REFUsol-Products

Please take note of the following:

	Death or severe bodily injury
WARNING	⇒ REFUsol Products may only be used for the applications specified in the catalog and in the related technical documentation. If third party products and components are used, they must be recommended or approved by REFUsol. Flawless and secure operation of the products requires proper transportation, storage, set-up, assembly, installation, start-up, operation and maintenance. The approved ambient conditions must be maintained. Notices in the related documentation must be observed.

## 2.3 Disclaimer

We have tested that the printed text's content matches the hardware and software described. Nevertheless, deviations cannot be ruled out, and as a result, we do not assume any warranty for it matching completely. The information in this printed text will be reviewed regularly, and necessary corrections will be contained in the subsequent editions.



# 3 Compatibility Overview

## 3.1 Inverter type compatibility

This software is compatible with the following products:

REFUsol 08K ... 23K (867 series) REFUsol 40K / 46K (840, 842 series) REFUsol 24K-UL (874, 876 series) REFUsol 48K-UL (843, 844 series) REFUsol 22K-JP (875 series)



## 4 Configuration with REFUset



for configuring AE 3TL inverter, use AE SetUp tool from the website <a href="http://www.advanced-energy.com">www.advanced-energy.com</a>



#### Note

Note

Depending on the active country code the displays can be different.

## 4.1 System Prerequisites

The following minimum prerequisites apply for the installation and use of REFUset:

- Windows XP SP3 or higher
- Microsoft .NET Framework 4.0

## 4.2 Preparatory Measures

Double click on the file that ends with ".exe" to install REFUset. The installation will then be executed.



A shortcut will be saved in the program list. You can start the program via this shortcut (Start  $\rightarrow$  Program  $\rightarrow$  REFUset).

## 4.3 Description of Functions

REFUset is a Microsoft<sup>®</sup> Windows<sup>®</sup> software to support the easy configuration of your REFUsol inverter.

It can be used to change the grid code settings or country-specific parameters of REFUsol inverters. Additionally, functions like sensor configuration, monitoring settings and firmware update are supported. The functions in detail:

#### 4.3.1 Grid-Interactive Functions

- Startup conditions
  - Frequency, voltage range
- Start-up behaviour
  - o Restart waiting time
  - Power ramp
- Grid monitoring
  - Actual voltage monitoring
  - o Actual frequency monitoring
  - o Phase voltage monitoring



- Average voltage monitoring
- Active power control
  - Permanent power limitation
  - Power reduction at over-frequency
  - Power reduction by external signal
  - o Inverter remote stop signal at sensor input
- Reactive power control
  - Static voltage support: fixed Cos Phi
  - Dynamic voltage support by characteristic: Q (U), Volt/Var, Cos Phi (P)
  - Dynamic voltage support by external control of Q or Cos Phi
- Fault Ride Through
  - Overvoltage Ride Through
  - Undervoltage Ride Through
- ROCOF (Anti-Islanding method)

#### 4.3.2 Other functions

- Firmware Update
- Sensor configuration
- Monitoring protocol
- Datalogging settings
- Saving / Loading of inverter settings



#### Note

Only the parameters enabled in the country code set for the inverter may be set. Unused parameters, e. g. additional levels of phase voltage monitoring or an under-voltage average value, are shown in grey and cannot be changed.

The values you should use will be preset by your distribution grid operator. If you set other values, the grid operator may take away your system's operating permit!

## 4.4 Connection Set-Up Ethernet and RS485

#### 4.4.1 Ethernet

- 1. Set your PC's network settings to the following values: (TCP/IP)
  - IP address: 192.168.130.100
  - Subnet mask: 255.255.255.0
  - Standard gateway: 192.168.130.1
- 2. Set up an Ethernet connection between your computer and the inverter
- 3. Start REFUset from the Windows start menu.

Here is how you access the inverter:



- via the Ethernet interface with the factory-set standard:
  - o IP Address 192.168.130.30
  - Port Number: 21062
  - USS Address: 0

If you have set the inverter to another IP adress, you have to change your PC into the same address range, and use this address to connect.

#### 4.4.2 RS485

Connect the Inverter to the PC using an RS485-USB converter. Select the correct COM-port of the converter and type the USS address of the inverter. The inverter is factory-set to a baud rate 57600.

Connect method Stat	ic 🔹
_ Interface	
Ethernet	
IP address	0.0.0.0
🔵 Host name	
TCP port	21062 🗘
◯ сом	
Port	•
Protocol	
USS address	0 🜩
	Ok Cancel

Fig. 1: Selecting the communication interface

The main window will open automatically after a connection is successfully set up and the inverter's parameter values are automatically read.

#### Automatically scanning a network IP range

If you do not know the IP address of an inverter, it is possible to scan IP ranges (e.g. If DHCP is used), subnets or entire networks for inverters.



