

the power to control

bachmann.

The Future of your Wind Farm

Efficient. Flexible. Secure.



 energy.industry.maritime.



Your Experienced Partner in Wind

Expertise and trust speak for themselves

Bachmann electronic is a world leader in wind automation. Besides future-proof technologies, high availability and quality from a single source, there's one thing we offer our customers above all: extensive experience and unique expertise in meeting challenging market and customer requirements worldwide with tailored solutions.

- 140,000 Wind Turbines automated with Bachmann worldwide
- 10,000 Condition Monitoring Systems installed with Bachmann
- More than 250 Automation Partners trust Bachmann in the wind sector

1. Turbine Automation

- Flexible: Modularity in hardware & software
- Investment security: Model-based, reusable software development
- Data protection: Integrated security functions
- Robust: Designed and tested for extreme environmental conditions and maximum availability

Wind Turbine Template

- Complete toolbox for turbine development
- Configurable software modules
- Object structure according to IEC 61400-25
- Event system and statistical evaluation
- Open source for individual adaptations

2. SCADA

- Wind Power SCADA
- Park overviews and in-depth turbine data at a glance
- Data models according to IEC 61400-25
- Standard communication via OPC UA
- User-defined configuration of views and reports directly in the SCADA system

3. Wind Farm Networking

- Configurable communication interfaces
- Parallel Ethernet real-time networking via bluecom protocol
- SSL/TLS-encrypted access security
- Standards according to IEC 60870-5-10x and DNP3
- OPC UA to SCADA and operational control

4. Condition Monitoring

- More than 25 years of CMS expertise
- 10,000 CMS installed worldwide
- The world's first GL certified PLC-integrated CMS
- Individual retrofit solutions made to measure

5. Park control with Smart Power Plant Controller

- Certified power plant controller in accordance with VDE-AR-N 4110/4120
- Modular, open and expandable controller concept
- Use in homogeneous and heterogeneous energy parks
- Web-based configuration and visualization incl. rights concept in accordance with IEC 62443
- Supports all communication protocols



Wind Energy 5.0

— *Automation solutions
for all areas of wind energy*

From control technology, Condition Monitoring, Wind Power SCADA to grid connection, we provide cutting edge solutions for wind farm automation. Our automation systems stand out on account of their extraordinary robustness, high performance and open interfaces. With our intelligent sensors and optimal power control algorithms we can automate your wind farm – making it open and flexible.



The Future in View

*Our automation solutions set new standards –
worldwide and around the clock*

With an innovative mindset driven by years of experience and a passion for knowledge, we focus our attention on four areas:



b.control



Automation: Scalable. Robust. Versatile.

Thinking further, always keeping one step ahead, staying open for everything that the future will bring – this is our mission at Bachmann and what makes our automation solutions so special. A holistic system, perfectly tailored to the individual requirements of our customers – today and in the future. The core of every Bachmann system solution is the Bachmann automation system: a modular hardware and software concept that guarantees maximum availability, future investment security and engineering efficiency.



b.grid



Grid Measurement, Protection and Control: Safe. Fast. Stable.

A scalable range of integrable, multifunctional power meters are available as plug-in modules for the Bachmann automation system. The measurement of all characteristic grid variables such as voltage, current, power or frequency directly within the control system allows significant correlation with other operational data, as well as an excellent reaction time. The measured data is rapidly calculated without additional delays due to fieldbusses or transceivers.



b.operate



Visualization and Operating: Visualize. Web compliant. Versatile.

In the automation industry, approaches such as Industry 4.0 and the associated breakdown of the rigid automation pyramid are widely discussed but rarely followed through. Unfortunately, solutions closely following this rigid principle are still frequently found in the field. The visualization solutions from Bachmann take a different approach. To advance the digitization in automation, our solutions focus on flexibility and freedom.



b.guard



Condition Monitoring System: Planning. Detecting. Preventing.

A Condition Monitoring System (CMS) integrated in the automation system can provide all information, in order to detect failure hazards early on and plan maintenance tasks in good time. With increasingly competitive markets and industries, companies are challenged to run their organizations with ever more output and greater efficiency. Knowing the health of assets has become key to increasing company productivity and profit.

The Bachmann Automation System

— Solutions for wind energy

We understand the big picture and are always thinking ahead for you. Our innovative solutions ensure efficient engineering of your plants. This is what intelligent automation of state-of-the-art wind turbines looks like.

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Park Control with Bachmann

Modular, flexible, standardized

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Condition Monitoring System (CMS)

Availability and greater yield

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Repowering or Retrofit?

Fast and efficient upgrades

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State-of-the-art Security

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Specialist for pitch applications

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Where the Future is Conceived **Smart Turbine Automation**

WIND ENERGY 5.0

- *Intelligent, robust turbine automation*
- *High-speed farm communication*
- *Smart grid and power control*
- *Integrated SCADA system*
- *Integrated Condition Monitoring*

Wind Energy 5.0

Wind turbines of the future will be integrated into complex data communication systems – with meteorological, grid and CMS sensor data. Bachmann has concepts and solutions for Smart Turbine Automation and the experience of 140,000 automated turbines.

Condition Monitoring

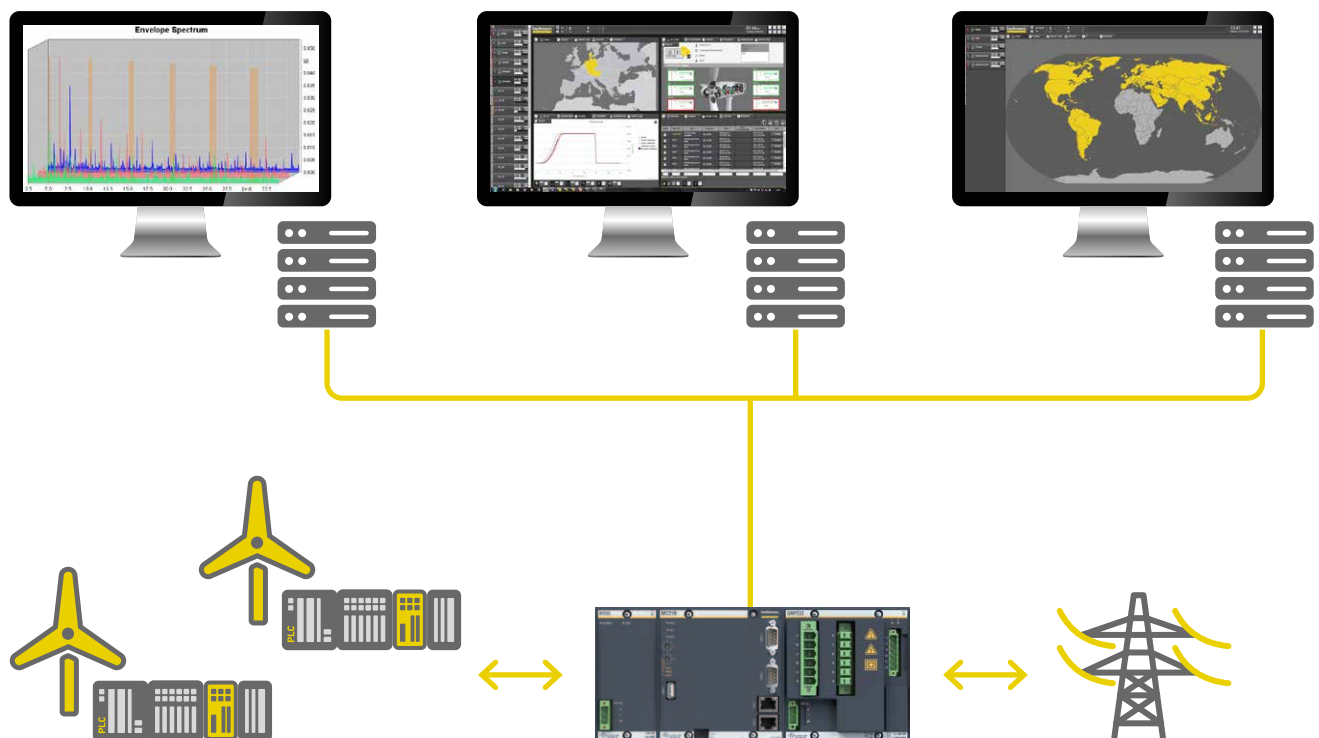
- WebLog Expert®
- CMS analysis
- Monitoring
- Reporting

Wind Power SCADA

- IEC 61400-25 structure
- Database coupling
- Safe in the event of communication failure to the turbine
- Data analysis and comparison
- Integration of CMS data in accordance with VDI 3834
- CMS ticket display with analysis function

Big Data Portal

- Data acquisition
- Data analysis/data correlation
- Alarming and events



Smart Turbine Automation

- Model-based design
- IEC 61400-25 structure
- Simulation and diagnostics
- Integrated safety
- Integrated CMS
- Grid measurement/protection

Smart Grid Automation Communication

- Ethernet/OPC UA based
- Redundancy
- High-speed (bluecom)

Substation with park control unit

- Park controller / power plant controller in accordance with VDE-AR-N 4110/4120
- Smart power plant controller in accordance with VDE-AR-N 4110/4120
- Grid measurement
- Grid protection

Energy protocols

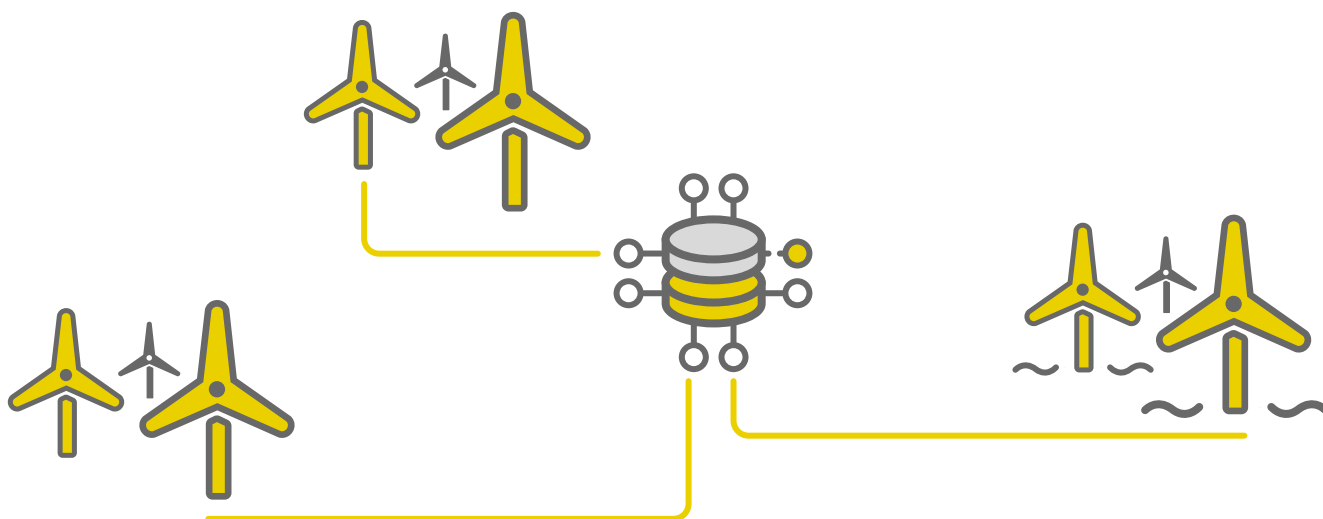
- IEC 60870-5-10x
- IEC 61850
- IEC 61400-25
- Modbus-x
- DNP3
- etc.



Smart Turbine Automation

— Concept for the entire wind farm

The requirements placed on wind turbine are continually increasing. Profitability can only be improved by using new technologies, processes, materials and expansions in infrastructures (IT). The turbine must no longer be considered as a separate entity but as part of an overall energy production chain.



Intelligent control center

Networks form the interface to the wind farm and ultimately also to the turbine. This in turn must be able to be adapted firstly to the characteristics and requirements of the networks, and secondly, to its own requirements.

Bachmann's Smart Turbine Automation makes this possible. The controller is no longer just used for processing individual standard signals for operational control, but functions more as an intelligent control center. For this, a wide range of measurement signals from the turbine and information from higher-level SCADA

systems, as well as analytical correlations etc. are evaluated and processed online. The actual states of the generator and its components are measured deterministically and processed directly in the turbine controller. Intelligent, model-based controller algorithms process this Condition Monitoring data from different units, together with signals, such as load recognition, wind forecast, information on wind conditions in the park etc., and ensure the optimum operating state of the plant. This makes it possible to optimize ongoing production yields (power generation) and the long term availability of the turbine.

Data transfer in milliseconds

Standard interfaces such as IEC 61400-25 (with the MMS protocol), OPC UA and MQTT provide data exchange with higher-level servers and cloud systems. Bachmann's Ethernet-based bluecom protocol makes it possible to perform data transfers in milliseconds in order to synchronize turbines in wind farms – with network redundancy included. The profitability of wind turbines also depends on key factors such as standardization, adaption and modularity. The demands placed on individual networks and technological requirements are constantly advancing.

Turbine modifications – particularly with regard to software and the behavior of the turbine – must be carried out swiftly and transparently. Bachmann Wind Turbine Template (WTT) provides a solution for creating the software architecture of this kind of wind turbine. The components of the turbine can be created as modules, based on IEC 61400-25 structures.

The openness of the system and the use of different programming languages (IEC 61131, C/C++, MATLAB®/Simulink®) enable these software modules or turbine components to be depicted as required. Proprietary simulation programs, which run simultaneously on the turbine controller, not only provide a model the turbine, but can be included in order to optimize the turbine parameters.


Bachmann also offers this standardized component and data structure with a SCADA system (Wind Power SCADA), which depicts these structures in the SCADA world. In this way, the structuring and data update between the turbine and SCADA can be carried out automatically. WPS features a large number of functions, displays and analysis tools.

The standardization and openness of the system also enables the online creation and adaption of displays, widgets and dashboards. The purely web-based system also meets all user management and access rights requirements (security). Responsive design allows access from different clients such as PCs, tablets and smartphones.

Bachmann's Smart Turbine Automation, however, not only covers the wind turbine itself. Model-based park control algorithms in the form of the Smart Power Plant Controller available as ready-to-use park controllers or the open structures (IEC-based), and a host of configurable energy protocols are available to create an intelligent wind park network. Highly resolved grid measuring and monitoring modules from Bachmann for the turbine and the wind farm round off the Bachmann solution for the Smart Turbine Automation.

BENEFITS

- Predictive control for pitch and turbine
- Drive train CMS with operational control
- Electrical CMS, temperature monitoring of the IGBTs in the inverter
- Tower vibration sensor with power regulation
- Calculation of component lifespan based on load cases
- Intelligent wind farm control – smart grid

 More on this topic is provided on our website

IEC standard benefits

IEC 61400-25 – A standard communication solution for easy access to relevant wind turbine data.

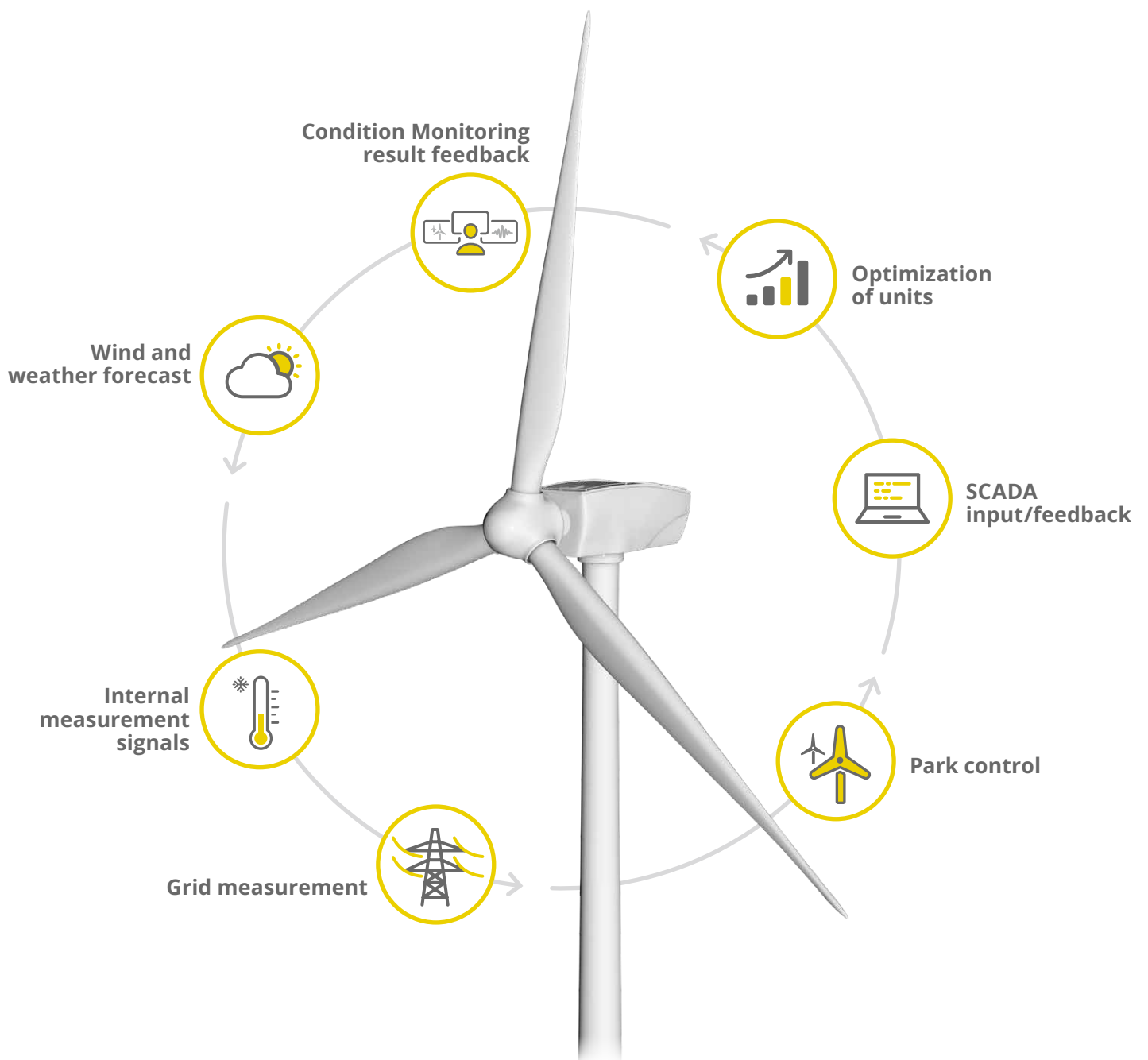


Certified systems

Internationally accredited test institutes verify the conformity of our systems with the most important global standards and thus provide approval for the most demanding applications.



