



APPLICATION WIND TURBINES

SMART PITCH AND YAW SOLUTIONS
EN

KEB AUTOMATION – THE SOLUTION PROVIDER FOR WIND TURBINES

Energy transition is one of the most urgent tasks of our time. Only through joint efforts it will be possible to find answers to climate change and to effectively limit global warming. On the way to a more sustainable energy supply that is independent of fossil fuels, wind energy is of key importance.

Whether onshore, nearshore or offshore – wind turbines already represent the largest part within renewable energies. KEB Automation alone has equipped more than 40,000 wind turbines with 80+ GW in total with the appropriate drive train technology so far. Thus, KEB is contributing to reaching the goals of the Paris Climate Agreement.

Since the direction and speed of the wind change frequently, it is necessary to constantly adjust the angle of the rotor blades and to turn the nacelle into the wind. For the core areas of Pitch and Yaw control, KEB therefore provides reliable solutions which ensure that the wind turbine generates the maximum amount of energy. Certified drive controllers such as the pitch inverter COMBIVERT P6, the COMBIVERT F6 frequency inverter for the yaw drive, spring-applied brakes or motors in a wide power range – with matching components and KEB's decades of experience in the market, wind turbines up to 15 MW can be realised.



To cope with such demands, KEB has developed, amongst other devices, the 23P6 pitch inverter which has received UL Recognition. This pitch drive is designed to provide an electric pitch system for the biggest wind turbines in the world.

OPEN SOLUTION

- Various fieldbus systems without gateway
- Various encoder inputs on board
- PLC programming according to IEC 61131 standard
- For AC induction, synchronous and DC pitch motor
- For retrofit applications, the internal PLC can emulate older drives

LOCAL ADDED VALUE

- Core components supplied by KEB
- Local cabinet manufacturing
- Simple mechanical integration
- Cost savings

FREELY PROGRAMMABLE

- Own pitch algorithms with own know-how
- Maximisation of energy yield
- Reduction of fatigue loads
- Increase of availability of the turbine by implementing suitable reactions for each condition
- Condition monitoring of relevant pitch system components for well-fitting service support
- Differentiation from competitors
- Know-how copy protection available

ALL IN ONE

- Pitch inverter, backup charger, monitoring and PLC in one unit
- Reduced number of components
- Compact cabinet
- Clear cabinet layout, less wiring
- Supply of 24 V or high voltage brakes

FUNCTIONAL SAFETY

- Pitch drive with PL d according to EN ISO 13849
- Yaw drive with STO and SBC
- Certified by TÜV Rheinland
- Functional Safety is independent of the customer PLC program

COMBIVERT P6 – PITCH SOFTWARE SOLUTIONS

SOFTWARE PACKAGES AS REQUIRED

The P6 internal PLC can be programmed as needed. It comes with a Basic Library for all basic tasks, and the customer can program everything he needs on his own.

Or the P6 can be complemented with the Extended Pitch Library, which contains pre-defined function blocks for typical tasks of a pitch system. So the customer just needs to program the interface specific to the turbine.

Or the KEB experts can write a Customer-Specific Program for the pitch drive according to the customer's specification.

BASIC LIBRARY	EXTENDED PITCH LIBRARY	CUSTOMER-SPECIFIC PROGRAM
<ul style="list-style-type: none">• Speed control / Position control• Homing of motor encoder and blade encoder• Charging circuit control (set-point value and actual value)• Temperature measurements• Communication check• Mains failure detection and phase loss detection• Parameter download• Firmware update from remote• Visualization templates of all function blocks• Sample program incl. field bus drivers• Monitoring of internal fans	<ul style="list-style-type: none">• Motion control (velocity mode, positioning mode, torque limitation, brake control)• Encoder monitoring (homing, plausibility check etc.)• Monitoring of motor status and motor cable• Health check of the motor brake• Charging and monitoring of ultracapacitors and lead batteries• Health check of ultra-capacitors• Controlled discharge of ultra-capacitors (for service)• Freely programmable data logger, event-triggered	<ul style="list-style-type: none">• Customised pitch algorithm to<ul style="list-style-type: none">- improve performance and maximise energy yield- reduce fatigue loads on mechanical components• Pitch state machine<ul style="list-style-type: none">- Selection of manual/automatic operation- Selection of speed/positioning control• Plausibility check of limit switches• Specific reactions on warnings and errors to increase the availability of the turbine• Field bus mapping and monitoring• Control of auxiliaries (grease pump, cabinet heater and fan)• Additional visualisations for service personnel• Condition monitoring of ultra-capacitors, motor brake, etc.

