COMBIVERT *S6*

COMPACT SERVO DRIVES

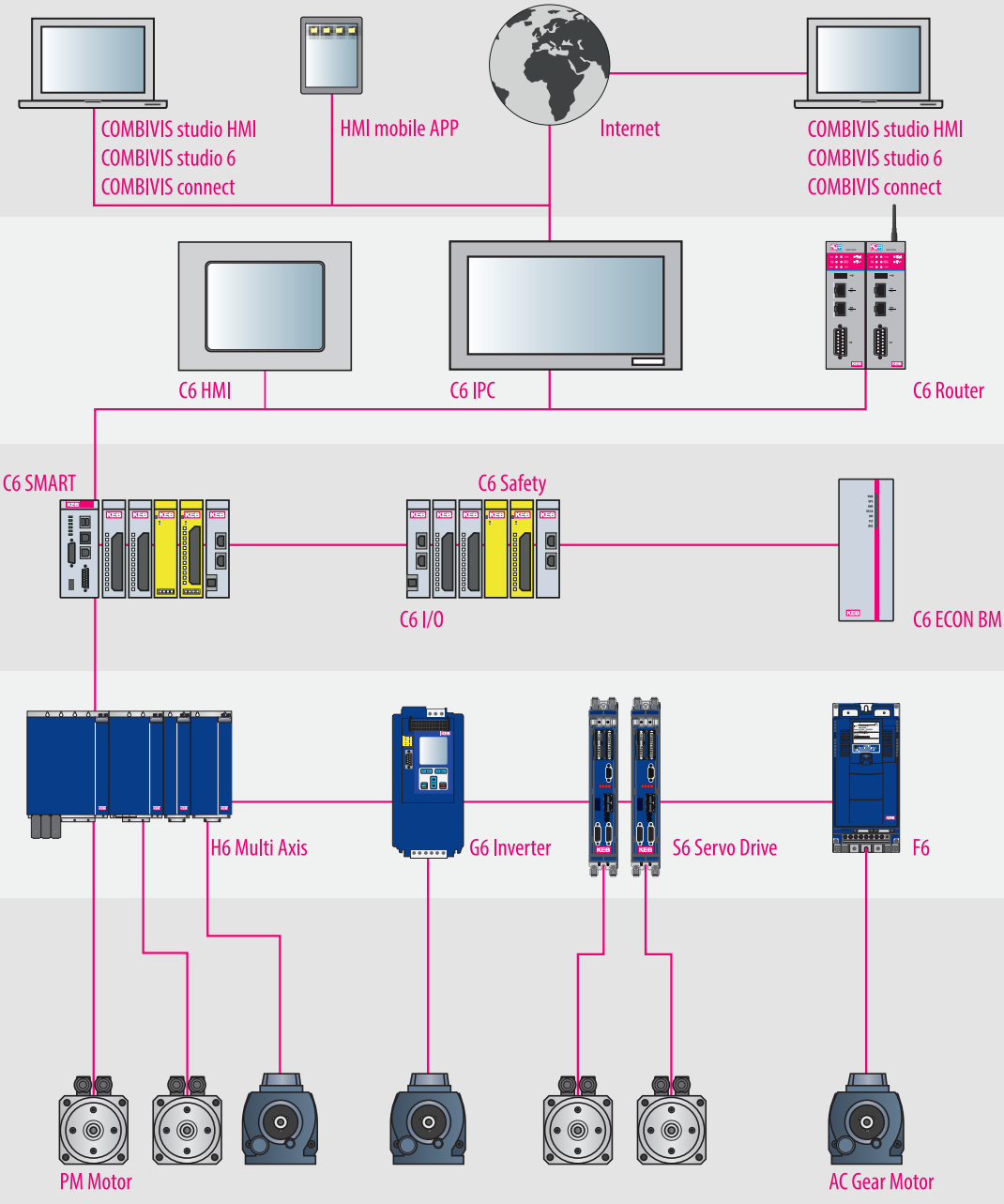
V 1.0 - **EN**

KEB

SYSTEM OVERVIEW

Automation **with Drive**
stands as a synonym for optimally selected combinations of control and automation solution. With the drive level at the end it is the key to successful machine concepts.

Let the following pages inspire you with regards to the diversity and performance of the COMBIVERT S6 servo system, and help you to find a solution that reliably meets your requirements.



OPTIMALLY SELECTED COMPONENTS

The COMBIVERT S6 servo system adds a compact, flexible and powerful drive module to the KEB product portfolio for highly dynamic servo applications.

The optimally selected KEB components are the key to this successful drive concept. At the heart, the innovative S6 servo drive is offered in an attractive book-style format and offers real-time performance. The S6 drives can be matched with the robust DL3 servo motors which are available in five sizes. Additionally, the DL3 servo motors may be paired with planetary gearheads with low rotational backlash.

