



Electrifying Innovations

REFUsol/

English Version 2012

PHOTOVOLTAIC INVERTER PRODUCT LINE



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Photovoltaic inverter product line 2012

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EFFICIENCY FROM EXPERIENCE

REFUso/ GmbH

A pioneer in photovoltaics

As a specialist in power electronics, REFUso/ GmbH has been producing **high-quality inverters** in Germany for more than 47 years. As early as 1997, REFUso/ developed the first line-commutated photovoltaic inverter, based on the many years of experience. Today, our products can be found in solar power systems and solar parks all over the world. Our quality standards are stringent. That's why we're ISO 9001: 2000 certified.

REFUso/ GmbH focuses on developing, manufacturing and distributing efficient photovoltaic inverters. With a peak efficiency of 98.7% REFUso/ inverters are among the most efficient on the market. The product range comprises string and central inverters with **power outputs ranging from 3.6 kW to 1.3 MW**. The variety of applications for our systems is correspondingly extensive, from single-family houses to megawatt solar parks.

Our commitment to photovoltaics extends beyond the development and manufacture of cutting-edge technology. We have developed a web-based tool for documenting the performance of a PV system daily: the REFUlog Internet portal. This enables customers to view or display in graphical form and evaluate all important operating parameters of their solar plants.

20 countries, 4 continents, 1 goal

Strong presence

REFUso/ operates around the globe: with staff in Germany and Europe, subsidiaries in the **U.S., India, China and South Korea** and many national sales and service partners. Our goal is to support our customers with our expertise and our products in all major PV markets around the world.





Range: Our products can be found in all major PV markets around the world. With its branches, subsidiaries and service partners, REFUsol has representation in twenty countries on four continents – in other words, everywhere photo-voltaics matter.

SUSTAINABILITY IS ACHIEVED WHEN RESEARCH BECOMES TECHNOLOGY



*Contact point:
REFU**sol** brings current online from
PV modules, strings
and solar parks.*

Reliability with impressive yields

With sophisticated MPP tracking and outstanding partial load efficiency, remarkably high yields can be achieved with any PV system – in high or low levels of sunlight.

And because we focus on efficiency across the entire system, we have designed our components to be compact and resource-saving, and to deliver the exceptional **reliability** that customers can expect from our products.

Fast and precise MPP tracking

For us, sustainability also means harnessing an endless resource like sunlight efficiently. After all, it's only through efficiency that **sustainability** becomes profitable. Efficiency was therefore the guiding principle when designing our range of photovoltaic inverters.

Incorporating a new circuit topology enabled us to increase efficiency levels over a wide input voltage range. Peak efficiency is now in excess of 98%, with European efficiency over 97%. These kinds of figures only lead to high yields if the MPP tracking optimally adjusts components to the ambient conditions. In order to achieve this we have developed a new, particularly fast and yet very precise **MPP algorithm**. On the basis of this algorithm, the MPP tracking efficiency reaches a top value of 99.9%.

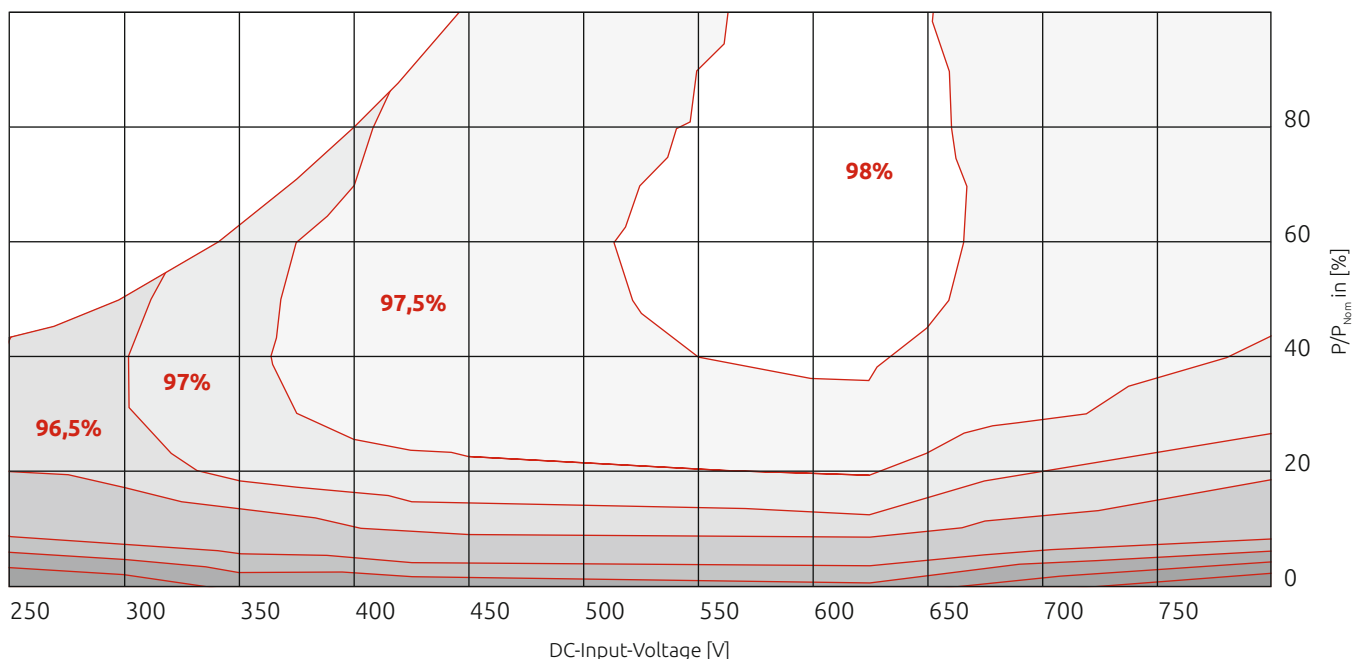
Tested and confirmed

We welcome the challenge from our competitors. And we're happy to take on critical experts, because we know what our products can do. For example, they demonstrate maximum efficiency precisely at the point where solar generators generally operate. When our products are scrutinized in rigorous tests, we're delighted. Such testing repeatedly confirms to us that we are making **first-class photovoltaic products** based on good ideas. The REFUsol photovoltaic inverter for example, where even at 2.5% of the nominal power, 90% of the solar power produced is fed into the grid. These features have been tested and confirmed by several independent institutes. Among others, the magazine Photon tested the REFUsol 013K, the REFUsol 017K and the REFUsol 020K and gave their highest rating of "very good" and "very good +".



Commendation: REFUsol products routinely score exceptionally highly in independent tests.

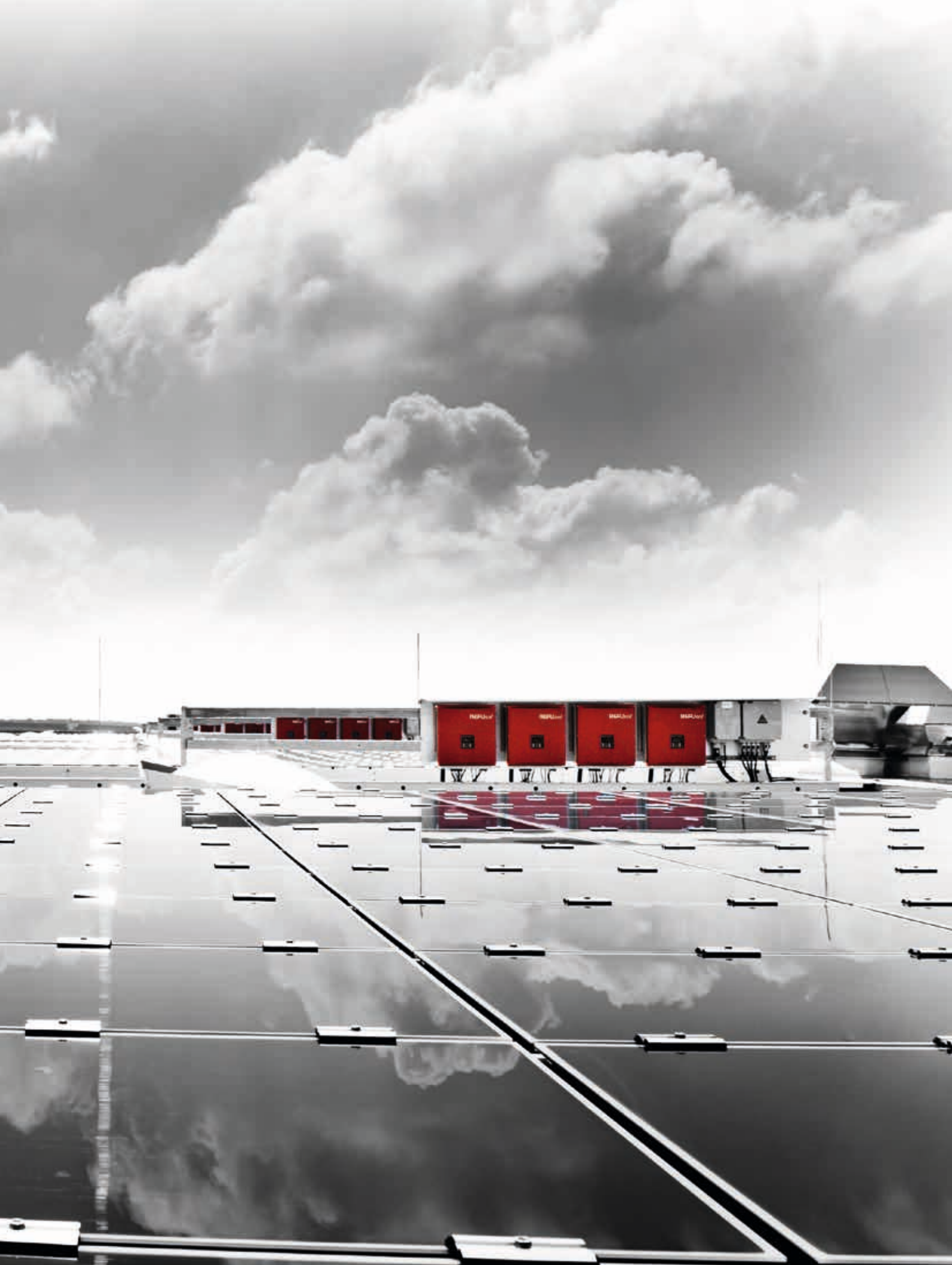
Below: Efficiency calculation for REFUsol 017K inverter.



“REFUso^l STRING INVERTERS WITH **ULTRAETA**[®] TOPOLOGY ARE BASED ON THE PRINCIPLES OF **NATURE**: THEY USE RESOURCES EFFICIENTLY AND ARE PERFECTLY ALIGNED. THIS STANDARD GUIDES US AS WE DEVELOP SYSTEMS THAT PROVIDE OUR CUSTOMERS WITH MAXIMUM **YIELDS**.”

J. HANTSCHER, TECHNOLOGY AND INNOVATION MANAGEMENT

Bitterfeld solar park, equipped with REFUso^l inverters.