Maximum availability:
Greater performance, greater yield



One System for every Condition

PLC-integrated Condition Monitoring – AIC

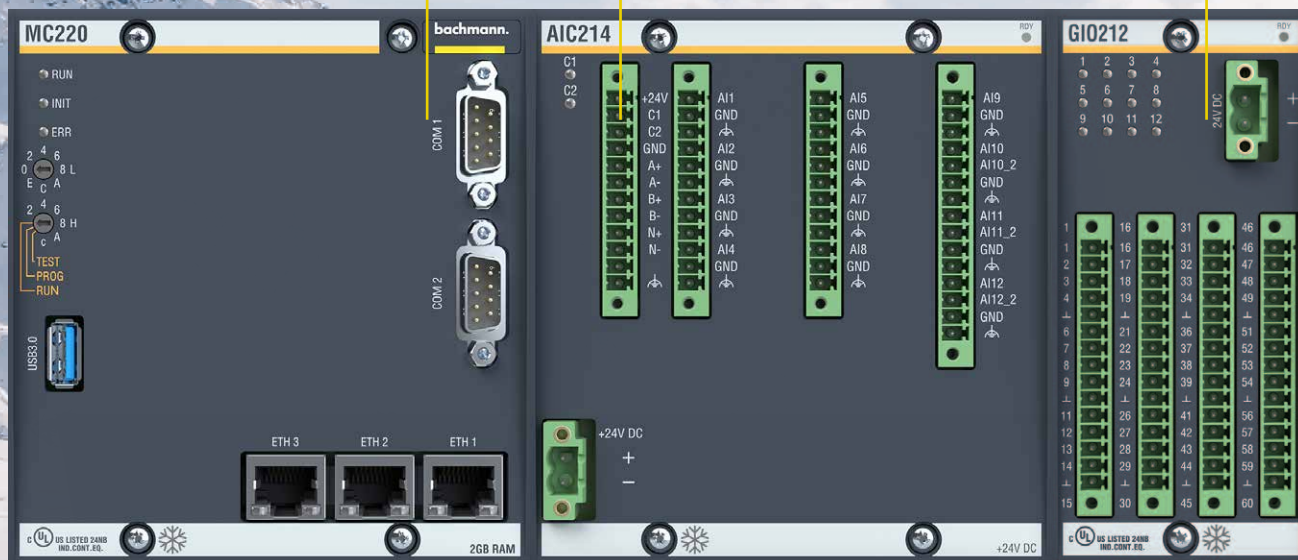
Germanischer Lloyd has certified the Ω -Guard Condition Monitoring System (CMS) of Bachmann electronic as the world's first PLC-integrated solution. Ω -Guard makes it possible for the first time to execute the entire logging, analysis and evaluation independently of the PLC program. The AIC214 CMS module of the Bachmann automation system is equipped for this with high-resolution vibration measuring inputs for the recording of data from different measuring points. This results in extended monitoring functions without doubling the amount of sensors. The integration in the Bachmann controller system means that any signals and variables from the entire control system, such as the actual power or the operating state, can be included in the Condition Monitoring analysis.

CPUs of the MC series

Maximum performance for demanding closed-loop control tasks, process control and signal processing, as well as a comprehensive range of communication protocols – all provided by the CPUs of the MC model series: state-of-the-art Multicore processors, fast GBit networks, large CFA memory, Non-Volatile Data Storage (NVRAM), Ethernet, serial and USB interfaces.

GIO I/O module

The world's unique GIO212 offers an impressively wide range of functions, thus making the use of expensive additional modules in most places unnecessary. All channels of the universal I/O module can either be configured as analog or digital inputs or outputs, as counters or for temperature and resistance measurement.

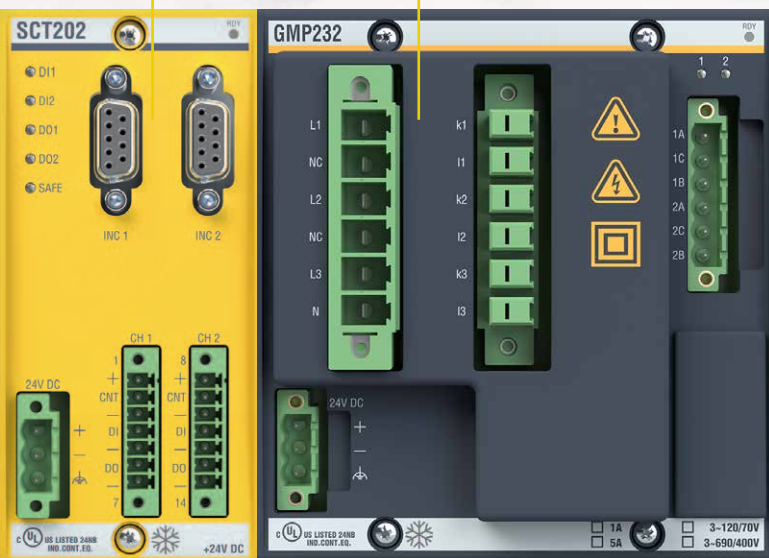


SCT safety counter module

Integrated safety modules offer efficiency in development, transparency and diagnostic capability. The SCT202 is a safety module for measuring safety-related rotations. For this it provides inputs and outputs which enable the implementation of safety applications up to SIL2 and PLd. Other safety signal types: digital/analog IO, PROFIsafe.

GMP grid measurement/grid monitoring

The PLC integrated GMP module provides solutions for grid measurement, protection and power quality. In other words, the modular Bachmann programmable controller system (PLC), combined with the plug-in module (GMP232/x), can also be used as a three-phase grid measuring system, grid and system protection device, power quality monitor and fault recorder. The entire system thus performs the operational control automation as well as the grid functions.



COLDCLIMATE -40° TO +70° C

- Very broad operating temperature range
- High moisture condensation resistance
- Use of modules used in an extreme temperature range from -40 °C to +70 °C
- 100% RUN-IN Test for all modules with extreme temperature changes in climatic chambers



More on this topic
is provided
on our website

Functional Support

M1 ServiceCenter

With the constantly increasing requirements of today's technology, service operations on wind turbines or machine parks are unavoidable. The M1 ServiceCenter from Bachmann electronic offers the customer maximum support in the design of service operations such as software updates or hardware replacements, and enables the simple execution and monitoring of the defined process operations directly at the plant or by remote access – even simultaneously on several plants.

BENEFITS

- *Software for automated service tasks (updates, backups, hardware replacement and configuration on the Bachmann automation system)*
- *Catalog with "ready-to-use" operation functions*
- *Offline engineering*
- *Wizard dialogs for more complex processes*
- *Live monitoring of the running processes*
- *Execution for an individual plant and park possible*
- *Creation of reports for archiving*
- *Software can also be run without USB installation*

Versatile tool: The M1 ServiceCenter is a software tool that supports the user with recurring tasks for the Bachmann automation world. Software updates on existing plants, making a backup of the running system beforehand, loading new programs, modifications to configuration files or even connecting new hardware – these are routine tasks in the field of wind turbine and machine service operations.

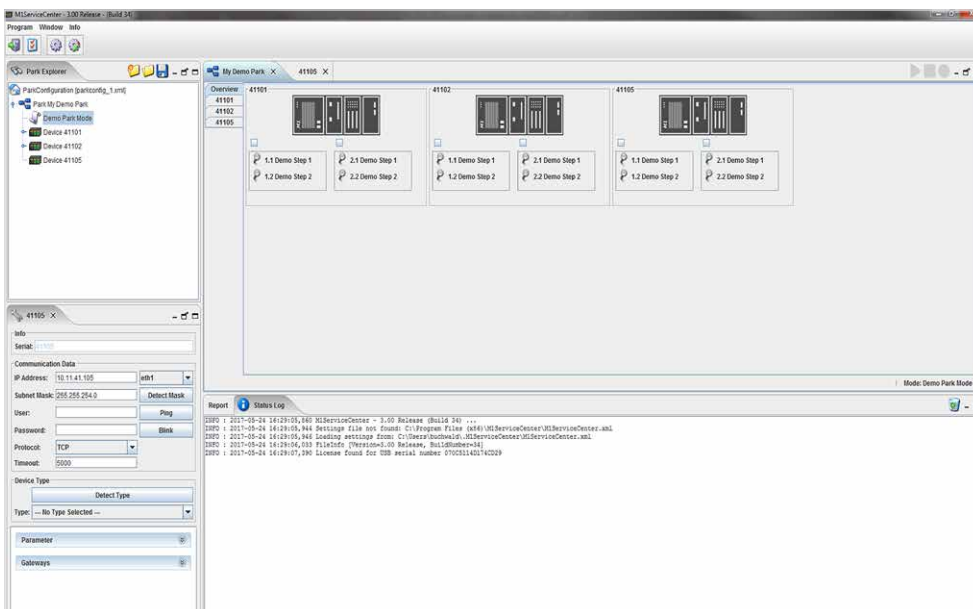
In the M1 ServiceCenter, Bachmann has gathered the experience of customers performing these tasks and the obstacles they face. The resulting software implementation features applications from actual cases, thus enabling the customer to perform tasks easily, quickly and automatically.

Offline Engineering

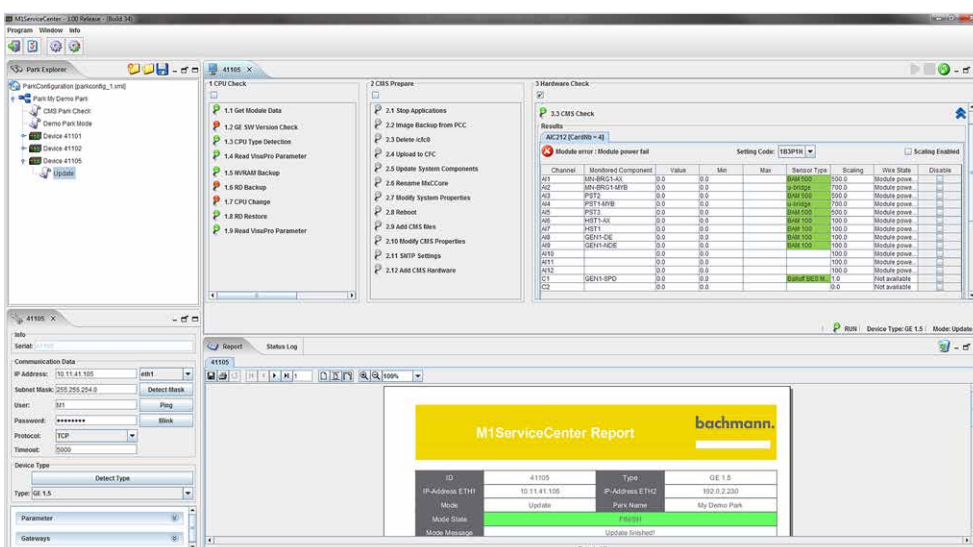
Service operations can be designed really easily. A process configurator is used to collate and configure the individual process steps, such as an "M1 Applications" backup, by selecting them from a catalog. More complex process steps, such as the software handling when replacing of an Bachmann CPU, are also included in the catalog. These contain step-by-step instructions, so that unskilled personnel can also complete these tasks without any extensive training. The process configurator also allows several process definitions to be managed clearly in a tree structure and also logically linked. The monitor view is used to manage the plants and farms in a tree structure. This topology can likewise be created and pre-configured offline – access to an Bachmann controller is not required.



More on this topic is provided on our website



▶ Park view: Process started



▶ Park view: Results page for the individual turbine

LIBRARY FUNCTIONS

Software

- Information
- Start/stop of applications
- System version check
- Reading/writing variables
- "Mconfig.ini" manipulation
- Device protocol

Hardware/firmware

- Version check
- Firmware update/downgrade
- Safety (SLC) program upgrade
- Replacement
- Reboot

File handling

- Loading/storing/copying
- Automatic update
- Zip functions

Licenses

- Checking of RT licenses
- Automatic update

Communication/security

- Connection test
- CAN-SDO read/write
- M1 secure storage operation

Process sequence and monitoring

If a service operation has to be performed, the appropriate Bachmann controller, representing for example a wind turbine, is selected, and the process operation from the already created process definition assigned to this plant. The process steps are shown individually and, once the sequence has started, the user is shown the status of each individual step via color markings in the live view. If a step fails, the corresponding message is logged.

A report (pdf and Excel) is created automatically after each pass, logging all executed process steps as well as their status and result values. These reports are also directly available for view-ing in the program but are also saved automatically.

The created service operations can also be assigned on the park level to the entire previously configured farm and monitored in live view during execution. This application is particularly suit-able for fetching remote information, such as the status data of controllers, via installed software or hardware, as well as for performing file backups.

User management

The M1 ServiceCenter provides a configuration user interface for user management (WTT AccessControl) and transfer to the Bachmann controllers. A user-friendly tabular display enables the creation and removal of users and attributes, such as passwords, user profile and date of validity. The editing of user lists is also password protected.

M1 SenAccess

Bachmann electronic offers an access solution for Servion turbines. Only the access control software for the Bachmann controller is renewed, enabling the customer/operator to control and operate the plants again. The connection to Wind Power SCADA is also supported.

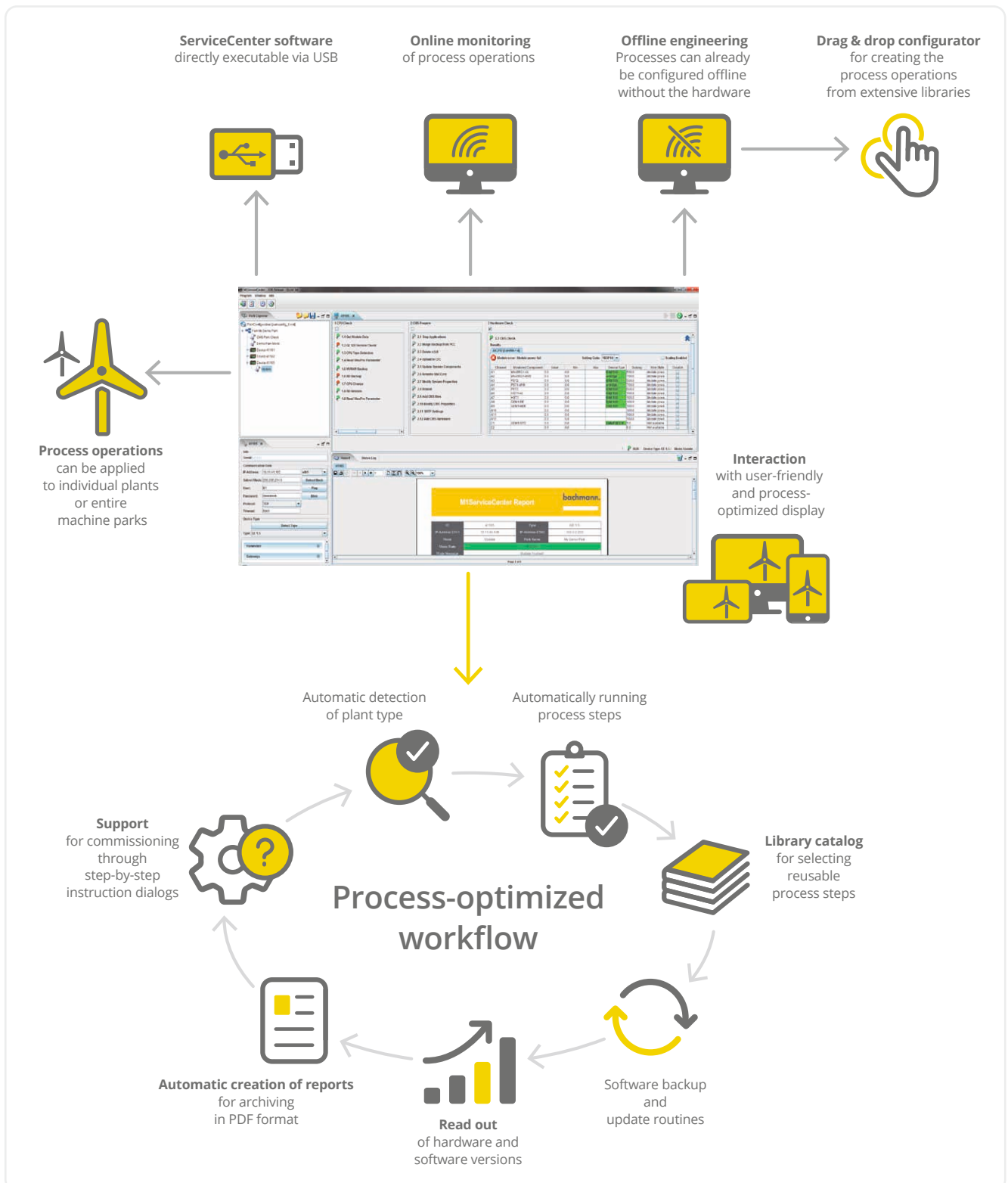
The M1 Service Center is the main role in both cases: The tool enables all the necessary software conversions to be carried out on the Bachmann controller and supports any forthcoming hardware replacement step by step.

Ready-to-use procedures and reliably imple-mented plant type detection enable users to roll out this access solution for the fleet on their own with the M1 ServiceCenter.

Wish to find out more about this? Read here a success story from one of our customers:



M1 ServiceCenter Service made Easy



All-in-one Engineering

SolutionCenter

The Bachmann SolutionCenter represents a genuine milestone in the reduction of engineering costs. A single all-round software solution covers all areas of the engineering process – from configuration, programming, closed-loop control, motion, communication, safety, visualization, right through to testing and commissioning.

SolutionCenter – the all-in-one engineering tool

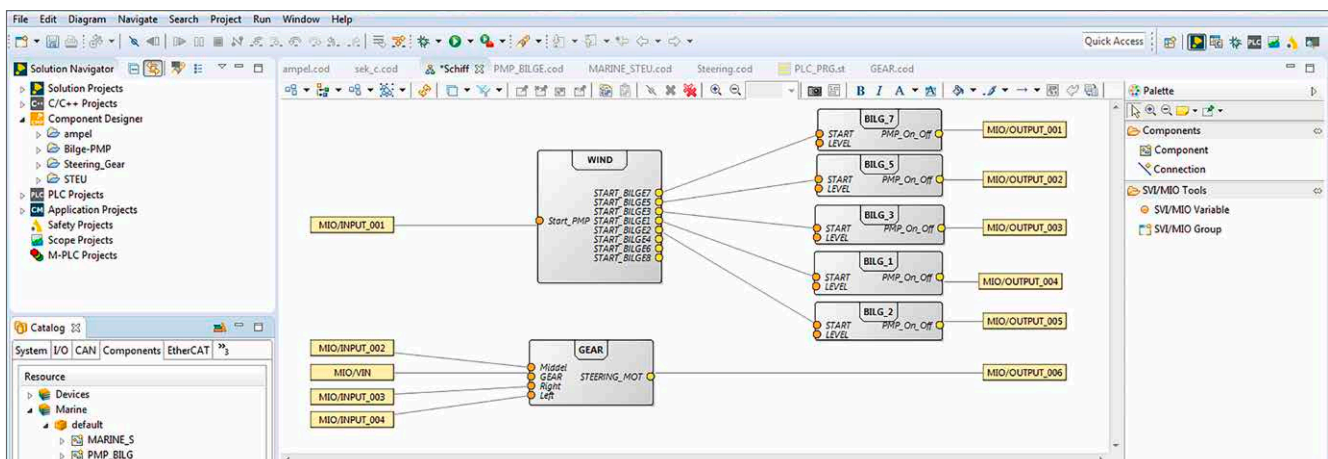
SolutionCenter supports all aspects of the engineering for wind power applications and perfectly integrates to Bachmann devices and systems. It was designed in collaboration with experienced users and allows effective engineering in all phases. Through the plugin concept, the SolutionCenter enables necessary functions or user-specific requirements to be added at any time. This can be done either by selecting a third-party plugin from the extensive offering or with in-house developments.

