

innovation in wind

INTEGRATED SYSTEMS

NGC NEXT GENERATION CONVERTER

FRAMEWORK WIND SOFTWARE

WFS WIND FARM SERVER

PCU PITCH CONTROL UNIT

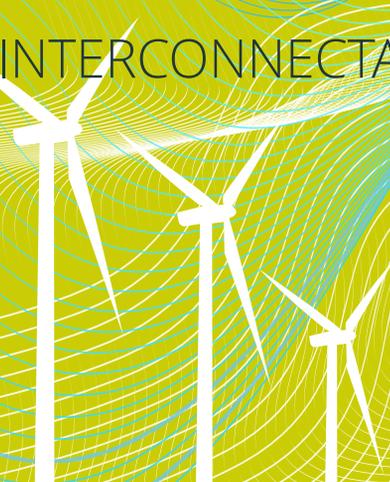
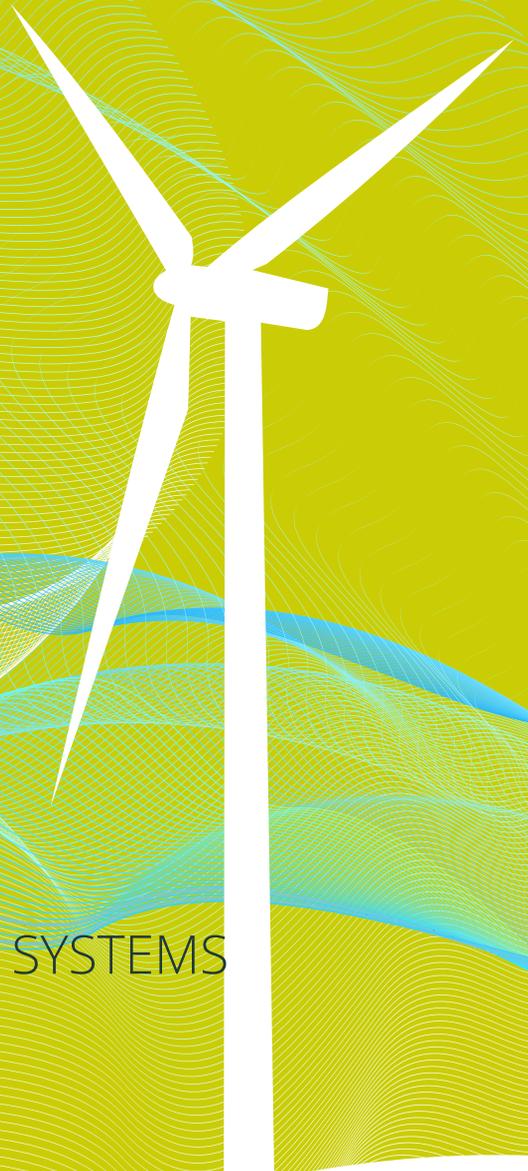
CERTIFIED SAFETY SYSTEMS

VIBRATION MONITORING

SPEED MONITORING

OVERCURRENT PROTECTION

IIGS INTERCONNECTABLE ISLAND GRID SYSTEMS



FREQCON



About Us

German Competence in Engineering

FREQCON GmbH is a German manufacturer of power converters and control systems for renewable energy projects and energy storage applications.

The family-owned company was founded in 1988 and trades as Freqcon GmbH since 2005. FREQCON was one of the pioneering companies providing power electronics and controllers to the wind turbine industry.

FREQCON GmbH is based in Walsrode, Niedersachsen, Northern Germany.

We provide the complete package: installation, commissioning, staff training, remote monitoring and support service.

FREQCON has a strong focus on research & development and co-operates with a number of universities and research institutes from all over the world. We take on the challenges of the future and develop tomorrow's energy solutions.

Products

Tailored Solutions

FREQCON's power converter and control systems allow efficient and reliable grid integration of wind turbines, solar farms and battery storage systems. We provide solutions for grid-connected systems as well as island grid systems.

A special focus is on micro-grid systems where different energy sources can be integrated efficiently. Our products cover the whole range from several hundred kW to multi-MW systems.

We provide customer specific solutions tailored to meet the individual requirements of each project.

Our products are deployed world-wide in applications with 36 GW installed capacity.

innovative • effective • reliable



Quality

High-End Components – Highly Qualified Engineers

Our products are „Made in Germany“ and satisfy highest reliability requirements.

We exclusively purchase high-quality components of world-wide availability.

Our products are designed with optimised life cycle costs in mind, based on high-quality manufacturing process and low maintenance design.

FREQCON GmbH is certified according to ISO 9000:2008.

Our products are certified according to IEC standards and GL guidelines.