SINGLE-PHASE STRING INVERTERS

*Perfect form:
Big enough to
collect the energy
from the roof
– small enough
that you hardly
notice it: REFU**sol**
003K–005K.*



REFU**sol** 003K–005K

For use at home

In the market for single-phase, transformerless string inverters, we offer the REFU**sol** inverter with nominal power of 3.6 to 4.6 kW. These feed into the low voltage network and their **high IP66 protection class** makes them particularly suitable for roof systems from 3.6 kW upwards, installed either inside or out. Thanks to fast and precise MPP tracking, efficiency levels of up to 97.7% are possible.

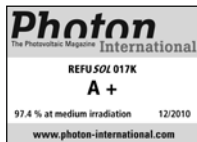
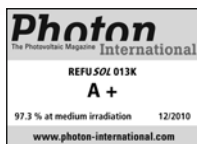
Our data management system REFU**log** enables you to display and evaluate operating and performance data for each PV system. With the **integrated RS485 interface**, our REFU**pmu** power management unit, and an Internet connection you can monitor your system via the inverter at any time, anywhere in the world, on your computer or on a smartphone using the REFU**log app**. Find out more about REFU**log** on page 30.

TECHNICAL DATA	REFU <i>sol</i> 003K	REFU <i>sol</i> 004K	REFU <i>sol</i> 005K
DC DATA			
Max. PV power, kW	4.3	4.9	5.4
MPPT range, V	350 ... 710	351 ... 710	348 ... 710
Max. DC voltage, V	880		
Max. DC current, A	11.5	13.0	14.5
MPP tracker	1		
Number of DC connections	2		
Internal overvoltage protection, type	3		
AC DATA			
Rated AC power, kVA	3.68	4.12	4.6
Max. AC active power, kW	3.68	4.12	4.6
AC grid connection	230 V (+/-20 %) single-phase, 47.5–52.5 Hz		
Rated power factor	1		
Adjustable displacement factor	0.9i ... 1... 0.9c		
Max. AC current, A	16	17.9	20
Distortion factor THD, %	0.97	1.00	1.08
Max. efficiency, %	97.7		
European efficiency, %	97.4		
Feed-in starting at, W	7		
Internal consumption in night operation, W	< 2		
Internal overvoltage protection, type	3		
COOLING, AMBIENT CONDITIONS, EMC			
Cooling	Natural convection		
Ambient temperature, °C	-20 ... +60		
Elevation	Up to 2000 m above sea level		
Noise	t.b.d.		
Environment classification	4K4H acc. to DIN IEC 721-3-4		
Certification	ÖNORM E8001-4-712, VDE 0126-1-1:2006-02, Belgium C10/C11:2009-05 Denmark TF 3.2.1, RD 1663/2000, RD 661/2000PPC-Continent VDE, EN 50438:2007 – IE, NL, SE, CZ, FI, SI EN 50438:2007 – Standard, Great Britain G83/1:2008;G59/2:2010LV; G59/2:2010HV, PPC - VDE0126-1-1 Greece, UTE C15-712-1, VDE: AR-N4105		
Grid code	VDE-AR-N 4105		
SZS or grid protection	Acc. to VDE 0126-1-1		
Interfaces	RS485 & RS232		
GENERAL DATA			
Type of protection	IP66 as per EN 60529		
Dimensions Width/Height/Depth, mm	320/720/250		
Weight, kg	27	27	28

THREE-PHASE STRING INVERTERS



*Champion:
Awarded top
marks by the mag-
azine Photon:
REFU**sol** 008K–
020K. For the U.S.
market we have
developed a UL
model (differs
from the one pic-
tured here).*



REFU**sol** 008K–020K

For medium-sized to megawatt installations

The three-phase string inverters in the 8.25 to 19.2 kW power classes are perfect for rooftop systems from 8 kW upwards, right through to megawatt parks. They comply with all requirements for IP65 protection – their housing provides reliable protection from dust and water, including high pressure washing. These systems can therefore be installed out in the open without any problem. All five string inverters are **easy to handle and compact**. For example, they can be installed on an area smaller than three A4 pages laid side by side. Operation and monitoring are easy, further facilitated by the graphic display, the integrated RS485 interface and an Ethernet connection.

Fast MPP tracking and a wide input voltage range also ensure the high levels of efficiency that are typical in REFU**sol** systems. Even at low irradiation, the three-phase inverters achieve an **efficiency of up to 98.2%**. As a result of these high efficiency levels convection cooling is all that's needed to dissipate the heat. Thanks to the low voltage fluctuations against earth, the transformerless devices can also be used for many thin-film modules.

The integrated data-logger can send all important operating data to the REFU**log** Internet portal. For visualization and evaluation purposes, data can be transferred via the standard cable or an optional wireless connection using the new REFU**connect** radio module. Comprehensive information on operating conditions and the productivity of your plant is available at any time. Find out more about REFU**log** on page 30.

TECHNICAL DATA	REFU <i>sol</i> 008K	REFU <i>sol</i> 010K	REFU <i>sol</i> 013K	REFU <i>sol</i> 017K	REFU <i>sol</i> 020K ¹⁾
DC DATA					
Recommended max. PV power, kWp	9.3	11.2	13.9	18.5	21.6
MPPT range, V	370 ... 850	410 ... 850	420 ... 850	445 ... 850	480 ... 850
DC start voltage, V	350				
Max. DC voltage, V	1000				
Max. DC current, A	23	25	30	38.5	41
MPP tracker	1				
Number of DC connections	3 x MC4	3 x MC4	4 x MC4	6 x MC4	6 x MC4
DC disconnection switch	Yes				
Internal overvoltage protection, type	3				
AC DATA					
Rated AC power, kVA	8.25	10.0	12.4	16.5	19.2
Max. AC active power, kW	8.25	10.0	12.4	16.5	19.2
AC grid connection	3AC 400 V + N, 50–60 Hz				
Rated power factor	1				
Adjustable displacement factor	0.9i ... 1 ... 0.9c				
Max. AC current, A	12	18	18	29	29
Distortion factor THD, %	< 2.5	< 1.8	< 1.8	< 1.8	< 1.8
Max. efficiency, %	98.0	98.0	98.0	98.2	98.2
European efficiency, %	97.3	97.4	97.5	97.8	97.8
Feed-in starting at, W	20				
Internal consumption in night operation, W	< 0.5				
Internal overvoltage protection, type	3				
COOLING, AMBIENT CONDITIONS, EMC					
Cooling	Natural convection				
Ambient temperature, °C	-25 ... +55				
Elevation	Up to 2000 m above sea level				
Noise, dBA	< 45				
Emitted interference	EN 61000-6-4:2007				
Interference immunity	EN 61000-6-2:2005				
Environment classification	4K4H acc. to DIN IEC 721-3-4				
Certification	CE, VDE0126-1-1, Belgium C10/C11, Italy ENEL, Spain RD1663, RD661, Australia/Israel AS3100, AS4777.2, AS4777.3, Austria ÖNORM, EN 50438:2007: Cyprus, Portugal, G59/2: England ²⁾ , UTE C15-712-1, EN 62109-1, EN 61727, EN 62116				
Grid code	Complies with all German low and medium voltage grid regulations (BDEW, VDE-AR-N 4105, EEG 2012)				
SZS or grid protection	Acc. to VDE 0126-1-1				
Interfaces	Ethernet & RS485				
GENERAL DATA					
Type of protection	IP65 as per EN 60529				
Dimensions Width/Height/Depth, mm	535/601/225	535/601/225	535/601/277	535/601/277	535/601/277
Weight, kg	28.5	28.5	35.5	41.5	41.5

¹⁾ Optional: for use with grounded modules (Positive or minus pole earthing possible, insulated grid required (D: IT-Netz)), Higher electric strength against PE
²⁾ only for REFUso/ 010K–020K

THREE-PHASE STRING INVERTERS



*Premium package:
Special materials
and optimized fea-
tures for broad
applications in the
solar business:
REFUso! 020K-SCI.*



REFUso! 020K-SCI

Breaking through thresholds

The 008K–020K three-phase inverters are the tried and tested partners of the photovoltaics sector. They deliver very high efficiency levels, run reliably and demonstrate their high technological maturity day after day. As experienced developers, however, we are always setting ourselves new goals. The threshold between high and maximum performance can only be crossed by those who overcome technical limitations. In developing the REFUso! 020K-SCI we have taken this step towards absolute maximum output. Equipped with special materials like silicon carbide and a raft of **optimized features**, the REFUso! 020K-SCI can do everything that bit better than its cousins. With a peak efficiency of 98.7%, it's extremely quiet and we have increased its power to 20 kW AC. With its wide input voltage range from 490 to 800 V, fast and precise **MPP tracking** and its light weight of just under 40 kg the REFUso! 020K-SCI sets the standard in the category up to 20 kW. The REFUso! 020K-SCI is cutting edge technology at its most refined – a high-end inverter for system operators who want to achieve the maximum yield from their PV system.

TECHNICAL DATA		REFUso/ 020K-SCI
DC DATA		
Recommended max. PV power, kWp		22.3
MPPT range, V		490 ... 800
DC start voltage, V		350
Max. DC voltage, V		1000
Max. DC current, A		41.5
MPP tracker		1
Number of DC connections		6 x MC4
DC disconnection switch		Yes
Internal overvoltage protection, type		3
AC DATA		
Rated AC power, kVA		20.0
Max. AC active power, kW		20.0
AC grid connection		3 AC 400 V + N, 50–60 Hz
Rated power factor		1
Adjustable displacement factor		0.9i ... 1 ... 0.9c
Max. AC current, A		29.2
Distortion factor THD, %		< 1.8
Max. efficiency, %		98.7
European efficiency, %		98.5
Feed-in starting at, W		20
Internal consumption in night operation, type		< 0.5
Internal overvoltage protection, type		3
COOLING, AMBIENT CONDITIONS, EMC		
Cooling		Natural convection
Ambient temperature, °C		-25 ... +60
Elevation		Up to 4000 m above sea level
Noise, dBA		< 35
Emitted interference		EN 61000-6-4:2007
Interference immunity		EN 61000-6-2:2005
Environment classification		4K4H acc. to DIN IEC 721-3-4
Certification		CE ¹⁾ , VDE0126-1-1 ¹⁾ , Belgium C10/C11 ¹⁾ , Italy ENEL ¹⁾ , Spain RD1663 ¹⁾ , RD661 ¹⁾ , Australia/Israel AS3100, AS4777.2, AS4777.3 ¹⁾ , Austria ÖNORM ¹⁾ , EN 50438:2007: Cyprus, Portugal ¹⁾ , G59/2: England ¹⁾ , UTE C15-712-1 ¹⁾ , EN 62109-1 ¹⁾ , EN 61727 ¹⁾ , EN 62116 ¹⁾
Grid code		Complies with all German low and medium voltage grid regulations (BDEW, VDE-AR-N 4105 ¹⁾ , EEG 2012)
SZS or grid protection		Acc. to VDE 0126-1-1
Interfaces		Ethernet & RS485
GENERAL DATA		
Type of protection		IP65 as per EN 60529
Dimensions Width/Height/Depth, mm		535/601/277
Weight, kg		40.0

¹⁾ in preparation

THREE-PHASE STRING INVERTERS



*High performer:
The new member
of our inverter
family: REFUso!
023K-460 VAC.*

REFUso! 023K-460 VAC

String inverters for medium voltage systems

The transformerless REFUso! 023K string inverter with 460 VAC complements the product range between the 008K–020K string inverters with 400 VAC and the high-power REFUso! 333K central inverter with 690 VAC. With an output voltage of 460 V and an input voltage range from 575 to 900 V, the REFUso! 023K-460 VAC is the perfect choice for medium voltage applications in **large-scale PV plants**. It has an efficiency level of more than 98%.