No matter who does the programming: The know-how of the customer program can be protected against third-party access by using password protection, compiled libraries and encryption.



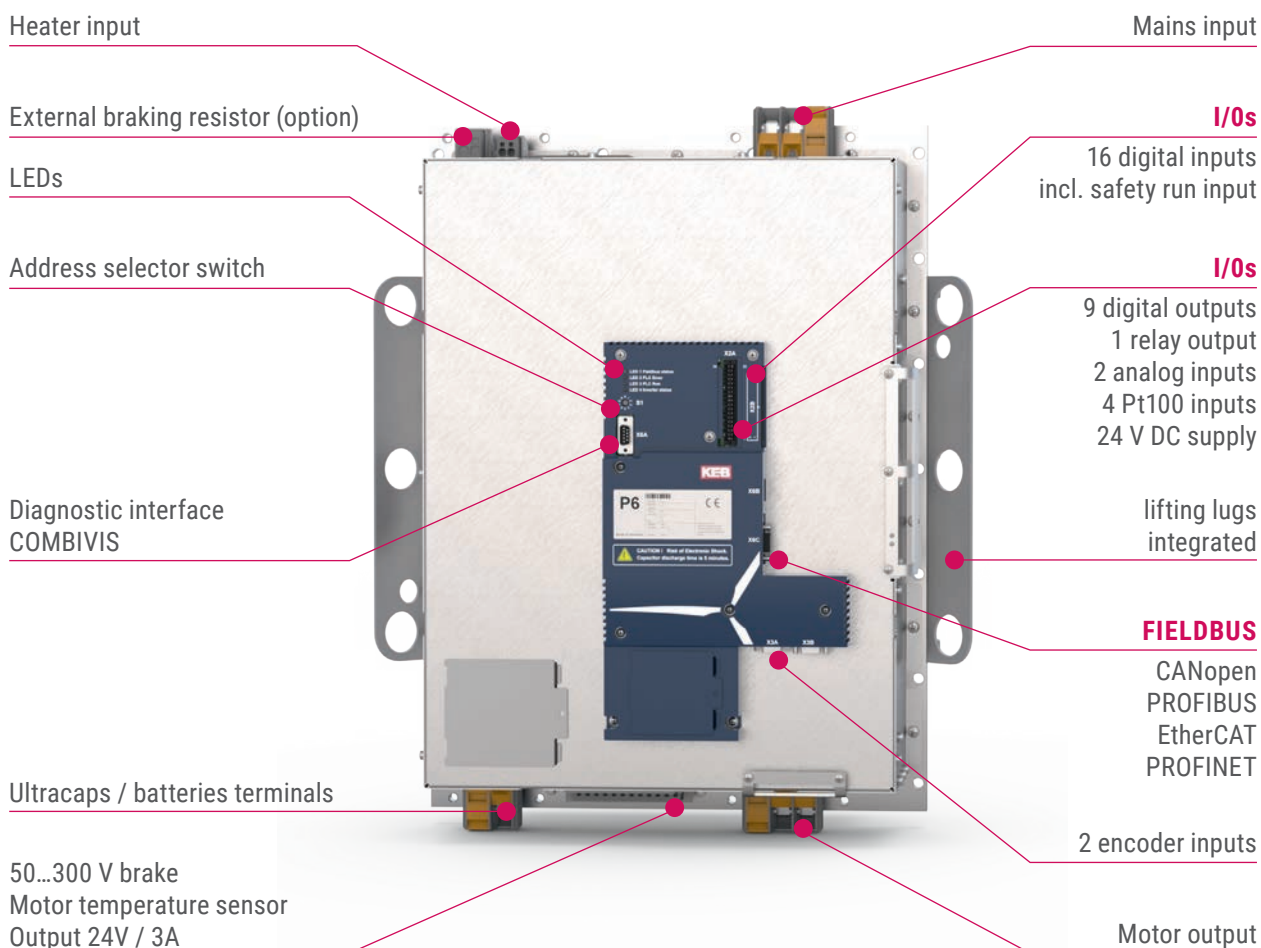
HIGHLIGHTS

- Specific software libraries available
- Programming support
- Flexible solution for customer add-ons

VARIOUS SIZES

The P6 hardware is available in three electrical sizes for AC and for DC motors, suitable for pitch systems of 1 ... 15 MW wind turbines.