We are a certified „Siemens Solution Partner“ in wind energy.

Based on our long lasting experience in development and manufacturing of power converters and control systems you can feel confident and at ease whenever purchasing a FREQCON product.

References

World-Wide Applications

FREQCON power converters and control systems can be found in applications around the world, especially in Asia and Europe.

A number of the leading wind turbine manufacturers are among our customers, as well as project developers of wind and solar farms along with system integrators of battery storage systems and operators of different manufacturing plants.

Examples:

- Integrated Electrical Systems for wind turbines 1.5 MW – 6.5 MW
- Energy Storage Systems 5 MW/10 MWh
- STATCOM Converter 14 MVA
- Island Grid System (Wind/Solar/Diesel/Battery Storage) 200 kW
- Combined System with wind turbine for RO desalination plant 2 MW

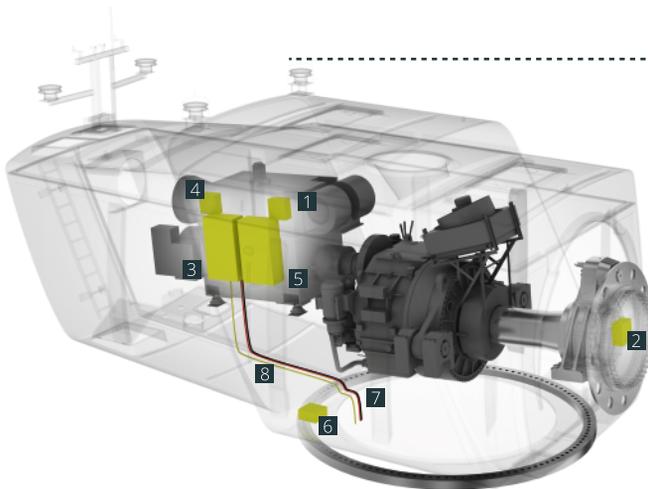
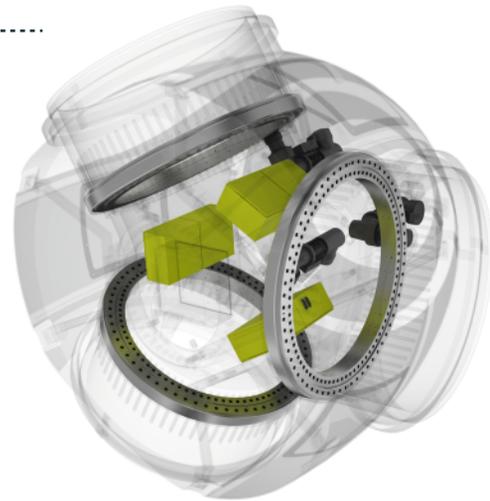
tailored solutions provided
by FREQCON



Centralized control system integrates the

Hub

- Pitch Control Unit:
 - Integrated Power Supply
 - Adaptive Charging Supercaps
 - Low Voltage Design
 - Lightning Protection
 - High Speed Realtime Communication 

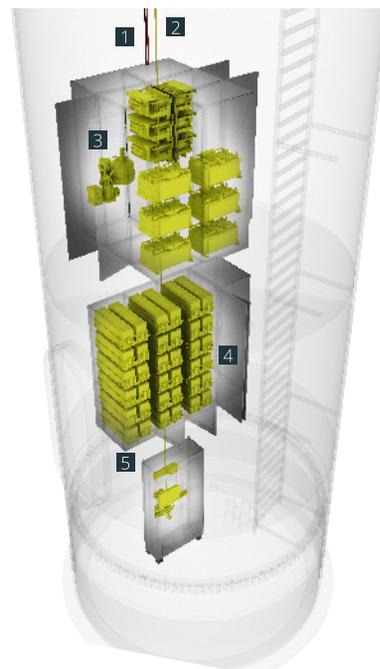


Nacelle

1. Certified Safety System
2. HRS Hub Rotational Sensor
3. Rectifier
4. GAS Generator Vibration Sensor
5. Top Box:
 - Yaw, Cooling, Heating,
 - Hydraulic, Weather
6. NAS Nacelle Acceleration Sensor
7. DC Link
8. High Speed Realtime Communication 

Tower Base

1. DC Link
2. High Speed Realtime Communication 
3. Next Generation Converter NGC
4. Integrated Energy Storage
5. Control Unit:
 - HMI, Wind Farm Server, Remote Access



entire wind turbine

A complexity of control functions is required to ensure smooth operation of a wind turbine. Often wind turbine manufacturers employ subsystems of different suppliers that do not have a unified data interface. This can lead to critical issues regarding data communication, measurement values and finally turbine reliability.

