WOODWARD
WIND IS OUR PASSION

Woodward was founded in 1870 and is an independent developer, manufacturer and service provider of energy control systems in the aviation industry and the energy market. For more than 20 years Woodward is a global and independent supplier of partial and full power frequency converters for renewable power generation.

More than 30 GW of installed power realized in a large number of Onshore and Offshore projects, stand for Woodward’s expertise and extensive knowledge within the wind energy business worldwide.

Woodward’s competence and experience within the wind energy industry has consolidated its reputation as a reliable supplier and development partner.

The Woodward concept considers the future trends of international grid code requirements together with the target of highest possible energy yield.

For special projects Woodward will assist you with tailor-made solutions, flexible systems integration, simulation models and product optimization.

The global presence of Woodward ensures the active technical support over the product lifecycle and beyond. You can profit from practical Onshore and Offshore experience of our special skilled and motivated service team.

The high degree of trust between Woodward and their customers as well as structured processes and high quality standards during the complete product lifetime are important success factor.

HISTORY IN THE WIND ENERGY BUSINESS

The CONCYCLE® frequency converter technology is based on experience with products for decentralized energy generation, for instance variable-speed converter systems for marine applications, industrial systems for uninterrupted power supply, and their protection and control.

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CONCYCLE®

www.woodward.com
WOODWARD
YOUR RIGHT CHOICE

With the modular frequency converters Woodward sets new benchmarks in wind energy technology. CONCYCLE® frequency converters are small, light and powerful, allowing every possible design combination in nacelle and tower installations.

The development and implementation of the CONCYCLE® technology has considerably enhanced the success of large wind turbines. CONCYCLE® frequency converter systems ensure highest reliability, best efficiency and energy quality in your application.

HIGHEST EFFICIENCY AND RELIABILITY

YOUR BENEFITS

- Maximum annual energy production (AEP)
- High reliability
- More reactive power capability
- Expertise in implementation of customer requirements
- Flexible system integration
- Optimum grid connection
- Designed for future grid code requirements
- Experts in simulation and modelling behavior
- Software verification on the Hardware-In-The-Loop (HIL) test bench
- Qualified hotline for professional technical support
CONCYCLE® - FREQUENCY CONVERTER

PARTIAL CONVERTER (DFIG) CW1000LD

FULL-SIZE CONVERTER (FSC) CW2000LF

<table>
<thead>
<tr>
<th>FEATURE / FUNCTION</th>
<th>YOUR BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>High efficiency</td>
<td>Maximum annual energy production (AEP)</td>
</tr>
<tr>
<td>Enhanced reactive power management</td>
<td>Compliance to the latest grid codes</td>
</tr>
<tr>
<td>Additional power stacks possible for higher reactive power request</td>
<td>Voltage support for weak grids</td>
</tr>
<tr>
<td>Maximum drive drain damping during fault-ride-through of the grid failure</td>
<td>Extended service lifetime of the drive train</td>
</tr>
<tr>
<td>Woodward IGBT driver and power stacks technology</td>
<td>Availability and reliability of the core components used during the lifetime of the converter</td>
</tr>
<tr>
<td>Partial redundancy (optional)</td>
<td>High yield</td>
</tr>
<tr>
<td>Sophisticated control of the power modules in the partial load range</td>
<td>Better efficiency in the partial load range</td>
</tr>
<tr>
<td>Robust design</td>
<td>High availability and AEP</td>
</tr>
<tr>
<td>Advanced control technology to protect the IGBT power modules</td>
<td>Improved reliability</td>
</tr>
</tbody>
</table>
## Typical Application Examples

### CW 1000LD
- **Partial converter application**

<table>
<thead>
<tr>
<th>Performance class</th>
<th>CW 1000LD (DFIG)</th>
<th>CW 2000LF (FSC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rated output</strong></td>
<td>1.5 MW</td>
<td>1.5 MW</td>
</tr>
<tr>
<td><strong>Rated current</strong></td>
<td>600/600 A</td>
<td>1600 A</td>
</tr>
<tr>
<td>Dimensions</td>
<td>L: 2400 mm H: 2000 mm D: 600 mm</td>
<td>L: 2400 mm H: 2000 mm D: 600 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1700 kg</td>
<td>2400 kg</td>
</tr>
</tbody>
</table>

### CW 2000LF
- **Full-size converter application**

<table>
<thead>
<tr>
<th>Performance class</th>
<th>CW 1000LD (DFIG)</th>
<th>CW 2000LF (FSC)</th>
</tr>
</thead>
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<tr>
<td><strong>Rated output</strong></td>
<td>1.5 MW</td>
<td>1.5 MW</td>
</tr>
<tr>
<td><strong>Rated current</strong></td>
<td>600/600 A</td>
<td>1600 A</td>
</tr>
<tr>
<td>Dimensions</td>
<td>L: 2400 mm H: 2000 mm D: 600 mm</td>
<td>L: 2400 mm H: 2000 mm D: 600 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1700 kg</td>
<td>2400 kg</td>
</tr>
</tbody>
</table>