Like the other inverters in the REFUso! product line, the REFUso! 023K-460 VAC also works with the fast and precise REFUso! MPP tracking system. The data-logger, RS485 interface and Ethernet connection make data communication easy. It can be configured quickly and easily via LAN. These inverters can be integrated into a network using W-LAN if required. To do this, they just have to be connected to the REFUconnect radio module. All configuration and monitoring functions can then also be used wirelessly. You can analyze the power budget of the systems being operated using the web-based evaluation tool REFUlog. Here you can focus fully on parameters, curves and values as there is no need to worry about maintaining the 023K-460 VAC. It functions with maintenance-free convection cooling.

TECHNICAL DATA		REFUso/ 023K-460VAC
DC DATA		
Recommended max. PV power, kWp		25.8
MPPT range, V		575 ... 900
DC start voltage, V		350
Max. DC voltage, V		1000
Max. DC current, A		41
MPP tracker		1
Number of DC connections		6 x MC4
DC disconnection switch		Yes
Internal overvoltage protection, type		3
AC DATA		
Rated AC power, kVA		23
Max. AC active power, kW		23
AC grid connection		3 AC 460V + N, 50–60Hz
Rated power factor		1
Adjustable displacement factor		0.9i ... 1 ... 0.9c
Max. AC current, A		29.2
Distortion factor THD, %		< 1.8
Max. efficiency, %		98.34
European efficiency, %		98.1
Feed-in starting at, W		20
Internal consumption in night operation, type		< 0.5
Internal overvoltage protection, type		3
COOLING, AMBIENT CONDITIONS, EMC		
Cooling		Natural convection
Ambient temperature, °C		-25 ... +55
Elevation		Up to 2000 m above sea level
Noise, dBA		< 45
Emitted interference		EN 61000-6-4: 2007
Interference immunity		EN 61000-6-2: 2005
Environment classification		4K4H acc. to DIN IEC 721-3-4
Certification		CE, VDE0126-1-1, Belgium C10/C11, Italy ENEL, Spain RD1663, RD661, Austria ÖNORM, EN 50438:2007: Portugal, UTE C15-712-1, EN 62109-1, EN 61727, EN 62116, VDE AR-N4105
Grid code		Complies with all German low and medium voltage grid regulations (BDEW, VDE-AR-N 4105, EEG 2012)
SZS or grid protection		Acc. to VDE 0126-1-1
Interfaces		Ethernet & RS485
GENERAL DATA		
Type of protection		IP65 as per EN 60529
Dimensions Width/Height/Depth, mm		535/601/277
Weight, kg		41.5

“BECAUSE **PLANNERS**
WHO THINK ON A
LARGE-SCALE, APPLY
OTHER **BENCHMARKS**,
WE DEVELOP
AND MANUFACTURE
DEVICES AND
SOLUTIONS THAT
MORE THAN SURPASS
THESE BENCHMARKS.
WITH REFU*sol*
YOU ARE INVESTING
IN A FUTURE WITH
IMPRESSIVE YIELDS.”

M. BEHLEN, PRODUCT MANAGEMENT

*Meuro solar park,
equipped with
REFU*sol* inverters.*

REFU*sol*



CENTRAL INVERTERS

TOP
100

*Top athlete:
The many innovations brought together in this inverter provide impressive performance. It is without a doubt the most sought after model in its class:
REFU**sol** 333K.*



REFU**sol** 333K

For open field sites and factories

The REFU**sol** 333K is the new, highly efficient central inverter for open field sites and industrial rooftops. Low system costs and an **extremely high level of efficiency** of over 98.5% are just two of the many good reasons to use this model for large-scale projects. Operated together, just three of these devices provide one megawatt of power.

Despite being developed for high power outputs, this inverter is elegantly reserved in terms of its weight and the space it needs. A weight of just 850 kg, spread throughout a compact housing, is beneficial in terms of transport and infrastructure costs.

Thanks to a standardized voltage level of 690 VAC, this inverter is the ideal solution for **developers** of large-scale PV systems.



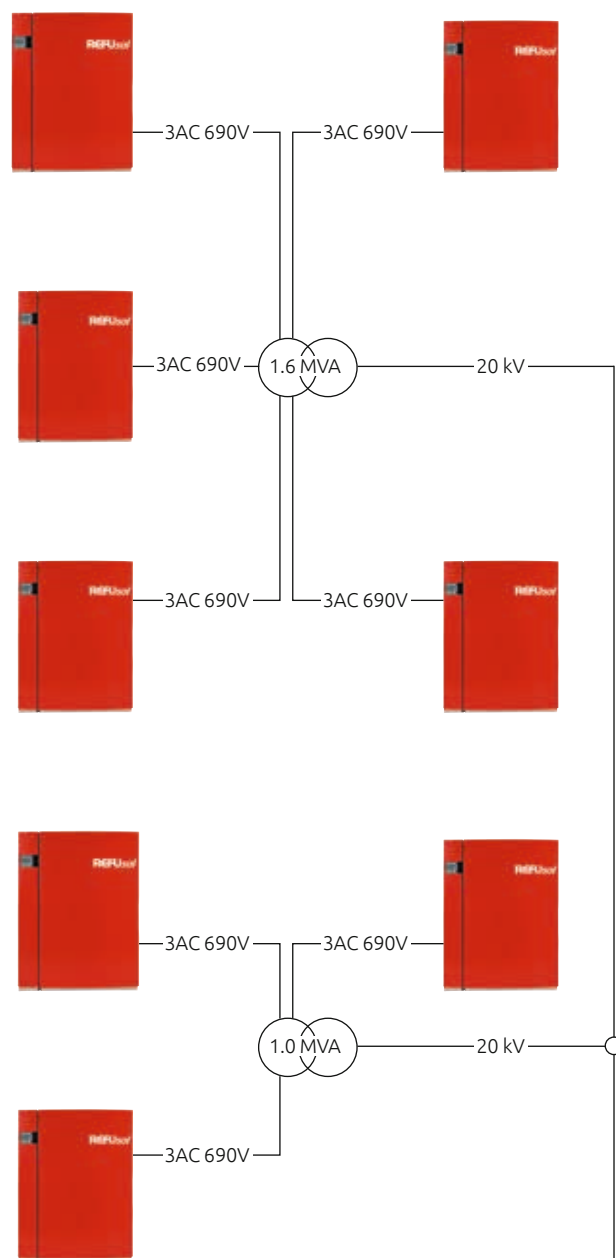
A question of configuration

Cost-effective thanks to clever technology

Connecting several inverters on one transformer reduces both costs and system-related losses. This architecture has already been relied upon in wind farms for some time. And with great success.

The central principle is now also available for large-scale PV systems. The high output voltage of 690 VAC of the REFUsol/333K enables the **parallel operation** of several inverters on just one transformer. The higher output voltage reduces conveyance losses by 66% compared to 400 VAC devices with the same cable cross section. In large-scale systems, fewer transformers are required and cabling lengths are shorter on the DC-side. Device, infrastructure and maintenance costs are therefore considerably less.

Due to the **high input voltage** of up to 1500 V, strings can be arranged in significantly longer configurations than was previously possible. Losses within a string are reduced, while performance remains the same. Overall this improves the cost-effectiveness of the entire PV system.



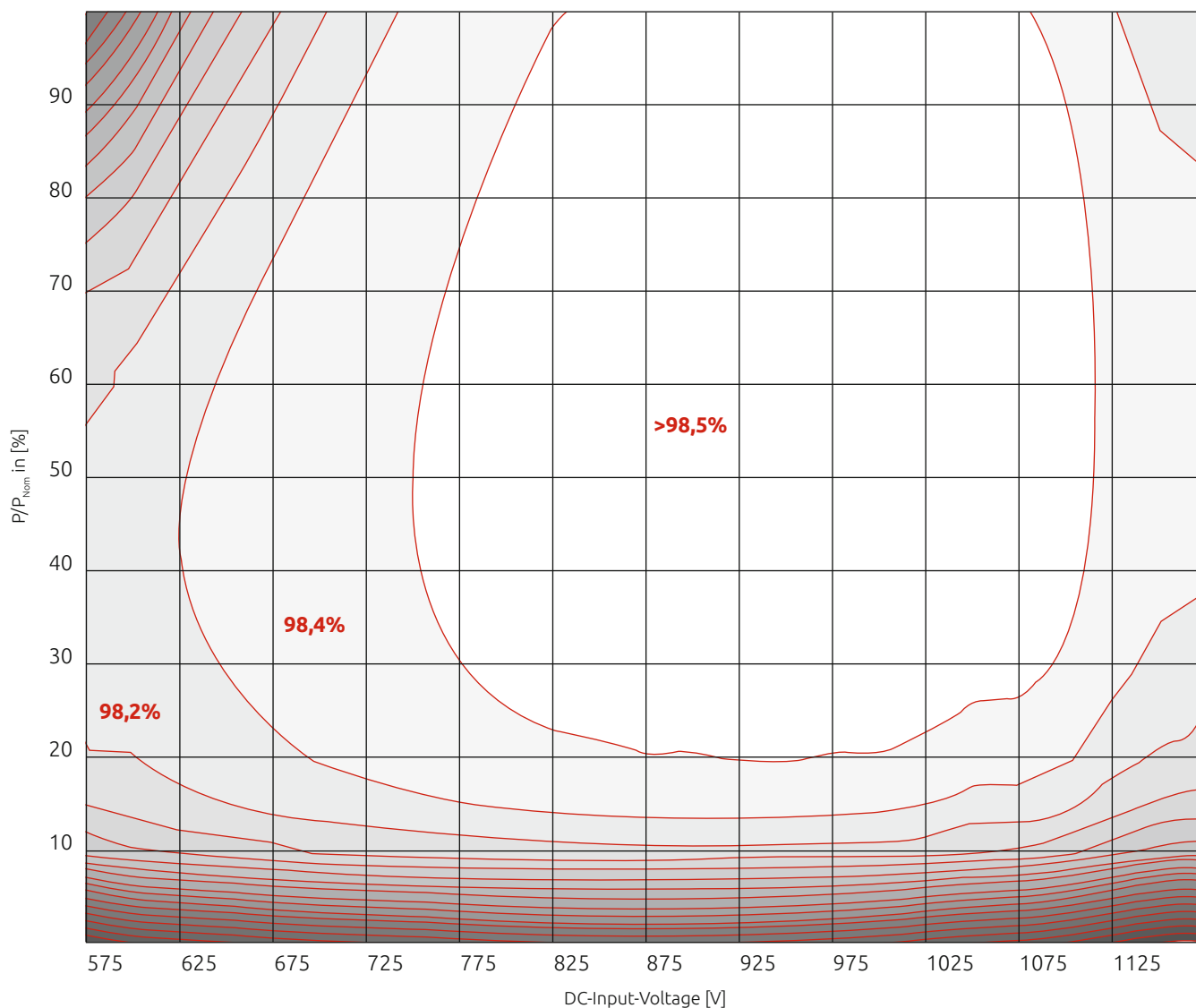
*Parallel operation:
Clusters of
REFUsol devices
can be connected
together in paral-
lel, reducing infra-
structure and op-
erating costs.*

Wide working environment

Stable yields from sunrise to sunset

The REFUsol 333K has a very high peak efficiency of over 98.5% thanks to the **UltraEta**® circuit technology. The curve shows an efficiency of over 98.4% across a wide voltage range and across a wide MPP range. This means high levels of efficiency are also guaranteed at low levels of sunlight. The high energy yield, easy installation, user-friendly handling and the possibility of using industrially manufactured standard transformers and components from the wind industry results in a significant reduction of the absolute system costs for larger PV systems.