FREQCON has developed an integrated control system with unified data interface and communication protocol. A consistent software is programmed based on IEC 61131 standard. All subsystems have access to measurement values of the complete system to optimise operation mode. This reduces the number of sensors and avoids problems with data communication and data consistency.

Data communication is based on PROFINET, a reliable high-performance fieldbus system with real-time communication. This system allows not only control of standard functions like hydraulic, yaw, cooling, lubrication, HMI etc., but also time-critical functions like pitch-control and triggering of IGBTs, all through one centralised controller.

A secure data protocol version also allows integration of our modules for vibration and speed monitoring as well as cable twist sensor and overcurrent protection.

Our power converter allows the integration of several energy sources like photovoltaic or diesel generator.

Our latest control platform offers the possibility to integrate battery storage or super-capacitors. This enables the wind turbine to provide grid support services (more details in our „innovation in grid & storage“ brochure).

The integrated battery storage system enables the wind turbine to operate in stand-alone mode (relevant for offshore) or in island-grid mode.

High Dynamic
Single Blade
Pitch Control

High Speed
Realtime
Communication

Safe
Operation

High
Availability

Low Loss
DC Link

Stand
Alone
Capability

Grid
Support

Smooth
Grid
Operation



NGC Next Generation Converter

NGC Next Generation Converter for Wind, Solar and Grid Support

FREQCON Next Generation Converters offer high efficiency and a cost effective solution, and come as **full size 2-Q or 4-Q converters for all generator designs** (synchronous generator, induction generator) for wind, hydro, cogeneration units and diesel generators.

The system is used as solar converter, providing a centralized design with high voltage DC-bus for saving cable costs.

FREQCON NGC as **battery to grid converter** provides advanced grid support services, e.g. fast frequency response and synthetic inertia.

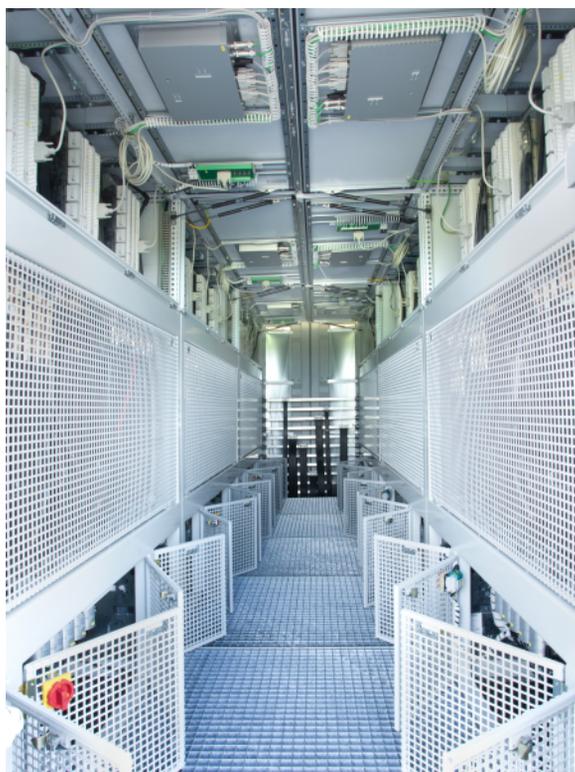
Reactive power compensation for high dynamic grid voltage control

Harmonic filtering based on ultra-fast IGBT-switching

Grid support applications according to BDEW2008, TC2007, TR8 FGW, DS3



3 MW wind converter



9 MW multi-level, high voltage converter

- **Field proven design**, with more than 15 GW installed since 1988
- **Low EME** design by symmetrically grounded DC-link
- **Low THD (<2%)** certified in many applications
- **Fully scalable design** (single module size: 500 kW, 1 MW, 1.5 MW, 3 MW)
- High efficiency through **optimised pulsing** (1.5% AC/DC conversion)
- **Variable frequency** for noise reduction and optimal inductor efficiency
- **Phase shift capability** for ripple current reduction
- **LVRT and HVRT** capability
- Full range **reactive power control**
- Integrated long term, **multi-channel trace function**, **remote monitoring** and **software updates**, **WEB interface**
- Designed to meet CE, UL, CSA as well as standards and directives like IEC 62477-1, IEC 60204-1, IEC 60146-1-1, Low Voltage Directive 2014/35/EU, EMC Directive 2014/30/EU and more

Framework Wind - FREQCON Software Solutions for Wind Turbine Controls

Software for modern wind turbines needs to be customized to a wide range of turbine types and modified versions of the same turbine. Additionally, requirements for grid integration, condition monitoring and SCADA systems comprising components by multiple manufacturers are ever changing.

