



# AUTOMATION SOLUTIONS FOR HIGH-SPEED APPLICATIONS

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## POWERFUL SOLUTIONS FOR HIGH-SPEED APPLICATIONS

Processing spindles, turbo blowers or compressors, gas turbines, expanders or vacuum pumps: For these and many other applications in which output frequencies of up to 2,000 Hz are required, KEB Automation offers the ideal solution with its "High-Speed Drives".

In combination with the appropriate sine filters, motors are particularly well protected at high speeds and system efficiency is effectively increased. Innovative simulation methods are available for fast and resource-saving commissioning of the high-speed drives.

KEB offers system solutions for your automation and drive tasks from a single source. From state-of-the-art control technology and drives in a wide performance range to motors and gear units as well as brakes and clutches, KEB offers you the choice from an extensive and established product portfolio. The perfectly harmonised products ensure that machines and plants are operated reliably and with maximum efficiency.

### IIOT



### CONTROL SOFTWARE

Visualisation



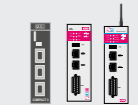
HMI

Engineering



Control Software

Remote Control



Router

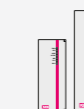
### CONTROL HARDWARE



Web HMI



Embedded Control



IPC



I/O



Safety PLC

### DRIVES



Inverter



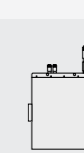
Servo Drive



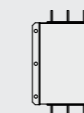
Drive Controller



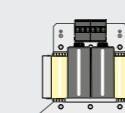
Pitch Drive



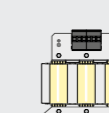
eMobility Drive



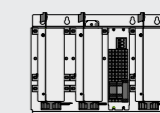
EMC & THD Filter



Sine Wave Filter



Motor Choke



Sine Wave EMC Filter

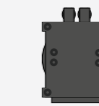
### MOTORS



AC Motor



PM Motor



PM Gear Motor



AC Gear Motor

### BRAKES & CLUTCHES



Permanent Magnet Brake



Spring Applied Brake



Electromagnetic Brake



Electromagnetic Clutch

# KEB



### HIGHLIGHTS

- Drive controller with outputs of up to 450 kW / 800 A
- Integrated safe speed monitoring
- Motor protection and optimum system performance with sine filter
- Precise encoderless control of a wide range of motor types
- Up to 120,000 rpm and output frequencies up to 2,000 Hz
- Integrated supply for magnetic bearing controls
- 3C3 protective coating for aggressive environments

The COMBIVERT S6 is available especially for servo applications as a compact and at the same time flexible servo controller for a rated current of 2.6 A to 16.5 A in two housing sizes. It can drive a wide range of motor technologies, with or without encoder and scalable safety functions.

- Power range 0.75 kW to 7.5 kW
- High overload up to 250 % for optimum dynamics
- Low leakage current mains filter (<5 mA) integrated, optionally without filter
- Book format for space-saving control cabinet installation
- Wide range of motor options, encoders and communication
- Precision and maximum repeat accuracy
- Integrated safety technology

The COMBIVERT F6 and S6 drive controllers are already in use in numerous applications – and are now also optimised for high-speed applications. This means that solutions are available for the drive of a processing spindle as well as for turbo blowers or compressors. Power ratings of up to 450 kW, motor currents of 800 A and rotating field frequencies of up to 2,000 Hz are possible for precision manufacturing.