The calculated efficiencies of the REFUsol 333K inverter are exceptionally high across a wide input voltage range.



TECHNICAL DATA		REFU <i>sol</i> 333K
DC DATA		
Recommended max. PV power, kWp		375
MPPT range, V		575 ... 1150
DC start voltage, V		500
Max. DC voltage, V		1500
Max. DC current, A		610
MPP tracker		1
Number of DC inputs		4
AC DATA		
Rated AC power, kVA		333
Max. AC active power, KW		333
AC grid connection		3 AC 690 V + N, 50–60 Hz, use external transformer
Rated power factor		1
Adjustable displacement factor		0.9i ... 1 ... 0.9c
Max. AC current, A		280
Distortion factor THD, %		≤ 3
Max. efficiency, %		98.5
European efficiency, %		98.2
Feed-in starting at, kW		0.6
Internal consumption in night operation, W		0
Internal overvoltage protection, type		1 + 2
COOLING, AMBIENT CONDITIONS, EMC		
Cooling		Temperature controlled air cooling
Ambient temperature, °C		-20 ... +55
Elevation		Up to 1000 m above sea level, with power derating up to 2000 m, with voltage derating up to 3000 m
Noise, dBA		Max. 70
Emitted interference		EN 61000-6-4:2007
Interference immunity		EN 61000-6-2:2005
Environment classification		4K4H acc. to DIN IEC 721-3-4
Certification		CE, Italy ENEL ¹⁾
Grid code		Complies with all German low and medium voltage grid regulations (BDEW ¹⁾ , EEG 2012)
Interfaces		Ethernet, RS485, CAN-Master
GENERAL DATA		
Type of protection		Electronic unit: IP65 as per EN 60529
Dimensions Width/Height/Depth, mm		1230/1610/810, without base
Weight, kg		850
Disconnection system DC		DC contactor
Disconnection system AC		Main contactor

¹⁾ in preparation

CENTRAL INVERTERS



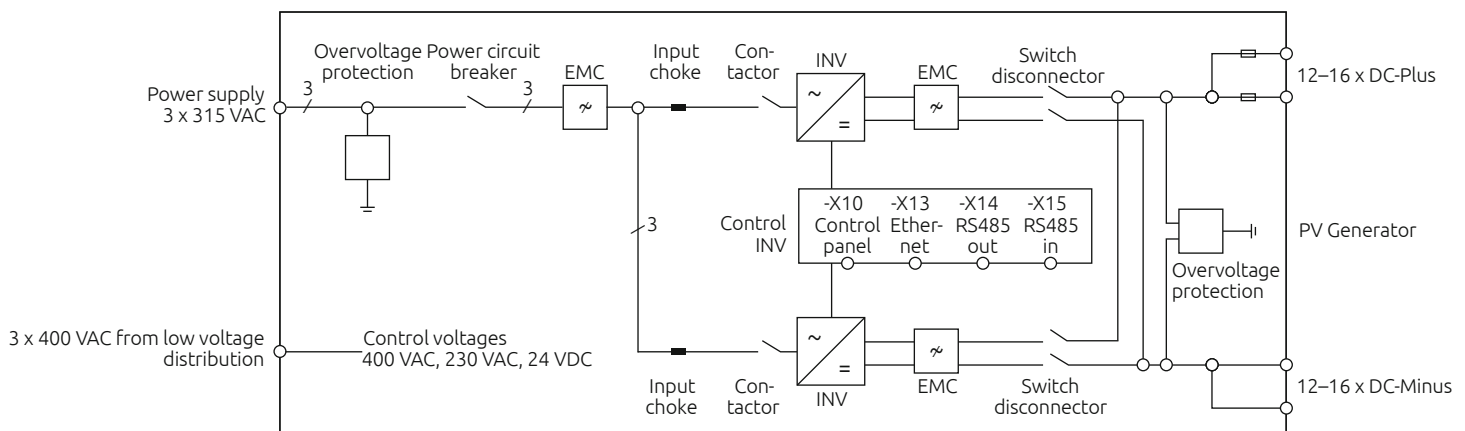
*Stronghold:
High performance
needs a
solid basis. Stable,
solid and
designed for heavy
loads: REFUso^l
500K–630K.*

REFUso^l 500K–630K

Utility scale – start where others give up

When the electrical performance parameters reach ranges reserved for large-scale systems, nothing surpasses the REFUso^l 500K–630K inverters. Their use begins where others reach their limits. They bring together almost 50 years of experience in power electronics and control cabinet construction with current developments from the 21st century, such as the fast and **precise MPP tracking system** used in REFUso^l models 008K–023K. The REFUso^l 630K has an active cooling system which uses external water/air heat exchangers. For the 500K this feature is available as an optional extra. Both devices are equipped with anti-islanding functionality.

Solid in construction, robust in operation, precise in alignment – REFUso^l also impresses in the upper power classes. And we embrace our **efficiency principle** here too, where huge currents of up to 1300 A flow. The peak efficiency of this central inverter is over 98.1%, with a European efficiency of 97.6% and an MPPT range from 460 to 850 V. Even at extremely high power levels we understand how to make careful use of resources.



TECHNICAL DATA		REFU ^{sol} 500K	REFU ^{sol} 630K
DC DATA			
Recommended max. PV power, kWp		565	710
MPPT range, V		460 ... 850	
DC start voltage, V		560	
Max. DC voltage, V		950	
Max. DC current, A		1000	1300
MPP tracker		1	
Number of DC connections		12	16
Overvoltage protection, type		2	
AC DATA			
Rated AC power, kVA		500	630
Max. AC active power, KW		500	630
AC grid connection		3 AC 315 V, 50–60 Hz, use external transformer	
Rated power factor		1	
Adjustable displacement factor		0.9i ... 1 ... 0.9c	
Max. AC current, A		920	1220
Distortion factor THD, %		≤ 3	
Max. efficiency, %		98.14 without transformer	
European efficiency, %		97.60 without transformer	
Feed-in starting at, W		5000	
Internal consumption in night operation, W		50 ... 600	
Overvoltage protection, type		1 + 2	
COOLING, AMBIENT CONDITIONS, EMC			
Cooling		Standard cooling or hermetically sealed system with liquid cooling	Hermetically sealed system with liquid cooling
Ambient temperature, °C		–20 ... +50 ¹⁾	–20 ... +45 ¹⁾
Elevation		Up to 1000 m above sea level, with power derating up to 2000 m	
Noise, dBA		t.b.d.	
Emitted interference		EN 61000-6-4:2007	
Interference immunity		EN 61000-6-2:2005	
Environment classification		3K3 acc. to DIN IEC 721-3-3	
Certification		CE, Italy ENEL, Spain RD1663, RD661	
Grid code		Complies with all German low and medium voltage grid regulations (BDEW, EEG 2012)	
GENERAL DATA			
Type of protection		IP43 or IP54 (option) as per EN 60529	IP54 as per EN 60529
Dimensions Width/Height/Depth, mm		2800/2000/600, Additional cooling unit: 600/2000+200 ²⁾ /800+160 ³⁾	1230/1610/810, Additional cooling unit: 600/2000+200 ²⁾ /800+160 ³⁾
Weight, kg		1700	1800
Disconnection system DC		DC contactor	
Disconnection system AC		Main switch and main contactor	

¹⁾With option "hermetically sealed system" without P-derating ²⁾ base for water connections can be removed ³⁾Control of cooling

POWERBOX



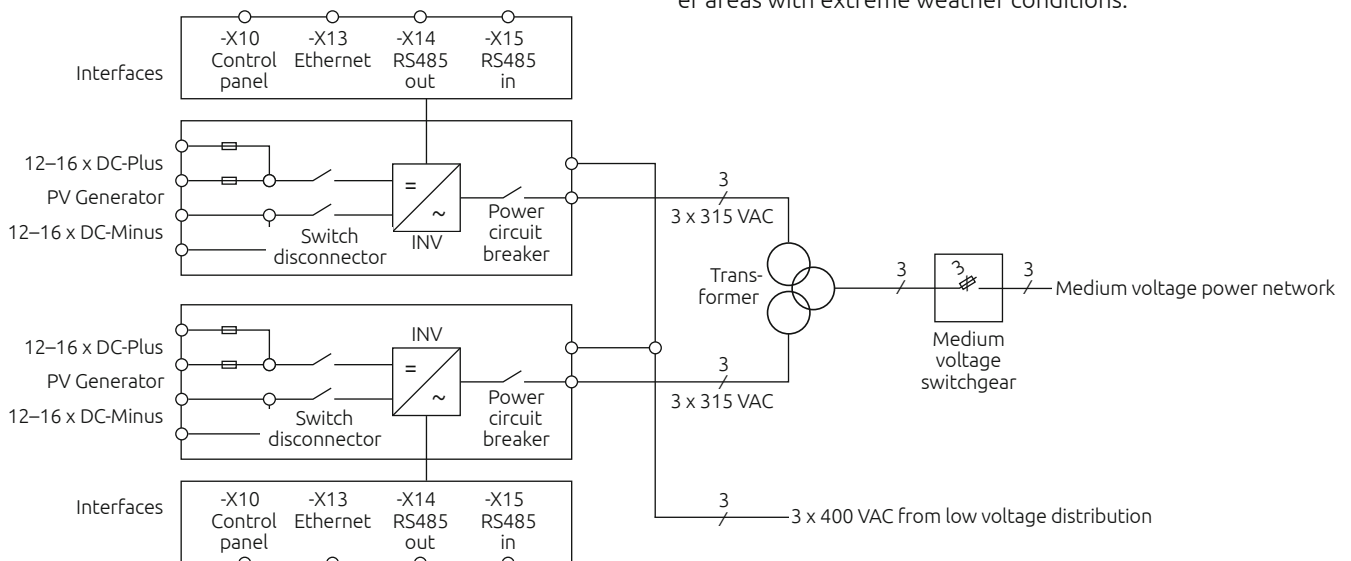
*Ready-to-use:
Total package for
power transfer
in your individual-
ly configured PV
park: REFUs_{pb}.*

REFUs_{pb}

Also built for extreme applications

Based on the REFUsol central inverters, we have created the ready-to-use REFUs_{pb} powerbox. Suitable for power rates from 500 kW to 1.3 MW, the powerbox can also be equipped, if required, so that it works smoothly, even in extreme load conditions.