In order to meet these requirements, **FREQCON** has developed software for wind turbines that allows for a project oriented approach due to its modular design and extensions, with clearly defined software interfaces written in clear and reusable code.

The **FREQCON** Framework Wind library serves as foundation for our software and enables us to implement a great deal of control tasks with already approved and field-tested software modules.

Included are all required functions for the usual wind turbine operational management, condition monitoring and directly controlling the **FREQCON** power units of the converter.

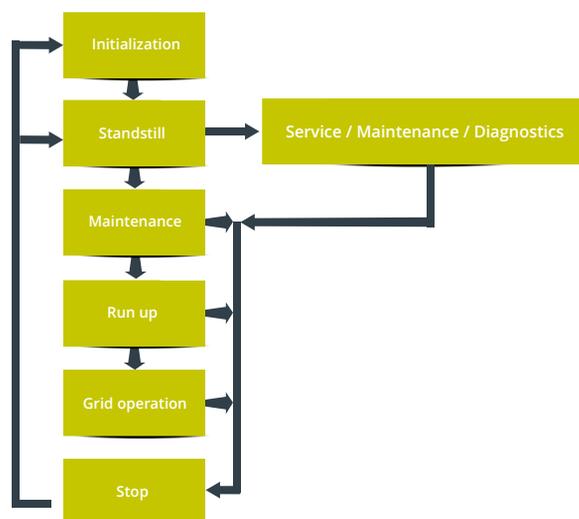
The software is designed to be used in state of the art multitasking control systems. Control functions are processed according to their requirements in their respective clock cycle (per second for temperature monitoring to micro second for fast converter control).

Safe control tasks are also seamlessly integrated. In combination with the **FREQCON** monitoring modules, performance level „d“ can be reached according to ISO 13849.

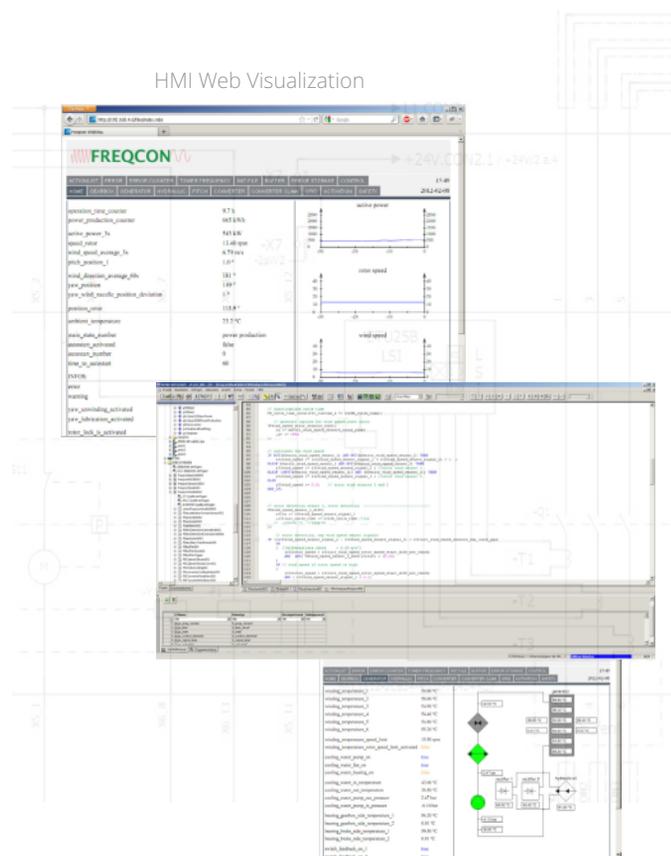
- According to IEC 61131
- Modular
- Object orientated
- Reusable

Control of:

- Pitch
- Converter
- Condition Monitoring
- HMI
- Wind Farm Server



Main Loop Operation WT States



WFS Wind Farm Server

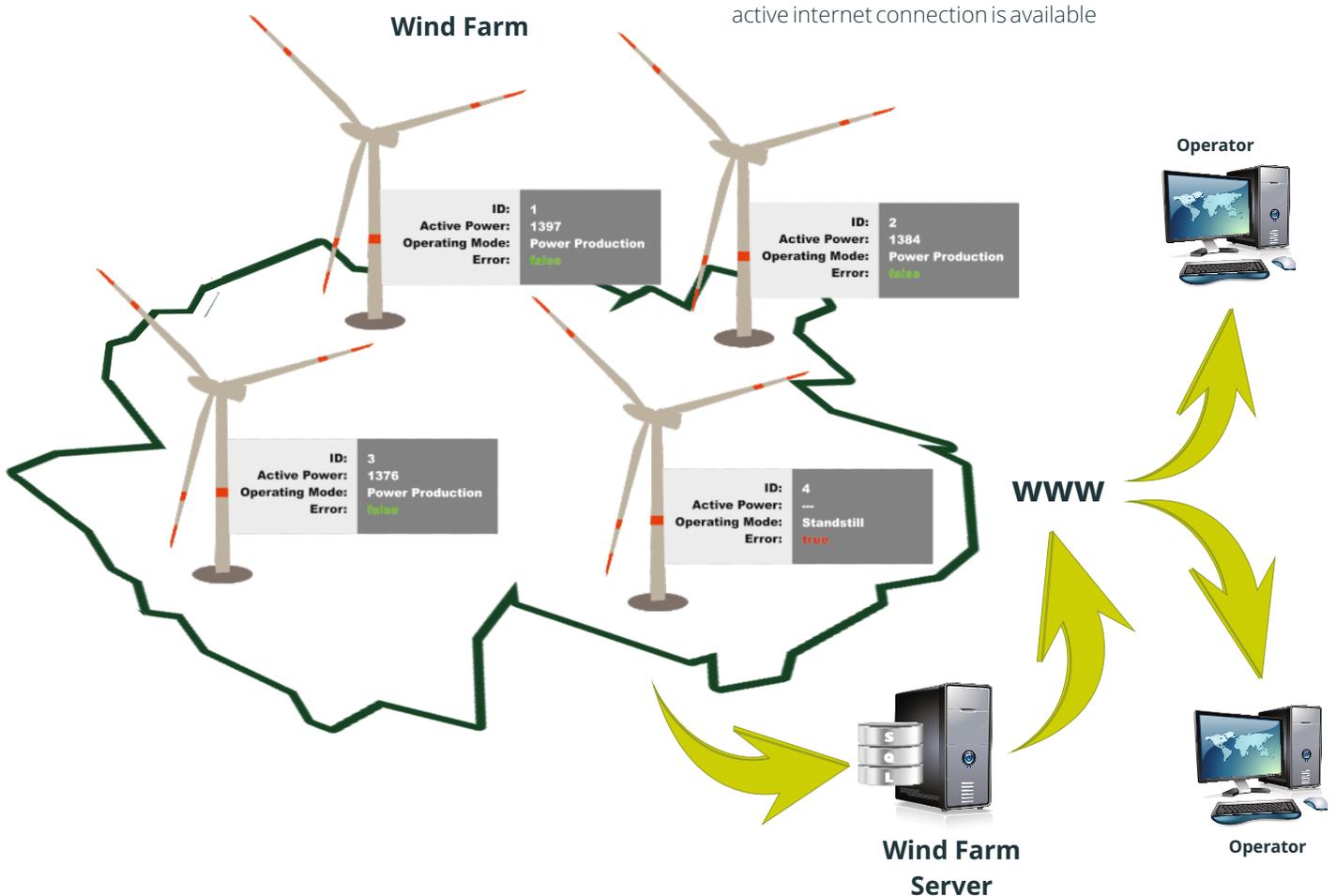
WFS Wind Farm Server – The Answer to the Demands of Every Wind Farm Operator

Every wind energy plant produces large quantities of data. In order to analyze the generated information, all data collected has to be stored over a period of time. This is why it makes sense, to install a wind farm server, which stores the data from all wind turbines in the farm in a centralized database.

The **FREQCON WFS Wind Farm Server** is able to handle further tasks, such as sending error messages, generating evaluations and graphic charts of the stored data. Beside the database, the server features a web server which allows remote access to the data from everywhere in the world.

The MySQL database provides a reliable and powerful tool with compatibility to all major programming languages and many years of stable operation in the field. The automatic backup gives additional protection against the loss of data in case of failure of a wind turbine.

- Provides services like Web- and FTP server
- Linux based system
- Reliable database
- Installed in a 2U rack mount chassis
- Web front end with farm overview provides data such as ID, Active Power, Operation Mode and the Error State for each wind turbine
- Error buffer - redundant backup of data on the main control and the WFS
- Error messages - provided by email or text message
- Error messages can also be sent by GSM or UMTS if no active internet connection is available



PCU Pitch Control Unit with Integrated High Speed Communication Interface, Power Supply and Smart Capacitor Charger

Even today, many pitch systems in modern wind turbines are equipped with lead-acid batteries for backup power supply and therefore, suffer from their well-known downsides (short service life and the danger of total failure at low temperatures).

To avoid these problems, **FREQCON** has developed a new generation of pitch systems with double-layer capacitors for energy storage as early as 1999. With more than 24.000 systems installed worldwide, this technology has proven more than 15 years of service life in the field, rendering failures due to extreme temperatures a non-issue.