#### Note

It is recommended to scan within the smallest possible IP range to minimize the duration of the search



Connect m	ethod	Scan IP Range	•		
Start IP	10.10	4.68.220 -	]		
End IP	10.10	4.68.250 -	]		
TCP port		21062 🗘			
				Scan	Clear all
🔺 Invert	ers				
IP Addre	ss	Serial	Inverter ty	pe	Compatibility
10.104.68	.231	080137716	AE REFUS	sol 20K	<b>S</b>
10.104.68	.232	060010068	802R020		
10.104.68	3.250	1709	862R024		
▼ Filters	;			Cancel	Connect

Fig. 2: Selecting the communication interface

After completing the scan all found inverters are shown in a list. You also see incompatible inverters; they are displayed in grey and with an exclamation mark in the compatibility column. With this version of REFUset connections with incompatible inverters are not possible. For this, download the corresponding REFUset version in the download section of the REFUsol website.

Clicking "Filter" unfolds the filter area, where a specific serial number or inverter-type can be filted.

	-							
Connect me	Connect method Scan IP Range							
Start IP	10.104.							
End IP	10.104.68.250 -							
TCP port		21062 🗘						
						Scan		Clear all
▲ Invert	ers							
IP Addre	ss	Serial	Inverter type Comp		npatibility			
10.104.68.231		080137716		AE 3T				-
▲ Filters								
Filter serial								
Filter inver	ter type	AE 3TL 20	、	,		1		
						Cancel		Connect

Fig. 3: Result of the scan by using the filter function

The connection to a particular inverter is carried out by double-clicking on the corresponding line or clicking the button "Connect".



## 4.5 REFUset Main Window

#### 4.5.1 Initial Settings

On successful connection to the inverter, the date and time can be set according to the PC's local time. Press OK to set the time:

Set inverter time ×	REFUset ×
Do you want to set the inverter time to computer time? Current inverter time:	Inverter time set to 07.12.2016 10:44:59
Ok Cancel	ОК

If the inverter has no country setting, the following screen appears. Please select the appropriate country code and press Save.

Change c	ountry code	×	Change	e country code	×
Country		v	Country Germany-VDE 0120		26 ~
	Save	Cancel		Save	Cancel

#### 4.5.2 Password

To change the inverter's limit values of the country a password is needed. This is available after completing the Confidentiality Agreement (found in the downloadable zip file on the REFUsol website) on request to the REFUsol Services.

To set the password click on "File  $\rightarrow$  Settings  $\rightarrow$  Passwords".



Fig. 4: Selection settings



#### Note

Changed values in all screens described below are only active when the Save button is pressed.



#### Note

Voltage and frequency limits are always shown relative to the nominal value. Voltage values are shown as a percentage of the nominal voltage, frequency values as the difference to the nominal value.



	Save	Cancel

Fig. 5: Input password

#### 4.5.3 Main Screen

Using the menu bar (File, Configuration, Extras and Help), you can select several functions offered by the software, which are explained below in detail.

The device information is shown in the upper part of the main window, as well as current measurement values such as line voltage and DC current in the corresponding categories. Via a pull-down menu it can be selected what actual data is displayed: AC, DC, sensors (temperature and irradiation), energy and feed-in (reactive power requirements and power reduction set-points).

File Configuration Extras Help				
Static data Inverter type: AE 3TL 20-IE Firmware package version: 300-01 Serial number: 08 MAC address: 7CBDC Country setting: UK-G5 Nominal voltage: Nominal frequency:	Actual data EC (Gen 3) 1-03-13-S Power: 180137716 Voltage L1 106010016 Voltage L2 59/3 240V Voltage L3 416 V 50 Hz	AC AC DC Sensors Production Grid management	L1: 50.03 Hz ( L2: 50.00 Hz ( L3: 50.03 Hz (	Current L1: 4.1 A Current L2: 4.2 A Current L3: 4.1 A
Feed-in conditions Power ramp	Reactive Power Actu	al voltage monitoring	Actual frequency monitoring	Power reduction
Feed-in conditions Minimum voltage: Maximum voltage: Minimum voltage after grid fault: Maximum voltage after grid fault: Minimum frequency: Maximum frequency: Minimum frequency after grid fault: Maximum frequency after grid fault: Connection time Connection time after grid fault	80 \$ % 120 \$ % 80 \$ % 120 \$ % -5.00 \$ Hz +5.00 \$ Hz +5.00 \$ Hz 20 \$ s 20 \$ s			
				Save
Status: Connected on 10.104.68.231:21062	2			Done

Fig. 6: Main window REFUset

In the lower part, the settings are organized in tabs. Different tabs are selectable depending on the country configuration. All settings are explained in separate chapters.

### 4.6 File Menu

In the **File** menu, you can establish an inverter connection without closing the program, create a new connection or terminate the program.



The passwords for changing the country-specific settings can be set.

In addition, a language can be set and the Anglo-American or Metric unit systems can be selected.



Fig. 7: File Dropdown Menu

### 4.7 Configuration Menu

The following functions can be found in the **configuration** menu: **Communication**, **Data logger**, **Analog input configuration**, **REFUlog** and **Set time to computer time**.