The TA series combines in direct connection the servo motor and industrial gears in the designs helical , helical bevel , helical worm and flat. You can now design the complete servo drive system that is best suited to your application.
The package is made complete with pre-fabricated motor and encoder cables, which create the ideal conditions for easy installation, quick start-up and problem-free operation.

For the upper power range the new COMBIVERT F6 drive controller complete the drive line with 1:1 features up to 400 kW.

POSSIBLE SELECTION: S6 SERVODRIVE AVAILABLE WITH OR WITHOUT INTEGRATED EMC FILTER

- 2.6 … 12 A in two enclosures with five electrical sizes
- Book format for space-saving control cabinet configuration
- Direct connection to the mains for 230 V and 400-480 V grids, DC-input is also available, 260 … 750 V
- Low leakage current mains filter (<5 mA) integrated, optional without filter
- High overload for excellent dynamics (250% / 3 s, 200% / 60 s)

HIGHLIGHTS

- uncompromising integration, highest perfomance
- modern realtime communication standards
- integrated functional safety
- particular compact size
- Modular design, flexible cooling systems

DRIVE BASED SAFETY

- integrated Safety functionality
- basic function STO in compact version
- additional High Level Safety in Application version

REAL-TIME COMMUNICATION

- or simply serial
- Real-time Ethernet-based interfaces
- CAN
- RS232/485 for diagnostics or display

ANALOG & DIGITAL I/O

supports actual machine concepts with

- 8 digital and 2 analog inputs
- 2 digital and 1 relay output
- 1 analog output 0 … 10 V

ALL IN ONE - UNIVERSAL MOTOR OPERATIONS

- control for synchronous, asynchronous, IPM or synchronous reluctance motors
- Motor operation with encoder feedback or encoderless ASCL/SCL for precise speed control
- Motor temperature monitoring with PTC, KTY or PT1000 sensors
- Two-channel multi-encoder interface
- Integrated GTR7 brake transistor
- Integrated brake control and brake supply

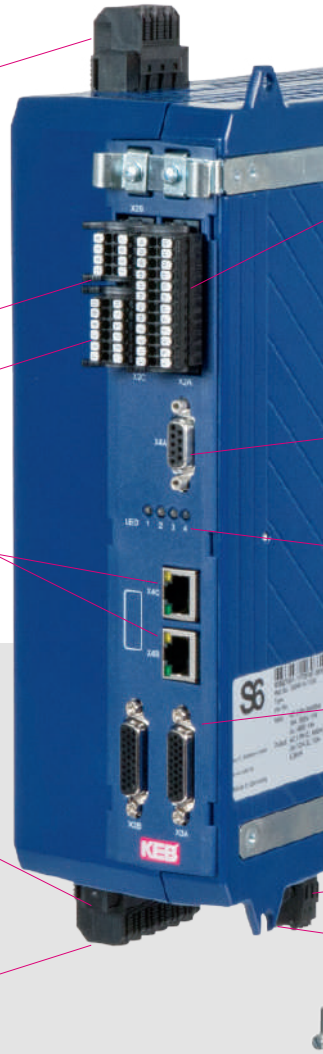
S6-K COMPACT

HIGHLY INTEGRATED AND ECONOMICAL

The S6-K offers uncompromising integration, maximum performance and an optimum price/performance relationship.

These are the advantages of the compact version S6-K

- Fast link to the control level using EtherCAT and the CAN interface
- Integrated safety function „Safe Torque Off“ (STO) according to ISO 13849- Performance Level e / IEC 62061- SIL 3.



REALTIME ETHERNET INTEGRATED

EtherCAT

and as communication interface (standard feature)

CAN

DIAGNOSTIC RS232/485

EtherCAT®

CANopen®

HIGHLIGHTS

- uncompromising integration, maximum performance
- optimum price/performance relationship
- safety function STO according to ISO 13849 Performance Level e / IEC 62061- SIL 3
- integrated Real-time EtherCAT and as communication interface CAN
- diagnosis interface

S6-A APPLICATION

MODULAR AND FLEXIBLE

The S6-A can be summarized as modular, flexible and reliable.

The characteristics of the application version S6-A

- It includes all of the advantages of the compact version and offer more flexibility for selecting the bus connection to the control level and a larger selection of safety functionality.
- For the bus communication a single device supports EtherCAT and in addition PROFINET and POWERLINK.
-
- STO and SBC are already integrated as standard safety features.
-
- Optionally, with safety module 3 users can also select up to three additional functions from an extensive package.