### CW 1000LD (DFIG)
- **Performance class**: 1.5 – 6 MW
- **Electrical data**
  - AC voltage: 690 V AC ±15%
  - Nominal DC voltage: 1100 V DC
  - Mains frequency: 50/60 Hz ±5 Hz
- **Power factor**: 0.90 ind. / 0.90 kap.
- **Total Harmonic Distortion**: BOEW / IEEE
- **Generator side du/dt**: <1 kV/µs
- **Inverter technology**: IGBT

### CW 2000LF (FSC)
- **Performance class**: 1.5 – 6 MW
- **Electrical data**
  - AC voltage: 690 V AC ±15%
  - Nominal DC voltage: 1100 V DC
  - Mains frequency: 50/60 Hz ±5 Hz
- **Power factor**: 0.90 ind. / 0.90 kap.
- **Total Harmonic Distortion**: BOEW / IEEE
- **Generator side du/dt**: <1 kV/µs
- **Inverter technology**: IGBT

### CW 1151LD
- **Type**: 1.5 MW
- **Rated output**: 600/600 A
- **Dimensions**: L: 2400 mm H: 2000 mm D: 600 mm
- **Weight**: 1700 kg

### CW 1201LD
- **Type**: 2 MW
- **Rated output**: 900/600 A
- **Dimensions**: L: 2400 mm H: 2000 mm D: 600 mm
- **Weight**: 1850 kg

### CW 1251LD
- **Type**: 2.5 MW
- **Rated output**: 900/600 A
- **Dimensions**: L: 2400 mm H: 2000 mm D: 600 mm
- **Weight**: 1850 kg

### CW 1301LD
- **Type**: 3 MW
- **Rated output**: 1200/600 A
- **Dimensions**: L: 2400 mm H: 2000 mm D: 600 mm
- **Weight**: 2010 kg

### CW 1351LD
- **Type**: 3.5 MW
- **Rated output**: 1500/900 A
- **Dimensions**: L: 2400 mm H: 2000 mm D: 600 mm
- **Weight**: 2200 kg

### CW 1401LD
- **Type**: 4 MW
- **Rated output**: 1500/900 A
- **Dimensions**: L: 2400 mm H: 2000 mm D: 600 mm
- **Weight**: 2300 kg

### CW 1451LD
- **Type**: 4.5 MW
- **Rated output**: 1800/1200 A
- **Dimensions**: L: 3200 mm H: 2000 mm D: 600 mm
- **Weight**: 3100 kg

### CW 1501LD
- **Type**: 5 MW
- **Rated output**: 2200/1200 A
- **Dimensions**: L: 3200 mm H: 2000 mm D: 600 mm
- **Weight**: 3200 kg

### CW 1551LD
- **Type**: 5.5 MW
- **Rated output**: 2200/1200 A
- **Dimensions**: L: 3200 mm H: 2000 mm D: 600 mm
- **Weight**: 3300 kg

### CW 1601LD
- **Type**: 6 MW
- **Rated output**: 2400/1500 A
- **Dimensions**: L: 3200 mm H: 2000 mm D: 600 mm
- **Weight**: 3500 kg

### CW 2151LF
- **Type**: 1.5 MW
- **Rated output**: 1600 A
- **Dimensions**: L: 2400 mm H: 2000 mm D: 600 mm
- **Weight**: 2400 kg

### CW 2201LF
- **Type**: 2 MW
- **Rated output**: 2100 A
- **Dimensions**: L: 2400 mm H: 2000 mm D: 600 mm
- **Weight**: 2440 kg

### CW 2251LF
- **Type**: 2.5 MW
- **Rated output**: 2600 A
- **Dimensions**: L: 1600 mm H: 2000 mm D: 1200 mm
- **Weight**: 2600 kg

### CW 2301LF
- **Type**: 3 MW
- **Rated output**: 3100 A
- **Dimensions**: L: 1600 mm H: 2000 mm D: 1200 mm
- **Weight**: 2750 kg

### CW 2351LF
- **Type**: 3.5 MW
- **Rated output**: 3600 A
- **Dimensions**: L: 1600 mm H: 2000 mm D: 1200 mm
- **Weight**: 2850 kg

### CW 2401LF
- **Type**: 4 MW
- **Rated output**: 4200 A
- **Dimensions**: L: 2000 mm H: 2000 mm D: 1200 mm
- **Weight**: 2940 kg