In order to further increase the service life of the double-layer capacitors, **FREQCON** has developed a power supply for pitch systems in cooperation with one of the leading capacitor manufacturers. The new and sophisticated charging-algorithm increases the service life of the capacitors up to 20 to 25 years in order meet the service life expectations of modern wind turbines.

Furthermore, the power supply features a fast real-time interface which can be integrated into the **FREQCON** main control. It provides a short signal delay time of only 10 ms and thereby allows for pitch control with virtually no dead time. Thanks to this technology, the wind turbine operates very smoothly and can be stabilized at gusting wind without overshooting.

Due to the integration of all required interfaces, such as SSI, DI/DO, AI/AO, PT100 etc., overvoltage protection and main control functions, the system can be set up with few components and for an attractive price.

- High dynamic pitch speed and position control
- Independent position control for each single rotor blade
- Maintenance free double-layer capacitor backup
- Smart capacitor charger for over 20 years of capacitor life
- Galvanic insulation between single blade units, redundant operation
- Integrated lightning protection
- Integrated PROFINET and CAN communication Interface
- SSI, AI/AO, Pt100, 24 V DI/DO
- Temperature monitoring, control of cooling/heating
- LVRT ready design, no switch over to emergency operation
- Cold climate and hot climate versions (-40 ... +60 °C)
- Available for wind turbines from 100 kW to 7.5 MW

Just 3 components for entire pitch system!



FREQCON Pitch Control Unit



Double-layer capacitor backup



Pitch motor

Certified Safety Systems

Certified Safety Systems for Wind Turbines According to IEC 61400

Safety systems for wind turbines must prevent threats to life and physical condition as well as protect the turbine from damage. On the other hand malfunction of the safety system can lead to turbine downtime and has to be avoided.

Based on diverse redundancy **FREQCON** has developed a safety system that protects the wind turbine from overspeed, excessive vibrations, cable twisting and overload. Due to robust sensors and EMI-resistant design unnecessary turbine shut-downs are avoided.

The speed and vibration monitoring system is certified according to ISO 13849-1:2008 „Safety-related parts of control systems“ and according to „GL guideline for certification of wind turbines“ for safety functions up to Performance Level PL “d”.

The system comprises of the **FREQCON OSM Overspeed Module** for rotor speed measurement by incremental sensor in the slipping-system or by proximity sensor at main shaft flange. G-Speed is a sensorless system determining generator RPM by analysing generator frequency.

The **FREQCON** vibration sensor **NAS** is based on a micro system acceleration sensor and measures nacelle acceleration as well as shock and tower torsion. These modules are installed in more than 10.000 wind turbines world-wide.

Detection of

- Overspeed
- Excessive vibrations
- Malfunction of Generator
- Excessive cable twisting
- IEC 61400 standards and the „GL guideline for certification of wind turbines“
- ISO 13849-1:2008
- Safety functions up to Performance Level PL “d”



Speed Monitoring Devices



Overcurrent Protection



Vibration Monitoring Devices

NAS Digital Nacelle Acceleration Sensor

The **FREQCON NAS Digital v.1.0 Nacelle Acceleration Sensor** is used for precise real-time monitoring of wind turbine vibration and tower torsion.

The sensor detects critical operating states of the wind turbine so that the operator can intervene and make adjustments to avoid potential damage to the wind turbine. The **FREQCON NAS Digital v.1.0** monitors strong vibrations or erratic accelerations of wind turbines caused by sudden wind loads.



GAS Digital Generator Acceleration Sensor

The **FREQCON GAS Digital v.1.0 Generator Acceleration Sensor** can detect harmful vibration of the generator caused by false alignment or mechanical unbalancing.

The **FREQCON GAS Digital v.1.0** is mounted directly on the generator housing and reliably detects the occurring forces on the generator.

The sensor is protected by a sturdy aluminum housing that allows operation in almost any environment.



- Double-channel for safety chain triggering (two separate relays)
- Equipped with USB-port connection for maintenance via PC
- Adjustable limit-values for system operation and safety precaution chain via PC
- Parameterizable via software
- Integrated RMS value calculation is provided as an output data signal
- Sensor transmits X, Y axis position signals separately and an additional root means square (RMS) signal
- Parameter protocols can be generated

Speed Monitoring

OSM Overspeed Module Rotor Speed Monitoring for Wind Turbines

The **FREQCON OSM Overspeed Module** is able to accurately measure the shaft speed by utilizing an optical, 2-channel rotary encoder at the slip ring between the nacelle and hub.

The Overspeed Module is housed in a sturdy casing for DIN Rail mounting and is connected by removable 19-pole screw or spring terminals.