I/O
8 digital inputs
2 digital outputs
1 relay
2 analog inputs
1 analog output
24V DC supply

DIAGNOSTIC INTERFACE

STATUS LEDS

MULTI ENCOCER INTERFACES
Resolver, EnDAT, Hiperface, BISS, SSI,
Incremental HTL/TTL,
Incremental output

KTY/PTC/PT1000 EVALUATION

BRAKE CONTROL 24 V / 2 A

REALTIME ETHERNET INTEGRATED

EtherCAT
PROFINET
POWERLINK

and communication interfaces as standard
CAN

DIAGNOSTIC RS 232/485

ETHERNET POWERLINK

PROFINET INDUSTRIAL ETHERNET

HIGHLIGHTS

- flexible adaption in usage
- high Level Safety Function STO and SBC „Safe Brake Control" according to ISO 13849 Performance Level e / IEC 62061- SIL 3
- optionally version Safety Module 3 with up to three additional functions including SS1, SS2, SEL, SLI, SLP, SOS, SLA, SDI, SLS, SSM, SMS, SAR, SSR,

and prepared for real time safety communication FSoE (fail safe over EtherCAT)

EC Type-Examination Certificate

Reg.-Nr./No.: 01/205/5517.00/16

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TÜVRheinland®
Precisely Right.

HIGHLIGHTS

- possible download of encrypted data packets through machine controllers modular safety concept
- dual channel ripple interface for cascading functional safety over multiple KEB drives
- dual OSSD outputs for supply of the safe digital inputs (detection of wire break, shortcut and external supply)
- safe parameterization through COMBIVIS 6 with protected operation levels

FUNCTIONAL SAFETY

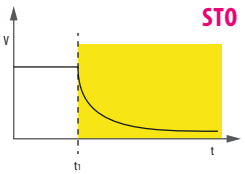
SAFETY FUNCTIONS ACCORDING TO IEC 61508 - SIL3, ISO 13849 - PL e

With the drive-based-safety, safety functions are shifted into the drive platform and the costs of separate protective devices are reduced. The drive controllers COMBIVERT S6 are prepared for the different requirements in their modular structure.
In the compact version S6-K, STO is an „on board" integrated component. The application version S6-A can be equipped with different safety modules. Depending on the requirement, basic functions with the Module 1 and a wide range of functions are available with the Module 3, which are addressed via safe inputs and outputs and safe FSoE communication.

The full Safety System results in the interaction of the drive controllers with the KEB C6 Safety PLC and the C6 Safety I / O's.