INVERTER SIZE		18	19	19 DC	23
Rated input voltage		3 AC 400 V			
Output rated power	[kW]	18			42
Output rated current AC	[A AC]	45	52	-	120
Maximum current AC at ≥ 6 Hz for 3 s	[A AC]	90	120	-	350
Output rated current DC	[A DC]	-	-	52	-
Maximum current DC for 12 s	[A DC]	-	-	120	-
Rated current for shunt winding	[A DC]	-	-	5	-
Rated switching frequency	[kHz]	4	2	2	4
Max. switching frequency	[kHz]	4	4 (at I < 45 A)	4 (at I < 45 A)	4
Ultracaps charging current	[A]	5			10
Dimensions	[mm]	240 x 400 x 310			430 x 590 x 330
Weight	[kg]	16			50

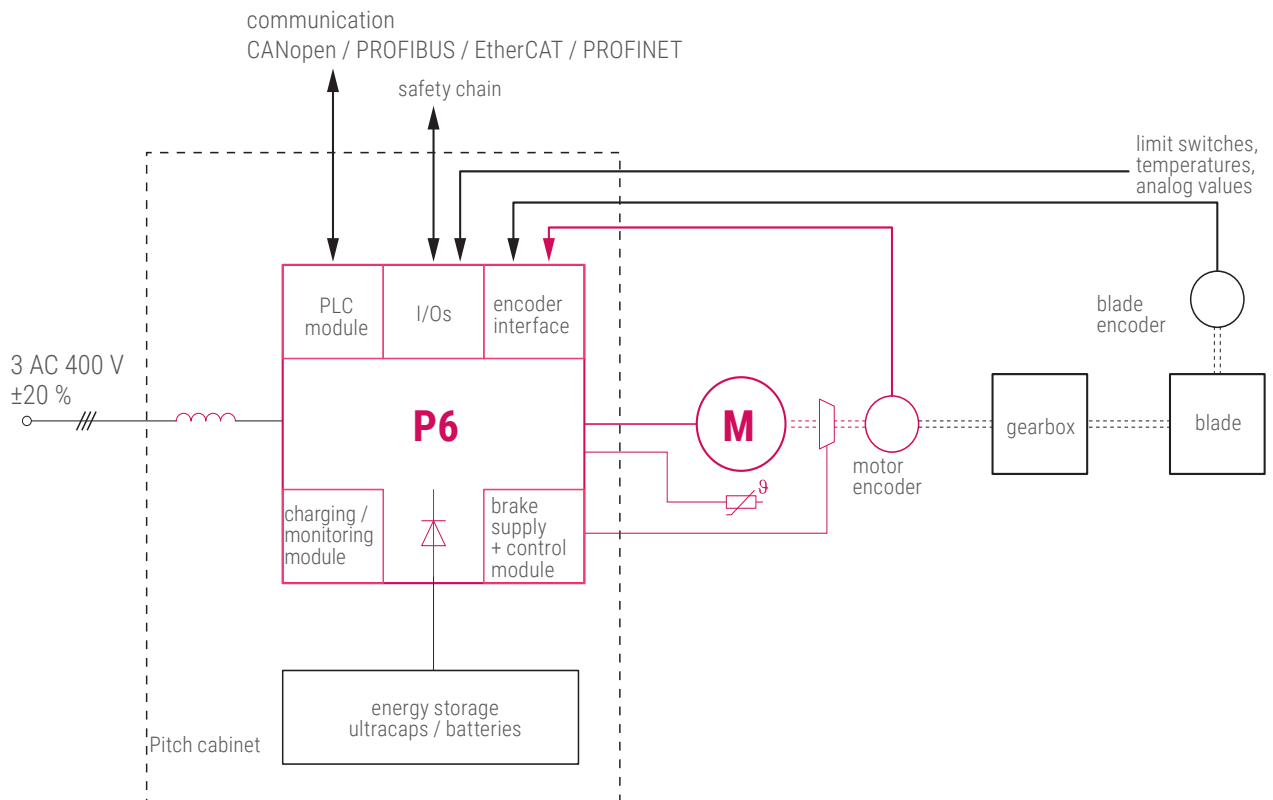


COMBIVERT P6 – SYSTEM INTEGRATION

EASY INTEGRATION OF P6 INTO THE SYSTEM

Typically, KEB supplies the core components of the pitch system, as marked in red.