The ambient conditions at photovoltaic sites around the world vary sharply. That's why we have sought technical solutions, which can expand the range of operational areas of the REFUsol central inverters and the REFUs_{pb} powerbox to include extremely challenging environments. We have therefore opted for an additional, optional cooling system. If requested by the customer, a hermetically sealed **cooling system** can be added to the system's standard cooling capabilities. This enables higher admissible maximum ambient temperatures and protects the system's components from external influences such as dust or air with a high salt content. The REFUs_{pb} is therefore particularly suitable for **solar parks in coastal areas**, by the sea, or in other areas with extreme weather conditions.



TECHNICAL DATA	REFU spb 500K	REFU spb 630K	REFU spb 1.0M	REFU spb 1.3M
DC DATA				
Recommended max. PV power, kWp	565	710	2 x 565	2 x 710
MPPT range, V	460 ... 850			
Max. DC voltage, V	950			
Max. DC current, A	1000	1300	2 x 1000	2 x 1300
Disconnection system DC	DC disconnection switch			
AC DATA				
Rated AC power, kVA	500	630	2 x 500	2 x 630
Max. AC active power, KW	500	630	2 x 500	2 x 630
AC grid connection	Depending on transformer, e.g. 3 AC 20 kV, 50–60 Hz			
Rated power factor	1			
Adjustable displacement factor	0.9i ... 1 ... 0.9c			
Max. AC current, A	920	1220	2 x 920	2 x 1220
BOX				
Dimensions Width/Height/Length, mm	3020/3560/6600 (optional 7200)			
COOLING				
Model	Air cooling ¹⁾	Hermetically sealed system	Air cooling ¹⁾	Hermetically sealed system
Type of cooling	Power unit: Liquid cooled with internal water/air heat exchanger ¹⁾	Power unit: Liquid cooled with internal water/air or air/water heat exchanger	Power unit: Liquid cooled with internal water/air heat exchanger ¹⁾	Power unit: Liquid cooled with internal water/air or air/water heat exchanger
Ambient temperature, °C	–20 ... +50, P-derating from 45 ¹⁾	–20 ... +45, up to 45 full range of rated power	–20 ... +50, P-derating from 45 ¹⁾	–20 ... +45, up to 45 full range of rated power
Elevation	Up to 1000 m above sea level, power derating up to 2000 m	Up to 1000 m above sea level, power derating up to 2000 m	Up to 1000 m above sea level, power derating up to 2000 m	Up to 1000 m above sea level, power derating up to 2000 m
Dimensions Width/Height/Depth, mm	600/2200/960	600/2200/960	600/2200/960	700/2200/960
Weight, kg	300 ¹⁾	410	300 ¹⁾	430

¹⁾Option with hermetically sealed system → Additionally with air/water heat exchanger → –20°C ... +45°C, up to 45°C full range of rated power → 410 kg

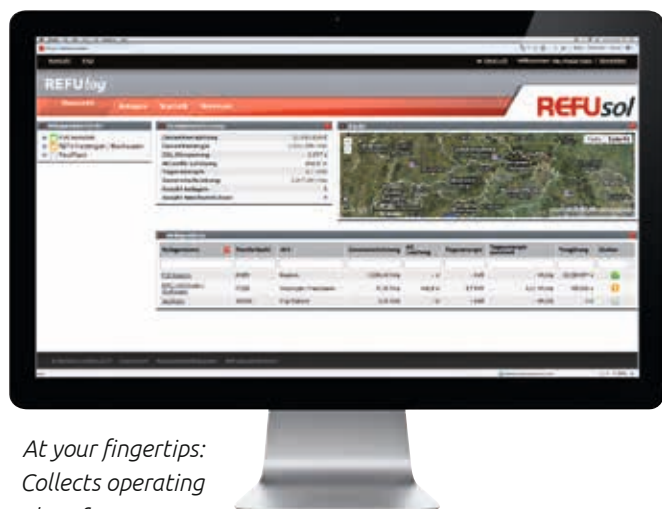


*Tongeren solar
park, equipped
with REFU**sol**.
inverters.*

“TO **IMPROVE** THE
OPERATING RELIABIL-
ITY AND THEREFORE
THE YIELD **RELIABILITY**
OF PHOTOVOLTAIC
SYSTEMS WE HAVE
DEVELOPED A WIDE
RANGE OF ACCESSO-
RIES. THIS GIVES
YOU ACCESS TO ACCU-
RATE YIELD ANALYSIS
AND ERROR DIAG-
NOSIS **AT ANY TIME**
AND AT ANY PLACE.”

H. SCHNEIDER, MICROELECTRONICS

DATA POOL



*At your fingertips:
Collects operating
data from PV sys-
tems and creates
summary data
tables and graph-
ics: REFUlog
Internet portal.*

REFU**log**

Gather, process and analyze data

To be able to provide pertinent information on the yields and cost-effectiveness of a PV system, the relevant operating data has to be captured and analyzed. That's why every REFU**sol** 008K–630K has an **integrated data-logger**. This records all key operating parameters and communicates these to an on-line database.

REFU**sol** customers can analyze and monitor their PV system data through the **Internet portal www.refulog.com**. Every REFU**sol** 008K–630K inverter can be connected using a local network or the Internet. For all 8 to 630 kW devices, installation is via plug & play. Via an Ethernet connection or optionally via the REFU**connect** radio module, the inverters communicate with your network. REFU**sol** 003K to 005K devices can be connected to your local network via the RS485 interface with the REFU**pmu**. This means you can evaluate the data from an unlimited number of inverters anywhere in the world. Data can be recorded over long time frames for all inverters. In addition to an automated **performance check**, status monitoring and error reporting options are also integrated. The two operational **monitoring and analysis systems** SolarLog and Meteocontrol are also supported.

TECHNICAL DATA		REFUlog + REFUsol 003K–005K	REFUlog + REFUsol 008K–630K
GENERAL DATA			
Prerequisite for REFUlog	REFUpmu, firmware package 5-0	Compatible from firmware package 25-10 for REFUsol 008K–023K and firmware package 5-4 for REFUsol 500K–630K	
Data-logger	Integrated from firmware package 5-0	Already integrated	
PV plant installation	RS485, REFUpmu (1000 m range)	Plug & Play installation through the use of standard Ethernet network; optional with REFUconnect (300 m range)	
Configuration of plants and sub-plants	Easy to integrate inverters using a unique activation code, location information, plant-specific data, pictures		
Number of inverters	Unlimited		
Administration	User and rights administration supported		
Languages	EN, DE, IT, FR, ES, CZ, RO, GR with localized display of number formats, dates etc.		
Data dispatch	Automatic monitoring of functions		
Protocol	TCP/IP		
PERFORMANCE SPECTRUM			
Display of plant and inverter data	In clearly laid out lists for easier comparisons		
Visualization of current parameter values per plant and per inverter	Total yields, daily yields (absolute and normalized), AC/DC power rating (absolute and normalized), AC/DC voltage, AC/DC current, AC frequency, device temperature, irradiation values, module temperature, performance ratio ¹⁾		
Graphical analysis of historical data	Day, month, year and total sum view, display of relevant plant and inverter parameters, combination of various channels in one diagram using a freely configurable statistical view, Excel and PDF export available		
Error management	Overview of inverter error messages and error notification by e-mail		
Report dispatching	Daily, monthly or yearly notification of monitored data by e-mail		

¹⁾ available with temperature and irradiation sensor SI-13TC-T-K

MORE ROOM TO MOVE



REFUlog pro

Everything under control and in full view

Keep an eye on your PV systems. The REFUlog *pro* version, in addition to summary **statistics in table form** also offers an extended automatic monitoring function for every PV system. This controls, among other things, the optimum AC performance, based on a **target-actual comparison**. In the event of a deviation, you are notified immediately by e-mail.

Generate up-to-date reports. A standard commercial display is all you need to present your PV system's operating data in an appealing and informative manner. System values such as daily, monthly and total yields as well as **CO₂ savings** can be presented in a personalized and clear way. Up-to-date information can always be extrapolated on the basis of these displays.



*Mobile information:
Keep an eye on the
efficiency of your
PV system at any
time wherever you
are: REFUlog app.*