S6-K

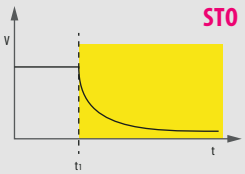
S6-K ON BOARD



Safe Torque OFF

S6-A

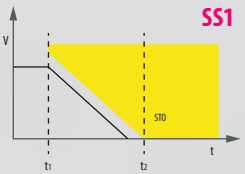
S6-A MODULE 1



Safe Torque OFF

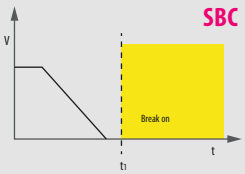
+

S6-A MODULE 3

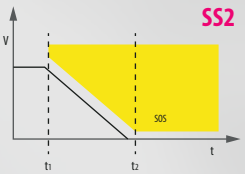


Safe Stop 1

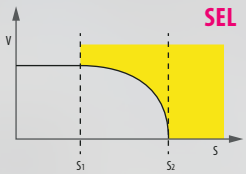
Safety over EtherCAT®



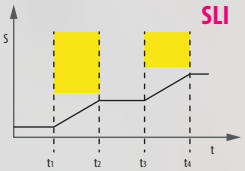
Safe Brake Control



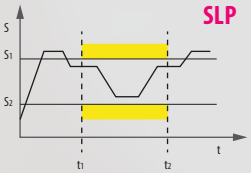
Safe Stop 2



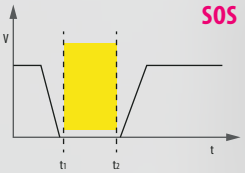
Safe Emergency Limit



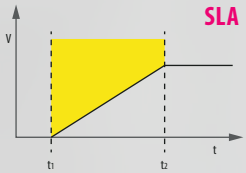
Safely-Limited Increment



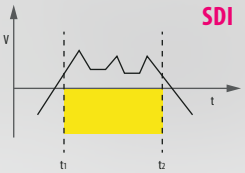
Safely-Limited Position



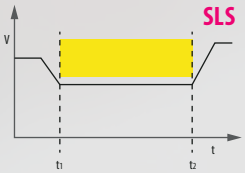
Safe Operating Stop



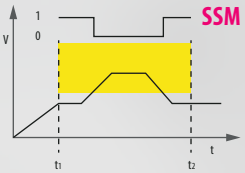
Safely-Limited Acceleration



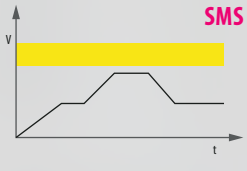
Safe Direction



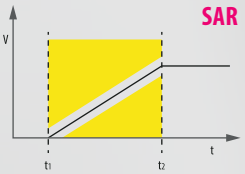
Safely-Limited Speed



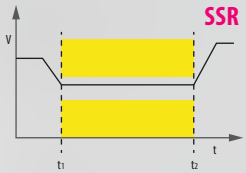
Safe Speed Monitor



Safe Maximum Speed



Safe-Acceleration Range



Safe Speed Range

ELECTRICAL PROPERTIES

HOUSING			**2**			**4**	
Device size			07	09	10	12	13
Mains phases			3				
Output rated current	I_N	[A]	2.6	4.1	5.8	9.5	12.0
Short maximum current (3 s / 60 s) 1)	I_{HSR}	[%]	250 / 200				
Output rated power *	S_A	[kVA]	1.8	2.8	4	6.6	8.3
Typical rated motor power	P_{mot}	[kW]	0.75	1.5	2.2	4.0	5.5
Max. current 0 Hz / cutoff frequency at fs = 4 kHz [1)]	I_0	[%]	200/250		150/250		200/250
Max. current 0 Hz / cutoff frequency at fs = 8 kHz [1)]	I_0	[%]	125/200		100/200	150/250	125/200
Max. current 0 Hz / cutoff frequency at fs = 16 kHz [1)]	I_0	[%]	75/180	50/120	50/120	75/150	75/125
Cutoff frequency point	f_d	[Hz]	6				
Input rated current	I_{IN}	[A]	3.6	6	8	13	17
Max. permissible mains fuses	Typ gG	[A]	16			20	25
Rated switching frequency	f_{SN}	[kHz]	8				
Max. switching frequency	f_{Smax}	[kHz]	16				
Rated losses	P_D	[W]	52	60	80	145	198
Standby losses	P_{Dnop}	[W]	8				
Min. brake resistance	R_{Bmin}	[Ω]	170	120	85	39	39
Max. braking current	I_{Bmax}	[A]	5	7	10	21.5	21.5
Input rated voltage (AC)	U_N	[V]	3-phase 400 (UL: 400 … 480)				
Input voltage range (AC) [2)]	U_{in}	[V]	184 … 550 ±0				
Input voltage range (DC)	U_{indc}	[V]	260 … 750 ±0				
Mains frequency	f_N	[Hz]	50 / 60 ±2				
Output voltage	U_A	[V]	3 x 0 … U_{IN}				
Output frequency	f_A	[Hz]	0 … 400 (fs=4 kHz) / 0 … 599 (fs=8 kHz)				

* at rated voltage 400 V AC

1) the figures relate to the output rated current I_N on a percentage basis.
2) in the case of rated voltage ≥460 V, multiply rated current with a factor of 0.86

MECHANICAL DATA, OPERATING TYPES, STANDARDS

OPERATING MODES

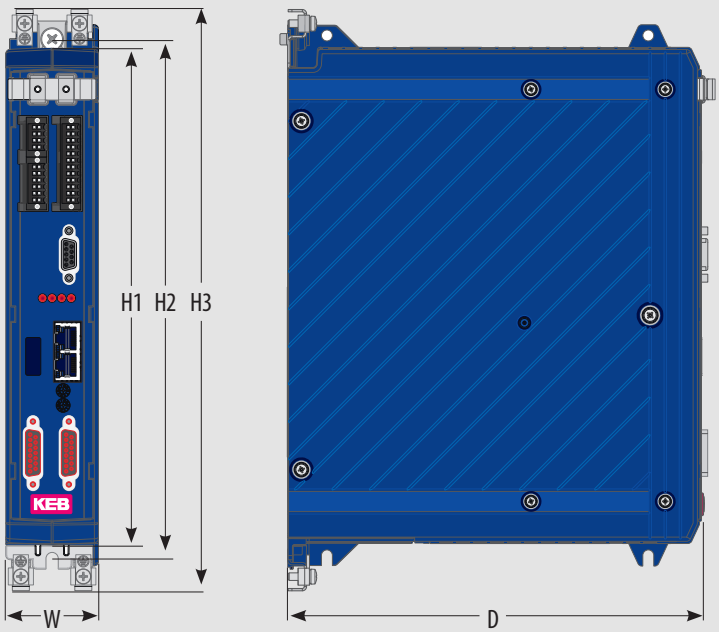
Motor control mode	**PMSM**: field-oriented with encoder, S.C.L. encoderless. **IPMSM**: field-oriented with encoder, S.C.L. encoderless. **SyncRM**: field-oriented with encoder, S.C.L. encoderless **ASM**: V/F, SMM, field-oriented with encoder, A.S.C.L. encoderless.
Application profile	CiA Draft Standard Proposal 402
Control mode	Asynchronous speed specification (Velocity Mode) Cycl. Synchronous speed specification (Cycl. Sync. Velocity Mode Cycl. Synchronous position specification (Cycl. Sync. Position Mode) Cycl. Synchronous torque specification (Cycl. Sync. Torque Mode) Single-axis positioning module (Profile Positioning Mode) Homing Mode Torque pilot control crank drives

