Motion Control Equipment for Wind

SINAMICS Pitch & Yaw Solutions
Positioning of rotor blades at perfect angle

- Dynamic operation depending on
  - Wind speed
  - Position of blades and rotor
  - for optimized power generation
  - and load reduction
- Safe shutdown of wind turbine
  - For safety reasons
  - At high wind speed and storm
  - For maintenance

An efficient pitch control is a prerequisite for the reliable and safe operation of a wind turbine!
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System requirements

**Pitch Control**
- Optimal positioning of all blades
- Feed back to control system about blade position
- Controlled movement to unload structure
- Quick speed to react on strange wind conditions
- Limit high loads on the turbine structure
- Optimize power production to power curve
- Air brake for planned stop of turbine
- Independent power supply at line drop

**Emergency stop**
- Store sufficient power to bring turbine to safe stop under all wind and temperature conditions
- System unaffected by lightening
- Short start up time after shut down

**Maintenance**
- Reliable system to reduce down time for service
- Clean system in operation and during service
- Easy replacement of wearing parts
- Long operation time without maintenance
SINAMICS Pitch Solutions
Our goals

- Customizing solutions using a modular system out of standard and tailored components
- Supporting optimal drive train control through high flexible motion functions
- Increasing reliability of wind turbines
- Decreasing maintenance / life cycle costs
- Protect your projects and investments by future-proof SINAMICS Drive technology
## SINAMICS Pitch Solutions

**System out of building blocks**

<table>
<thead>
<tr>
<th>Performance</th>
<th>Cabinets</th>
<th>Batteries</th>
<th>Converter</th>
<th>Motor</th>
<th>Blade Encoder</th>
<th>Pitch Controller</th>
<th>Interfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td></td>
<td><strong>Ultra Caps</strong></td>
<td><strong>5MW-Class</strong></td>
<td><strong>Synchron direct</strong></td>
<td><strong>Drive CliQ</strong></td>
<td>+Motion +Safety</td>
<td>Profinet</td>
</tr>
<tr>
<td>Advanced</td>
<td></td>
<td><strong>Lithium Ion</strong></td>
<td><strong>2MW-Class</strong></td>
<td><strong>Synchron</strong></td>
<td><strong>Profibus absolut</strong></td>
<td>+Safety</td>
<td>Profinet</td>
</tr>
<tr>
<td>Standard</td>
<td></td>
<td><strong>Lead battery</strong></td>
<td><strong>&lt; 1MW-Class</strong></td>
<td><strong>Asynchron</strong></td>
<td><strong>SSI</strong></td>
<td>Basic Function</td>
<td>CanOpen</td>
</tr>
</tbody>
</table>

**Components Configuration Matrix**

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# SINAMICS Pitch Drive System Cabinets

<table>
<thead>
<tr>
<th>Cabinets</th>
<th>Key characteristics samples</th>
</tr>
</thead>
</table>
| Standard      | + protection class IP 53, with filter fan  
|               | painted steel corrosions class 3  
|               | -15°C to + 40°C  
|               | normal duty connectors, Production China SFAE (Lead Factory WKC) |
| Advanced      | + protection class IP 64,  
|               | + powder coated steel corrosions class C5I  
|               | + GL-Rules |
| High          | + protection class IP 65, GL-Rules  
|               | + stainless steel corrosions class C5M  
|               | + ambient temperature -30°C to + 50°C  
|               | + heavy duty connectors  
<p>|               | + Condition monitoring integrated |</p>
<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Batteries</th>
<th>Key characteristics samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced</td>
<td>Ultra Caps</td>
<td>+ life cycle &gt;10 years&lt;br&gt;+ op. temp. -30°C to 60°C&lt;br&gt;+ lower peak current on slip rings&lt;br&gt;+ LVRT no influence on live cycle&lt;br&gt;+ easy condition monitoring</td>
</tr>
<tr>
<td>High</td>
<td>Lithium Ion</td>
<td>not under development</td>
</tr>
<tr>
<td>Standard</td>
<td>Lead</td>
<td>life cycle &gt;3 years&lt;br&gt;op. temp. -15°C to 50°C&lt;br&gt;higher peak current on slip rings&lt;br&gt;LVRT has influence on live cycle&lt;br&gt;limited condition monitoring</td>
</tr>
</tbody>
</table>
## SINAMICS Pitch Solutions

### Converter

<table>
<thead>
<tr>
<th>Performance</th>
<th>Key characteristics samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>Advanced</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