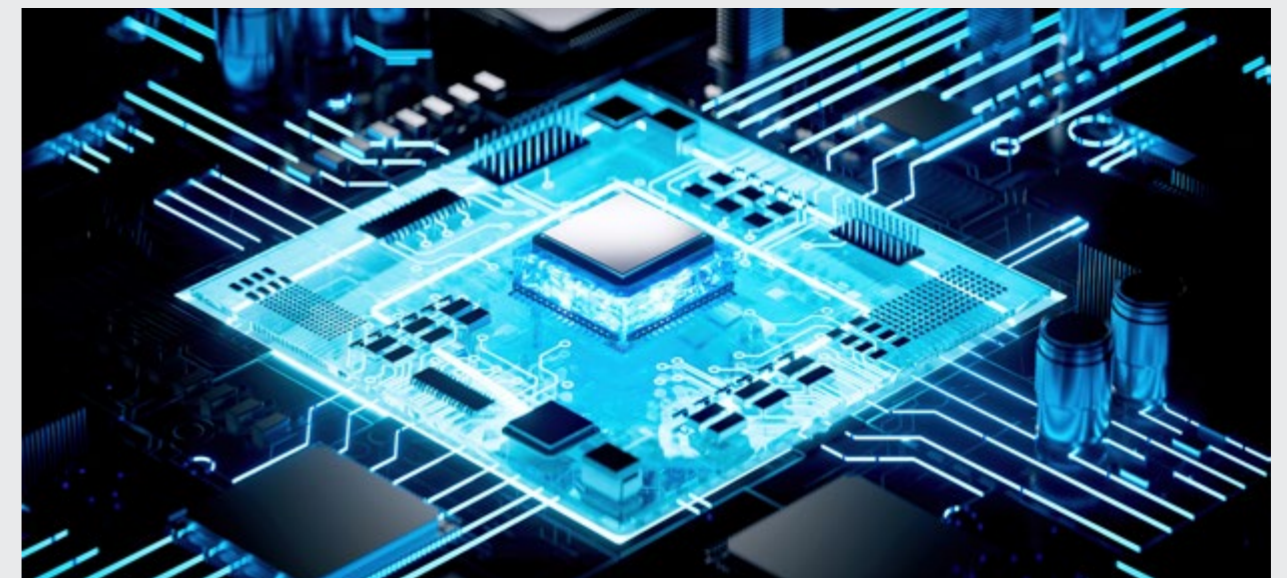
In addition, the F6 and S6 can be flexibly customised thanks to a wide range of configurable encoderless safety options, encoder interfaces and efficient cooling concepts.

#### DRIVE CONTROLLER COMBIVERT F6

- Output from 7.5 kW to 450 kW in seven housing sizes
- Air or liquid cooled, built-in or push-through mounting
- Flexible switching frequencies from 2 kHz to 16 kHz
- High output frequencies up to 2,000 Hz
- Special 3C3 coating for harsh environmental conditions such as in sewage treatment plants
- High flow temperature of 55 °C for liquid-cooled variants
- Encoderless speed control of IPM, PM, asynchronous and synchronous reluctance motors
- Safe buffering of the magnetic bearing power supply
- Multi-Ethernet interface for flexible connection to control systems
- Integrated encoderless safety functions for safe speed monitoring
- Multi-fieldbus interface for plug & play connection to the control level

#### PROTECTIVE COATING

Harsh environmental conditions can corrode and permanently damage the electronic components installed in machines and plants. This is where the optional 3C3 protective coating (IEC/EN 60721-3-3 Class 3C3) of the circuit boards in the drive controllers from KEB comes in. Tailored to the environmental requirements, the coating offers protection and prevents defects and unwanted downtime. As a result, this means extended service life and reduced operating costs.



The COMBILINE Z2 filters are matched to the COMBIVERT F6 and S6 drive controllers and are specially designed for use at higher output frequencies. This combination offers a highly efficient solution. A special core material and the HF strands of the windings developed specifically for KEB ensure a design with very low losses ( $\eta > 0.99$ ). This increases the overall efficiency of the drivetrain.

- Reduced rotor heating, longer motor service life
- Protection of the motor winding against voltage peaks
- Less noise and losses in the motor
- Reduced EMC disturbances/interference
- Enables long motor cable lengths of more than 100 m
- High flexibility due to combination of choke and capacitor

### MATLAB AND HARDWARE IN THE LOOP SIMULATIONS

KEB relies on **Matlab/Simulink** to optimise the interaction of all high-speed components. The software is an established standard for modelling and simulating complex, dynamic systems. Using the available motor data, reliable predictions can be made about the static and temporal progression of speed or voltage, among other things. Costly practical tests are no longer necessary thanks to the extensive simulation options.

This also applies to **Hardware in the Loop (HIL)** – a simulation technology that enables KEB to model high-speed applications in advance. A real motor is no longer necessary here. Even before the actual commissioning on site, it is possible to check whether, for example, parameterisation errors occur that could later lead to unstable operation of the machine or system.