GENERAL

Product standard	EN 61800-2, -5-1
Power part with integrated EMC filter - EMC transient emissions	
Grid-bound disturbance	EN 61800-3, C1 - 30 m / C2 - 50 m motor cable
Emitted disturbances	EN 61000-6 -1. . .4, C2
Protection class	IP 20 / VBG 4
Environment	EN 60721-3-3 Operating temperature -10 . . . 45 °C Storage temperature -25 . . . 70 °C Humidity 3K3 - 5 . . . 85% (no condensation)
Site altitude	Rated to 1000 m (1% derate per 100m above 1000m). max. 2000m above sea level.

HOUSING	2	4
H1	265	265
H2	275	275
H3	310	310
D	220	220
W	50	90

All dimensions in mm



ACCESSORIES

STABLE OPERATION IN INDUSTRIAL ENVIRONMENT

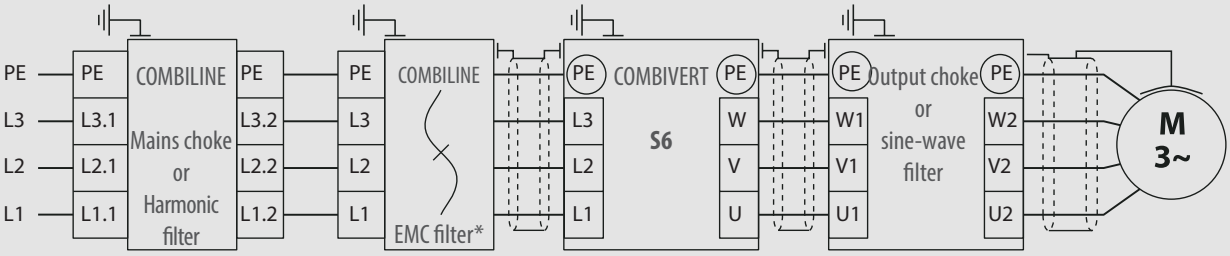
An EMC-compliant assembly with efficient control cabinet and suppression system is the basis for safe operation of machinery and equipment. The current and voltage limiting COMBILINE modules are optimally designed to meet the requirements of the COMBIVERT S6 servo sytem and support the use through:

MAINS EMC FILTERS

specially designed for the COMBIVERT S6 power part version without internal EMC filter reduce the cable-fed emission to the required limits IEC 618000-3 - C1-50 m/C2-100m . Main feature is the low leakage for multiple drive systems

Three-wire HF-Filter 3-phases 400/480 V AC (UMAX = 550 V), 50/60 HZ ± 10 %

Part-No.	I_N [A]	P_v [W]	I_{ab} [mA]	B [mm]	H [mm]	T [mm]	Weight m [kg]
12E6T60-3000	12	8	<3	45	252	77	0.9
14E6T60-3000	22	14	<3	55	252	92	1.3
16E6T60-3000	43	18	<3	65	252	106	1.8
18E6T60-3000	65	27	<3	130	240	142	3.9



** only for power parts without EMC filter*

MAINS CHOKE

reduce the input peak current draw and the mains distortion. By smoothing the input current draw, the lifetime of the drive is enhanced, in particular at constantly high utilization.

Mains choke 3-phases 400 V AC (U_{max} = 550 V), 50/60 Hz

Part-No.	I_N [A]	P_V [W]	f_{Main} [Hz]	B [mm]	H [mm]	T [mm]	Weight m [kg]
07Z1B04-1000	2.7	19	45-65	100	55	121	0.9
09Z1B04-1000	4.3	23	45-65	100	55	121	1.1
10Z1B04-1000	6.1	24	45-65	100	64	121	1.5
12Z1B04-1000	10	37	45-65	148	68	145	2.1
13Z1B04-1000	12.6	48	45-65	148	78	145	2.6
14Z1B04-1000	17.3	69	45-65	148	77	145	2.8
15Z1B04-1000	25.2	86	45-65	178	73	180	4.4
16Z1B04-1000	34.7	99	45-65	178	88	178	5.9
17Z1B04-1000	44.1	123	45-65	219	101	215	8.4
18Z1B04-1000	52.5	126	45-65	219	111	220	10