If the predetermined rpm limit is exceeded, the Overspeed Module detects the exceedance and triggers the safety chain of the wind turbine.



G-Speed Generator Speed Monitoring

The **FREQCON** speed monitor **G-SPEED** was designed specifically for generator speed monitoring in wind turbines and comprises a line of modules developed by **FREQCON** named **G-PULSE** and **G-CON**.

Two G-Pulse Modules supply the G-CON Module with 24 V pulse signals which are processed by the unit and send to the main control. When using the G-Speed Module in combination with the **FREQCON** OSM, no additional sensors are required to reliably monitor the rotor speed of wind turbines.



HRS Hub Rotational Sensor

The **FREQCON Hub Rotational Sensor HRS** is used for precise hub rotational speed detection in wind turbines from 0 to 20 rpm and rotor blade position detection from 0° to 360°.

Speed and position is measured by an 2-axis acceleration sensor giving sinusoidal signals when the hub is rotating.



OTU/vF Overcurrent Trip Unit Module for Variable Frequency Range 0 ...100 Hz

Standard current breakers are developed to operate in electric circuits of 50 or 60 Hz frequency. Modern wind turbine generators however operate in a variable frequency range of 0 ... 100 Hz which requires advanced overcurrent protection systems.

The **FREQCON OTU/vF Overcurrent Trip Unit** is designed to work in combination with the current breaker Siemens 3WL and protects the generator and power converter of wind turbines, based on specially developed current sensors and electronics. The reliable operation in the whole frequency range 0 ...100 Hz has been verified by an independent test laboratory.

To protect the current breaker contactors, a triggering at low frequencies can be suppressed by selecting the corresponding mode of operation. Nonetheless, a signal is given to the safety chain of the wind turbine to allow reduction of rpm or cut-out of generator field current.

The tripping current can be adjusted by a rotary encoder switch at the cover plate of the OTU/vF. The trigger delay is also adjustable.

The **FREQCON OTU/vF** is connected to a 24 V external power supply, giving resistance to high frequency ripple harmonics which can be induced by operation of IGBT power converters.



- Measurement value logging
- Integrated error memory with back-up function
- Measuring range 0 ... 100 Hz
- Suppression of triggering in range of 0 ... 5 Hz
- Tripping current adjustable in the range 400 ... 1600 A
- Optional trigger delay, adjustable in the range 50 ... 800 ms
- Possibility for connection of different Hall-Sensors
- Wide temperature range: -20 °C ... +60 °C
- Maintenance free (no battery)
- Resistant to ripple harmonics due to 24 V external power supply
- PROFINET Interface in preparation

Power supply:	24 VDC
Connection:	19 pin connector
Measuring range:	0 ... 100 Hz
Operating temperature range:	-20 °C ... +60 °C
Weight:	0.25 kg
Dimensions (L x W x H):	100 x 75 x 110 mm

IIGS Interconnectable Island Grid Systems for

Worldwide, more than 1.2 billion people live in rural or urban off-grid areas. The supply with electricity can contribute to the alleviation of poverty and become the foundation for development and progress.

In collaboration with selected partners **FREQCON** offers **Interconnectable Island Grid Systems (IIGS)** based on our MSC-Technology which can provide a reliable and competitive electricity supply for rural communities and commercial operations.

The **MSC Multi-Source Converter** allows parallel operation of several energy sources (wind turbine, photovoltaics, diesel generator), while the integrated battery storage system reduces diesel consumption to a minimum.

The system provides a very stable, local electricity supply, also called a micro grid. The optional interconnection with other micro grids via AC or DC connection helps to balance intermittency of supply and demand. The connection to a public grid or a railway powerline is also possible.

The IIGS can also be operated in connection with RO desalination plants. Intermittency of renewable generation can be compensated by water storage tanks, and the electrical pumps can be connected to a highly efficient DC-grid.