File	Configuration	Extras Help						
<ul> <li>Stati</li> </ul>	Communi	cation •						
Inve	Data logg	er						
Firm	A	a de la constance de						
Seria	Analogue	input configuration						
MAC	REFUlog							
Cou	Set time t	o computer time						
Cour	Set time t	o computer time						

Fig. 8: Inverter Configuration Dropdown Menu

#### 4.7.1 Ethernet-Configuration

In the menu item **Communication**  $\rightarrow$  **Ethernet-Configuration** you can see the IP-Configuration of the inverter and change it.



#### Notice

IP configuration and RS485 settings will not be effective until after restarting. You can only restart directly via the inverter thus far.



O DHCP						
Static IP						
IP address:	10 . 104 . 68 . 231					
Subnet mask:	255 . 255 . 240 . 0					
Standard gateway:	10 . 104 . 64 . 10					
DNS server IP:	0.0.0.0					
Reboot after save						
Reconnect after reboot						
Save Cancel						

Fig. 9: Connection Settings

#### 4.7.2 RS485

You can set the baud rate and the USS address in the **Communication**  $\rightarrow$  **RS485** menu item.

Baudrate:	57600 🔹
USS Address	1 🗘
Protocol:	Meteocontrol 🔻
Reboot after save	
Reconnect after reboot	
Sav	ve Cancel

Fig. 10: RS485 Settings

#### 4.7.3 Data logger

You can set the data logger's time interval in the **Configuration**  $\rightarrow$  **Data logger** menu item.

Data logger interv	/al	5 🔻 min
(	Save	Cancel

Fig. 11: Data Logger Configuration



#### 4.7.4 Analog Inputs

You can configure analog sensor inputs in the **Configuration**  $\rightarrow$  **Analog Inputs** menu item. This is the insolation sensor and the temperature sensor.



Fig. 12: Radiation and Temperature

If you have connected an external monitor to one of the analog inputs, please select the sensor type "External monitoring". It can be configured in the mask displayed below.





Fig. 13: Radiation and Temperature

#### 4.7.5 REFUlog

You can activate the portal data forwarding function in the **Configuration**  $\rightarrow$  **REFUlog** menu item. In addition, a test function and the configuration of the inverter can be sent from here.

Misc	
Portal activat	ion
Send test funct	Send configuration
Send configuratio	n status
Configuration f	orwarding complete
Actual data	
Last sent data	3/27/2015 11:05:01 AM Refresh
Last sent error	3/27/2015 11:06:58 AM
Sending behavior	
Send date data	3/27/2015 11:05:01 AM 💌 Reset (data date)
Send date error	3/27/2015 11:06:58 AM 💌 Reset (error date)
	Save

Fig. 14: REFUlog configuration

The date of the last data shipment and delivery of the last error is in the "Current data" visible.

# **REFU**sol

In the area "sending behavior" you can enter a past date from that the data will be transmitted again. By pressing the button "Reset" all data is sent from the beginning of the recording.

#### 4.7.6 Set time to computer time

By pressing configuration Configuration  $\rightarrow$  Set time to computer time, the inverter time will be synchronized to the computer time. The following acknowledgment message appears.

Inv	erter time set to 30.04.2015 09:05:15
	ОК

Fig. 15: Message after setting the system time

## 4.8 Extras Menu

#### 4.8.1 Reboot

You can do a remote controlled restart with Extras  $\rightarrow$  Reboot.

#### 4.8.2 Error and event memory

Clicking the button "Extras Error/event memory" produces on the screen the following list:

Date	Error Code	Error Text
3/17/2015 1:27:58 PM	090052	User lock active 🔺
3/16/2015 2:11:57 PM	09002B	Update End
3/16/2015 2:09:37 PM	090028	Update Start
3/12/2015 5:48:15 PM	09002B	Update End
3/12/2015 5:46:16 PM	090028	Update Start
3/12/2015 3:42:08 PM	09002B	Update End
3/12/2015 3:38:25 PM	090028	Update Start
3/6/2015 11:33:46 AM	09002B	Update End 🖕
Refresh Export	Send report	
		Close

Fig. 16: Error and event memory

By pressing the appropriate buttons, it is possible to update this list, to generate a XML-file or to send the report by email to REFU Elektronik GmbH.

After pressing "Export Parameters", the following screen will appear:



#### 4.8.3 Firmware-Update



#### Material damage during interrupt the update process possible.

 $\Rightarrow$  Only perform update when sufficient sunlight is available until the end of the process.



#### Note

It is not possible to install an older firmware version. If this is necessary, contact the service.

For a firmware update, proceed as follows:

- 1. Download current firmware package from REFUsol webpage and save it local on your computer.
- 2. With "Browse" find corresponding .RFWPS file. Make sure the file extension in in capital letters!
- 3. Click Button "Update".
  - $\Rightarrow$  Update process is displayed on the progress bar.
  - 分 After successful upgrade, a status message appears.