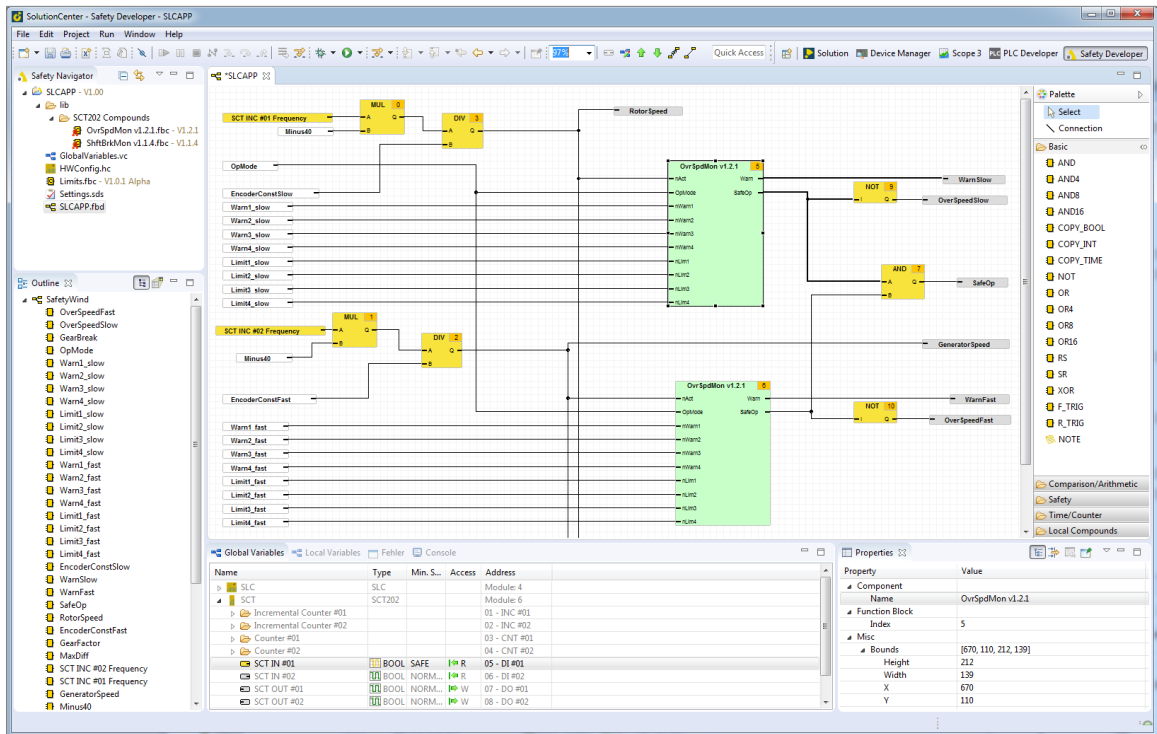
Component Manager

More than ever, modern wind power sites consist of complex mechatronic systems, which can only be implemented through the close collaboration of all the engineering sciences required for the process. This complexity is handled by breaking down the plant into logical function units, also known as components. Bachmann's Component Manager is designed for this task. The tool allows you to form systems from different components which are represented as software modules in the system. These com-

Component Manager:

Clear application display in the SolutionCenter.





Seamless integration: The complete integration in the SolutionCenter reduces the time required for the configuration and reduces downtimes, thanks to the simple remote diagnostics and onsite troubleshooting – safety included.

BENEFITS

Simple

- Seamless and flexible operating concept

Efficient

- No redundant or unnecessary manual entries
- Reuse on all engineering levels
 - Program code
 - Configurations
 - Diagnostics

Universal

- One tool for all areas of engineering
 - Configuration
 - Programming
 - Diagnostics
 - Testing



More on this topic is provided on our website

Bachmann ensures perfect integration in the Bachmann automation target system. Extensive libraries are available in any programming language for a variety of different tasks.

Testing/quality/simulation

Quality assurance tests must be carried out during and after software development. SolutionCenter supports the programmer while performing extensive software test procedures (unit test, static code analysis ...) as well as when testing the application software. The component-oriented design of the application program enables targeted testing. Software can be tested as a complete application or as individual software modules. For these tasks, processes based on CSV tables, as well as extensive processes such as hardware-in-the-loop (HIL) are available.

Security/safety

Plants in the energy sector must comply with stringent security and safety standards. This involves both the area of unauthorized access to the controller as well as safety shutdowns in dangerous conditions. SolutionCenter allows the configuration of extensive security fea-

tures and provides the Safety Editor as an easy to use tool with the CFC Editor for programming a software control program integrated in the Bachmann controller system. A wide range of libraries with compliant modules are available for the rapid implementation of the safety application. This includes the exchange of variables with the operational control program. The integration of the safety engineering in the turbine controller enables remote diagnostics and maintenance to be carried out easily.

Communication

Modern plants are no longer possible today without the implementation of a network. The Bachmann controller supports all commonly available networks, fieldbuses and protocols, such as Ethernet TCP/IP, PROFINET, EtherCAT, CAN bus or Modbus, IEC 61400-25, IEC 60870-5-104 or OPC UA. The configurators required are also included as well as diagnostic and testing tools.

Visualization

The increasing complexity and constantly rising level of automation in different plants require the use of HMI and SCADA systems. These sys-

tems support both very small applications, with only a few dozen data points, as well as large-scale plants with several 100,000 process variables. It must be possible to adapt visualizations quickly and effectively to the requirements of the application. SolutionCenter provides solutions for this based on standard technologies (OPC UA, HTML5 ...).

Diagnostics

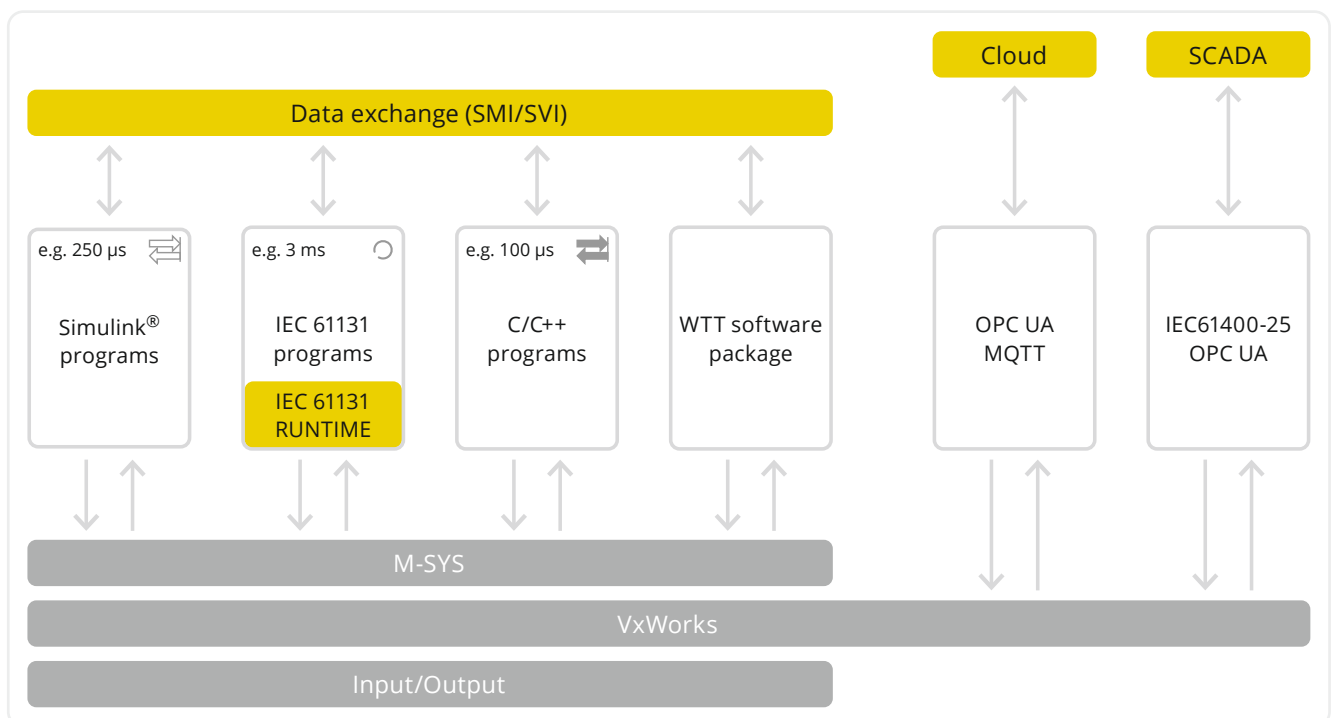
In all engineering phases, SolutionCenter offers an interface to all the information about the plant. With dynamic processes, the display of physical variables as numerical values is often not enough. The Scope 3 Software Oscilloscope enables automatic long-term archiving (logging) as well as the automatic recording

of sporadically occurring events in relation to other process variables. The acquired data can be archived in a database for subsequent processing. Scope 3 is fully integrated in the SolutionCenter. This for example enables Scope recording configurations to be assigned to a project and managed in the integrated version manager.

Operational control

During the operating phase, SolutionCenter provides support with a clearly arranged display of all turbines and subsystems. The actual operating state as well as all necessary parameters are clearly displayed. SolutionCenter provides all the turbine data and information required for the operation of the plant.

Comprehensive engineering: Basic structure of the Bachmann controller system for open and flexible design using standardized software modules.



The Fast Way to Reliable Diagnostics

— Scope 3 data recorder and watch list

Regardless of whether during commissioning, troubleshooting or maintenance – the more modern and complex the automated plant, the more important transparent information on process states and sequences in the overall system becomes. The Bachmann SolutionCenter provides users of the Bachmann automation system with all the diagnostics tools needed in one software solution and keeps all the data reliably in view – in real time.

BENEFITS

- *Autonomous real-time data acquisition on the controller*
- *Long-term archiving by database configurable*
- *Number of recorded signals only limited by hardware resources*
- *High resolution (from 100 microseconds) and variable sampling priority*
- *Several trigger options as well as pre-trigger and post-trigger functions*
- *Data analysis with outstanding PC software*
- *Recalculation of logged data (standard algorithms, user-defined algorithms)*
- *Seamless integration in M1 webMI pro web visualization*



More on this topic is provided on our website

Scope 3: Data recording at high speed

With many dynamic processes, a single numerical value is no longer sufficient to diagnose the physical variable. Only the recording of processes over time and their relationship to other process variables gives the necessary information. Bachmann's Scope 3 software oscilloscope is the ideal solution here. The core of Scope 3 is a powerful data logger: It offers an outstanding scan rate that can be selected in a range from 100 microseconds to 60 minutes. Thanks to the multi-tasking architecture of the Bachmann automation system, several data series can be logged in parallel and with different scan rates. Interfaces for several application programs increase the functionality of the product.

Database with selective access

The archiving and provision of data are central issues for an automatically operating data recorder. With Scope 3 a database archives all data in the background and offers a selective access. Archive size and archiving intervals can be set to individual requirements. All data from the online buffer and also from the database is available at the same interface.

Simple analysis of complex interrelationships

A simple click on the data recorder of an Bachmann controller enables data to be displayed immediately and makes it ready for analysis. The configurations can be managed in the work space and the logged data stored in a structured way. Frequently used diagram functions, such as measuring cursor, zooming, color adaptations are supplemented in Scope 3 with important new functions – curve recalculation, the graphical comparison of logged data or the fast Fourier transform function are also now directly available for the user. It is also possible for the user to implement his own calculation methods or export formats.

Simplified maintenance and service

In the event of a fault, a connection to the relevant machine or plant often had to be established in order to fetch the relevant data for analysis. In certain cases, work directly on site was then unavoidable. With Scope 3 this is no longer necessary. The occurrence of a fault automatically initiates the logging of the relevant data. Data generated around this time range can be incorporated easily with the

pre-trigger and post-trigger functions. After logging has been completed, a file with all the relevant data of the event is generated on the controller and automatically sent to the service technician by email.

The Bachmann Watchlist

When watching process variables, the user sees the controller as a black box: Defined signals are fed to the inputs and their trace observed at the outputs. If it is possible to read and write variables selectively, this enables conclusions to be drawn about the behavior of the automation system. For efficient work, however, a randomly sorted list of all controller inputs and outputs, as offered by most manufacturers, is not enough. That is why Bachmann offers a freely configurable variable list in the SolutionCenter – a so-called watch list.

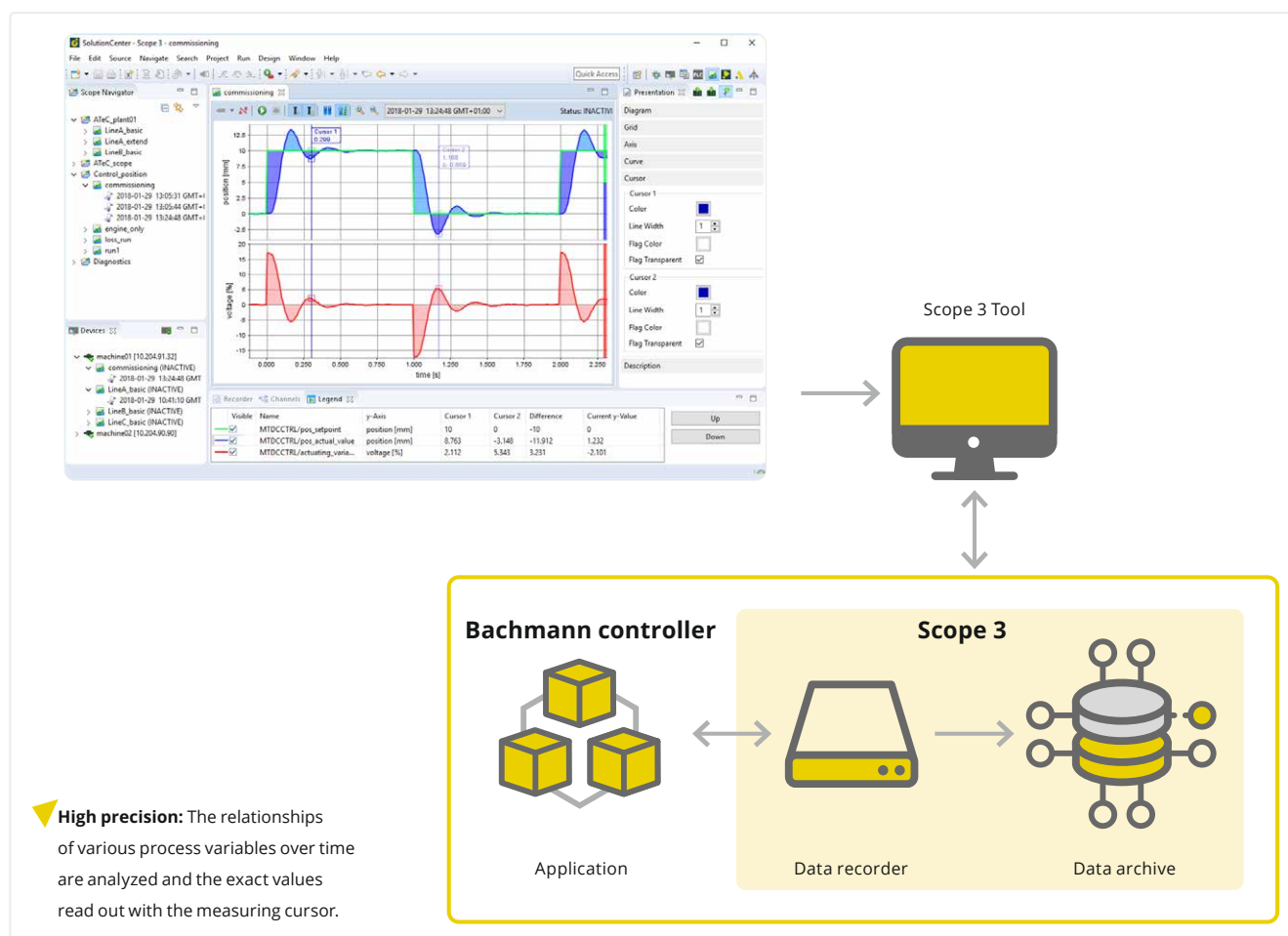
The user defines the content

The variable list can be configured quickly by the user – by selecting the variables or channels with drag & drop or in the dialog window

with an unlimited number of entered variables. Different filter and sort functions are also provided that simplify the handling of extensive lists. The user can furthermore manually sort the variables and, for example, place the most important ones at the beginning of the list. Variables and channels of different controller systems can be managed in just a single list. In this way, overlapping processes in large machines and plants can be observed and followed.

Integrated setpoint definition

Setpoints for individual parameters can be defined very easily with the help of the watch list. These can be defined with multi-selection in a separate column and downloaded to the controller with just one command. Conversely, actual values from the controller can be entered directly as setpoints in the list. The Bachmann SolutionCenter also shows all the selected variables in a trend diagram. This makes it possible to trace signals over time without any extensive configurations required: for maximum efficiency with maximum certainty.



Simulation, Process and Control

Model-Based Design

The challenges placed on the automation in and around wind turbines are constantly increasing. Leading manufacturers are meeting the growing complexity of operational control and the control algorithms required for it with new development techniques. These enable technically mature and highly available plants to be brought out whilst saving development effort at the same time.

BENEFITS

- *Development of automation algorithms (open-loop and closed-loop control) with integration in the target hardware directly in MATLAB®/Simulink®*
- *Automatic code generation and transfer to Bachmann controller without additional parameter setting*
- *Free choice of Bachmann CPU core for application processing with individually defined priority*
- *Online communication between the Simulink® development environment and the PLC program for simplified parameterization and diagnostics*
- *Integrated interfaces to automation programs created in conventional programming languages (IEC 61131-3, C/C++)*
- *Integrated interfaces to visualization systems and other PLC systems*
- *Support for hardware-in-the-loop systems with regression tests and environmental simulation*

The design of comprehensive wind turbine plants instead of individually isolated subsystems presents engineers with a new set of challenges. Simple analytical calculations provide insufficient information on the behavior of connected systems. One possible solution is an empirical approach, in which the information acquired is used in the solution process. What do you do, however, if a prototype is too expensive or its operation too dangerous?

Simulation

Today's solution is: digital simulation. This enables the engineer to model the behavior of the entire wind turbine in the simulation environment of choice. Irrespective of the software used, mathematical interrelationships are ultimately used to describe the response of the system. M-Target for Simulink® enables the simple use of computer-aided simulation, taking the actual automation solution into account. The resulting virtual prototype is simulated as

often as required, and both the parameters and environmental conditions derived from the user's design considerations. The viability and design risks of a new plant generation can thus already be drastically reduced during the development phase.