REFUlog app

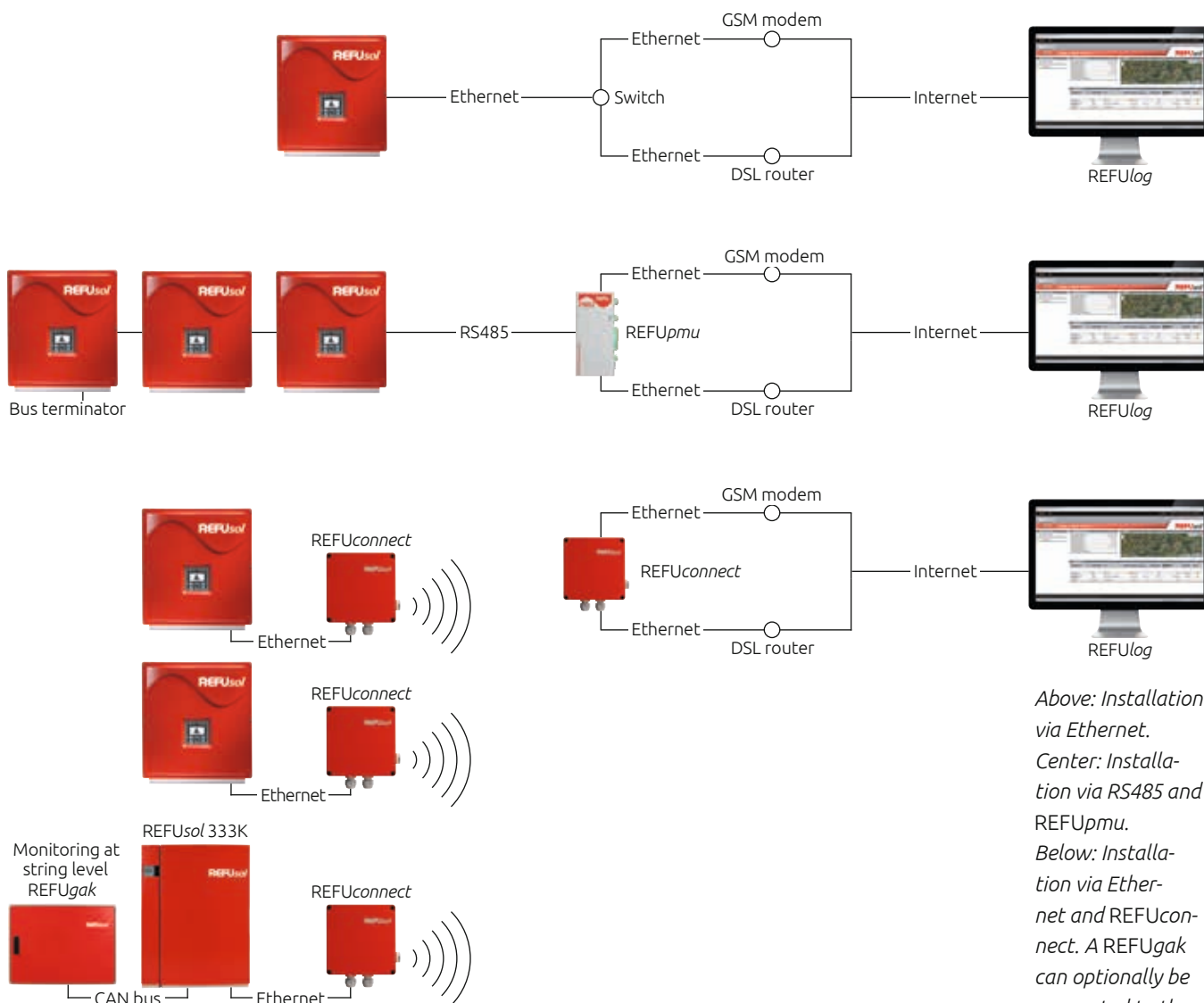
Everything at your fingertips

Stay **connected**. Even with a smartphone you can access data from REFUlog right now. With an iPhone® or Android app REFUlog users can keep track of their PV system at any time wherever mobile networks are available. You won't miss a thing: the mobile version of the REFUlog portal provides all key information on your PV system in easy-to-read table and graphic form.

TECHNICAL DATA**REFUlog pro****ADDITIONAL FUNCTIONS**

Automatic monitoring of	Ideal AC power rating ¹⁾ , statistical energy forecast, daily energy divergence, current performance
Statistical data tables for	Energy, normalized energy, yield and CO ₂ savings for plants, sub-plants and inverters Performance ratio ¹⁾ display
File storage	Up to 50 MB per plant
Big screen application	For the presentation of CO ₂ savings, daily, monthly, yearly and total yields

¹⁾ available with temperature and irradiation sensor SI-13TC-T-K



Above: Installation via Ethernet.

Center: Installation via RS485 and REFUpmu.

Below: Installation via Ethernet and REFUconnect. A REFUgk can optionally be connected to the REFUlog 333K for monitoring functions at string level.

SENSOR AND FAN MODULE



A key player in the team: The temperature and irradiation sensor measures light intensity and temperature, and enables target-actual data comparisons to be made.

Temperature and Irradiation sensor

More data – better quality information

Get the measure of your PV system's performance. The external temperature and irradiation sensor accurately captures the two ambient parameters, which together have an impact on the current performance of a PV system: temperature and light intensity. The sensor is compatible with all REFU**sol** 008K to 630K inverters. The device's **active temperature compensation** function increases its measuring accuracy. The extended measurement range of up to 1300 W/m², the individual calibration to the standard measurement signal and the possibility of measuring module temperature make the sensor a powerful **data collection** tool. The integrated data-logger records the temperature and irradiation values and communicates them to the REFU**log** system. These additional values allow you to display the operating conditions of your PV system even more accurately and to identify system errors more quickly. In the REFU**log** online monitoring portal, this data provides information on the performance ratio.



Provides additional cooling for inverters, therefore extending areas for use: REFUpowercap.

REFUpowercap

Air flow for shift work

If high power needs to be achieved where space is tight REFU**sol** inverters can be arranged on top of one another in three packs to save space. As convection cooling is no longer sufficient under these conditions, we have developed the **active fan module** REFUpowercap. It is designed for REFU**sol** photovoltaic inverters with rated power from 13 to 23 kW. The additional air flow helps you use space more effectively in cramped conditions.

By supplementing the system with this fan, the permissible ambient temperature of the inverters is increased by 5°C. This enables you to reliably operate REFU**sol** inverters in **small spaces** and where ambient temperatures are high.

TECHNICAL DATA**SI-13TC-T-K
+ REFUsol ≥ 008K****GENERAL DATA**

Shunt resistor, Ohm	0.10 (TK = 22 ppm/K)
Ambient temperature, °C	-20 ... +70
Supply voltage, VDC	12 ... 24
Current draw, mA	0.3
Connecting cable	4 x 0.14 mm ² , 3 m (UV-resistant)
Cell dimension, mm	50 x 34
Dimensions Width/Height/Depth, mm	145/81/40
Weight, g	340

SOLAR IRRADIATION

Measuring range, W/m ²	0 ... 1300
Output signal, V	0 ... 10
Measuring accuracy, %	+/- 5 of full scale

MODULE TEMPERATURE

Measuring range, °C	-20 ... +90
Output signal	$2.268\text{ V} + T [^{\circ}\text{C}] * 86.9\text{ m V}/^{\circ}\text{C}$
Measuring accuracy	+/- 1.5 % at 25°C
Nonlinearity, °C	0.5
Max. deviation, °C	2

TERMINAL ASSIGNMENT

Orange	Irradiation output signal (0 ... 10V)
Red	Supply voltage (12 ... 24VDC)
Black	GND
Brown	Temperature output signal (0 ... 10V)

TECHNICAL DATA**REFUpowercap
+ REFUsol 013K-023K****ELECTRICAL DATA**

Supply voltage, VDC	24
Voltage supply connection	Sensor connector
Internal consumption, W	2.4

GENERAL DATA

Free space in front of device, mm	1500
Type of protection	IP54 as per EN 60529
Dimensions Width/Height/Depth, mm	488/90/250
Weight, kg	1.4
Connection of	REFUpowercap or SI-13TC-T-K possible

POWER MANAGER



*Compliance:
Supports feed-in
and network man-
agement in PC sys-
tems as required
by law: REFUpmu.*

REFUpmu

Tasks required by law

The rules and regulations on renewable energy are constantly being updated in Germany and many other countries. The current version of Germany's **Renewable Energy Act** requires all PV systems brought into operation since 31 December 2011 to take part in feed-in and network safety management. Comparable rules also apply in other countries. The issue of feed-in and network safety management is therefore gaining importance in more and more PV markets.

One important measure is that the network operator can influence the power of a plant by remote control. An exception to this feature are PV plants with a maximum power of up to 30 kW, which can limit the feed-in supply to 70% of the module output. Existing PV plants with a power of 30 kW or higher, brought into operation since 1 January 2009, must be retrofitted for feed-in management: PV plants from 30 to 100 kW no later than 31 December 2013; PV plants with 100 kW and higher no later than 30 June 2012.

The power management unit – REFUpmu for short – can offer you and your network operator control and regulation-functions as required under the Renewable Energy Act, like **power limitation** and reactive power of all connected REFU**sol** 003K to 630K inverters. In conjunction with our REFU**log** monitoring portal, you can also display the total power output and total energy in graph format. The scope of supply of the REFUpmu can also be extended according to your preferences, by connecting additional sensors for example.

TECHNICAL DATA**REFUpmu****FUNCTIONS**

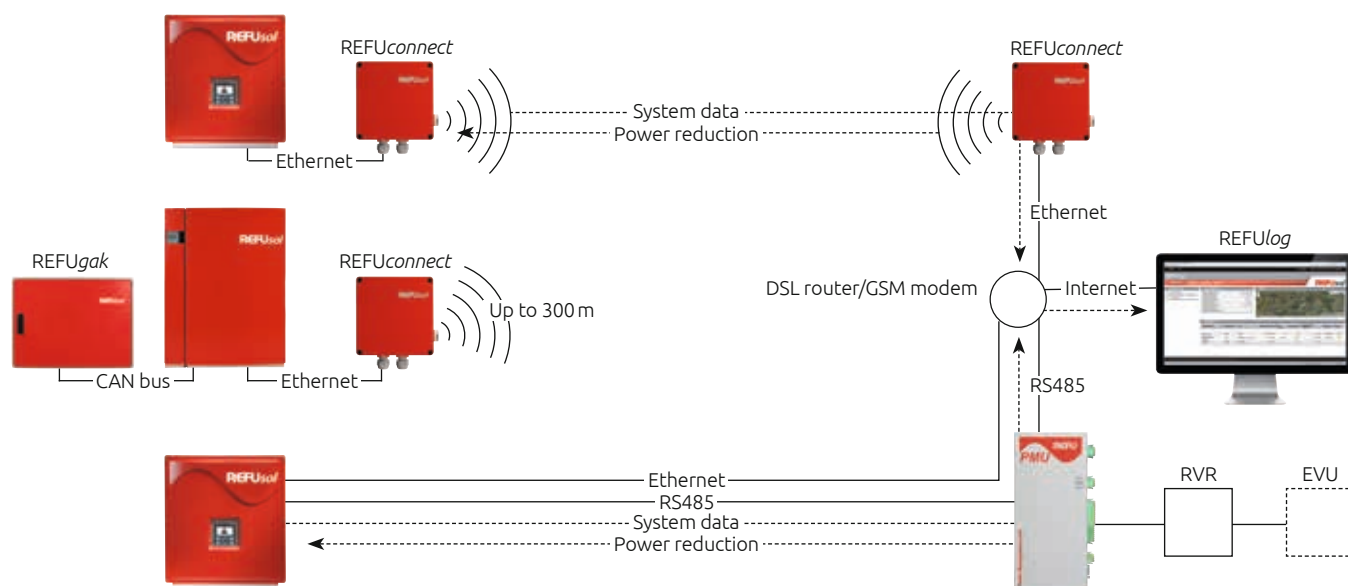
Grid code for inverter	Complies with all German low and medium voltage grid regulations (BDEW, VDE-AR-N 4105, EEG 2012)
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ELECTRICAL DATA

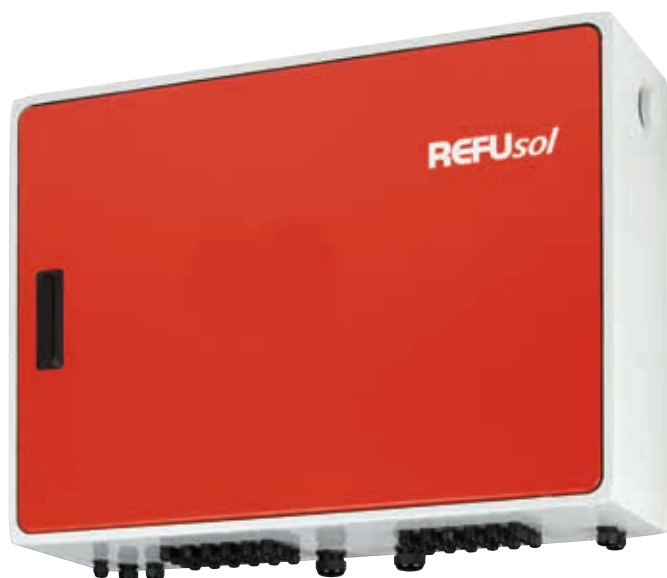
Max. supply power, W	18
Supply voltage	AC 115 ... 230 V / 50 ... 60 Hz (external AC adaptor)