The customer makes the cabinet construction and manufactures the cabinet locally; this increases the value added locally. Thus, the mechanical integration of the pitch cabinet into the nacelle is achieved easily, while the electrical integration into the system is simple due to using the P6.



By using the highly integrated KEB P6, just very few components are needed externally in the cabinet.



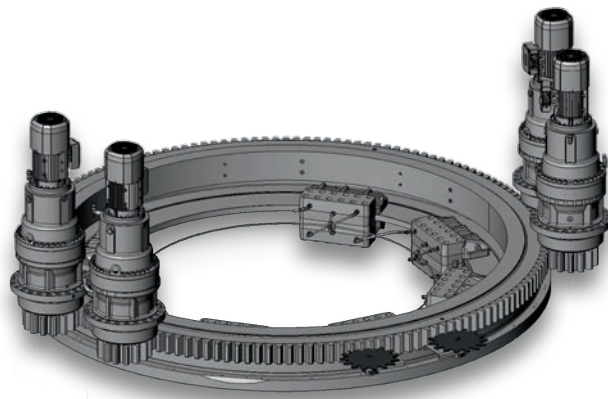
NON-REDUNDANT SYSTEMS

For the yaw drive of wind turbines, KEB can provide different yaw solutions. They all contain:

- smooth movement of the nacelle,
- torque sharing,
- reduction of mechanical load,
- reduction of wear of the material.

Depending on the system configuration, the yaw drive controllers can also:

- tense up the drives against each other,
- use the electrical motor brakes instead of a hydraulic brake,
- add STO for the safety of service personnel during service operations.



REDUNDANT SYSTEMS

Used with a multiple inverter solution, the KEB Yaw Library PLC software ensures:

- improved torque sharing,
- monitoring and protection of motors, cables and gear-boxes,
- redundant operation, even if one drive is not operational,
- increased availability, especially for offshore turbines.

This can be implemented by adding turbine-specific enhancements to the pre-programmed IEC 61131 function blocks.

KEB_YawMotionControl			
Enable	BOOL		BOOL LicenseValid
TorqueSharingMethod	7_TQ_SHARING_METHOD	ARRAY[1..MAX_NR_OF_DRIVES] OF BOOL	PositionCalibrationDone
MotionControlMode	1_MOTION_CTRL_MODE	BYTE	NumberOffailedDrives
StartDrives	BOOL	REAL	FilteredMasterTorque
StartPosi	BOOL	REAL	AverageTorque
Reset	ARRAY[1..MAX_NR_OF_DRIVES] OF BOOL	REAL	ActMasterSpeed
CalibratePosition	BOOL	REAL	ActMasterPosition
ReferencePosition	REAL	BOOL	TargetPositionReached
TargetPosition	REAL		
TargetWindow	REAL		
PosRelative	BOOL		
SetSpeed	REAL		
TorqueLimit	REAL		
SlaveSpeedOffset	REAL		
GearRatio	REAL		
EncoderResolution	REAL		
TechnicalUnits	REAL		
NumberOfDrives	BYTE		
MasterIndex	BYTE		
DisableDrive	ARRAY[1..MAX_NR_OF_DRIVES] OF BOOL		
TorqueFilterNrOfValues	WORD		
TiSpeedTrim	REAL		
TiSpeedTrim	REAL		
ResetIntegralFactor	BOOL		
PrecessionTorque	ARRAY[1..MAX_NR_OF_DRIVES] OF REAL		