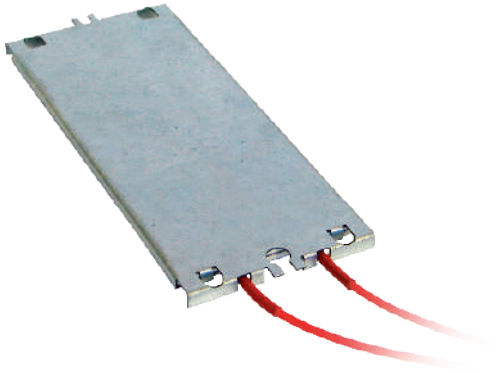
BRAKING RESISTOR

Braking resistors can be connected to the series terminals of the GTR7 brake transistor, and ensure that energy peaks are absorbed and discharged. The compact design require only small space and they are intrinsically safe; without additional temperature sensors.

To protect against overheating and fire hazards, the brake resistors feature thermal monitoring which can be integrated into the external circuit.

Braking resistors - „intrinsically safe“

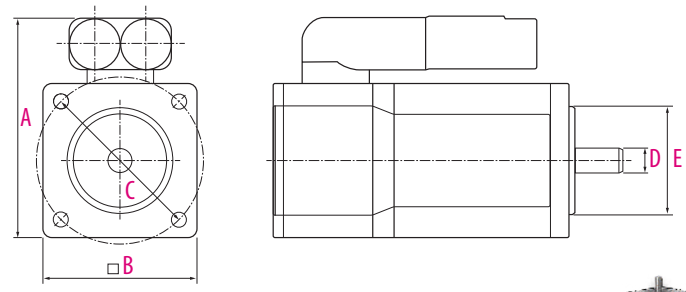
10G6A90-4300	wire 0.2 m	200 W; 160 Ohm; IP40
13G6B90-4300	wire 0.2 m	250 W; 110 Ohm; IP40
15G6C90-4300	wire 0.2 m	300 W; 56 Ohm; IP40



THE FURTHER OPTIONS ARE

Output chokes	reduce the voltage and current stress of the motor winding.
Sine-wave filters	protect the motor winding from voltage peaks and allow the use of long motor cables.
Harmonic filters	reduce the low frequency mains distortion of B6-rectifier supplied devices. These harmonic filters are the new innovative solution to comply to most international standards. The integration to a switch gear layout is as simple as of mains chokes.
Sine-wave EMC filters	allow operation of motors with long motor cables even without screening.
High performance ferrite cores	reduces the values of du/dt's also in the frequency range of the bearing currents.

SERVOMOTORS DYNAMIC LINE 3



A_SMH__	0.5 … 1.2
B_SMH__	1.38 … 3.22
C_SMH__	2.45 … 5.65
D_SMH__	4.9 …… 11.4
E_SMH__	12.8 …… 29.0

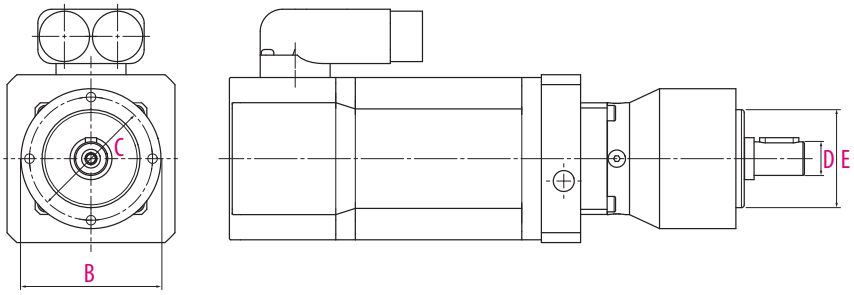
Stall torque in Nm

MOTOR	T_0 [Nm]	T_N [Nm]	I_N [A]	ID_0 [A]	N_N [rpm]	A [mm]	B □ [mm]	C Ø [mm]	D Ø [mm]	E Ø [mm]	BRAKE OPTION M_0 [Nm]
A1	0.5	0.5	0.85	0.85							
A2SMHF_	0.8	0.7	1.30	1.50	8000	82.4	58	63	9	40	0.8
A3	1.2	1.0	1.85	2.20							
B1	1.4	1.3	1.90	1.95							
B2SMHF_	2.4	2.2	2.75	2.95	6000	96.4	72	75	14	60	2
B3	3.2	2.7	3.60	4.10							3.5
C1	2.5	2.3	2.90	3.00	6000						
C2SMHF_	4.1	3.7	3.80	4.10	5000	128.5	87	100	19	80	9
C3	5.7	4.9	4.75	5.40	5000						
D1	4.9	4.4	4.20	4.75	5000						9
D2SMHF_	8.2	6.9	5.20	6.30	4000	145.5	104	115	24	95	9
D3	11.4	8.4	6.30	8.80	4000						13
E1	12.8	11.0	6.80	7.80							20
E2SMHF_	21.1	15.2	9.40	12.4	3000	183.5	142	165	32	130	20
E3	29.0	13.2	8.10	17.2							30