- Cost-efficient variant of commissioning
- Virtual commissioning often possible within 24 hours
- Simulation based on motor, sine filter and inverter data
- Ready-made parameterisation for real commissioning

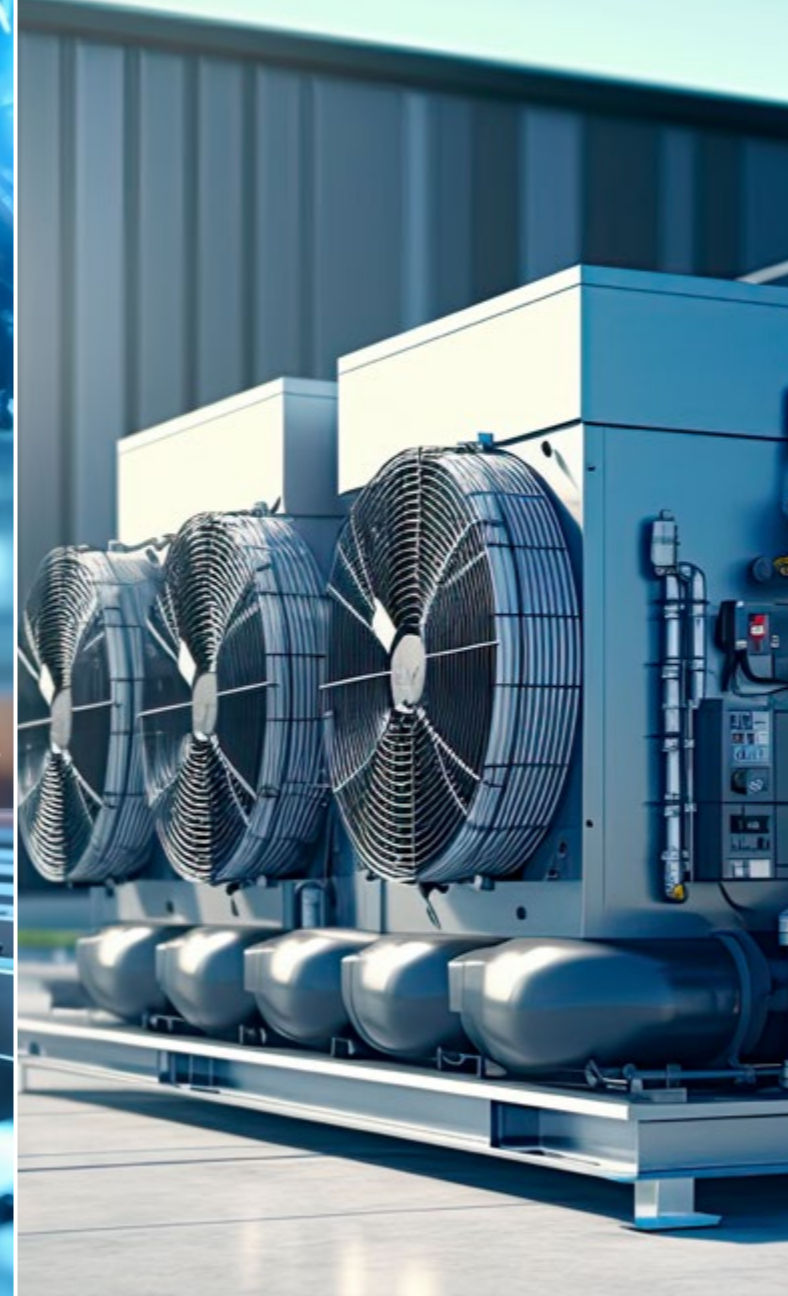


The drives from KEB offer scalable safety functions directly in the drive controller. In the PRO device variant, the COMBIVERT F6 and S6 enable encoderless safety to be implemented. The safety functions and limit values can be flexibly adapted via digital I/Os and/or Safety over EtherCAT (FSoE). In addition, safe encoderless speed monitoring can be used independently of the motor used and therefore for a wide range of applications. This reliably prevents the drive from exceeding a set speed without additional effort.



### HIGHLIGHTS

- Cost savings compared to conventional safety solutions
- Avoidance of dangerous speed ranges without additional effort
- Less wiring – no need for contactors and other traditional safety components
- Fast response – direct evaluation of the safety functions in the drive
- Easy handling – up to eight different safety settings per function



## HIGH-SPEED DRIVES IN PRACTICE

High-speed drives from KEB are used in numerous applications where output frequencies of up to 2,000 Hz are required. Precise drive control, high energy efficiency and the longer service life of plants and machines are just some of the benefits that users in various industries benefit from – whether in sewage treatment plants, the pharmaceutical industry or food production. High-speed drives are the first choice in these fields of application:

- Turboblower
- Turbocompressors
- Vacuum pumps
- Gas turbines
- Spindles
- Vaporisers
- Refrigerant compressors

Two exemplary applications that are realised with the drives from KEB:

### TURBOBLOWER

- Ideal for harsh environmental conditions: Circuit boards with optional 3C3 protective coating
- Special software function keeps magnetic bearings active even after a power failure
- Cost savings thanks to integrated maximum speed monitoring (SMS) and safely limited speed (SLS) – encoderless
- Minimised rotor heating and losses thanks to high switching frequencies and sine filters
- Easy integration into process control systems thanks to multi-fieldbus interface
- Maximum efficiency, compactness and service life thanks to liquid-cooled drives, among other things

### HIGH-SPEED SPINDLES

- Optimised drives for driving spindles with different tools
- Drives enable high torque across the entire speed range
- Encoderless positioning and speed stiffness up to 120,000 rpm
- Safe field-weakening operation and utilisation of the reluctance torque for synchronous machines with asymmetrical reactance (e.g. IPM motors)
- Multi-encoder interface and all operating modes in the standard modular system
- Cost and time savings thanks to HIL simulation and virtual commissioning with digital twin

**COMBIVERT F6**

**HIGH-SPEED DRIVE**

Housing		2		6			7			8			9				
Device size		12	13	22	23	24	26	27	28	28	29	30	30	31	32	33	
Cooling variant		AC	AC	AC	LQ	LQ	AC (LQ)	AC	LQ	LQ	LQ	LQ	LQ	LQ	LQ	LQ	
Rated output power	[kVA]	6.6	8.3	80	104	125	173	208	256	256	319	395	395	436	492	554	
Max. Rated motor power	[kW]	4	5.5	55	75	90	132	160	200	200	250	315	315	355	400	450	
Rated output current 400 V	[A]	9.5	12	115	150	180	250	300	370	370	460	570	570	630	710	800	
Rated output current 480 V (UL)	[A]	7.6	11	106	124	156	210	260	325	325	400	495	495	545	615	692	
Short-time limit current (60 s / max.)	[%]	150	150	***	***	125	106	106	106	125	106	125	125	125	125	125	
Maximum current 0/100 Hz at rated switching frequency	[%]	171/216	125/180	***	***	56/150	32/125 (44/150)	40/110	30/125	54/150	44/146	***	53/150	48/150	42/142	34/126	
Rated input current 400 V	[A]	13	17	126	158	189	263	315	390	390	485	600	600	660	746	840	
Rated input current 480 V (UL)	[A]	11	15	106	128	162	217	269	337	337	414	513	513	575	646	726	
Rated switching frequency	[kHz]	8		6	8	8	8	6	8	8		6	8				
Max. switching frequency	[kHz]	16									8						
Mains phases								3									
Rated input voltage (AC)	[V]							400 (UL: 480)									
Input voltage range (AC)	[V]							280 ... 550									
Input voltage range (DC)	[V]							390 ... 780									
Mains frequency	[Hz]							50 / 60 ±2									
Output voltage	[V]							3 x 0 ... U <sub>IN</sub>									
Output frequency	[Hz]							0 ... 599 (0 ... 2000)									
Max. flow temperature (only LC)	[°C]				55	(55)		40	55	40	40	55					

AC=Air-cooled LQ=Liquid-cooled \*\*\* values follow

**COMBIVERT S6**

Housing		2		2			4	
Device size		07	09	07	09	10	12	13
		230 V	230 V	400 V	400 V	400 V	400 V	400 V
Rated output power (With output voltage 400 V AC)	[kVA]	1.8	2.8	1.8	2.8	4	6.6	8.3
Max. Rated motor power	[kW]	0.75	1.5	0.75	1.5	2.2	4.0	5.5
Rated output current I <sub>N</sub>	[A]	4	7	2.6	4.1	5.8	9.5	12.0
Short-time limit current (60 s / max.)	[%]	150	150	200	200	200	200	200
Rated input current I <sub>IN</sub>	[A]	8	14	3.6	6	8	13	17
Rated switching frequency	[kHz]	8						
Max. switching frequency	[kHz]	16						
Mains phases		1		3				
Rated input voltage (AC)	[V]	1-phase 230		3-phase 400 (UL: 480)				
Input voltage range (AC)	[V]	184 ... 265		184 ... 550 ±0				
Input voltage range (DC)	[V]	260 ... 375		260 ... 750 ±0				
Mains frequency	[Hz]	50 / 60		50 / 60 ±2				
Output voltage	[V]	3 x 0 ... U <sub>IN</sub>						
Output frequency	[Hz]	0 ... 599 optional 0 ... 2000						



**Automation with Drive**

**keb-automation.com**

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