5 MW Permanent Magnet Offshore Wind Energy Converter

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5 MW Offshore Wind Mill Prototype

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- System Solution for an 5 MW Offshore Wind Mill Prototype
- Electrical System
  - Generator
  - Converter

with friendly approval by Multibrid Entwicklungs GmbH
Market Dynamics

Increasing demand for wind energy / on-and offshore installations

- Move to more powerful, larger sized wind turbines with maximum energy output
- More and more variable speed drives are used with respect to better performance, reliability and improved economical operation
- Power utility companies demanding higher mains supply stability

ALSTOM established as supplier for Generator-/Converter Systems
Market Dynamics

Evolution of power ratings

Year

Power [MW]


0 1 2 3 4 5 6

1,50 2,00 2,75 5,00
Market Dynamics

Generator- and convertersystems for variable speed solutions

Synchronous generator with fully rated converter

Doubly-fed asynchronous generator with converter
System requirements for an Offshore Wind Mill

5 MW Drive system

Maximum reliability guarantees highest availability of Multibrid offshore wind energy converter, this is achieved:

- elimination of high speeds
- small number of rotating parts
- few noise sources
- only two meshings
- a structure made stiff against torsion from hub

The small mass of the tower head affects the favorable dimensioning of tower and foundation.
Hochintegriertes Triebstrangkonzept
Entstanden in Zusammenarbeit der Firmen

FAG (Rotorlager) RENK (Antriebstechnik) ALSTOM (E-Technik)

AERODYN
(Systemtechnik)
Highly Integrated Drive-Train Concept

Direktantrieb
520 to

Aufgelöste Bauweise
390 to

MULTIBRID®
290 to

Größenvergleich der verschiedenen Bauweisen

Multibrid®
Hybridbauweise aus direktgetriebener und modularer Bauweise
System requirements of the electrical system

- **Electrical**
  - Complete factory test of the converter system
  - „Worst case“ construction: electr. emergency brake
  - Save operation caused by conditioning atmosphere

- **Mechanical**
  - Surface seawater resistant
  - Corrosions resistance against salt content in the air
  - Vibration resistance

- **Minimal erection and commissioning**
  - High infrastructure cost (sea based cranes)
  - Weather dependence on sea: short windows only

- **Service friendly design**
  - Teleservice
  - in case of problems, quick exchange
“MULTIBRID” Wind Converter System

- High power density due to optimised gearbox- and generator concept
- Medium voltage converter and transformer in offshore-container
- Permanent magnets synchronous generator

Hersteller: Prokon Nord Energiesysteme GmbH
# 5 MW Antriebsystem

## Data sheet MULTIBRID M5000

### Technical data:

#### Blade pitch system
- **Method**: electrical single blade adjustment
- **Power control**: pitch- and speed control

#### Generator und converter
- **Rated power**: 5315 kW
- **Type of construction**: Synchronous generator, permanent magnet
- **Rated voltage**: 3000 V
- **Rotation speed range**: 58.6 - 146.9 min\(^{-1}\)
- **Cooling**: Water cooling
- **Protection class**: IP 54
- **Type of construction**: 4-quadrant-GTO-converter
- **Power factor**: 0.9 inductive to 0.9 capacitive
Electrical Concept - Overview

- Grid connected Switchgears in Tower
- Transformer-Container
- Converter-Container

Sea cable

- 3 ~ 50 Hz
- 20 kV

Transformer-Container

- 20 kV 160 kVA 0.4 kV
- 20 kV 6 MVA 3.0 kV

Converter-Container

- USV
- 5.3 MVA $U_N = 3.0$ kV
- G

Transformer specifications:
- 20 kV
- 160 kVA
- 0.4 kV

Converter specifications:
- 5.3 MVA
- $U_N = 3.0$ kV
5 MW Drive system

“MULTIBRID” Wind energy converter

Tower
Passable level in the tower, in the containers and on the passable platform

Transformer container

Cable floor in the tower, in the containers and below the passable platform

Converter container

Standing position for container (Support construction)
Medium Voltage Converter

Basic connection 3 level medium voltage (NPC)

Converter-Clamp Voltage
(without filter)

\[ U_d \rightarrow \frac{U_d}{2} \]

Pulse frequency 250 Hz
Medium Voltage Converter

ALSPA VDM 7000, Rated Power 6 MVA

Mains

20 kV
50 Hz

3 level GTO Phaseleg

PMSG
3~

3 kV
0 ... 40 Hz

Generator
Medium Voltage Converter

Phaseleg ALSPA VDM7000

- Pulse converter
- Liquid cooling type
- Machine voltage: 3 kV
- Power: ≥ 5 MW
- Power factor: controllable
Medium Voltage Converter

Resistant against environment influences

- Seawater resistant container
- Corrosion resistance for all climates, especially against salt content in the air
- Reliable operation thanks to air conditioning
- Vibration proved
Type of Permanent Magnet Machine

- Radial Flux
- Surface Mounted Permanent Magnets (SMPM)

Our experience: Magnet weight reduced

ALSTOM’s choice as per today.
C Type Generators

Example of Main Characteristics

Mains data
- 5.260 MW, 3 000 Volts, 1 020 A
- 28 Poles, 13.7 - 34.3 Hz
- 58 - 147 RPM
  (Single stage gear box, ratio 1:10)
- Liquid cooling

Weights & dimensions
- 25 000 Kg
  (Rotor 10 000 kg + Stator 15 000 kg)
- Stator : OD 2 700, ID 2 120
- Rotor : OD 2108, CL : 900

ALSTOM generator's scope of supply:
- PM Rotor
  (rim + magnets)
- Wound Stator with WJC
- Stator insertion into the frame
- Rotor insertion into the stator
- Heat exchanger
- HV & Auxiliary TB

Off-shore design
Structure and connection to the transmission
C Type Generators

PM Generator

5 MW - 145 RPM