### CW 2451LF
- **Type**: 4.5 MW
- **Rated output**: 4800 A
- **Dimensions**: L: 2000 mm H: 2000 mm D: 1200 mm
- **Weight**: 3050 kg

### CW 2501LF
- **Type**: 5 MW
- **Rated output**: 5300 A
- **Dimensions**: L: 2000 mm H: 2000 mm D: 1200 mm
- **Weight**: 3300 kg

### CW 2551LF
- **Type**: 5.5 MW
- **Rated output**: 5900 A
- **Dimensions**: L: 2000 mm H: 2000 mm D: 1200 mm
- **Weight**: 3300 kg

### CW 2601LF
- **Type**: 6 MW
- **Rated output**: 6400 A
- **Dimensions**: L: 2000 mm H: 2000 mm D: 1200 mm
- **Weight**: 3500 kg

### Environmental conditions
- **Coolant temperature range (water/glycol)**: 5 … 50°C / 41 … 122°F
- **Ambient temperature range**: -25 … 45°C / -13 … 113°F
- **Incl. option Cold Climate Region (CCV)**: min. -40°C / -40°F
- **Incl. option Hot Climate Region (HCV)**: max. 50°C / 122°F
- **Protection class**: IP54 (IP65 optional)
- **Height above sea level**: <2000 m (till 4000 m optional)

### System parameters
- **Remote controlled management and diagnosis**: ✔ ✔
- **Initial configuration**: in line or back-to-back
- **Installation**: tower or nacelle
- **Cable entry**: top or bottom
- **Coolant connection**: left, right, top or bottom

*Back-to-back arrangement
Woodward’s customers are successful in a wide range of markets using different electrical drive train technologies and concepts. They are using wind turbine designs with a gear box or gearless systems, through to various generator concepts, such as:
- asynchronous squirrel-cage induction generators (SCIG)
- synchronous generator with magnetic or electrical excitation (PMSG, EESG)
- doubly-fed induction generators (DFIG)

with national-specific grid code requirements in terms of Fault-Ride-Through (FRT) and power quality (PQ).

We not only ensure different ‘Local Content’ requirements in various countries or other national regulations, we can also provide systems for various climate, extreme ambient conditions and specific Offshore requirements.

Complex, tailor-made solutions as well as market-specific variants can be successfully implemented due to the modular platform of the CONCYCLE® wind converter systems.
EXPERIENCE AND FLEXIBILITY - FOR OPTIMUM YIELD

The frequency converter is one of the core components in wind turbines. Independent of the wind conditions and rotational speed, a constant voltage at a constant frequency is fed into the grid. Intelligent control algorithms help that your systems meet all national grid requirements at the point of common coupling.

TAILOR MADE SOLUTIONS
Woodward offers you flexible solutions for nacelle, tower and container installations – customized electrical converter systems for your individual requirements in terms of function, design and ambient conditions.

FLEXIBLE SYSTEM INTEGRATION
The integration of function and supervision is aligned with tailor-made interfaces by using established fieldbus and communication protocols. We offer you support starting with the system concept through to electrical protection concepts for entire systems and wind farms.

SIMULATION
You can use the detailed models for the dynamic simulation of the system behavior or the simplified models for analyzing the grid integration of wind farms. The HIL (Hardware-In-The-Loop) test bench ensures a verification of the software before the system is commissioned in the field. It reduces the time to market and the test effort at site.

OPTIMIZED GRID CONNECTION - CONCYCLE® ACTIVE FRT™
Grid connection requirements for wind turbines are constantly changing globally. The proven hardware and software solution CONCYCLE® active FRT™ optimizes the Fault-Ride-Through system behavior in line with the latest upcoming grid connection requirements. It ensures a high level of grid stability and at the same time optimizes the dynamic drive train load. Other functional options packages with asymmetric regulation and the dynamic supply of reactive power have been used successfully to stabilize weak grids across the world.

OFFSHORE
Due to years of experience, CONCYCLE® Wind is perfectly equipped to meet the challenging requirements in Offshore installations: higher reliability even under extreme conditions, remote diagnostics and optional partial redundancy operation.

RESEARCH & DEVELOPMENT
Woodward invests continuously in the active development of innovative technology and trend setting solutions. We also cooperate with international research institutes and universities and are a member of associations and committees.

SERVICE SUPPORT
- commissioning
- spare part logistics
- technical trainings
- preventive manufacturer maintenance
- technical support and hotline
- modernization of systems in the field
- maintenance and service contracts
Woodward converter systems are showing best-in-class performance across the world, in Europe, Asia, Africa, Australia and also North and South America.

In all these regions Woodward’s frequency converters maintain operating under harsh conditions.

For your personal support you can contact us in eight national branch offices from Fort Collins to Makuhari.
WIND IS OUR PASSION

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