HIGHLIGHTS

- 0.5 . . . 29 Nm in five frame sizes
- Low inertia - high impulse torque
- Resolver or absolute rotary encoder, HIPERFACE single or multi-turn
- High degree of total efficiency
- Lifetime lubricated
- Universal installation positions
- Robust mechanics (optional: COMBIPERM holding brake, keyway with key, IP65 shaft sealing)

PLANETARY GEAR SG PAIRED WITH DYNAMIC LINE 3:



GEAR SIZE	T_{2N} [Nm]	T_{2MAX} [Nm]	N_{MAX} [rpm]	I	BACKLASH arc_{min}	B Ø [mm]	C Ø [mm]	D Ø [mm]	E Ø [mm]	DL3-MOTOR recommended
1	5 … 11	8 … 17.5	5000	5 … 40	15	50	44	12	35	A
2	15 … 28	24 … 45	4500		10	70	62	16	52	A B C
3	38 … 85	61 … 136	4000		7	90	80	22	68	A B C D
5	95 … 115	152 … 136	3000		7	120	108	32	90	B C D E
7	210 … 460	336 … 736	2800		8	155	140	40	120	C D E

Simple selection and ordering by system configuration in COMBIVIS 6

- output torque and speed
- gear ratio
- motor size

HIGHLIGHTS

- Low backlash
- High output torque
- High efficiency (97%)
- Gear ratios i = 5 to 40
- Low audible noise
- Lifetime lubricated

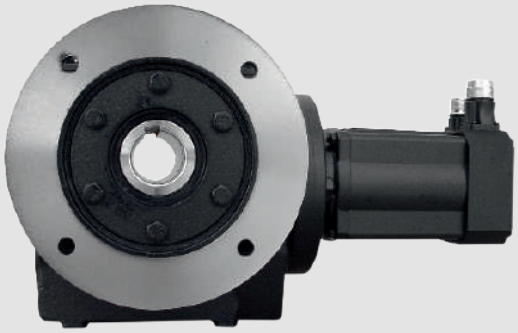
SERVO GEAR MOTORS

INTEGRAL SERVO DESIGN

Based on the industrial standard with AC motors the portfolio of COMBIGEAR series offers a full basket of servo gear solutions.
The dynamic and efficient TA servo motors are direct connected in the first gear stage - best choice for minimum lenghts, nearly zero wear and small inertia of the gear motor system.
Flexible designs for flange-, foot- or combined flange/foot- mounting and a wide range of options secure individual needs in the machine. Ultra-fine speed ratio range, adjustable down to speed 0, enables optimum adaptation of torque and speed on output. Life-time lubrication, high overload and low torsional backlash ensure a long service life.

TYPE	SIZE	DESIGN	T_N [Nm]	I	TA2	TA3	TA4	TA5
G	0 … 7	Helical gear	60 … 4880	3.37 … 250.97	■	■	■	■
F	2 … 7	Shaft mounted helical gear	245 … 4880	3.20 … 274.23	■	■	■	■
K	0 … 7	Helical bevel gear	58 … 4880	3.38 … 183.21	■	■	■	■
S	0 … 4	Helical worm gear	55 … 1160	5.09 … 247.58	■	■	■	■