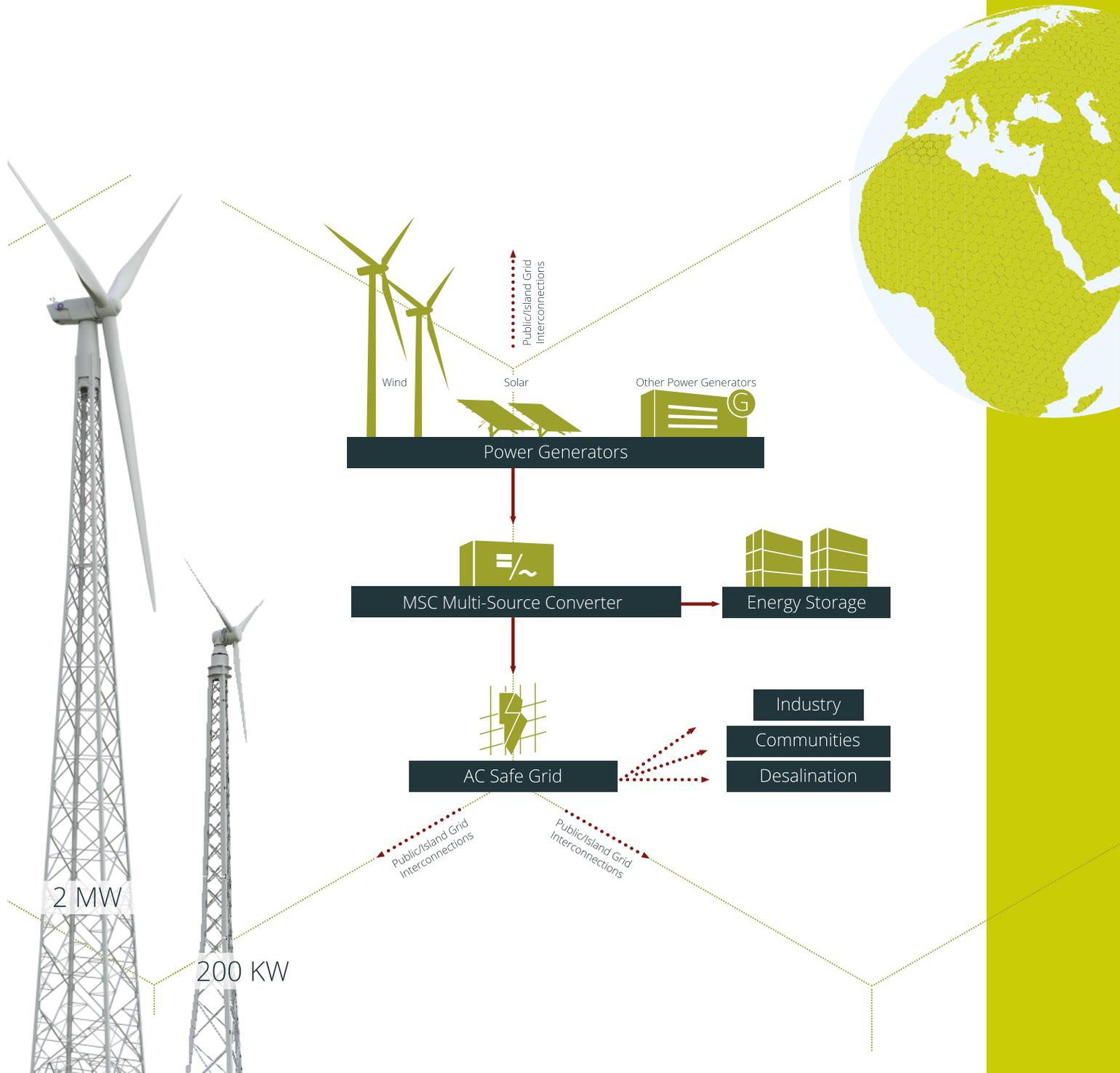
The following table shows 2 exemplary versions with different capacities. Systems are configured on a project specific basis, considering the requirements of the local consumers and the available energy sources.

Interconnectable Island Grid System 300 kW	Interconnectable Island Grid System 1.0 MW
Wind Turbine 200 kW	Wind Turbine 2.0 MW
Photovoltaics 300 kWp	Photovoltaics 1.0 MWp
Diesel Generator 100 kW	Diesel Generator 500 kW
Battery Storage (Li-ion) 600 kWh	Battery Storage (Li-ion) 2.0 MWh
MSC Converter 300 kW DC-AC Output	MSC Converter 1.0 MW DC-AC Output
RO Desalination Plant 50 m3/day	RO Desalination Plant 275 m3/day
Electricity Production: 1.000.000 kWh/year	Electricity Production: 6.000.000 kWh/year
Savings Diesel Consumption: 320.000 l/year	Savings Diesel Consumption: 1.800.000 l/year
Fresh Water Supply: 18.000 m3/year	Fresh Water Supply: 100.000 m3/year

IIGS Interconnectable Island Grid Systems

stable local Grid Supply

Energize the world!



tailored solutions provided
by FREQCON



Today, renewable energy systems are in use all over the world and continue to provide clean and reliable energy to the end user. **FREQCON**´ technology provides the perfect solutions for renewable energy systems that are applicable in all environments - no matter whether it is dry, hot and sandy (like the Taklamaka Desert) or humid and salty (like the East China Sea) or cold and icy (like in parts of Canada or at the South Pole).

Countries in which we operate:



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