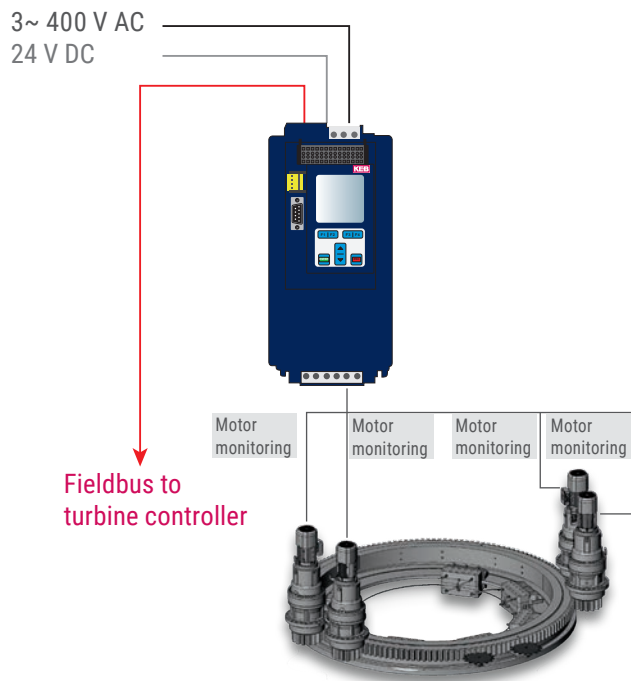


HIGHLIGHTS

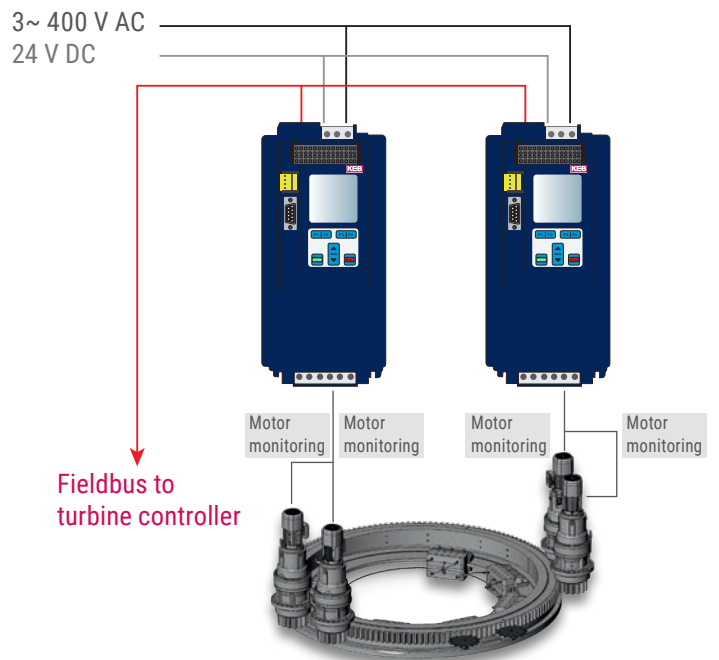
- Smooth movement of the nacelle
- Reduction of wear
- Increased availability

CONTROLLED YAW SOLUTIONS – HARDWARE

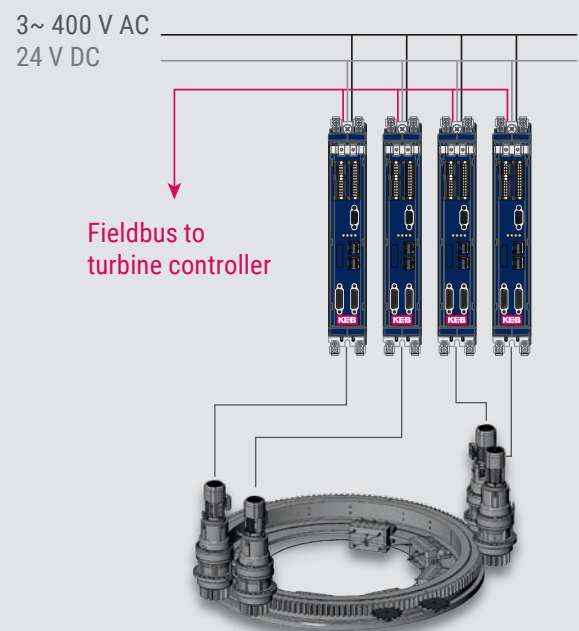
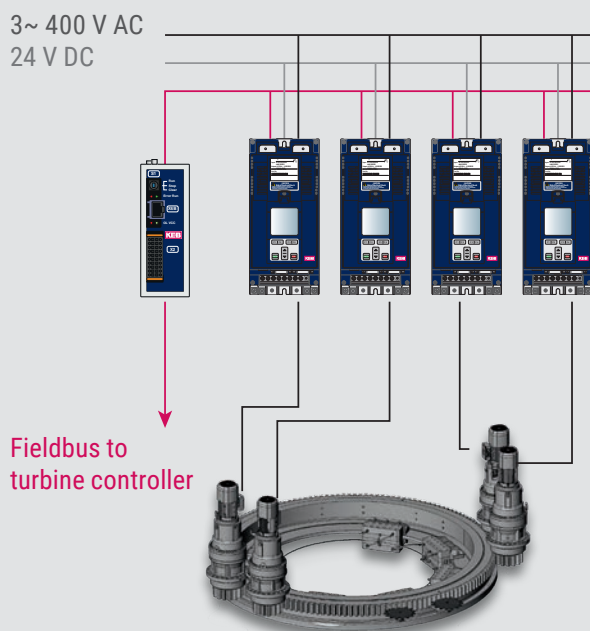
SINGLE INVERTER