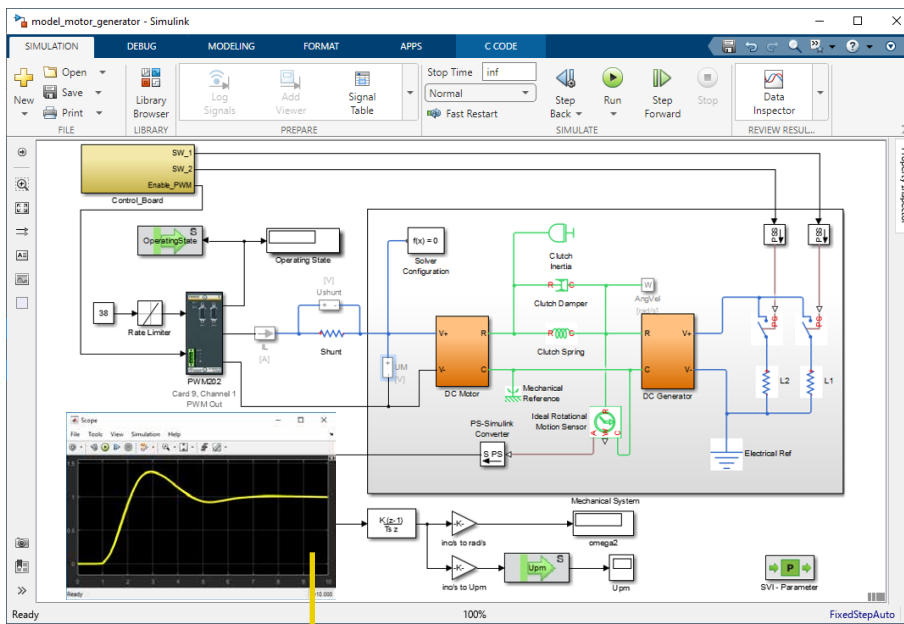
Quality and efficiency

The engineer uses the simulation program not only for modeling plants, but also for designing the sequential and closed-loop control programs required for them. The use of new control concepts available increases the resulting product quality. Furthermore, the optimization algorithms used increase the yield of the wind turbine concerned.

Solutions that were developed with M-Target for Simulink® come into their own in this discipline. The MATLAB®/Simulink® program from MathWorks is a well-established platform on the market, which is ideal for closed loop



More on this topic is provided on our website



Simulation: Solution development on the computer model and direct download to the Bachmann controller.



design with M-Target for Simulink[®]. The software package provides an extensive range of toolboxes and help for creating the simulation model. It also provides interfaces to other domain-specific simulation programs, in which subsystems were already simulated. The functionality of the entire model is then checked and adjusted until the required results are achieved.

Automatic code generation

In line with the model-based development methodology, the Bachmann controller code is then generated directly out of the simulation model. The code is generated here at the push of a button and installed with M-Target for Simulink[®] as a separate software module on the Bachmann controller. This process is fully automated and does not require any subsequent parameter setting on the controller. In this way, any subsequent compilation and configura-

tion errors are excluded from the simulation from the start. The programmed controller is then available for use in an Hardware-in-the-Loop (HIL) test setup, including regression tests, or can be operated directly in conjunction with the actual plant. The generated code can alternatively be processed in the context of an IEC61131-3 or C/C++ application if required, for which M-Target for Simulink[®] can generate libraries directly from the simulation model.

Cost optimized

The ability to also equip complex plants with advanced automation quickly offsets the inexpensive initial investment required. A transparent license model that does not require any quantity-based runtime licenses also simplifies the pricing of a completed wind turbine. M-Target for Simulink[®] thus makes an essential contribution to the aim of "bringing better goods to the market faster".

Efficient and Future-Proof

— *Wind Turbine Template*

The Wind Turbine Template (WTT) software package is tailored to the requirements of wind turbine manufacturers. It helps to considerably reduce the time required for developing and commissioning the controller software and the visualization. WTT from Bachmann electronic covers many standard tasks required for the automation of a wind turbine.

The faster a wind turbine can supply power to the grid, the sooner it can be paid off through the yield. For this reason, time-to-market is one of the most critical factors for financial success, irrespective of whether a new plant is being built or an existing plant is being converted or extended. The development of the operational control software is a key element of the required work: This software integrates the expertise on a wind turbine to control the main functions of the turbine.

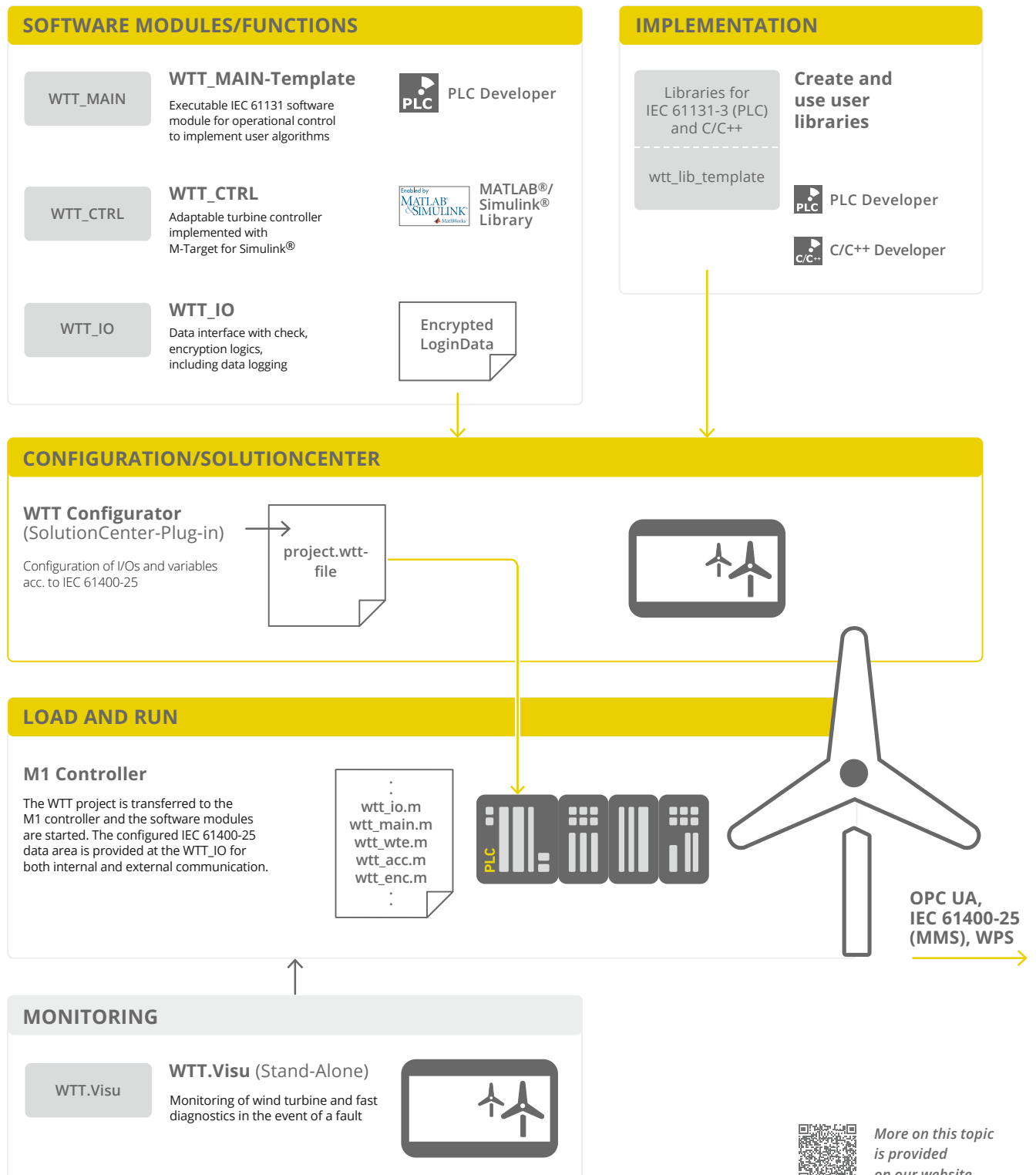
The WTT software framework contains the most important structures and functions for the operational control of a wind turbine and offers a kind of editable template. Based on the IEC 61400-25 data model, the template provides all plant components (nacelle, rotor, converter, generator, etc.) with their data structures and variables. Functions for data logging, trends, wind rose, power curve, login, fault and alarm handling are also ergonomically integrated. The design of the structures is so open that users can implement their own functions or if necessary change the functions provided. This also ensures know-how protection. The modular design enables unit testing, i.e. functions and libraries

are inherently tested, thus shortening the final testing required for the entire plant software. The sensor and actuator interfaces as well as access to variables or other specifically implemented software are defined with a configurator and can thus be easily adapted to the requirements of the plant. The functions and libraries are programmed with the SolutionCenter in IEC 61131-3 standard language, in C/C++, or with MATLAB®/ Simulink® using Bachmann's M-Target for Simulink® interface. The user is provided with a freely configurable turbine visualization as well as the OPC UA/DA and IEC 61400-25 interfaces for connecting to SCADA systems. All the necessary configurations for Bachmann's Wind Power SCADA are already generated as well, and the entire data structure of the turbine is depicted in the SCADA in an instant.

Reducing expenditure

The Wind Turbine Template covers the requirements of the basic software packages of a wind turbine. The openness of the structures enables the user to make modifications. Tested, reusable software modules considerably reduce the engineering, increase plant safety and availability and shorten the time to market.

WTT Architecture – IEC Standard "Ready-to-use"



More on this topic
is provided
on our website



SCADA – the Smart Generation



— Wind Power SCADA (WPS)

With Wind Power SCADA (WPS) Bachmann is bundling its expertise in the area together with a long term and flexible SCADA solution based on pure web technology. Regardless of the terminal devices used, plant operators can gain a fast and comprehensive overview of the entire wind farm – right through to the detail of each single turbine.

Wind Power SCADA (WPS) is the perfect addition to Bachmann's Wind Turbine Template (WTT) software controller platform, which provides the most important structures, components and functions for the operational control of a wind turbine, and makes these available in the form of IEC 61400-25 data structures. This considerably reduces the development and commissioning times required both for the control software (operational control program) and for the creation of the necessary visualization. WPS is based on atvise® scada (generic SCADA platform) – a field-proven product from Bachmann subsidiary Certec and thus a visualization system built with pure web technology. All types of visualization devices such as smartphones, tablets as well as PCs and powerful operator

terminals – can be connected at the same time. This is implemented simply with a standard web browser, without any need of special add-ons such as plugins, ActiveX, Java or Silverlight. Through the use of SVG graphics it is also possible to implement responsive web design, so that only one engineering process is required for all platforms. WPS offers complete integration for the user at all levels. The number of levels can be configured as required so that both smaller units as well as large wind farms can be created and displayed clearly. A wide range of modern display elements, graphics and diagrams support the user in monitoring parks and turbines. Dashboard views on all levels enable users to create their own working environment.



▼ **For history and plant comparisons:**
Flexible window arrangement



▼ **In-depth plant access:**
WPS: Tablet/Smartphone view of wind farm

BENEFITS

- *SCADA system for wind turbines*
- *OPC UA standard communication protocol*
- *Standardized data structure acc. to 61400-25*
- *High, seamless scalability, open system*
- *Online creation of custom widgets*
- *Online dashboard configurator*
- *CMS ticket display*
- *Automatic scaling of the graphic resolution for PC, tablet or smartphone (RWD)*
- *Standard user management for SCADA and turbine via online configurator*
- *Online/offline trending*
- *Online language selection*
- *Alarm and data history via an SQL database*
- *Active status/access control*
- *CMS ISO VDI3834 data integration*
- *Individual Reporting*



More on this topic
is provided
on our website

Convenient data handling

WPS is based on a consistent implementation of the OPC UA (Unified Architecture) communication standard. Process variables are standardized thanks to the use of data structures compliant with IEC 61400-25. When linked to the Bachmann controller, live process data can be displayed to IEC structure already prepared. This object-oriented concept in atvise® scada reduces the programming required, is more structured, more compact and easier to maintain and expand. Commissioning and maintenance in particular are considerably simplified, since WPS offers a full range of analysis options for the recorded data (sorting/filter functions), including elements such as power curve, wind rose or event-controlled snapshots and energy meters (measuring of generated and consumed active and reactive energy).

WTT's highly dynamic data logging concept also helps the user in WPS. The long-time logging recorded on the Bachmann control system, for which each individual data point can be configured via WTT, can be analyzed in WPS with powerful diagram components. The WTT logging function can also be used to create highly granular event-driven recordings. This makes it possible to assign one or several events or turbine states to each data point – logically linked for triggering a data recording. The sampling rate for logging the value of each channel can be set individually, and also the pre-trigger and post-trigger time of the recording.

This configuration work is worthwhile since it enables a precise evaluation of the plant fault using the above mentioned diagram components by simply clicking in the alarm list of the WPS. If, however, a channel is missing for the subsequent in-depth analysis, this can be added from the long-time logging data pool (SQL database) and included in the same diagram. The diagram also offers functions such as the setting of markings, the display and hiding of curves, the highlighting of individual lines and the assignment of different curves to a y axis. The configuration changes made can naturally also be saved and called up later. In order to make comparisons, the power curve and the wind rose can be displayed separately for each individual turbine, as well as together in a single image for an entire wind farm. An

online trend component enables live process data to be read and compared across several plants and parks in the form of a trend diagram. The configuration can be carried out online WPS at any time. The standard process values of a plant can be already preconfigured and accessed via a selection box to help with the start.

Simple, specific and nevertheless open

The WPS is designed using the atvise® builder tool. The IEC 61400-25 compliant object structure enables the user to design the required elements simply. As with atvise® scada, the data points are linked in the Builder by browsing an OPC UA data source in the atvise® builder. The standards compliant preparation of objects, as well as the use of the generated WTT configuration files makes it possible to engineer a specific turbine type clearly, quickly and easily. The scripting functionality as well as all the other benefits of the atvise® builder can likewise be used for designing a WPS project. A comprehensive library offers a wide range of ready-to-use components specifically designed for the wind sector. The turbine instances created in this way can be added to the visualization using drag and drop.

Historization and reporting

WPS uses some of the functions familiar to users of atvise® scada, such as alarm handling, historization, trending and language selection. The historization function of the Wind Power SCADA sector product has been updated to meet the requirements of customers from the wind energy sector. The turbine data is firstly recorded directly on the controller via the Wind Turbine Template logging function and then transferred to an SQL database on the SCADA server according to definable criteria. This data can then be displayed easily in the WPS and examined in greater depth with the analysis tool. If necessary, the SQL database can also be accessed via other tools if it is necessary to link the database or relay the data to another higher-level system.

In terms of "report generation/reporting", Bachmann's Wind Power SCADA also answers the increasing requirements of our customers in the wind energy sector for reports that are

Customizable turbine / park views configured at a single location



Pure web technology with SSL security and "token" based access

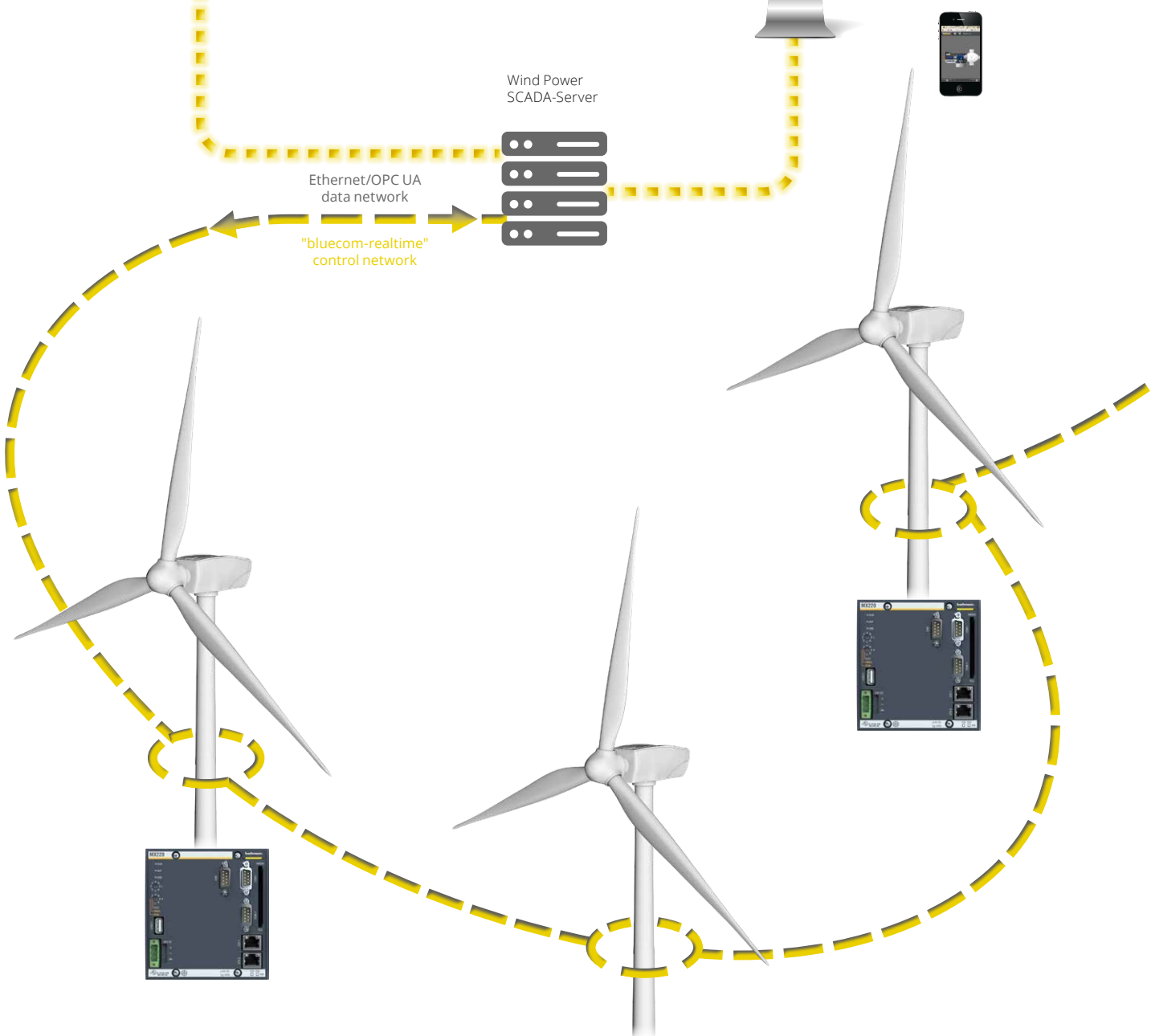


Wind Power SCADA-Server



Ethernet/OPC UA data network

"bluecom-realtime" control network



Bachmann Gateway

Integrate turbines from multiple manufacturers to the same SCADA network with our gateway solution



Turbine controller interface

BENEFITS

- *Any browser-based device becomes an HMI*
- *Value displays with high refresh rate*
- *Loss-free scaling on all screen sizes*
- *As safe as Internet banking (HTTPS)*
- *Short refresh in the browser instead of time-consuming software rollouts*
- *Use of the application on different devices (smartphone, tablet or stationary HMI devices)*
- *Integration in higher-level SCADA applications*

as flexible as possible. The dashboard views already mentioned are used for this purpose. These are filled from a catalog by the user with information elements (widgets) and thus used firstly for the individual monitoring of the turbines/parks and also as a template for report generation. Each user can thus configure the content of their individual report. The PDF document can either be output directly in the browser or the automatic report generation can be configured directly online in the WPS.