GENERAL DATA

Operating notification	Via LED (On, Operating, Error, Switching Status for power reduction)
Specification of power reduction	4 digital combined inputs (stepping 0 %, 30 %, 60 %, 100 %, optionally reprogrammable or binary function, resulting in 16 possible programmable switching statuses)
Specification of reactive power	From external via analog interfaces or alternatively via programmable characteristic curve
Integrated interfaces	Ethernet connection for connecting with modem, 2 x RS485 (galvanically isolated), USB (service interface), Digital and analog input and output
Max. controllable inverters	RS485: 2 x 31 inverters, i.e. max. 62 inverters, Total length per branch: max 1000 m
Data-logger	For confirmation of the system operator's lost earnings all signals for power limitation and reactive power are logged
Communication with REFUlog portal	Communication via Ethernet connection with REFUlog, Evaluation possibilities for all internal data loggers of the connected inverters via REFUlog, therefore no additional connection, e.g. via Ethernet, is necessary
Installation	Wall mounting; top hat rail installation (optional)



DC COMBINER BOX

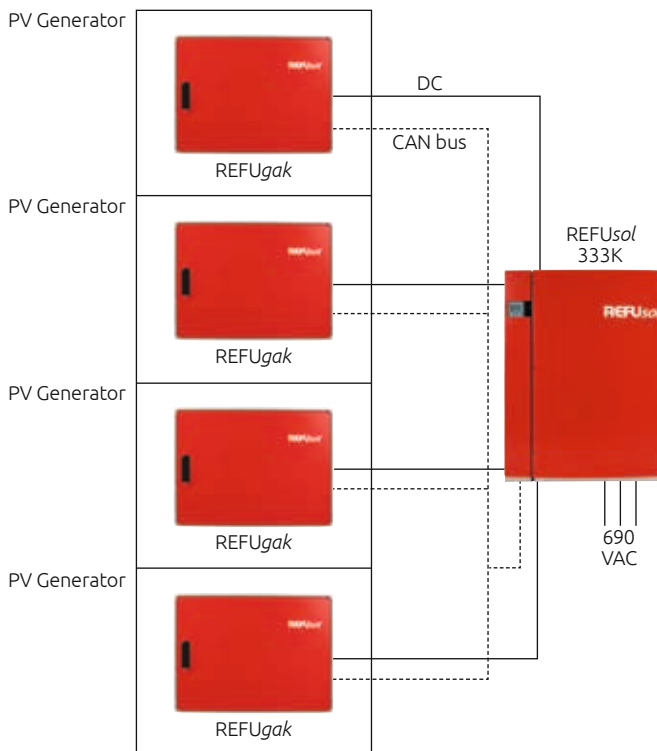


*Main line:
Concentrates up to
32 strings and
monitors at string
level: REFUg^{ak}.*

REFUg^{ak}

Clustering and monitoring at string level

Increase the efficiency of large-scale PV systems by concentrating multiple strings. The REFUg^{ak} DC combiner box can concentrate up to 24 strings (at 1500 V: 32 strings) in a single REFUg^{ak}. This **concentrated power unit** is connected to the inverter using just one cable. REFUg^{ak} monitors your system and diagnoses errors at string level. In the event of an error, REFUg^{ak} protects the connected strings and PV modules from being damaged. REFUg^{ak} communicates directly with the inverter without additional components, and is available in a 1000 V model, with a 1500 V model on request.



TECHNICAL DATA	REFUgak 1000-08/ 16-x-P	REFUgak 1000-08/ 16-x-PM	REFUgak 1000-12/ 12-x-P	REFUgak 1000-12/ 24-x-PM	REFUgak 1000-16/ 16-x-P	REFUgak 1000-16/ 16-x-PM	REFUgak 1000-20/ 20-x-P
STRING CONNECTIONS							
Number (with double assignment)	8 (16)	8 (16)	12	12 (24)	16	16	20
Conductor cross section/terminal type	max. 6 mm ² /disconnect terminal						
CURRENT MEASUREMENT							
Number of measuring channels	8	8	12	12	16	16	20
String fuses on the plus and minus poles		Yes		Yes		Yes	
Measurement range of current/Precision	-25 A ... +25 A at max. 1000 VDC/±0.5% upper range value, within operational temperature range						
Fuses available, A	12,16, 20, 25	12,16, 20, 25	12,16, 20, 25	12,16, 20, 25	12,16, 20	12,16, 20	12,16
Formula	$I_{\text{fuse(min)}} = I_{\text{sc}} \cdot 1.4$						
MEASUREMENT							
Number of measuring channels	1						
Measurement range of voltage/Precision	0 V ... 1000 VDC/±0.5% upper range value, within operational temperature range						
Temperature range/Precision	-30 °C ... +100 °C/±2% upper range value						
ELECTRICAL DATA							
Rated operational and insulation voltage, VDC	max. 1000						
Rated current, ADC	max. 230						
Rated impulse withstand voltage, VDC	6000						
Rated voltage of auxiliary circuits, VDC	24 through CAN bus						
Power consumption, W	max.1.5	max.1.5	max.1.5	max.1.5	max. 3	max. 3	max. 3
INTERFACES							
Data interface	CANopen as per CiA standard DS-301, cable Li2YCYv 8 x 2 x 0.5 (TP)						
Current inlets	16	16	12	24	16	16	20
Inlets for signaling contact	2 potential-free digital						
CAN bus	1						
DC main switch	250 A at 1000 V, cable glands Al/Cu, max. 300 mm ² , Optional motor-driven						
Overvoltage arrester	Combi-arrester type 1 and type 2						
GENERAL DATA							
Operation/storage temperature, °C	-25 ... +45/-30 ... +70						
Relative ambient humidity, %	Up to 95, non-condensing						
Degree of protection impact energy (EN 62262)	54						
Standards	EN 50178, EN 60439-1, EN 61000-6-2, EN 61000-6-3, EN 60269-6						
Dimensions, W x 750 x 320, mm	750	750	750	1000	1000	1000	1000
Weight, kg	36	36	36	44	45	45	44

SECURE RADIO CONNECTION



*Network partner:
Wireless data
transfer to and
from PV systems:
REFUconnect.*

REFUconnect

Lots of data – no cable

The REFUconnect radio module ensures wireless communication between all inverters in a PV system. It can network together **up to 2000 inverters** and transfer their data.

REFUconnect uses a radio standard, which also establishes and maintains **secure and reliable connections** even in high-interference industrial environments. In this context, the module is simultaneously used as a repeater, so that distances over several kilometers can be bridged without difficulty. The range of such an individual connection can total up to 300 m. The radio modules have very low power consumption and are supplied directly by the inverter. The network is password-protected. This means that data is transferred securely, remaining invisible to non-authorized network participants.

TECHNICAL DATA**REFUconnect****RADIO SYSTEM**

Frequency range, GHz	2.4 ... 2.5 (ISM band)
Transmission power, dBm	Max. 20
Receiver sensitivity, dBm	-94 at a bit error rate of 0.1%
Transmission rate	Up to 2.1 Mbits/s per hop and or between neighboring REFUconnects
Range	Up to 300 m per hop
Network size	Up to 2000 nodes
Connections	Up to 4 + 1
Security	128-bit encryption
Antenna	Weatherproof internal antenna

EXTERNAL INTERFACE

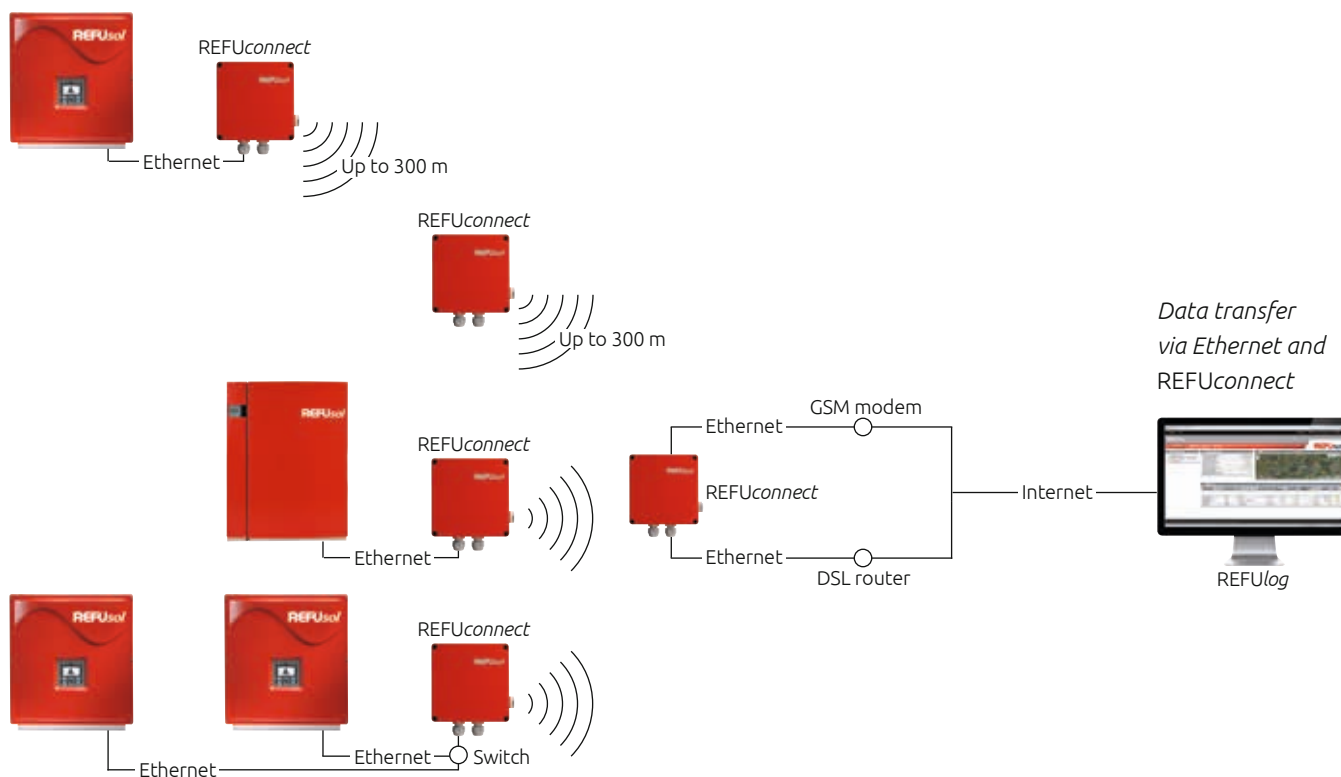
Power supply	7 ... 28 V/DC; typically 1.6 W / 2.8 W max.
Ethernet	IEEE 802.3u (Fast Ethernet), 10/100 Base-T