DOUBLE INVERTER



MULTIPLE INVERTER SOLUTIONS



COMPARISON OF HARDWARE SOLUTIONS



FEATURES	SINGLE INVERTER	DOUBLE INVERTER	MULTIPLE INVERTER SOLUTIONS
Adapted industrial design	X	X	X
Simple and user-friendly handling	X	X	X
Feedback control			
Open loop operation	X	X	X
Closed loop operation	—	—	X
Multiple encoder interface	—	—	X
Common DC bus	—	O	O
24 VDC 2 A Brake supply	X	X	X
Integrated safety module STO and SBC ¹⁾	X	X	X
IEC 61131 Programmable Control unit	—	—	External
Yaw Library	—	—	X
Bus Communication to turbine controller			
CAN, EtherCAT, PROFIBUS, PROFINET	O	O	O
Diagnostic and monitoring via PC software	X	X	X
Motor control			
Induction	X	X	X
SMPM	—	—	X
IPM	—	—	X
I ² t motor protection	External	External	X
Redundancy			
Single	—	X	X
Multiple	—	—	X
Heatsink design			
Forced ventilated	X	X	X
Push through	O	O	O
Supply with AFE for regulated DC Voltage			
External	O	O	O

X Integrated

O Option

¹⁾ depending on inverter type

DIAGNOSTIC TOOLS & PROGRAMS – PITCH AND YAW

KEB PITCH AND YAW – DIAGNOSTIC TOOLS & PROGRAMS

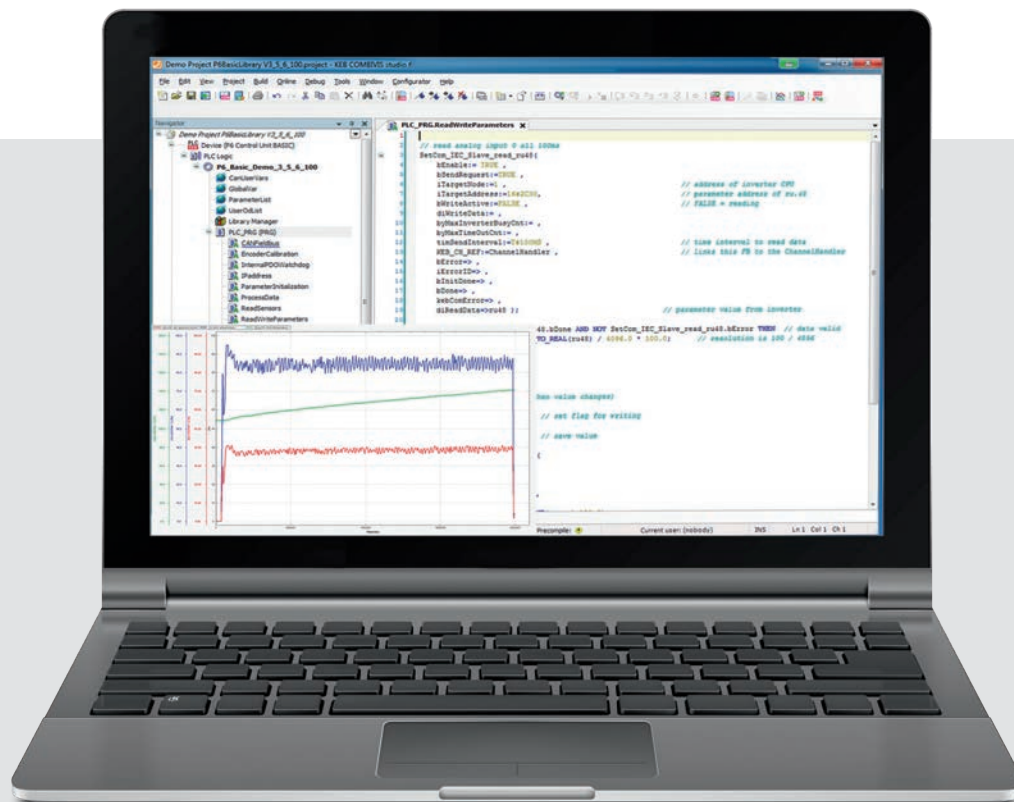
Programming and diagnostic tools optimised for this application reduce engineering efforts.