User management and security

An online user management function in WPS provides the user with transparent and simple user management support. A login to WPS is all that is needed to access an individual turbine. The well-known security standards of the Bachmann controller are used here for transmission (SSL) and user management (groups/level) in order to prevent unauthorized access. An additional active status function ensures that several users do not have write access to the plant at the same time. The active status can be requested via WPS and the current access status is clearly displayed.

Secure and open

The physical transfer of data is encrypted and carried out via secure connections (SSL). The standard OPC UA interface also makes it possible to integrate external systems based on the IEC 61400-25 data model directly into WPS. Systems not supporting these standards can for example be integrated via a Bachmann controller used as a gateway. All the standard communication and fieldbus protocols of the Bachmann controller system can then be used here. These provide the basis for acquiring the process data of the wind turbine or implementing customized, proprietary solutions on the gateway controller.

Integration of condition monitoring

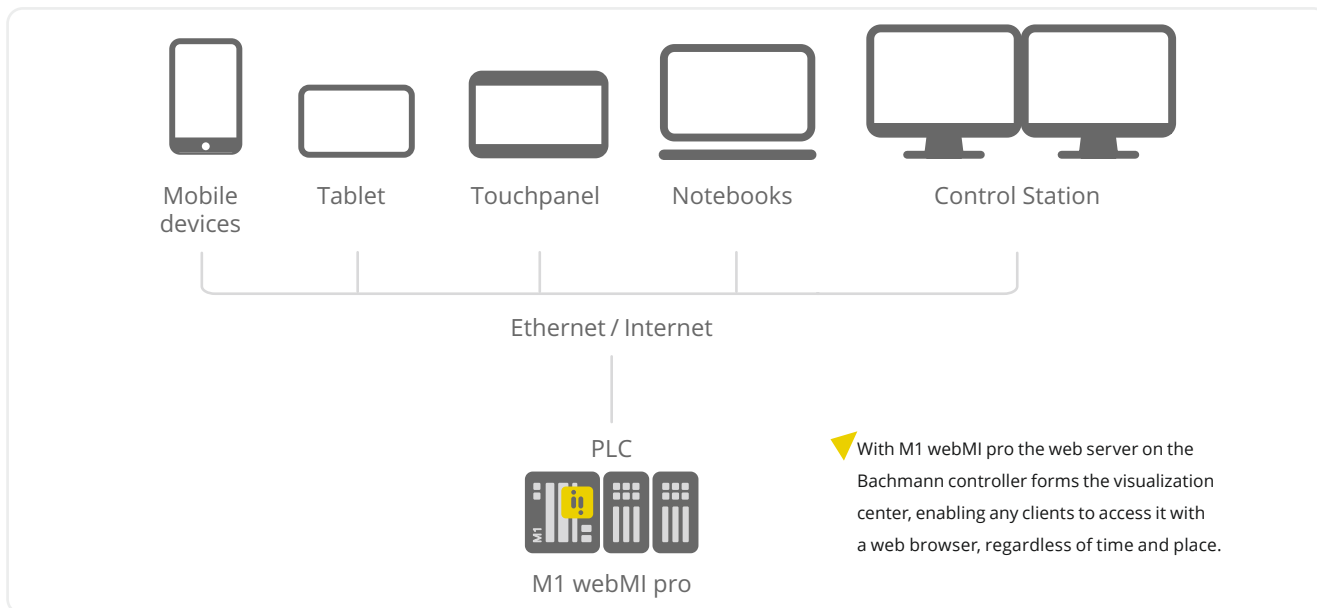
The integration of the Bachmann CMS provides WPS with the link to another important area of the wind sector: Condition Monitoring. WPS uses the data file of the Bachmann

CMS according to ISO VDI 3834. The CMS System submenu item contains a graphical representation of the drive train and the sensor positions, and indicates whether the ISO specifications have been permanently exceeded at different measuring points. The diagrams of acceleration and velocity values corresponding to the measuring points are also displayed. This display does not replace the proven analysis of the CMS Remote Service but acts as a useful indication tool for the user.

The WebLog ticket system (CMS) can also be accessed directly from the WPS. The respective tickets of the turbine components are displayed and a pre-configured trend display is opened for this purpose. This already contains the most important characteristic data of the monitored component and enables the user to display additional data from the database as well. These can then be reported back directly to the remote service via an e-mail interface.

Ready for the future with fewer costs

Wind power plants are becoming increasingly more complex. Their operation and monitoring involve increasingly more demanding requirements. This also increases the effort required for designing and maintaining the visualization, which has long required more than just local operation in the field. Connections to a control center, a separate visualization for tele-service and also some solutions for mobile terminal devices are now in demand. Often each requirement here has to be implemented with separate applications. Furthermore, the handling of different terminal devices and screen resolutions is also not possible with many visualization products. Not so with Bachmann WPS: For every operation level – from the control center to the farm management, right through to the individual turbine – the basis is provided for a simplified and flexible solution. Provided the necessary authorizations are in place, the application can now be accessed securely from almost anywhere in the world with virtually any display device.



M1 webMI pro

The widespread global use of Internet-enabled mobile devices has taken place at breathtaking speed. Their simple and intuitive operation is impressive. Internet and software applications no longer have a fixed location but can be used from anywhere in the world. With M1 webMI pro, Bachmann electronic is impressively demonstrating its technology leadership: Each Bachmann controller is turned into the central server for fixed or mobile HMI devices.

Pure web visualization for the Bachmann controller

Bachmann offers a powerful product for pure web visualizations called M1 webMI pro. A slim-line web server that is directly installed on the Bachmann controller enables the connection of any visualization devices such as smartphones but also powerful operator terminals. Provided the necessary authorizations are in place, the application can now be accessed from anywhere in the world. Thanks to M1 webMI pro, all the important information can be shown in a single view and with stunning definition. Perfect graphic results can be achieved on any visualization page without any losses in quality when scaling and zooming. This is thanks to the extraordinary benefits of HTML5 and SVG (scalable vector graphics), the basis for all graphic objects.

Engineering and maintenance – an important cost factor

Wind turbines are becoming increasingly more complex with ever increasing requirements. This also naturally increases the effort required for engineering and maintenance as well. It is often not only necessary to allow for local visualization in the field, but also for the connection to a control center, a separate visualization for teleservice and sometimes also solutions for mobile terminal devices. Often each requirement here has to be implemented with separate applications. With many visualization products, the handling of different terminal devices and screen resolutions is also not possible.

State-of-the-art project engineering and simple delivery

The Bachmann engineering tool atvise® builder is used for drawing process pictures, configuring animations and events as well as for other settings. A number of ready-made graphic objects and layouts, as well as the flexible reuse of pages using parameter transfers make it possible to create visualizations efficiently. Integrated editors even allow the drawing of new SVG graphic objects or the creation of additional functions with user-defined Java scripts. Once the visualization is completed, it is transferred to the web server via FTP with just a single click.

WEB PANELS FOR LOCAL VISUALIZATION

- *The powerful Bachmann OT1200 web terminal product series and M1 webMI pro web visualization are a perfectly matched complete package*
- *In only a few steps visualization is configured on the attractive and robust panels*
- *The brilliant displays are available with 7", 10.1" and 15.6" widescreen diagonals*
- *The system software was further developed for safety applications and can be maintained and updated remotely if required*



More on this topic is provided on our website

Modular, Flexible, Standardized

— *Smart Power Plant Controller – Certified Power Plant Controller
from Bachmann*

The key factor for turbine manufacturers and wind farm operators is high availability and consequently the maximum supply of generated energy. However, as the feed-in supply is subject to specific regulations due to national guidelines (such as FGW) and the requirements of energy suppliers, the provision of information on the characteristic values of the wind farm at any time is an absolute necessity. This specifically means being able to react to the values specified by the energy supplier, right through to the complete disconnection of the "wind farm" generator unit when there is excess power in the grid. The requirement of active "grid support" – feed-in of reactive power – must be ensured by the wind farm.

BENEFITS

- *Active/reactive power control method in accordance with VDE 4110/4120*
- *Primary control power and frequency control*
- *Power quality: Quality criteria for reactive/active power*
- *Frequency regulation*
- *Grid voltage monitoring and protection*
- *Monitoring of the NAPs and the cable load*
- *Integration of external components (e.g. compensation systems)*
- *Integration of non-controllable consumers (balancing)*
- *Grouping and prioritization function for PPCs/PGUs*
- *Freely configurable, smart data historization*

To survive the tough competition of the electricity market and also ensure the necessary financial amortization of the wind farm, direct marketers are also involved, who sell the electricity to the power suppliers at the current daily rates and thus ultimately to each one of us as well. This requires the wind farm to likewise send the ongoing data to the connected direct marketers in order to provide the necessary information to ensure marketing potential.

THE Solution: Smart Power Plant Controller

With its extensive hardware and software resources Bachmann offers THE solution for these tasks. An Bachmann controller with closed-loop control and data interface, together with our established technology module for GMP232 grid monitoring, form the Smart Power Plant Controller basic hardware

equipment. The Smart Power Plant Controller is also a certified power plant controller in accordance with VDE 4110/4120, and not only fulfils the required functions, but also special requirements from the renewable energy sector. Other hardware from the entire Bachmann portfolio can naturally also be added here for individual requirements. The closed-loop control is managed by programs of the Bachmann controller of the Bachmann automation system, which can be configured to meet specific requirements. Different program blocks and expansions for park control can be integrated as modules as required. When installed at the grid connection point, the GMP232 continuously measures the actual power output of the park and thus supplies the actual value for the controller. Besides the controller module, a distributor module for calculating the setpoints of the individual plants is also provided. This ena-



*More on this topic
is provided
on our website*

bles the display of simple evenly distributed power setpoints to all turbines of the park, right through to complex control algorithms, which for example monitor maintenance or wear. Another downstream software module manages the sending of the calculated setpoints to the turbines.

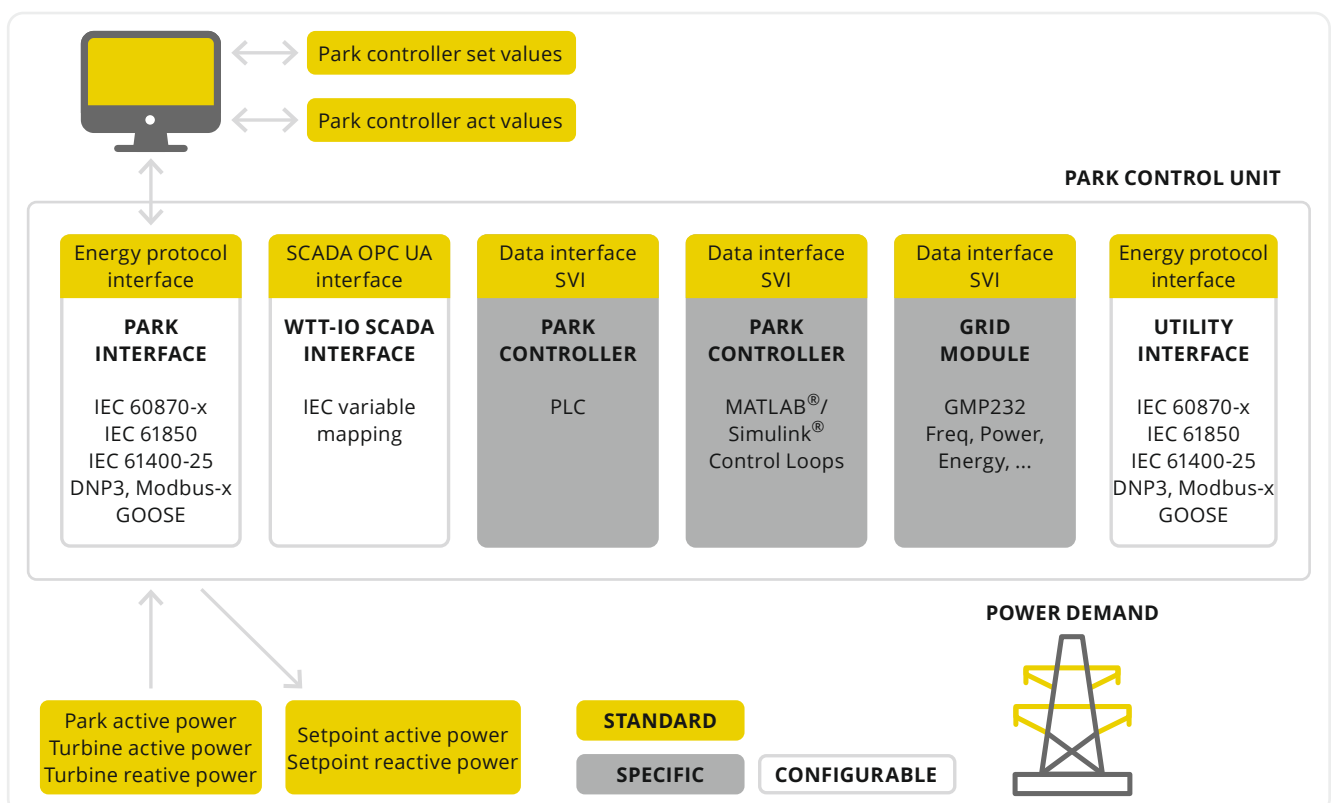
Data exchange via energy protocols and bluecom

Bachmann already offers all commonly used energy protocols (IEC 60870-x, IEC 61850, IEC 61400-25, Modbus-x, DNP3, GOOSE etc.) for the Bachmann automation system. This means that communication with the energy supplier or direct marketer only requires the presented data to be configured accordingly. The data exchange from the Smart Power Plant Controller to the individual turbines of the park can also be implemented with these protocols. If the requirements placed on the control performance of the park increase, another Bachmann solution can be used for park communication: the bluecom real-time park net-

working protocol. This also only requires a few configurations on the park controller and the turbine controller in order to provide reliable measured values for the plant, and for the rapid transfer of setpoints (within 20 to 50 ms) from the park controller to the turbines.

Furthermore, this product also features all the access protection mechanisms of the Bachmann solution. Secure data accesses and fast connections on one line are thus no longer a problem. Infrastructure and maintenance costs are reduced. Based on the Wind Turbine Template (WTT), the park controller software architecture is also designed as a modular template. Basic functions are thus already implemented and just have to be configured and assigned parameters. This is done via the web-based configuration and operation visualization, which is supplied with the Smart Power Plant Controller. The "open-source" structure also enables users to integrate their own functions both on the Bachmann controller and also in the visualization.

▼ **Smart Power Plant Controller architecture:** IEC standardized, configurable, flexible





Availability and greater Yield



Condition Monitoring System (CMS)

Our solutions combine control, communication, monitoring and visualization seamlessly into a comprehensive package. Bachmann automation solutions thus give you the essential value addition. For your success – and for the energy supply of the future.

Condition Monitoring involves the monitoring of the machine state in general, either continuously or at regular intervals through the measuring and analysis of significant physical variables (e.g. vibrations, temperatures, condition of lubricant etc.). The online comparison with reference values provides information for drawing conclusions about the actual condition of gears, generators, roller bearings, rotors and other hardware components.

Repair before it's too late

Condition Monitoring enables condition-based maintenance at a wind turbine. The preventive maintenance philosophy, involving the exchange of components within fixed time intervals and based on empirical values, is replaced by a condition-based maintenance strategy. This provides you with a clear financial edge.

Benefit: Integrated CMS solution

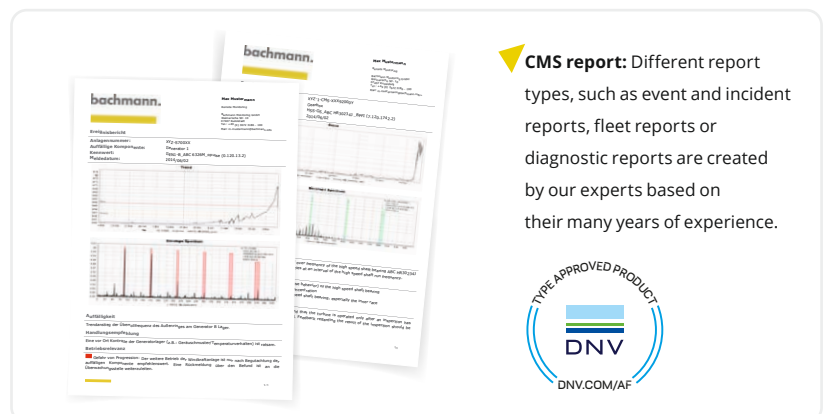
Bachmann integrates its Condition Monitoring Solution in the automation and links the measured values to other operating parameters. This increases the diagnostic reliability of the Condition Monitoring: Fault patterns can now be compared to the current operating situation and interpreted with greater accuracy. The control system of the turbine can use this information for reducing the mechanical loads of the machine. With adjusted operating conditions the lifespan of partly damaged parts can be extended up to the next planned repair date.

Certified safety


All the system components used for Condition Monitoring, including the online remote Monitoring Center are certified in accordance with the regulations of Germanischer Lloyd (GL). Bachmann automation components are furthermore provided with several internationally recognized approvals for use in wind turbines and offshore applications.

Online Condition Monitoring is worth it

The replacement of a bearing requires a planned downtime of the wind turbine of around one to two days. If wear damage was not detected in time, this sudden downtime can easily be ten times longer. For this type of event, material and personnel first have to be organized and brought to the plant.



CMS report: Different report types, such as event and incident reports, fleet reports or diagnostic reports are created by our experts based on their many years of experience.



Sudden breaks are also often caused by higher wind loads during strong wind periods and consequently high power production periods. If the sudden break causes consequential damage to components, which, due to their size and dimensions, can only partially be repaired, additional expenditure is required. For example, having to use a crane for a repair of an offshore turbine represents a huge expense, especially when it is unplanned.

Preventing consequential damage

Condition Monitoring provides reliable information about the state of important mechanical and electrical components of the wind turbine. This makes it possible to detect any faults early as well as preventing any possible consequential damage that would mean a lengthy downtime of the installation.

Risk protection

Condition Monitoring gives operators, investors and insurers a practical and transparent view of the condition of the plant – and, therefore, also of the expected risk of damage. This is particularly important when commissioning or at the end of the warranty period when service contracts and insurance premiums have to be recalculated.

Expertise in system solutions

Thanks to its many years of experience in the field of CMS, Bachmann is able to provide expert advice in Condition Monitoring. Bachmann

is also able to supply the cables required for the measurement technology, measuring modules and the evaluation software. A team of experts monitor 10,000 plants and report the relevant plant status.