Firmware version	300-01-03-14-5	
New firmware version	300-01-04-12-5	
Firmware package file	C:\Users\Desktop\AEFP_300-01-04-12-S.RFWPS	Browse
Update progress	0%	
Update status		
		Update

Fig. 17: Firmware-Update

## 4.9 Help

You will see information about the tool's product version by clicking on the Help  $\rightarrow$  About button.

#### Check for updates

With Help  $\rightarrow$  Check for updates you can find out, whether the newest version of REFUset is installed.



## **4.10** Feed in conditions

You can set the inverter's feed-in conditions here, i.e. at which line voltage range and line frequency range the inverter will begin to the feed-in. Also the connection time can be adjusted. All these limits can be configured for the first startup (in the morning) or after a grid fault (i.e. grid overvoltage).

File Configuration Extras Help		
Static data Inverter type: AE 3TL 20	-IEC (Gen 3)	tual data AC •
Firmware package version: 300	-01-03-13-S Pov	ower: 10,081 W
MAC address: 7CF	BD06010016 Vol	oldge L1: 445.9 V Frequency L1: 49.96 Hz Current L1: 15.1 A
Country setting: UK-	-G59/3 240V Vol	bitage L3: 444.2 V Frequency L3: 49.95 Hz Current L3: 13.1 A
Nominal voltage:	416 V	
Nominal frequency:	50 Hz	
Feed-in conditions Power ramp	Reactive Power	Actual voltage monitoring Actual frequency monitoring Power reduction
Minimum voltage:	80 🗘	%
Maximum voltage:	120 🌲	96
	220 \$	
Minimum voltage after grid fault:	80 🗸	• %
Maximum voltage after grid fault:	120 🤤	%
Minimum frequency:	-5.00 🗘	Hz
Maximum frequency:	+5.00 🗘	Hz
Minimum frequency after grid fault:	-5.00 🗘	Hz
Maximum frequency after grid fault:	+5.00 🗘	Hz
Connection time	20 🗘	s
Connection time after grid fault	20 🗘	s
		Save
Status: Connected on 10.104.68.231:210	62	Done

Fig. 18: Feed-in Conditions

# 4.11 Power Ramp

A power ramp limits the increase of power injection into the grid during startup, or after a grid fault. The ramp is defined as the time in seconds between startup and reaching the nominal power of the inverter. A typical power ramp is 600 seconds.

File Configuration Extras H	Help					
- Static data		Actual data	AC	•		
Inverter type: AE 3	TL 20-IEC (Gen 3)					
Firmware package version:	300-01-03-13-S	Power:	5,273 W			
Serial number:	080137716	Voltage L1:	440.6 V Fr	equency L1: 49.99 Hz	Current L1: 7.4 A	
MAC address:	7CBD06010016	Voltage L2:	439.6 V Fr	equency L2: 50.02 Hz	Current L2: 7.3 A	
Country setting:	UK-G59/3 240V	Voltage L3:	440.1 V Fr	equency L3: 49.99 Hz	Current L3: 7.4 A	
Nominal voltage:	416 V					
Nominal frequency:	50 Hz					
Feed-in conditions Power ran	mp Reactive Pow	ver Actua	l voltage monitoring	Actual frequency monitoring	Power reduction	
Power ramp-up times						
Ramp time after grid connection:	1.000 🗘	s				
Ramp time after grid fault:	1.000 🗘	s				
						Save
Status: Connected on 10.104.68.231	1:21062					Done

Fig. 19: Power Ramp



## 4.12 Actual voltage monitoring

Use the actual voltage monitoring tab to set the upper and lower limits of the Y-voltage (phase to neutral) and their corresponding trip times (cut-off time). The voltage limits are configured as percentage to the nominal voltage.

File Configuration Extras Help	)							
Static data		ctual data Pr	roduction	•				
Inverter type: AE 3TL 2	0-IEC (Gen 3)	(h.:.						
Firmware package version: 30	0-01-03-13-S D	aily energy:	9.8 kWh					
Serial number:	080137716 Te	otal energy:	5,062.5 kWh					
MAC address: 70	CBD06010016 O	perating hour	s: 1,704 h					
Country setting: UK	(-G59/3 240V							
Nominal voltage:	416 V							
Nominal frequency:	50 Hz							
Feed-in conditions Power ramp	Reactive Power	r Actual vo	ltage monitoring	Act	ual freque	ncy monitoring	Power reduction	
Actual voltage monitoring								
_	Level 1	Level 2	Level 3		Level 4			
Minimum voltage:	87 💲 %	80 🗘 🤋	% 0 🗘	%	0 🗘	%		
Minimum voltage cut-off time:	2.750 🗘 s	0.650 🗘 s	s 0.000 🗘	;	0.000 🗘	s		
Maximum voltage:	114 🗘 %	119 🗘 🤋	% 0 🗘	%	0 🗘	%		
Maximum voltage cut-off time:	1.150 🗘 s	0.650 🗘 s	s 0.000 🗘	;	0.000 🗘	s		
								Save
Status: Connected on 10.104.68.231:21	.062							Done

Fig. 20: Actual voltage Monitoring



# 4.13 Actual frequency monitoring

Use the actual frequency monitoring tab to set the grid frequency limits and their trip times (cut-off time). The frequency is defined as offset to the nominal frequency.