COMBIVIS 6

- Diagnostic tool for the pitch inverter P6 and for yaw drives
- Display of operating conditions
- Oscilloscope function
- Download of customised adjustments
- Analysis of communication between drive and control
- Wizards for easy commissioning and optimising
- Online help
- Document database
- Remote assistance tool

PROGRAMMING WITH COMBIVIS studio 6

- CODESYS based on IEC 61131-3
- Programming language: ST, IL, SFC, LD and FBD/CFC
- Integrated visualisation
- Tracing of variables
- Debugging and file-management



COMBIVIS CONNECT

COMBIVIS connect is the future-oriented remote maintenance solution from KEB for pitch and yaw drives. It allows programming, monitoring, fault search, file transfer and update of pitch or yaw projects remotely.

After a few minutes of router configuration, you have worldwide access to remote devices for maintenance and monitoring – irrespective of device type and manufacturer.

domain devices statistics router
CONFIGURATION MODE > ROUTER

Please enter the login credentials then click Discover. All matching Routers on the local network will reply.

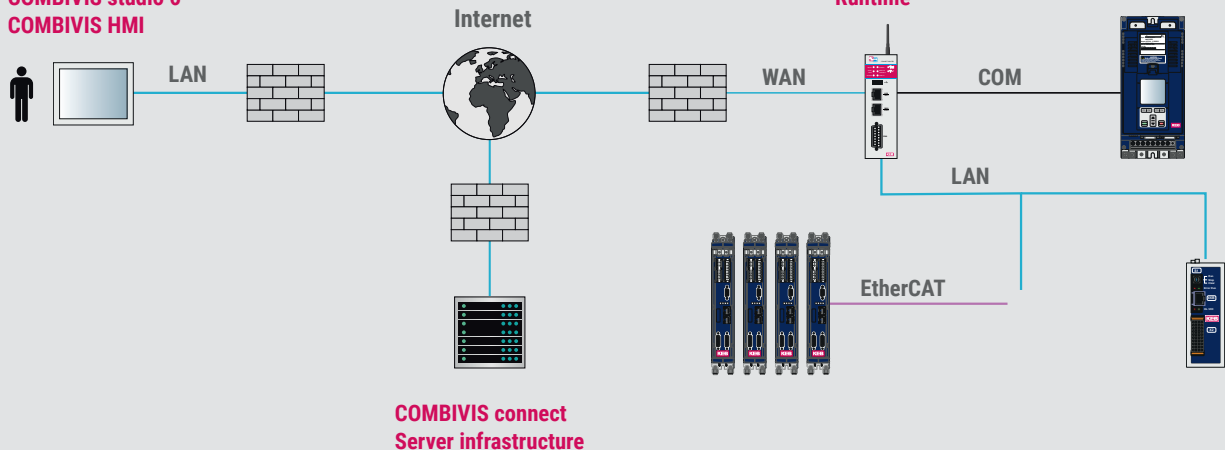
User name:
Password:

Routers found:
MACs: 00-12-CD-01-9E-39, 00-12-CD-01-9E-3A

LAN IP:	192.168.0.1
Mask:	255.255.255.0
WAN IP:	DHCP
User:	admin
Password:	admin
MAC LAN:	
MAC WAN:	



COMBIVIS connect
COMBIVIS studio 6
COMBIVIS HMI



HIGHLIGHTS

- Remote access to pitch and yaw drives using Ethernet-based router
- Access to remote devices via Ethernet or serial interface
- Proven COMBIVIS connect software connects the pitch or yaw system to be monitored to your workplace via VPN
- Additional HMI functionality for datalogging, long-term machine diagnostics and notification by e-mail and SMS
- Redundant and distributed server architecture guarantees reliability and transmission stability