Mobile measurements (offline)

Mobile measurements in the field are also possible, for example, as part of the installation acceptance or routinely at the end of the warranty period. For this, Bachmann will install the required sensors for monitoring vibration on your wind turbine for an agreed period in order to monitor selected characteristic values. Experienced analysts prepare the measured data and supply a meaningful status report on the condition of the monitored components. With offline measuring, our customers also benefit from the experience of our analysts, who have a detailed knowledge of over 80 plant types with an output range of 600 kW to 8 MW. It is now possible for the first time to effectively connect Condition Monitoring with a SCADA system for plant evaluation. This implementation is based particularly on the requirements of VDI 3834 and DIN ISO 10816-21. This provides at the same time the possibility to protect the operation of large turbine groups and effectively enhance the SCADA data with CMS.

CMS upgrade – the CMS solution

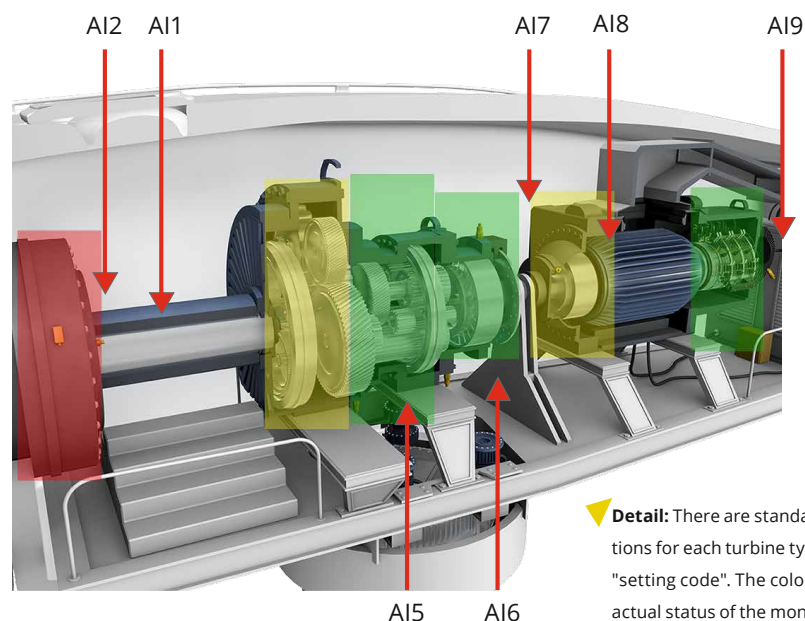
Condition Monitoring Systems are increasingly being used as a preventive measure. They enable any impending damage to wind turbines

BENEFITS

- *Reduction in maintenance costs through coordinated planning, timely procurement of spare parts and prevention of significant hardware damage*
- *Securing of electricity generation and power production optimization through selective and planned maintenance, e.g. in times of weak wind*
- *Greater utilization of the lifespan of machine elements thanks to accurate condition information*
- *Practical risk assessment in relation to the failure of important wind turbine components*



More on this topic is provided on our website



Detail: There are standard sensor configurations for each turbine type defined by a "setting code". The color coding shows the actual status of the monitored component.

to be detected and corrected early on. Bachmann has met the increasing demand for this with a PLC-integrated system solution that enabled the logging, analysis and evaluation of the plant condition in parallel with the PLC program. The Retrofit CMS is an alternative Condition Monitoring System that is particularly suitable for upgrading wind turbines: The CMS module here runs independent of the controller, either as a complete stand-alone solution or as a TopBox variant in an existing control cabinet. The interest of the wind energy market is considerable, as confirmed by Bachmann's current orders.

Complete offering and high expertise

Besides the special hardware and software, Bachmann's system offering includes a worldwide Monitoring Service, provided by its German subsidiary, Bachmann Monitoring: The diagnostics specialists based in Rudolstadt in Thuringia, Germany, analyze the measured data collected with the CMS module and compare it with reference data. This enables them to not only provide plant operators with verified fault reports, but also provide an evaluation of the current condition of their plants components. The experts at Bachmann Monitoring can rely on 25 years of experience with their analysis processes: proven on 10,000 wind turbines of over 27 different OEM customers that they currently monitor.

1. Stand alone solution

Besides the power supply for the CPU and the measuring module, a separate control cabinet houses two modules (sensor and processor module), and provides the option to retrofit a communication unit (e.g. router) as well as all relevant components for the sensors.

2. TopBox solution

PLC-independent mounting in the existing control cabinet, few hardware and installation requirements.

3. Fully integrated solution

Integration in the existing Bachmann controller environment as well as in the existing control panel, few hardware and installation requirements.



Communication with WebLog Expert®

WebLog Expert® is the web-based front end of the Bachmann Condition Monitoring System. It functions as the communication interface to the diagnostics system and enables the secure and location-independent access to the condition data of the wind turbine. When predefined limit values are exceeded, WebLog Expert® triggers an alarm message, which is displayed in a status window and which can also be sent by email. Extensive tools for signal analysis, such as envelope spectrums, amplitude spectrums, or frequency-based characteristic values support the diagnostics specialist in detecting and interpreting changes in the characteristic "healthy picture" of the monitored components.

Integrated trend analysis

An integrated database enables the trend analysis of the data recorded from individual machine components and units over an extended time period.

Acoustic monitoring

As well as convenient and clear visualization, WebLog Expert® also provides the possibility to make sensor signals audible. In this way, irregularities in the measured spectrum can be assessed acoustically – without, for example, having to travel to the offshore wind farm itself. This very often enables any actual fault to be identified quickly.



Fast and Efficient Retrofits

— *Repowering or Retrofit?*

A new installation or an upgrade? This is often the question in the sustainable environment of renewable energy. With many turbines, especially those with high costs, a targeted technological retrofit and upgrade makes more sense than a complete repowering of wind turbines with new ones. This is particularly the case if the operator can use a modular retrofit system that enables a rapid and simple upgrade. Retrofit is based on the following principle: change only the essential parts with as little impact to the whole system as possible, taking commercial factors into account to increase production and availability. And this with a break in production of only a few days.

As of the end of 2020, the wind capacity of 220GW installed in Europe provided a 16% share of electricity (Source: WindEurope Annual Report 2020). This is a value that needs to be increased significantly. Moreover, many of these plants have already been in operation for more than 10 to 15 years, so that modifications and upgrades are required in order to ensure reliable and economically viable operation. If warranty times and maintenance contracts have expired and the technology becomes increasingly obsolete or no longer available, a retrofit is the logical alternative to repowering or installing a new wind turbine.

Bachmann's special advantage? The operator receives a tailored retrofit solution for the automation of the turbine in order to upgrade the operation of the existing machinery. This is based on a modular automation platform with a pool of hardware and open source software that is configured to individual requirements. The retrofit can not only increase turbine life by five to ten years. The wind turbine is optimized so that its serviceability, availability and power production can be improved

thanks to the new technologies (CMS, grid measuring/monitoring, safety technology) and additional data transparency.

Specialists as partners

As specialists in the automation, closed-loop control and operational control of wind turbines, Bachmann is a reliable partner, offering consulting, service and technology from a single source. Operators in the wind power sector benefit considerably by identifying potential optimizations and access to already existing systems.

Intelligent retrofit

The intelligent controller retrofit solution brings wind turbines up to date with state of the art technology. Any fault prone or obsolete components are replaced, increasing plant reliability. The turbine is then made technologically fit for the future since Retrofit is geared for long-term operation. Through the use of innovative controller systems combined with integrated monitoring functions, potential for increasing the production of the power plant is identified and the systems are then enhanced with long lasting technologies.

The result: reduced turbine mechanical load, increased turbine lifespan, increased safety, improved turbine output and availability. In order to increase turbine efficiency, ensure operational reliability, reduce maintenance and service costs and secure access to proprietary data, the entire controller system is renewed.

Efficiency thanks to a modular system

Bachmann Retrofit is based on a modular, scalable basic system of software and hardware covering the basic functions. Individually configurable modules are already prepared for all the necessary plant functions such as visualization, networking, closed-loop control and diagnostics, in order to ensure flexible integration and parameterization. Most modifications to turbine specific functions and components can be configured. Thanks to the open source platform, it is also possible for the operator or service company to carry out the adaptations, provided the appropriate access rights and knowledge are available. A turbine or operator specific retrofit is not only more economical than a new investment, the solution can be implemented faster and more easily by accessing the existing components. Any expenses for training seminars becomes lower since the turbines are already known. The modules naturally also comply with the necessary industry standards.

Systematic Bachmann concept

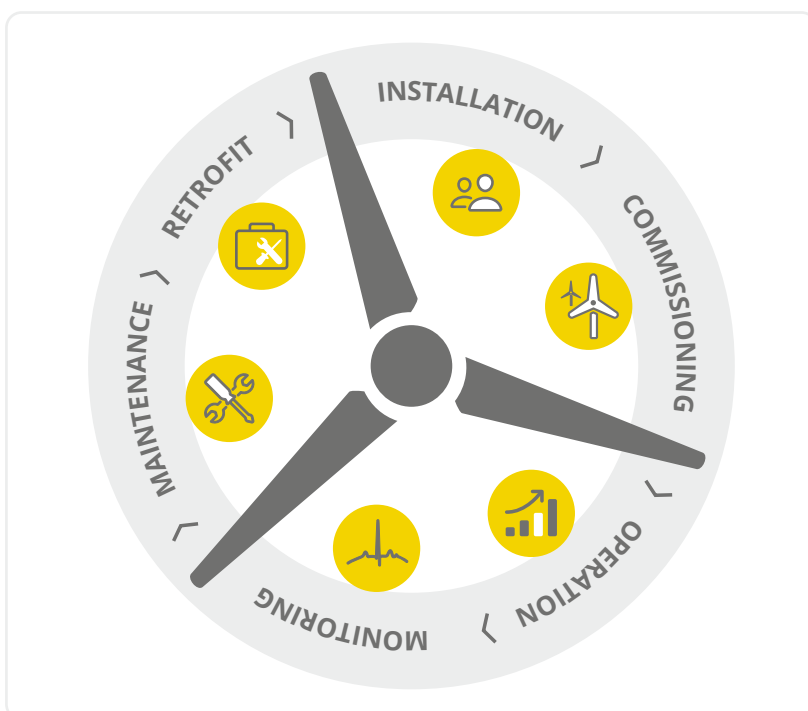
Analyze, develop, implement and use within a few days. This systematic process enables Bachmann to convert or retrofit wind turbines quickly and cost-effectively. This requires comprehensive documentation of the technical specifications of the plant, the sensors and actuators, as well as load calculations. An analysis of existing components and requirements of the installation is carried out first of all. A survey is then carried out of the cabling and mounting options in the existing control cabinets of the wind turbine in order to optimize their use. Pending questions on issues such as the grid connection are clarified and the retrofit is then planned. The design and implementation of the turbine software are critical factors. This includes the interfaces to the turbine components, the general operating sequence of the turbine and the control of the generated output. It also provides information about the state of machine components, monitors and responds to alarms and fault states, and ensures an optimum energy yield.

The implementation is completed virtually without any interruption. Bachmann allows an average project lead time of around one year for analysis, concept development, implementation and prototype commissioning of the controller retrofit for a turbine. With the right preparation, the actual upgrading of the plant with the hardware and software for a new control system only takes up to a few days, during which time the turbine is not connected to the grid. A retrofit is also advantageous with regard to turbine certification, since this lengthy and costly process is often only required for new installations. A retrofit is thus often preferable to repowering, particularly where a new build would require extensive approval processes.

Independent data access

Access to plant data is required in order to ensure that the basic upgrade and retrofit are completed correctly. For example, if original components have to be replaced that are no longer available, the controller will require new parameters for the replacement parts. This is only possible by having access to the software and parameter sets – something that manufacturers do not always allow. From the outside, the entire plant often presents itself as a black box with data that is not transparent or only partially. There are therefore good reasons for replacing the entire control system for the wind turbine with a custom system. By using an

▼ An intelligent upgrade – a retrofit is the start of a new life cycle for a wind turbine.





ANALYSIS, CONCEPT & IMPLEMENTATION

Implementation:
approx. 6 months



RETROFIT

Installation of
controller retrofit:
a few days



COMMISSIONING

Greater efficiency & fewer failures due to:
Openness & flexibility
Preventative CMS
IEC data structures

Plant running

Plant downtime

Plant running

With suitable preparation, the actual upgrading of the plant with a new controller system only takes a few days, where the turbine is off-line from the grid.

open system for him, the operator has access to all the necessary data and has the flexibility to modify and optimize their system.

Proven hardware and software system

Bachmann solutions are based on the Bachmann automation system, the central hardware element of the control, monitoring and networking of the turbines, the PLC software and other application functions, such as monitoring or visualization. The Wind Turbine Template (WTT) software framework from Bachmann electronic provides the most important structures and functions for the operational control of a wind turbine, and uses basic software modules to enable a fast and configurable implementation. Based on the IEC 61400-25 data structures, the template provides the user with all plant components (nacelle, rotor, converter, generator, etc.). Functions for data logging, trends, wind rose, power curve, login, fault and alarm handling are also directly integrated. The design of the structures is so open that users can implement their own functions or if necessary change the functions provided

at any time. The sensor and actuator interfaces are defined with a configurator and can thus be flexibly adapted to the requirements of the plant. This therefore enables considerable time and cost savings to be made.

Functions for increased efficiency

A retrofit also implies the integration of new functions in the plant that previously could not be used. These include Condition Monitoring Systems which are being increasingly implemented as a preventive measure. Condition Monitoring enables the early prevention or detection of any impending damage to the wind turbine, which leads to the efficient planning of any required cost. For this, Bachmann provides a system solution that is directly integrated in the PLC. This records, analyzes and evaluates the status of the turbine status parallel to the PLC program, and is one of the highlights of the Bachmann automation system. There is also an alternative CMS retrofit version which runs independently of the controller environment, either as a complete stand-alone solution or as a TopBox variant in an existing control cabinet.

BENEFITS

- *Extended service life*
- *Lower investment costs than with a new installation*
- *Short installation time*
- *New functions*
- *No new approvals required (depending on the plant and size)*
- *Manufacturer-independent*
- *Increased operational reliability*
- *Increased productivity through tailored retrofit solutions*
- *Flexibility thanks to a modular system*
- *Greater efficiency*
- *Prevention of failure and faults*



More on this topic is provided on our website

Access Rights and Security

— State-of-the-Art Security

The need for greater security in wind turbines is continuously increasing since any unauthorized manipulation of processes can result in serious damage. Furthermore, the full logging of interventions is a statutory requirement in the energy sector. Access permissions in the Bachmann automation system define who is allowed to perform actions at system, file and variable level. These can now be defined and managed even more simply.

Plants are controlled at the device level, using mobile devices or from a central control station. Operators, plant owners, process engineers, service technicians and many other plant users have completely different perspectives, interests and needs with regard to data access. The principal aim of rights management is therefore to assign each user according to his role with the correct read and write access rights to process variables as well as to the file system of the controller. This also makes it possible to prevent important data and parameters from being manipulated by unauthorized persons or even accidentally. The security functions of the Bachmann controller were therefore provided with more convenient configuration options in the SolutionCenter.

Group formation

Access rights were previously implemented using levels: The higher the level, the more rights the user had. However this can no longer fully cover the wide range of different applications. Part 8 of the IEC 62351 standard (Data

and Communication Security) describes a "role-based access control": Users are assigned to a group with privileges of Viewer, Operator, Engineer or Installer, depending on their role. The configuration of user rights was therefore fully overhauled in the SolutionCenter with this in mind, with groups and their system rights as a prime objective. Users are now no longer created with different individual rights but are assigned to groups to inherit the associated rights. These roles can be defined by the user as required. The existing settings are also available for actual configurations.

Detailed file and variable rights assignment

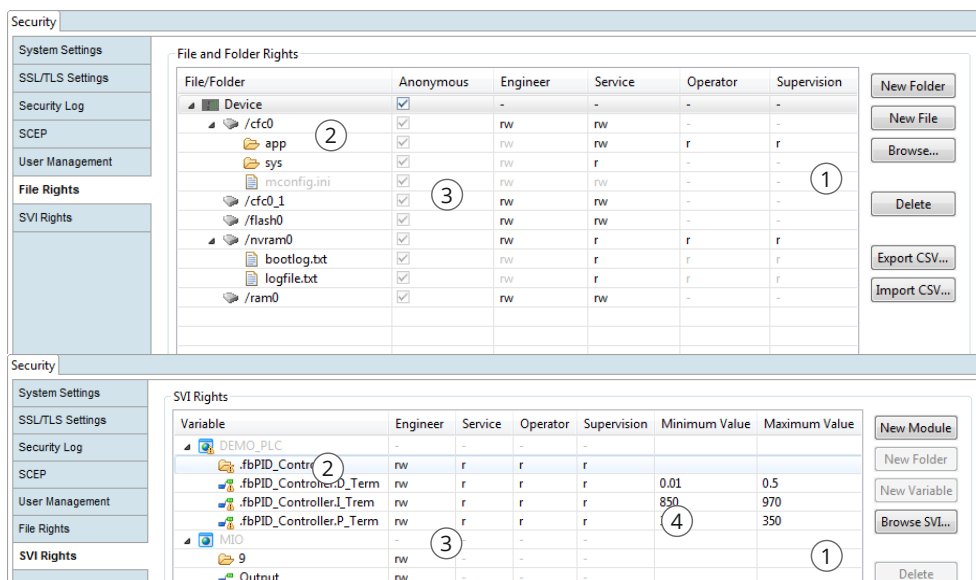
In a second step, rights to files or file paths are assigned to the individual groups. This enables read and write authorizations to be issued at the drive (USB stick, CF card, etc.), directory or individual file level. An intelligent inheritance concept mostly only requires a few entries here. SVI variables on the Bachmann automation system make process values from

BENEFITS

- *Data and partition encryption*
- *Cryptographic process for application programming*
- *End-to-end encryption via SSL*
- *Dynamic password generation*
- *Access protection at variable level*
- *Memory protection*
- *Security logging in the operating system*



More on this topic
is provided
on our website



Management of file and variable rights:

- (1) Individual files and variables or entire folders can be selected with a browser for rights management.
- (2) The display is implemented in a clear tree structure.
- (3) Inline editing enables the assignment of read and write permissions directly in the list with a high degree of granularity.
- (4) Variables can also be restricted in their value range.

the application available to the outside world. Actual values (temperatures, speeds, operating states etc.) are mostly set as "read only" in the variable declaration. It makes no sense to set these values from outside, regardless of the user role. However, it is now possible to assign rights as required: Individual read and write authorizations can now be assigned to individual process variables depending on the group to which the user belongs. As with file rights, the inheritance concept also applies here. However, the hierarchy is not structured according to file paths but according to software modules and instances of function blocks. It is also possible to define input limits for selected variables.

When the user logs into the controller, the Login Checker determines the Group and Level attributes of the user and from then on takes this into account in all activities. Whether the user wishes to make use of the plant visualization, the SolutionCenter engineering tool or a standard communication such as OPC UA

therefore does not matter at all. The rights control is always active, irrespective of the access path. If required, all activities from outside are permanently recorded in the security log: For example, if a SCADA or ERP system write accesses a variable via OPC UA, information such as the user name, time or original and new values are stored. All logins and interventions are also visible in an online monitor in the SolutionCenter.