### 5MW-class
- + 100Nm average, 200Nm peak

### 2MW-class
- 40Nm average, 80Nm peak
- Life cycle 20 years
- Op. temp. 0°C to 70°C

### > 1MW-class

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## Motor

<table>
<thead>
<tr>
<th>Performance</th>
<th>Motor</th>
<th>Key characteristics samples</th>
</tr>
</thead>
</table>
| Standard    | Synchron direct | + gearless  
+ high dynamic |
| Advanced    | Synchron | + no fan (smaller dimensions)  
+ easy to control at speed 0  
+ low inertia  
+ overload 1:4, |
| High        | Asynchron | op. temp. -15°C to 45°C without heating  
maintenance free  
overload 1:2 |
### SINAMICS Pitch Solutions

#### Pitch Controller

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Pitch Controller</th>
<th>Key Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>+Motion +Safety</td>
<td>+ Motion functions (load reduction) + Safety functions (EC Machinery Directive)</td>
</tr>
<tr>
<td>Advanced</td>
<td>+Safety</td>
<td>+ Safety functions (EC Machinery Directive)</td>
</tr>
<tr>
<td>Standard</td>
<td>Basic Function</td>
<td>engineered 1 axis plc &amp; drive controller</td>
</tr>
</tbody>
</table>
## SINAMICS Pitch Solution
### Interface turbine controller

<table>
<thead>
<tr>
<th>Interfaces</th>
<th>Key characteristics samples</th>
</tr>
</thead>
</table>
| **Profinet** | + fast communication and diagnostics  
+ “1 cable for all”, redundancy |
| **Profibus** | + replace safety loops  
+ synchronized emergency stop via ProfiBus  
+ TIA |
| **CanOpen** | Gateway required, hard wired safety loop required |
Cabinets for 1.0 to 6 MW-Turbines with DLC energy store

- Works direct on the 3 x 400V AC supply of the rotor hub
- Continuous / peak torque with synchronous servo motor 30 to 100Nm / 60 to 200Nm
- Degree of protection IP54 up to 65, suitable for CCV and HCV
- Single blade control with 4Q-operation
- Motion Controller with Profinet-Interface and Webserver
- Integrated condition monitoring and life-time self diagnostic
- Integrated Safety functions

2.5 MW-sample
SINAMICS Pitch Solution
Summary

Reduction of Loads and Wear
- Integrated motion functions supports turbine controller for load reducing pitch control methods
- Motion controlled pitch-drive reduces loads on pitch gear box and blade bearings

Reduction of Parts
- Replacement of Hardware by approved Safety Software
- Servo Motors without fan

Reduction of Maintenance and Lifecycle-Costs
- Integrated Condition Diagnostics enables predictive maintenance
- Less Parts means less probability for failure
- All Components out of Industrial high quantity production at highest quality standards
- Experiences from products for railways and cranes are considered

Excellent Cost Situation
- Use of high quantity standard products
- Configuration instead of engineering (fast & reliable)
- Local production for Chinese market

Know-how from Industrial Motion Control for your benefit!

September 2012
SINAMICS Pitch Solution

The decision to use SINAMICS Pitch Solution implies

- To get proven industrial control and drive technology
- To get newest innovative products
- To get world wide support
- To get the flexibility of a modular system
- To get best product and supply quality
- To get competitive prices on comparable products
- To be ready for new pitch control concepts

Know-how from Industrial Motion Control for your benefit!

September 2012
Thank you for your attention!
Wind – Pitch Control Concepts with Switchgears
Application example
Switch Cabinet in the Rotor Hub

Are industrial control products suited for such harsh applications?

Rotor hubs are subject to extreme loads:
- Extreme temperatures
- Strong vibration and acceleration
- Permanent self-rotation of switch cabinets
Industrial Controls in the Rotor Hub

Electromechanical industrial control products are very cost-favorable and are employed in stationary control cabinets as a standard.
In case of a network collapse, the rotor is able to reach the maximum speed and the contactors switch off even with maximum acceleration (up to 7*g)!

Operation under radial acceleration is supported up to \(70 \text{m/s}^2\) (confirmed by comprehensive tests)!

Offshore & Salt-containig air:
- The DC-Motor can be turned off at end-position by limit switches.
- Switches with improved protection against corrosion and made from stainless steel → highest reliability.
- Confirmation of acceptability according to Germanischer Lloyd → below (PDF).

These proven product characteristics distinguish Siemens solutions from competitor products and facilitate the industrial controls' safe application in wind power stations.