PITCH MOTOR

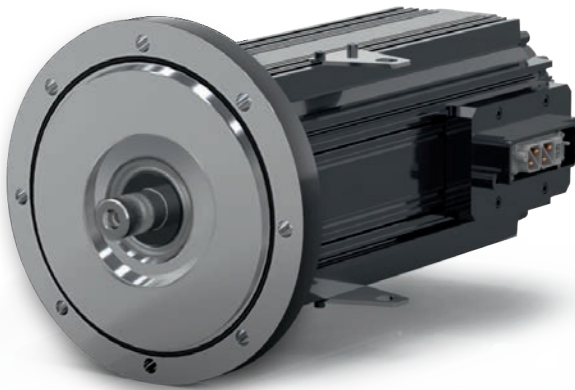
POWERFUL, EFFICIENT AND EXCESSIVELY RELIABLE

The KEB Pitch Motors are available for various wind turbines in the power range up to 15 MW. The high dynamic, vibration resistant servo motors are equipped with a robust encoder system and with the KEB fail-safe brake.

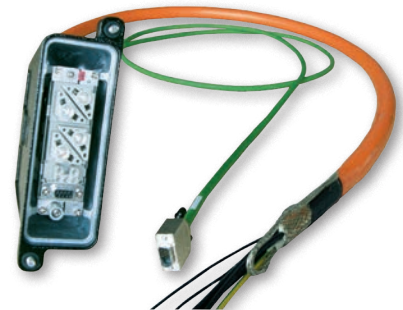
The high protection degree IP65 as well as the special corrosion painting allow using the KEB Pitch Motors in various climate conditions. If it is offshore or CCV / HCV – the KEB Pitch Motors guarantee safe and reliable operation. The dedicated housing design allows operation without additional forced ventilation.

PLUG AND DRIVE

KEB offers pre-assembled motor and feedback cables with very robust and easy-to-handle connector systems.



Pitch Motor



All-in-one motor cable



HIGHLIGHTS

- Vibration resistant
- HCV / CCV resistant
- Offshore operation, IP65
- Corrosion protection category C4M according to DIN EN ISO 12944-5
- Integrated holding brake, 24 V DC or 150 - 300 V DC with energy saving function
- Unique connector design with integrated power, encoder, brake and temperature sensor connectors

TWO BRAKE DESIGNS

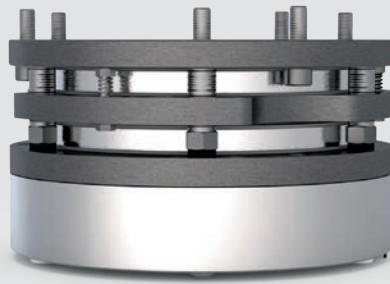
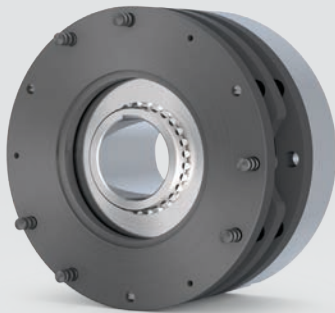
Optimized for applications with high demands on the protection degree. Rated torque from 36 to ≥ 800 Nm.



Spring applied brake IP65 type 28, mounted between gearbox and motor



Spring applied brake IP40 type 38, mounted on or inside the motor



Four-surface spring applied brake IP40 type 38, mounted inside the motor



HIGHLIGHTS

- More than 300,000 pitch and yaw brakes successful in operation
- HCV / CCV version available
- Rated voltage up to 300 V DC
- High vibration resistance (safety and lifetime)
- Coated and redundant springs with long lifetime for safe power-off stop
- Special friction lining for high emergency stop energy
- ≥ 200 Nm special anti-condensation and anti-icing design
- Low energy and low coil temperature rise system
- CSA / cUS

OTHER DRIVES FOR WIND TURBINES

INVERTER FOR SERVO PUMP OF HYDRAULIC PITCH SYSTEM



AUXILIARY DRIVES FOR PUMPS, FANS AND AIR CONDITIONING



LIFT AND HOIST DRIVES AND BRAKES

C6 ROUTER FOR REMOTE MONITORING C6 HMI



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