File Configuration Extras Help										
Static data		Actual dat	ta Pro	ducti	on	•				
Inverter type: AE 3TL 20	0-IEC (Gen 3)									
Firmware package version: 300	)-01-03-13-S	Daily ene	rgy:	1	L0.2 kWh					
Serial number:	080137716	Total ene	rgy:	5,06	52.9 kWh					
MAC address: 7C	BD06010016	Operating	hours:	1,	704 h					
Country setting: UK	-G59/3 240V									
Nominal voltage:	416 V									
Nominal frequency:	50 Hz									
Feed-in conditions Power ramp	Reactive Po	ower Act	ual volt	tage n	nonitoring	Actu	al frequency r	nonitoring	Power reduction	
Actual frequency monitoring	1			-	_					
	Level 1	L	evel 2		Level 3		Level 4			
Minimum frequency:	-2.50 🗘	Hz -3	3.00 🗘	Hz	0.00 🗘	Hz	0.00 🗘	Hz		
Minimum frequency cut-off time:	20.200 🗘	s 0.	650 🗘	s	0.000 🗘	s	0.000 🗘	s		
Maximum frequency:	+1.50 🗘	Hz +2	2.00 🗘	Hz	0.00 🗘	Hz	0.00 🗘	Hz		
Maximum frequency cut-off time:	90.200 🗘	s 0.	650 🗘	s	0.000 🗘	s	0.000 🗘	s		
										Save
Status: Connected on 10.104.68.231:21	062									Done

Fig. 21: Actual frequency monitoring

## 4.14 Power Reduction

Hard power-down of PV systems in conjunction with grid over-frequency can put the grid's stability in jeopardy. This is why the frequency-dependent reduction was introduced. The maximum deliverable power is reduced starting with a certain frequency value depending on the frequency. You can set the start value for the reduction, the reduction factor and the return frequency in the Power reduction tab.

The reduction factor (dP / df) is the power gradient after the start frequency is exceeded. 40% means 40% of nominal power is reduced at 1 Hz over-frequency.

Additionally, a Gradient (dP / dt) can slow down the power change at very fast frequency changes. 10% means the inverter's power is reduced by 10% of its nominal power per second.



Fig. 22: Configuration for Power Reduction

## 4.15 Reactive Power

There are different modes of operation available in the Reactive power tab to enable the inverter to play its part in regards to the voltage stability of the electrical grids as required by the electric power company.

A **Capacitive** reactive power supply is specified with a **negative angular offset (over-excited)**. The reactive power supply will accordingly be made **inductive** by setting a **positive angular offset (under-excited)**:

capacitive (-)





The phase offset of the overall system caused by the wiring and external components can be adjusted with the help of the "Device-specific offset". By setting the offset of the reactive power to 1%, it would adjust the capacitive reactive power by 1% of the nominal power of the device.

This function is always active regardless of which mode of operation is selected.

File Configuration Extras Help	
Static data	Actual data Production
Inverter type: AE 3TL 20-IEC (Gen 3	
Firmware package version: 300-01-03-13-5	Daily energy: 11.7 kWh
Serial number: 080137716	Total energy: 5,064.4 kWh
MAC address: 7CBD06010016	Operating hours: 1,704 h
Country setting: UK-G59/3 240V	
Nominal voltage: 416 V	
Nominal frequency: 50 Hz	
Feed-in conditions Power ramp Reactive	Power Actual voltage monitoring Actual frequency monitoring Power reduction
C Reactive Power	
Device-specific offset 0 🗘 %	Operating mode Device-specific offset only
	Device-specific offset only
	Static cos φ
	Variable cos φ
	Cos φ(P) characteristic
	Cos φ(U) characteristic
	Variable Q
	Static Q
	Q(U) characteristic
	Variable Q with reduced active power
	Static Q with reduced active power
II	

Fig. 23: Different modes of operation



#### 4.15.1 Static cos φ

A permanently applicable phase shift is specified by a static setpoint, either in degrees (°) or as a  $\cos \phi$  value.

The "rate of change of phase offset" indicates how fast the inverter adjusts to the new cos  $\varphi$ -fixed value.