DIMENSIONS/WEIGHT

Dimensions Width/Height/Depth, mm	120/122/65
Weight, g	approx. 400

ENVIRONMENTAL CONDITIONS

Permissible temperature range, °C	-25 ... +60 (during operation, storage and transport)
Protection rating	IP65 (suitable for outdoor use)



SYSTEM-LEVEL THINKING



Partner for utility-scale plants

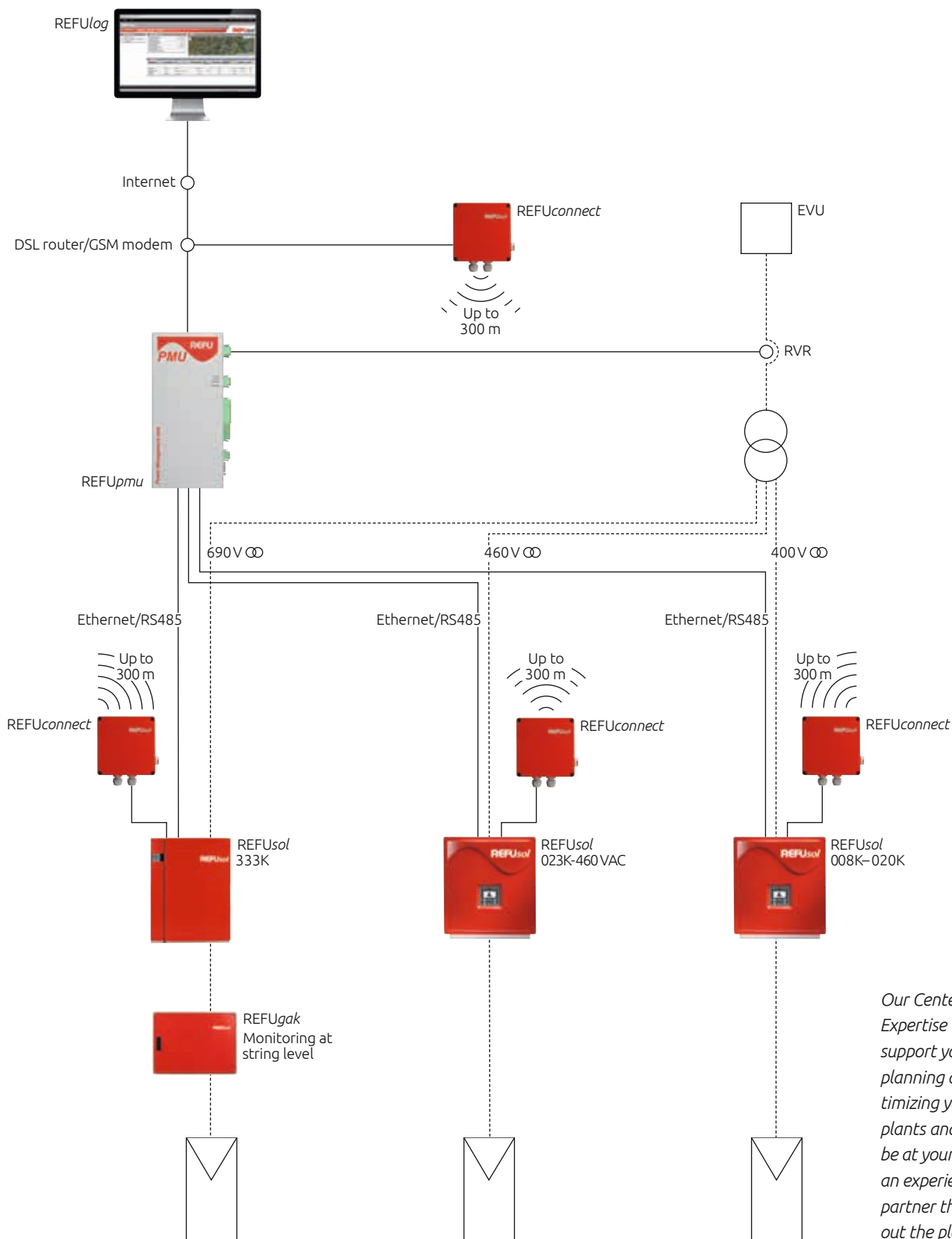
At REFU**sol** experts from the Center of Utility Expertise look after your **individual large-scale project**. One of our core principles is to view an entire system always in terms of effectiveness and yield reliability. With our system solutions we can help you reduce your BOS costs for example.

We start with your overall design concept. From this starting point and based on our **many years of experience**, we develop optimized system solutions together with you, which increase your energy yield, reduce your costs and make installation and operation extremely easy.

Benefit to you: maximum return on investment and minimum operating costs, with high availability. This complete-system thinking guarantees energy production with maximum effectiveness for you and your customers.

From our 50 years of experience we know how important it is to have experts by your side throughout the entire service life of your plant. Our Center of Expertise will support your PV power plant for life.





Our Center of Expertise will support you in planning and optimizing your plants and will be at your side as an experienced partner throughout the plant's service life.

“USING REMOTE MONITORING WE **RESOLVE** SOME PROBLEMS EVEN BEFORE THE CUSTOMER HAS NOTICED THEM. THIS IS HOW SERVICE SHOULD BE: FAST, SKILLFUL, RELIABLE. TOGETHER WITH OUR SERVICE **PARTNERS** WE PROVIDE SUPPORT WHEREVER OUR PRODUCTS ARE IN OPERATION.”

S. DIERKES, SERVICE

*Fossano solar park,
equipped with
REFUso! inverters.*



RELIABLE SUPPORT AROUND THE GLOBE



Warranties: Activate your individual warranty and servicing package, tailored specifically to your plant.

With us it's up to you

For operators of PV plants, flexibility is key. That's why we've developed a warranty concept which gives our customers the exact degree of flexibility that they need.

Over and above our free-of-charge **basic warranty**, it's up to you which warranty coverage you choose – for just a year or up to 20.

For our central inverters too, we also provide a servicing concept, which is tailored to your needs. Routine servicing is the best way to **prevent downtime** and unexpected repairs. Ensure high yields from your large-scale PV plants in the long term with individual servicing contracts.

Servicing, support, information

REFUso/ inverters are efficient and require little maintenance. If a technical problem should occur, however, our expert service team will be pleased to assist you. For us, service isn't just a job, it goes without saying. Our team can support you with any questions about our products, anywhere in the world. With service centers in the **U.S., Asia and Europe** we are represented in the key PV markets. We can assist customers on site, directly at their premises.

If a defect is reported on a working day a **replacement** string inverter leaves our company within 24 hours. When servicing is required, central inverters will be attended to by one of our **service engineers** within 48 hours. In addition, we also offer appropriate servicing and maintenance contracts for all REFUso/ central inverters.

REFUso/ Hotline

Tel. +49 7123 969-202

Fax +49 7123 969-302 02

E-mail service@refusol.com

Technical support

Inverter and system configuration

Tel. +49 7123 969-102



BY EXPERTS FOR EXPERTS



*Training:
Experience, expertise, value – at
REFU**sol** seminars
you learn from ex-
perienced practi-
tioners. Gain prac-
tical knowledge
that pays for itself.*

Training at REFU**sol**

Develop your professional knowledge of our products and photovoltaics in general at one of the REFU**sol** seminars in Metzingen. At a **day seminar** you can find out everything there is to know about REFU**sol** string and central inverters, hardware and software, and additional functionality such as data-logging and monitoring. Learn how to use interfaces and connections efficiently in practice, how to configure devices and how to transfer, evaluate and visualize operating data from systems. You can also refresh your knowledge of regulations and standards, and get to know powerful configuration tools. The seminars also provide enough scope to discuss individual questions with our experts and other professionals.

With REFU**sol** seminars you are always up-to-date and in a position to inform and advise your customers of the latest developments and legal requirements. Seminars are targeted at specialists, such as solar installers, system planners, architects, specialist tradespeople or sales employees with previous knowledge of photovoltaics. On request, we can also offer individually tailored training sessions at your company.

Further information on training content, dates and registration is available on our website, **www.refusol.com**. Our Training Team will also be happy to help you by phone on +49 7123 969-0. We look forward to hearing from you!

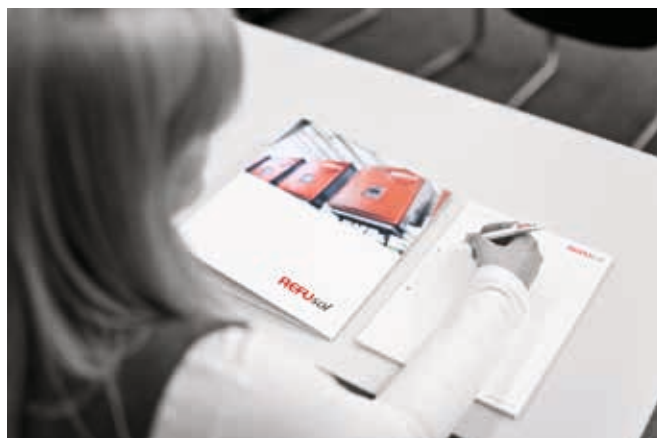
Get the best out of your devices and components: program

Our products are global leaders. So that our customers can get the best out of the **huge potential** provided by REFUso^l inverters and components in practice, we offer a range of product training seminars. The content of each seminar is tailor-made according to the customer's requirements. So you can extend your knowledge of exactly those devices that are used in your PV system.

You decide where the **seminars** are held. We have a range of well equipped, comfortable seminar rooms in Metzingen. But we are, of course, also happy to come to you.

REFUso^l training program

- REFUso^l 003K–023K: devices, operating panel and system topology
- REFUso^l 008K–023K: UltraEta[®] technology, installation and connection
- REFUso^l 333K central inverter
- REFUso^l 500K+630K central inverters
- REFUso^l ENS, NSR (VDE-AR-N 4105): MSR functions and MPP regulation
- REFUp^{mu} power management unit with power and COS PHI adjustment
- REFUso^l communication: Ethernet and RS485
- REFUconnect
- REFUlog online data visualization
- REFUso^l module calculation program
- REFUso^l overvoltage protection
- REFUso^l safety: hazards when dealing with PV systems



PERFORMANCE SPECTRUM OF PHOTOVOLTAICS



Practical test: REFU*sol* in operation

Since the introduction of the REFU*sol* inverter, over 3 GW of PV capacity has been installed under very wide-ranging climatic and geographical conditions. The spectrum ranges from rooftop systems on single-family homes and industrial facilities right through to large-scale PV power plants. REFU*sol* inverters and all accessories are available in all power classes. They incorporate clever, state-of-the-art technology, their construction provides **value and reliability**, and their design is based on the hard conditions of practical day-to-day operation. Our customers value the exceptional quality, which translates into high customer satisfaction.

Solar power is already a success story. We are delighted to be part of the shift towards renewables. In global terms, the photovoltaic sector is still in its infancy. But there is no doubt it will play a significant role in the energy mix of the future. This inspires us to innovate and to constantly fine-tune our products.

*Peace of mind:
The weather is al-
ways changing. It's
good to know that
some things are
constant: devices
from REFU*sol*.*

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33524-EN-V02-0612