One version for everyone

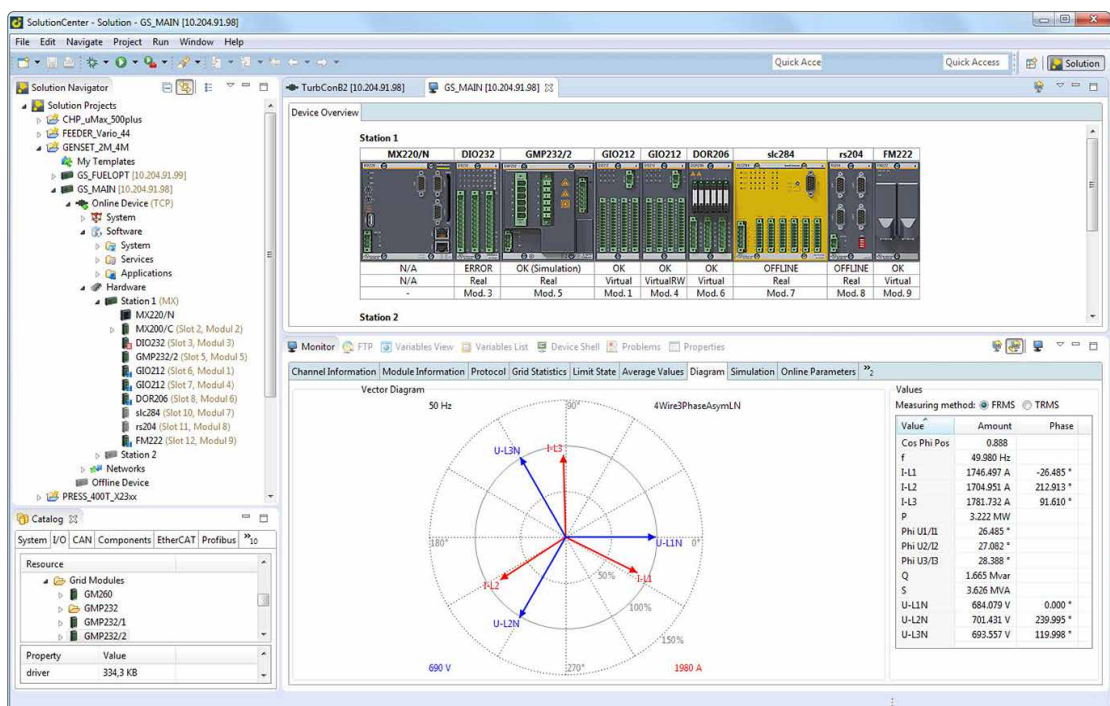
Groups, users and their access rights are defined completely independently of the application development and can be finalized before the delivery of the system or even not until commissioning. This means that any customization of rights does not require the operational control software to be recompiled, tested and archived in different versions: The same software version can always be delivered. For plant builders this means that the solution implemented in the SolutionCenter can therefore offer yet another key benefit.

Modules for Grid Measurement

Energy Management

Wind turbines are faced with some demanding requirements in terms of grid compatibility. All the relevant data of a three-phase supply grid must be recorded with high precision, and critical grid conditions detected reliably. The latest grid codes must be observed in order to ensure the stability and availability of the electrical supply. The GMP232 grid measurement and protection module from Bachmann provides operational control, grid measuring, quality monitoring, protection and a fault recorder integrated in a single unit.

Configuration and display: Power quality values, such as harmonic spectrum or various distortion factors, can be displayed immediately in the SolutionCenter without the need for any programming, or read via the application program.



Extensive grid and plant protection with the GMP232

Besides the reliable implementation of standards compliant grid and plant protection, wind turbine operation also requires the high precision and robust measuring of all grid data.

High dynamic measuring

The GMP232 supplies r.m.s. values, power values and data in compliance with IEC 61400-21 as fundamental positive sequence values. All measurements are also output in accordance with DIN 40110-2 as TrueRMS and fundamental values. The special design of the module continuously processes the grid data in a moving window for highly dynamic control and ultra-fast monitoring responses. This gives the users the unique ability to select the optimum effective value or power metric as required for the task. The integrated permanent frequency analysis according to IEC 61000-4-7 offers the harmonics up to the 50th harmonic, as well as global distortion characteristics such as THD/TDD for monitoring the quality of the grid and fault diagnostics.

Grid and system protection

A range of 40 configurable monitoring functions enable the required combination of grid and plant protection to be set up easily. All the protection functions required by standard grid codes are provided. This ranges from multistage time independent voltage and frequency protection to Q(U), right through to phase shift monitoring. Time-dependent func-

tions for LVRT and HVRT (low / high voltage ride through) for dynamic grid support can also be configured easily via configuration points. The modules of the GMP232/x series have been extensively tested by TÜV Nord (German Technical Supervisory Association) and have valid component certificates (grid code compliant) in accordance with international standards: BDEW guideline, FGW TR 3 & TR 8, ENA ER G99, IEEE C37.90.

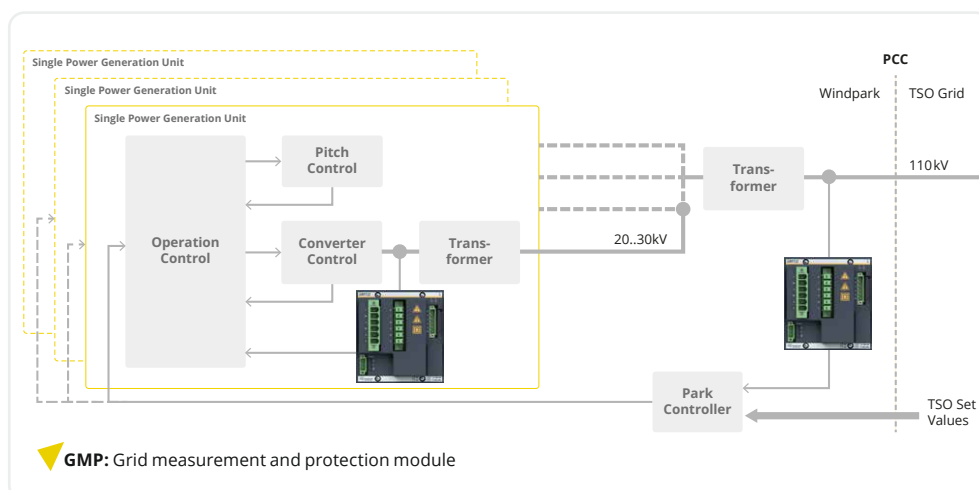
Data management

To prevent the overload of higher-level data collectors such as control centers or global service portals with a flood of data, the GMP232 can aggregate data automatically. The measuring and calculation values are then evaluated directly on the source data level at adjustable intervals in terms of minimum, mean value and maximum. An integrated network statistics function logs all extreme values with their corresponding time stamp.

Fault diagnostics

The time sequence data can be recorded at a resolution of up to 100µs, either manually or when a protection function trips. The adjustable pre-trigger thus also enables the time leading up to the fault to be recorded. The fault recording can be saved in the SolutionCenter or directly by the application program in the established COMTRADE format (IEEE Std. C37.111) or passed on. Each protection event is recorded in the event memory, together with all time stamps, which can be synchronized externally.

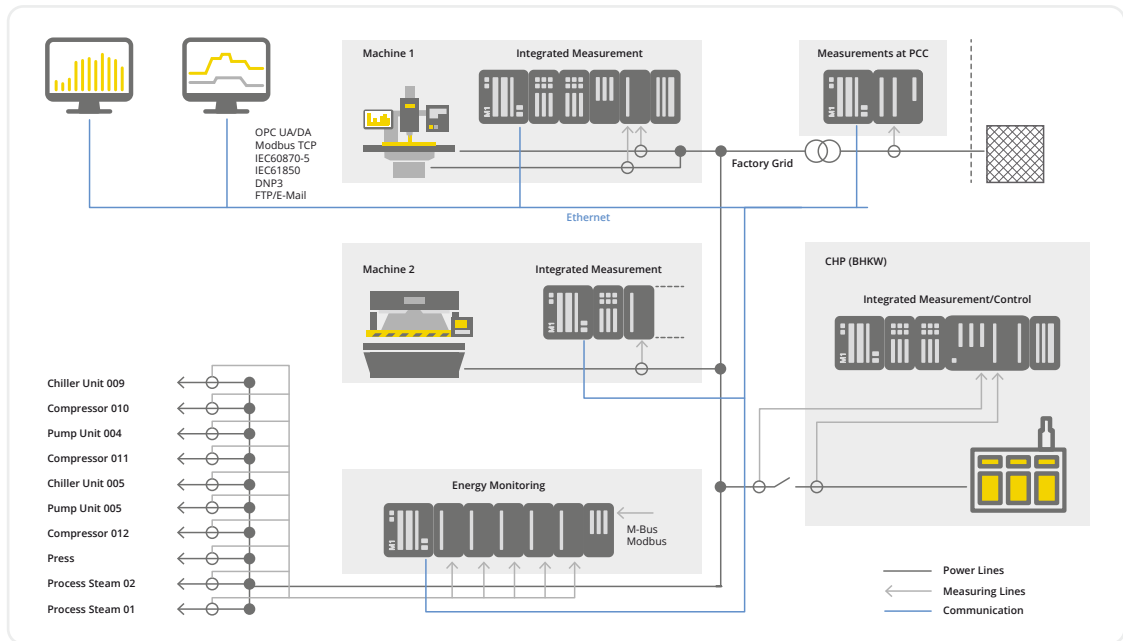
GMP232



- Positioning of the GMP232 directly at the grid feed-in point of the wind farm
- Earliest possible detection of critical fault situations
- Direct forwarding of setpoint values from the park controller to the individual energy generator units
- Fastest possible transfer of adjusted active and reactive power settings to the specific generator type
- Prompt initiation of appropriate countermeasures



More on this topic is provided on our website



Plant integration with synergy

The energy modules of Bachmann electronic guarantee the reliable and fast measuring of all essential grid variables for a wide range of applications. From operational measurement directly in a production machine to the monitoring of entire distribution panels, right through to higher-level power quality monitoring, system protection or the synchronization of generator plants. The I/O interfaces of the Bachmann controller system offer an ideal addition to the measuring units and communication protocols such as IEC 61850, IEC 60870, DNP3, OPC or Modbus are available for routing data to higher-level systems.

PLC integration

Bachmann's grid measurement modules comply with the design of the signal modules of the Bachmann controller system. When mounted in main stations or substations of the modular PLC system, they supply the key characteristic values of the measured three-phase systems already as channel values. This eliminates the need to configure communication elements or set fieldbus parameters. Values recorded from a highly dynamic process are provided in the user program without any delay caused by asynchronous bus cycles. Especially time-critical or safety-critical functions, such as protective tripping in the event of limit violations, are processed by the modules completely autonomously. The grid module can also be spatially separated from the PLC if it is mounted on an

electrically isolated substation connected via fiber optic cables. Insights gained from measured values or the status of the operational management can be incorporated into the energy tasks at any time, and vice versa. These correlations firstly allow the particularly low-stress operation of the plant, whilst also providing the basis for indirectly determining operating conditions and faults (for example, a change in power consumption in the particular operating state can indicate faults in heating circuits).

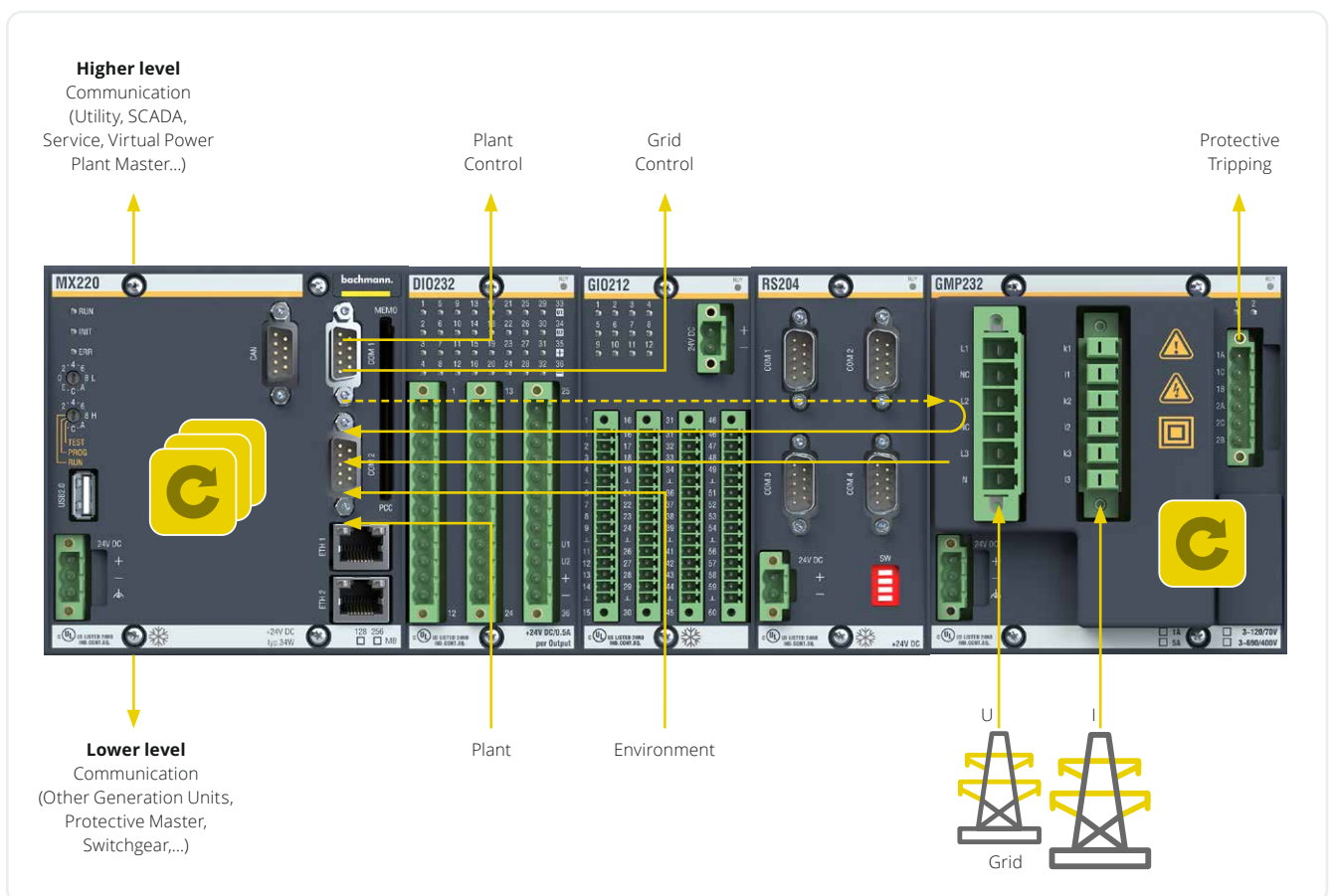
No separate signal lines or tools are required for monitoring and remote maintenance. By being integrated in the security concept and rights system, access to the grid modules and their data management are also controlled.

Configuration & display

Grid modules from Bachmann are fully integrated into the SolutionCenter. Configurations can be created efficiently and saved for reuse at a later time. An automated comparison of limit values set online with saved configuration files makes it easier to locate changes. The user interface shows both the recorded channel values and the derived (calculated) variables. Development, commissioning and fault analysis are simplified with tabular, vector and time sequence displays. It is also possible to configure all measured and calculation values of the monitored three-phase grids as graphic displays in a dynamic web interface (webMI). The actual sequence

of protection events (sequence of events) can be viewed in the event log of the protective devices. Thanks to globally synchronization time bases (SNTP, IEEE 1588 PTP), the event sequence can also be reconstructed from remote stations. The modules of the GMP and GSP families offer a high-performance data recorder that can be directly integrated. If a protection event occurs (or if called in the PLC user program), high-resolution time series of

selected grid values are also logged. The time leading up to the triggering event can also be logged using the pretrigger function. The data can be exported and transmitted in CSV or Comtrade format (IEEE Std. C37.111). Power quality values, such as harmonic spectrum or various distortion factors, can be displayed immediately in the SolutionCenter without the need for any programming, or read via the application program.



Safety without Compromise

Safety Control

Up to now, functional safety in wind power plants has been given very varying degrees of importance, and is nearly always restricted to the most necessary personal protection measures. Modern safety solutions using a programmable safety controller make it possible to implement functions that go far beyond the conventional emergency-stop chain: Secure remote monitoring and teleservice in combination with intelligently used redundant systems can secure and even improve availability.

Both wind turbine manufacturers and plant operators alike aim to achieve maximum availability – mainly for financial reasons. This is already implemented at critical points by measuring and evaluating multiple signals, such as rotor speed. Safety-relevant considerations, such as the redundant systems previously mentioned, are thus already implemented in the plant.

Safety engineering under control

The safety components from Bachmann electronic are ideally equipped for use in wind turbines. Operational control, safety engineering and operator terminals are directly compatible and allow open communication. The fastest possible response times, intuitive operation and comprehensive diagnostic options guarantee the highest possible level of safety. The SCT202 safety counter module enables the monitoring of all critical rotary movements in a wind turbine.

The SAI205 safety analog input module with 4-20mA inputs, temperature channels and inputs for strain gauges allows all relevant analog signals within the wind turbine to be safely acquired in one module. The new Bachmann PROFIsafe F-Host enables the user to integrate a wide range of safety sensors and actuators for the wind turbine safety solution. This saves space, wiring effort and additional costs.

Benefits for manufacturer and operator

Programmable safety engineering makes practical implementation and serial use easy. It enables the secure monitoring of all the internal states of a wind turbine during operation, including the safety circuits, from anywhere in the world. Our control components are already used successfully in thousands of wind turbines worldwide. Bachmann offers you tailored solutions based on this experience.

BENEFITS

- Safety solution fully integrated in operational control
- External access to safety variables for remote diagnostics and maintenance
- Reduced wiring effort
- Simple expansion



More on this topic is provided on our website

Redundancy in Communication

PowerPlant Network

For the grid operator, a wind farm should behave like a single power station. The stable implementation of this kind of virtual power station requires fast, deterministic and fault-proof data exchange within the park. The bluecom protocol was specially defined and developed for this kind of application. It provides the necessary throughput to enable the real-time exchange of large data volumes in short cycles between several nodes. It also enables the connection and disconnection of any wind turbine as required.

BENEFITS

- *Deterministic real time and stable intervals for reliable control via the farm network*
- *Use of the existing IT infrastructure – no special switches required*
- *No additional cabling*
- *Standard TCP/IP (SCADA, FTP) and bluecom on the same cable*
- *Optimized for many nodes with large data volumes and short intervals: 500 nodes transfer 250 bytes in both directions in 20 ms intervals*
- *The connection to a turbine can be disconnected without any interference*
- *Node addressing via IP address or name*
- *Redundant connections*



More on this topic is provided on our website

Reliable communication

Data exchange in the wind farm via a TCP/IP network has long been the standard technology in use for transferring time-critical information such as log files, snapshots or software updates. In order to implement control tasks, the question often arises whether an additional network should be installed or whether the existing infrastructure is sufficient. The bluecom protocol puts an end to this compromise. It combines the required capacity for exchanging large data volumes between several stations in short cycles, while at the same time transferring low priority background communication on

the same cable and switches. The operator is also free to choose the type of network structure (radial, tree, etc.) as required. Another important strength of the protocol is the fault tolerance. In a wind farm containing several turbines, individual turbines may occasionally have to be shut down for servicing, so that they are temporarily not accessible in the network. bluecom handles the coming and going of the stations in the field without any problem and without interrupting the cyclical data exchange. The connection state can be addressed from both sides. Station addressing via the IP address is only one possible way of establishing com-

Specialist for Pitch Applications

— CPC200: Powerful control and monitoring modules

Many factors have to be taken into account in the operation of wind turbines. Especially with regard to the most conspicuous components of a plant – its three rotor blades – constant monitoring and regulation is a vital necessity.