File Configuration	Extras	Help										
- Static data Inverter type: Firmware package ve Serial number: MAC address:	AE rsion:	3TL 20- 300-(	IEC (Gen 3) 01-03-13-5 080137716	Act Dai Tot	ual data ly energy al energy	Produ	11.8 kWi 5,064.5 kWi	h h	•	]		
Nominal frequency:		UK-G	559/3 240V 416 V 50 Hz	Op	eraung no	ours:	1,704 N					
Feed-in conditions Reactive Power	Power	ramp	Reactive	Power	Actual	volta	ge monitori	ng	Actu	al frequency monit	toring	Power reduction
Device-specific offset		(	) \$ %							Operating mode	Static	τος φ
Static phase shift (φ) Static cos φ	1.0000	0.00		🔊 Laggi	ing 🔘	Leadir	ng					

Fig. 24: Static cos  $\phi$ 

#### 4.15.2 Variable cos φ

This mode of operation dynamically controls the  $\cos \phi$  value. It is used together with an external control unit, like REFUcontrol or a 3rd party product. The actual setpoint for the phase shift is shown in the window.

File Configuration Extras Help	
Static data	Actual data Production
Inverter type: AE 3TL 20-IEC (Gen 3)	
Firmware package version: 300-01-03-13-S	Daily energy: 11.9 kWh
Serial number: 080137716	Total energy: 5,064.6 kWh
MAC address: 7CBD06010016	Operating hours: 1,704 h
Country setting: UK-G59/3 240V	
Nominal voltage: 416 V	
Nominal frequency: 50 Hz	
Feed-in conditions Power ramp Reactive P	ower Actual voltage monitoring Actual frequency monitoring Power reduction
Reactive Power	
Device-specific offset 0 🗘 %	Operating mode Variable cos φ
Current phase shift set point (φ) 0.	00 °
Cos(φ) 1.0000000	00

Fig. 25: Variable Cos φ

#### 4.15.3 Cos φ (P) - characteristic

The desired phase shift and reactive power supply can be specified in this function depending on the active power supplied by the inverter.

The settings are available for 0 ... 100% of the rated active power in steps of 10%.

You can enter the reactive power as a phase shift in degrees (°) or as a cos  $\phi$  value.

The "rate of change of phase offset" indicates how fast the inverter is adjusted to a new value.



File Configuration Extras Help		
Static data	Actual data AC	•
Inverter type: REFUsol 020K		
Firmware package version: 300-01-03-14-S	Power: 13,650 W	
Serial number: 080137716	Voltage L1: 403.4 V	Frequency L1: 49.98 Hz Current L1: 19.6 A
MAC address: 7CBD06010016	Voltage L2: 399.4 V	Frequency L2: 49.99 Hz Current L2: 19.8 A
Country setting: UK-G59/3 240V	Voltage L3: 401.0 V	Frequency L3: 49.99 Hz Current L3: 19.6 A
Nominal frequency: 50 Hz		
Nonina requercy. 5012		
Feed-in conditions Power ramp Reac	tive Power Actual voltage mo	onitoring Actual frequency monitoring Power reduction
Reactive Power		
Device-specific offset 0 🗘	%	Operating mode Cos φ(P) characteristic 🔹
Rated power [%] Operation mode C	los(φ) Phase shift [°]	- m
0 Lagging <b>v</b> 1.000	0000000 🗘 0.00 🗘	Lock-in function active
10 Lagging - 1.000	0000000 4 0.00 4	Activation threshold 0 🗘 % Un
20 Lagging • 1.000	0.00 🗘 0.00 🗘	Deactivation threshold 0 🗘 % Un
30 Lagging <b>•</b> 1.000	0.00 🗘 0.00 🇘	
40 Lagging <b>v</b> 1.000	0.00 🗘 0.00 🇘	
50 Lagging 🔻 1.000	0.00 🗘 0.00 🌩	
60 Lagging 🔻 0.981	6271834 🗘 11.00 🗘	
70 Lagging • 0.961	2616959 🗘 16.00 🗘	
80 Lagging <b>v</b> 0.030	F03E3U8 A 30 UU A	
Graph		Save
Status: Connected on 10.104.68.231:21062		Done



You can display the characteristic entered in a chart by pressing the "Graph" button.



Fig. 27: Cos  $\phi$  (P) – Characteristic Chart

#### 4.15.4 Cos φ (U) – characteristic

The desired phase shift and reactive power supply can be specified in this function depending on the grid voltage.

The settings are available for 90 ... 110% of the nominal voltage in steps of 2%.

You can either enter the constant via a phase shift in degrees (°) or via  $\cos \varphi$ .

The "Time constant for phase shift" factor indicates, how fast the inverter will react to voltage changes with the reactive power supply.

File Configuration Ex	tras Help							
<ul> <li>Static data</li> </ul>		Actual data	AC	•	]			
Inverter type:	REFUsol 02	OK			-			
Firmware package version	n: 300-01-03-14	4-S Power:	6,555 W					
Serial number:	0801377	Voltage L1:	401.1 V	Frequence	cy L1: 50.01 Hz	Current L	L1: 9.4 A	
MAC address:	7CBD060100	Voltage L2:	399.1 V	requent	cy L2: 49.99 Hz	Current L	L2: 9.5 A	
Country setting:	UK-G59/3 24	0V Voltage L3:	404.1 V	Frequence	cy L3: 50.00 Hz	Current L	L3: 9.3 A	
Nominal voltage:	410	H7						
Nominal frequency.		112						
Feed-in conditions Po	ower ramp	Reactive Power	Actual voltage monit	oring	Actual frequency mon	itoring	Power reduction	
Reactive Power								
Device-specific offset	0	\$ %			Operating mode	Cos φ(l	J) characteristic	
Rated voltage [%] Opera	ation mode	Cos(φ)	Phase shift [°]	Â				
90 Lagg	jing 🔻 (	0.9055687990 🗘	25.10 🗘					
92 Lagg	jing 🔻 (	0.9055687990 🗘	25.10 🌲					
94 Lagg	jing 🔻 (	0.9238795325 🗘	22.50 🌲	=				
96 Lagg	jing 🔹 (	0.9510565163 🗘	18.00 🇘					
98 Lagg	jing 🔹 (	0.9743700648 🗘	13.00 🗘					
100 Lagg	jing 🔹 1	L.000000000 🧘	0.00 🌻					
102 Lead	ling 🔹 (	0.9743700648 🗘	-13.00 🌲					
104 Lead	ling 🔹 (	0.9510565163 🗘	-18.00 🌲					
106 <b>Jaad</b>	ling 🔹 (	0228705225	-22.50 *	Ŧ				
Graph								Save
Status: Connected on 10.10	4.68.231:21062							Done

Fig. 28: Cos  $\phi$  (U) – characteristic

You can display the characteristic entered in a chart by pressing the "Graph" button.





Fig. 29: Chart Cos φ (U) – Characteristic

#### 4.15.5 Variable Q

This mode of operation dynamically controls the reactive power as an absolute or relative setpoint. It is used together with an external control unit, like REFUcontrol or a 3rd party product. The actual setpoint for the phase shift is shown in the window.



File Configuration Extras Help		
Static data	Actual data Production	
Inverter type: AE 3TL 20-IEC (Gen 3)		
Firmware package version: 300-01-03-13-S	Daily energy: 12.6 kWh	
Serial number: 080137716	Total energy: 5,065.3 kWh	
MAC address: 7CBD06010016	Operating hours: 1,704 h	
Country setting: UK-G59/3 240V		
Nominal voltage: 416 V		
Nominal frequency: 50 Hz		
Feed-in conditions Power ramp Reactive Po	wer Actual voltage monitoring Actual frequency monitoring	Power reduction
Reactive Power		
	Construction of the second sec	
Device-specific offset 0 🐺 %	Operating mode Waria	ole Q
Current reactive power set point (absolute) 0.00 kV		
Current reactive power set point (relative) 0 %	•	
		Save
Status: Connected on 10.104.68.231:21062		Done

Fig. 30: Variable Q

#### 4.15.6 Static Q

It is possible to enter a certain reactive power as fixed value. The fixed value can be entered absolutely as kVA or relative as %.

A device-specific offset can be specified.

File Configuration	Extras Help						
<ul> <li>Static data</li> </ul>		Ac	tual data	AC	•		
Inverter type:	AE 3TL 20-1	IEC (Gen 3)					
Firmware package ver	rsion: 300-0	01-03-13-S Po	wer:	4,120 W			
Serial number:	(	080137716 Vo	ltage L1:	438.1 V F	requency L1:	50.04 Hz	Current L1: 5.5 A
MAC address:	7CBI	006010016 Vo	ltage L2:	436.9 V F	requency L2:	50.04 Hz	Current L2: 5.5 A
Country setting:	UK-G	559/3 240V Vo	Itage L3:	441.3 V F	requency L3:	50.10 Hz	Current L3: 5.5 A
Nominal voltage:		416 V					
Nominal frequency:		50 Hz					
Feed-in conditions	Power ramp	Reactive Power	Actua	I voltage monitoring	Actual fre	quency monitorin	g Power reduction
Reactive Power			1				
Device-specific offset	C	) 🗘 %			Ор	erating mode Sta	atic Q ▼
Static Q (absolute)	0.00	kVA					
Static Q (relative)	0.0	% (Rated powe	r: 20.00	kWp)			

Fig. 31: Static value for reactive power

#### 4.15.7 Q(U) characteristic

Depending on the voltage, a characteristic curve for the reactive power can be defined.

In addition, you can enter an activation, deactivation threshold and the system-specific offset for power supply, for the hysteresis you can also define characteristic points. The resulting curve can be displayed as a graph. As a characteristic type are "linear interpolation" and "Hysteresis" available.