The turning of the blades into the wind is called "pitching". When the load is too strong on the other hand, the blades have to be taken out of the wind. This requires the use of powerful controller and monitoring modules. The compact CPC210 module was specially developed by Bachmann for pitch applications and can take over a wide range of tasks in the wind turbine. The blades for a wind turbine are up to 65 meters long and weigh between 8 and 18 tons. During operation, the pitch angles of the blades are adjusted in order to obtain maximum power from the wind. If, however, the blades turn too quickly, this will generate forces

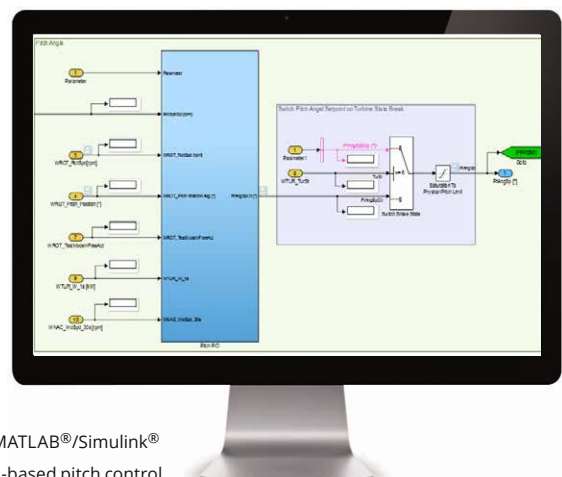
that can cause considerable damage to the turbine. The pitch angle of the blades is therefore constantly adjusted to suit the prevailing wind conditions. The blades are also turned out of the wind for braking, in strong winds and also during maintenance.

Multiple tasks, one solution

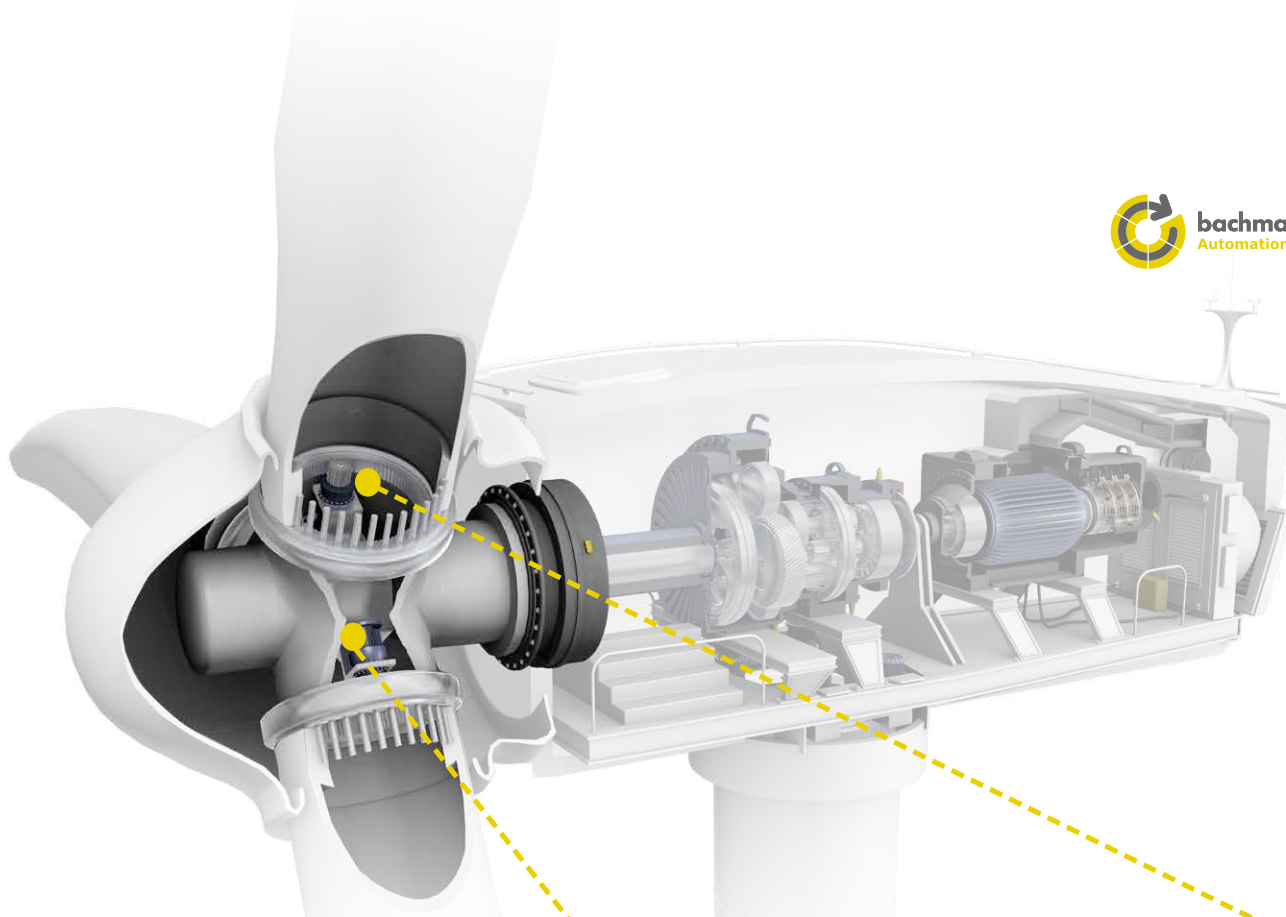
The compact CPC200 series is particularly suited as a pitch controller for wind turbines. Its central task is the control of the motors that turn the blades to the required position. At the same time, this controller also performs several monitoring functions. For instance, it

HIGHLIGHTS OF THE CPC MODULE

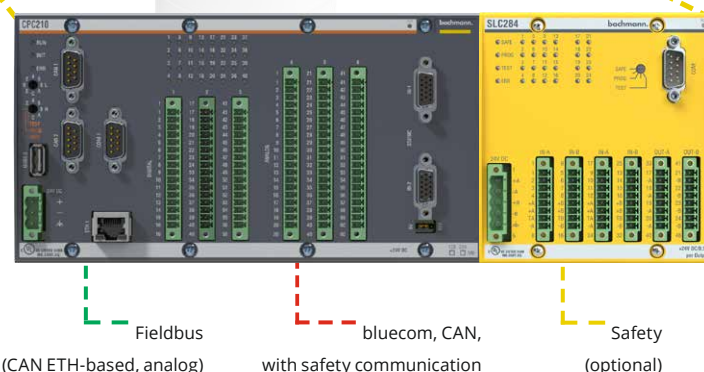
- Compatible retrofit solutions
- Optimized I/O framework on pitch applications
- Compact design saves space and costs
- Easily expandable with M200 modules
- Large performance reserves for pitch applications
- Vibration proof for pitch applications



▼ CPC: MATLAB®/Simulink®
model-based pitch control



▼ **Tasks of the CPC200 series:** control of the motors that turn the blades to the required positions as well as motor and torque monitoring.



monitors the temperature of the motor in order to prevent overheating. The torque on the blade surfaces is also measured by the CPC in order to prevent any overload on the wind turbine and any resulting damage. The control unit installed in the hub is powered by slip rings that have a connection to the main controller. If the power supply is interrupted, a backup battery system is provided, which can likewise be monitored and controlled by the CPC. A three blade control can also be implemented if required with a single CPC module, to which other modules of the Bachmann automation system are added.

Maximum connectivity

The CPC200 can be integrated in the higher-level controller system in a wide variety of ways. Voltage outputs or two CAN interfaces are provided to control the drives. The connection to the central higher-level Bachmann controller can be implemented via Ethernet, Modbus TCP, Profinet, bluecom or CAN. The Profibus connection, frequently used in China, can also be implemented

easily. For this the compact PLC can be operated both as a master and as a slave in the overall system. The CPC200 is a compact module that contains both digital and analog inputs or outputs as well as the CPU. Naturally, this can be easily expanded with Bachmann standard modules. The serial PPP interface or TCP over CAN can be used to implement remote diagnostics of the controller in the inaccessible rotor hub. The CPC is fully integrated in the SolutionCenter, enabling the user for example to perform program updates easily.

Specialist for pitch applications

The CPC200 series offers an ideal entry level into the world of Bachmann automation. Particularly all tasks related to pitch control can be handled optimally with the compact PLC. The large number of interfaces and supported communication protocols guarantee maximum connectivity – the Bachmann module can be integrated as a pitch controller in a wind turbine without any problem.



Benefit from our Expertise

Bachmann Trainings Offerings

Solid know-how combined with first-class products is the key to perfect automation. We offer you both. Take advantage of our extensive training program, which we will gladly adapt to your individual needs.



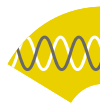
Solution Center

The SolutionCenter as an integrated and user-friendly engineering tool for project engineering, commissioning, configuration and diagnostics. The training also includes an introduction to programming and visualization.



Model Based Design

The MATLAB® program package from MathWorks offers a software tool for model-based development of controller applications. M-Target for Simulink® enables the user to integrate seamlessly in this development process inside the Bachmann controller environment.



Power Management

The safety and efficiency of the electrical energy supply are placing increasing demands on generation, transmission and consumers. This training seminar provides the knowledge required to use Bachmann grid measurement, monitoring and synchronization modules in the Bachmann controller system.



Safety Control

This seminar offers a practical and basic understanding of how to implement functional safety. You are shown how to program safety applications based on the Bachmann safety products in hardware and software.



Condition Monitoring System

Condition Monitoring involves the monitoring of the machine state through the measuring and analysis of meaningful physical variables. The training covers the basics of Condition Monitoring as well as providing a detailed knowledge of the hardware and software.

Always keeping up-to-date

Engineering training seminars

Even if the training needed for engineering is kept to a minimum thanks to the standard development environment: Updating and deepening one's knowledge of individual engineering areas at regular intervals is worthwhile. The combination of the user's sound knowledge with first-class products is ultimately the key to perfect automation.

BENEFITS

- *Perfect program adaption to individual requirements thanks to the modular concept*
- *Intensive knowledge transfer through hands-on training*
- *Training seminars held on site at Bachmann or as webinar*
- *Access to the in-depth knowledge of Bachmann application engineers*



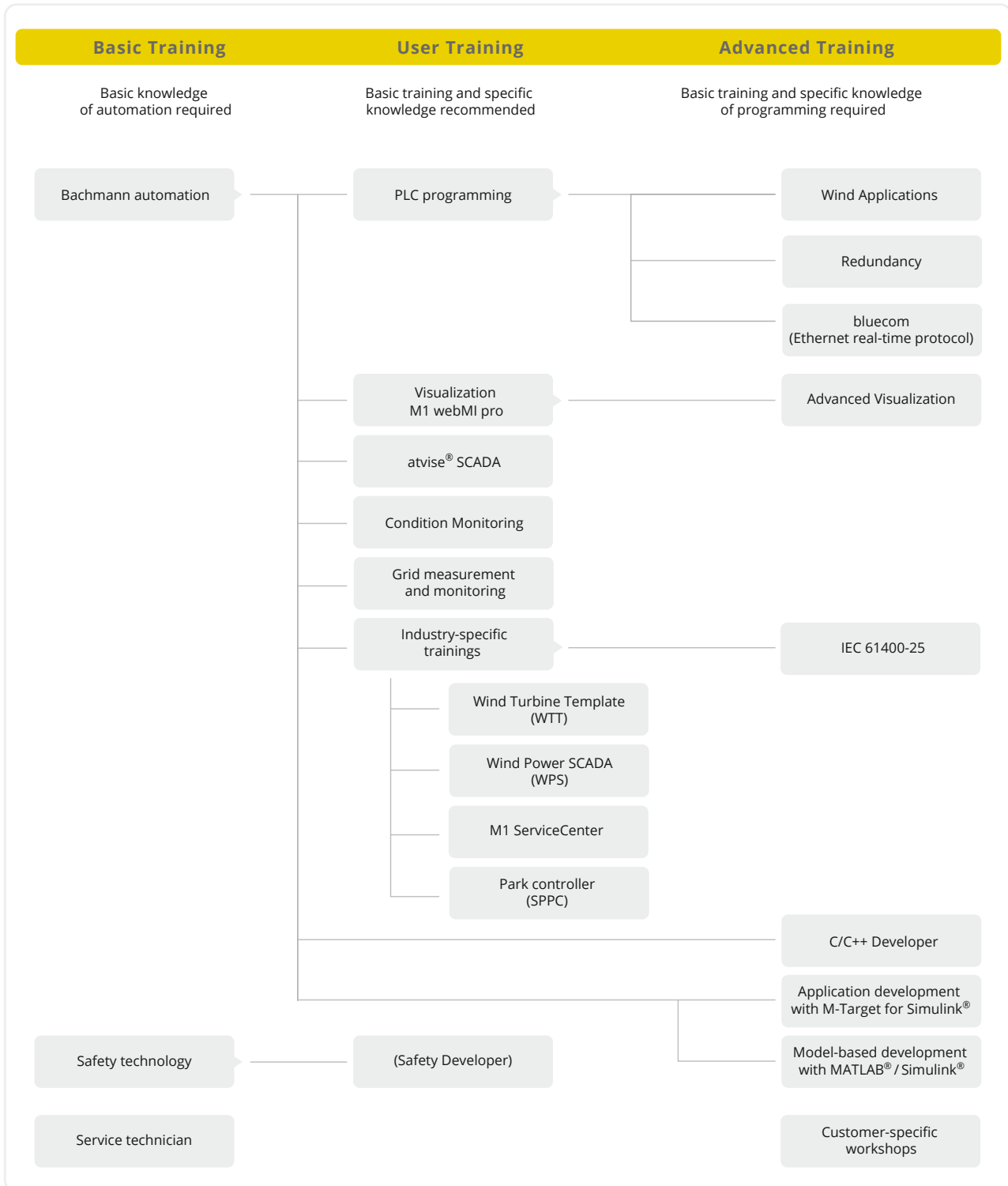
More on this topic is provided on our website

Precisely tailored training seminars

Bachmann's training offering ranges from the proven standard training seminars right through to workshops tailored to your individual requirements. The modular training concept enables the creation of training programs tailored precisely to company requirements. The training is always centered around an intensive knowledge transfer and hands-on practice with special problem solving tasks. The training sessions are held either in a Bachmann branch office or directly on site at the customer's premises. Individual modules can also be offered as webinars if required. Following each training course, the participants will receive a personalized certificate.

No questions unanswered

If a question remains unanswered despite the extensive training offer, Bachmann customers benefit from the know-how of several application engineers. These work in close proximity to the development team. They know every small detail of the Bachmann solutions and can therefore make use of all options available.



Trust through Expertise

Applications for the wind sector

Many of the leading global manufacturers and operators of wind energy plants rely on us. Together with them, we are setting new benchmarks and achieving new success.

**ABO
WIND**



ABO Wind was one of Bachmann's first customers to consistently pursue the implementation of Condition Monitoring Systems. Both companies are today working together on the internationalization of ABO Wind and are developing strategies for a CMS that is standard worldwide.

▼ YOU CAN READ THE COMPLETE ARTICLE ON OUR WEBSITE



For more than 20 years, AMSC Austria has been a leading developer of wind turbines, and has been using Bachmann controllers for a long time. With its "Windtec Solutions", AMSC Austria supplies plant concepts in the rating range from 0.6 to 10 MW.

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BKW



As part of its predictive maintenance strategy, BKW Group in Germany tested the Condition Monitoring System of Bachmann Monitoring. The test was so successful that the wind farm operator decided to form a strategic partnership with Bachmann Monitoring! The future aim of the two companies is to roll out a comprehensive health monitoring system for the wind turbine fleet.

▼ YOU CAN READ THE COMPLETE ARTICLE ON OUR WEBSITE



A well functioning Condition Monitoring System considerably increases the profitability of wind turbines. CSR Wind Power recognized this fact very early on and now has its own CMS department which equips its wind turbines with suitable systems.



▼ YOU CAN READ THE COMPLETE ARTICLE ON OUR WEBSITE



e.n.o. energy has been successful in erecting wind turbines since 1999, and has been developing, producing and selling its own wind turbines for the German and international market since 2008. The company produces the e.n.o. 82 in series production in Rostock (Germany).



▼ YOU CAN READ THE COMPLETE ARTICLE ON OUR WEBSITE



Guodian United Power Technology Company Ltd (in short: GUP) is one of the leading Chinese manufacturers of onshore and offshore applications, and is one of the largest producers worldwide. Bachmann electronic automation system makes up the core of its systems.



▼ YOU CAN READ THE COMPLETE ARTICLE ON OUR WEBSITE



Plant manufacturer Nordex is breaking new ground in the optimum control of service operations for its customers. This requires having the right qualifications for the relevant task and the possible combination of tasks in the same wind farm.



▼ YOU CAN READ THE COMPLETE ARTICLE ON OUR WEBSITE



The Sany SE905 weak wind turbine embodied the ambitious aims of the international developer team. The key requirement of the plant was intelligence with regard to dynamic optimization, load reduction and control.



▼ YOU CAN READ THE COMPLETE ARTICLE ON OUR WEBSITE



So far, most focus has been on replacing critical mechanical spare parts in wind turbines – while obsolete control systems have stayed largely untouched. But that is about to change.



▼ YOU CAN READ THE COMPLETE ARTICLE ON OUR WEBSITE



The need for electricity is increasing worldwide. This can be produced sustainably with wind power plants. These require the use of ingenious technologies. The Suzlon Group is one group of companies that has the necessary know-how and has become well-established as the fifth largest manufacturer on the market.



▼ YOU CAN READ THE COMPLETE ARTICLE ON OUR WEBSITE



With a completely new controller system based on the Bachmann controller, Vestas is taking a further step in the future of renewable power supply technology – and thus offering plant operators the key competitive edge.



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WEG, which has been active in the automation of energy systems for a long time, has now focused on the wind power market and is the only manufacturer of wind turbines in Brazil.



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WestWind is one Germany's leading full-service providers for the development of projects in the wind energy sector. The company's portfolio ranges from the design of wind farms to the operational management of its own plants or those of third parties.



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W2E Wind to Energy develops complete multi-megawatt wind turbines for the onshore sector. The technology installed makes these systems stand out on account of their long service life, high technical availability and maximum yields.



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As the manufacturer of the main control system for Senvion turbines, Bachmann electronic developed a software solution that enables full access to the turbines. This puts it back in the hands of the owners and ensures operation with the existing turbine hardware and control software.



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