File Configuration	Extras Help							_
Static data		<ul> <li>Actual data</li> </ul>	AC	•				
Inverter type:	REFUsol 020K							
Firmware package ver	rsion: 300-01-03-14-5	Power:	5,906 W					
Serial number:	080137716	Voltage L1:	401.9 V	Frequency L1:	50.00 Hz	Current L1: 8.5	Α	
MAC address:	7CBD06010016	Voltage L2:	403.1 V	Frequency L2:	50.01 Hz	Current L2: 8.5	Α	
Country setting:	UK-G59/3 240V	Voltage L3:	401.1 V	Frequency L3:	49.97 Hz	Current L3: 8.5	A	
Nominal voltage:	416 V							
Nominal frequency:	50 Hz							
Feed-in conditions	Power ramp React	ive Power	Actual voltage monit	toring Actu	ual frequency mon	itoring Power	reduction	
Reactive Power								
Device-specific offset	0 🗘 %				Operating mode	Q(U) character	istic	•
	•							
Rated voltage [%]	Y Value [%]				Chara	cteristic type Lin	ear Interpolation	•
93	-60 🗘 🕺					ack in function act	ive.	
94	-60 🗘					ock-in function act	ive of the	^ ~ ~
95	-60 ^				Active	ation threshold	0.	× 70
	E				Deact	tivation threshold	0	,՝ %
96	-48 🙄				Filter	time	0.000	v s
97	-35 🗘 🗖							
98	-22 🗘							
00	-11 📩							
	-11 🗸							
100	0 🐺							
101	11 🔺 🎽							
Graph							S	ave
Status: Connected on 1	0.104.68.231:21062							Done

Fig. 32: Determining Reactive Power characteristic depending on voltage

You can display the characteristic entered in a chart by pressing the "Graph" button.



Fig. 33: Chart Characteristic type "linear interpolation"





Fig. 34: Chart Characteristic type "Hysteresis"

## 4.15.8 Variable Q with reduced active power

The mode is used together with an external control unit, like REFUcontrol or 3rd party products. In this screen only the device-specific offset can be adapted.

File Configuration Extras Help				
<ul> <li>Static data</li> </ul>	Actual data	AC	•	
Inverter type: AE 3TL 20-IEC (Ge	13)			
Firmware package version: 300-01-03-1	3-S Power:	2,599 W		
Serial number: 080137	716 Voltage L1:	437.8 V Fr	equency L1: 50.06 Hz	Current L1: 3.6 A
MAC address: 7CBD06010	016 Voltage L2:	434.6 V Fr	equency L2: 50.07 Hz	Current L2: 3.6 A
Country setting: UK-G59/3 2	40V Voltage L3:	436.4 V Fr	equency L3: 50.12 Hz	Current L3: 3.6 A
Nominal voltage: 4:	6 V			
Nominal frequency: 50	Hz			
Feed-in conditions Power ramp React	ve Power Actua	al voltage monitoring	Actual frequency monitorin	g Power reduction
Reactive Power				
Device-specific offset 0 🗘 9			Operating mode	riable Q with reduced active power
Current reactive power set point (absolute) 0.	0 kVA			
Current reactive power set point (relative)	0 %			

Fig 35: Variable Q with reduced power

#### 4.15.9 Static Q with reduced active power

It is possible to enter a Q-fixed value. This can be expressed in absolute terms as Q-fixed value in kVA or relative in %. The conversion from absolute to relative or vice versa is done automatically. In addition, you can change the device-specific offset.

File Configuration	Extras Help					
<ul> <li>Static data</li> </ul>			Actual data	Sensors	•	
Inverter type:	AE 3TL 20-	-IEC (Gen 3)				
Firmware package ve	rsion: 300-	01-03-13-5	Heat sink 1:	36.6 °C	Interior 1: 46.6 °C	
Serial number:		080137716	Heat sink 2:	35.8 °C	Interior 2: 39.9 °C	
MAC address:	7CB	D06010016				
Country setting:	UK-	G59/3 240V				
Nominal voltage:		416 V				
Nominal frequency:		50 Hz				
Feed-in conditions	Power ramp	Reactive Powe	er Actual	voltage monitoring	Actual frequency monitor	oring Power reduction
Reactive Power						
Device specific offset		0 ^ %			Operating mode	Static O with reduced active power
Device-specific offset		v ↓ /₀			operating mode	State Q marreddeed deare power
Static Q (absolute)	0.00	kVA				
Static O (relative)	0.0	% (Rated po	wer: 20.00 k	(Wp)		
		•				
						Save
Status: Connected on 2	10.104.68.231:210	52				Done

Fig. 36: Q fixed value with reduced power



# 5 Contact

Please address any questions on malfunctions or technical problems to

Mexico / North Amer	ica
Service-Hotline:	+ 1 970-318-2301
	(24 hours)
Europe	
Service-Hotline:	+49 (0)7121 4332 – 333
	(Monday - Thursday, 8 am to 5 pm, Friday 8 am to 4 pm)
Online	
Email:	service.usa@prettl-energy
Website:	www.refu-sol.com
Direct Link:	www.refu-sol.com/en/accessories/technischer-support/

#### You should have the following data at hand:

- Exact description of the error with error code.
- Data from the type label, particularly the device type on the top left of the type label.