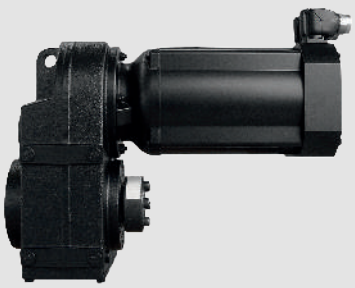
HELICAL GEAR



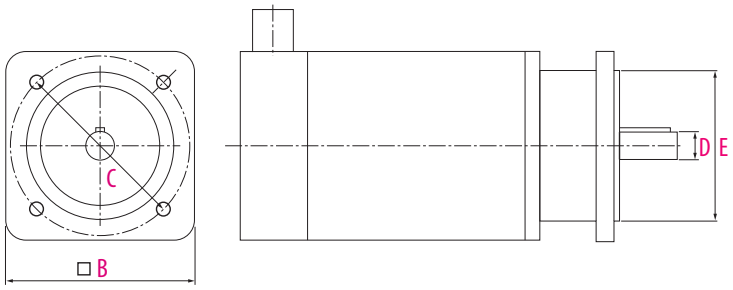
HELICAL WORM GEAR

HELICAL BEVEL GEAR

SHAFT MOUNTED HELICAL GEAR



SERVO MOTORS - TA SERIES



TA 2	0.82 … 1.45
TA 3	1.5 … 3.9
TA 4	6.9 … 11.7
TA 5	11.5 … 20.0

Stall torque in Nm

MOTOR	T_0 [Nm]	T_N [Nm]	I_{D0} [A]	I_N [A]	N_N [rpm]	B □ [mm]	C Ø [mm]	D Ø [mm]	E Ø [mm]	BRAKE OPTION T_N [Nm]
TA21	0.82	0.85	0.9	0.87	4500	75	75	11	60	2.0
TA22	1.45	1.55	1.52	1.42						
TA31	1.5	1.4	1.1	1.1	3000	88	100	14	80	4.5
TA32	2.8	2.6	1.8	1.7						
TA33	3.9	3.6	2.5	2.4						
TA41	6.9	6.3	4.0	4.1	3000	116	115	19	95	9
TA42	9.2	8.2	5.9	5.2						
TA43	11.7	10.1	7.3	6.3						
TA51	11.5	10.4	7.4	6.6	2000	145	165	24	130	18
TA52	16.1	13.5	10.3	8.7						
TA53	20.0	16.1	12.8	10.3						

HIGHLIGHTS

- 0.82 … 20 Nm in four frame sizes
- Low inertia - high impulse torque
- Easy plug connection, straight or angled (360° rotatable)
- Compact size - directly integrated in the gear modules
- High total efficiency, lifetime lubricated, universal installation positions and robust mechanics
- Resolver or absolute rotary encoder, BiSS single and multi-turn
- Optionally with COMBIPERM holding brake

FEEDBACK AND POWER CABLES

Pre-fabricated motor and encoder cables ensure the easy commision and simplify the final installation

General performance is the high-quality and flexible design for all cables, made for drag chains

Quick and tool-less installation with Speedtec plug connectors guarantees a optimally connection and EMC shielding.

RESOLVER FEEDBACK CABLES

- motor side connector - series 615
- drive side connector D-sub 26 pin

00S6L50-00___

cable length	1...30 m	in 1m step
	35...50 m	in 5 m step

HIPERFACE FEEDBACK CABLES

for single and multi turn encoder
- drive side connector D-sub 26 pin
- motor side connector - series 615

00S6L55-00___

cable length	1...30 m	in 1m step
	35...50 m	in 5 m step

POWER CABLES

- drive side open end with 0.3m open shielding
- motor side connector - series 615 motor size A...B

00H6L10-00___

cable length	1...30 m	in 1m step
	35...50 m	in 5 m step

- motor side conncetor - M23 speedtec motor size C - E

00S4519-00___

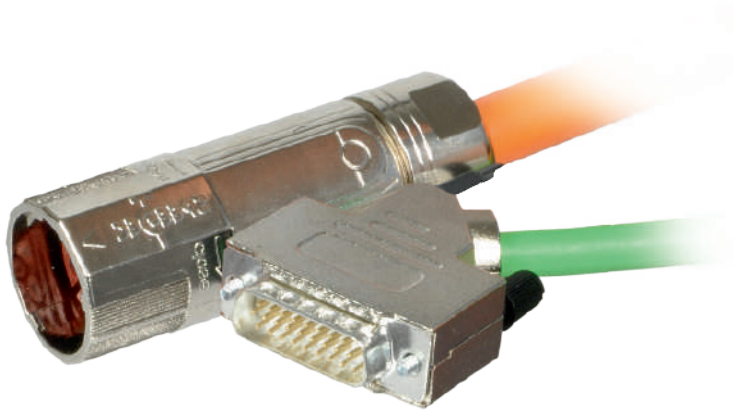
cable length	1...30 m	in 1m step
	35...50 m	in 5 m step

FEEDBACK AND POWER CABLES

Pre-fabricated encoder and motor and encoder cables ensure the easycommision and simplify the final installation

General performance is the high-quality and flexible design for all cables, made for drag chains

Quick and tool-less installation with Speedtec plug connectors guarantees a optimally connection and shielding.



RESOLVER FEEDBACK CABLES

- motor side connector - 16 pin M23 - Speedtec
- drive side connector D-sub 26 pin

00S6L50-10__

cable length	1...30 m	in 1m step
	35 .. 50 m	in 5 m step

BISS FEEDBACK CABLES

for multi turn encoder

- motor side connector - 16 pin M23 - Speedtec
- drive side connector D-sub 26 pin

00S6L51-20__

cable length	1...30 m	in 1m step
	35 .. 50 m	in 5 m step

POWER CABLES

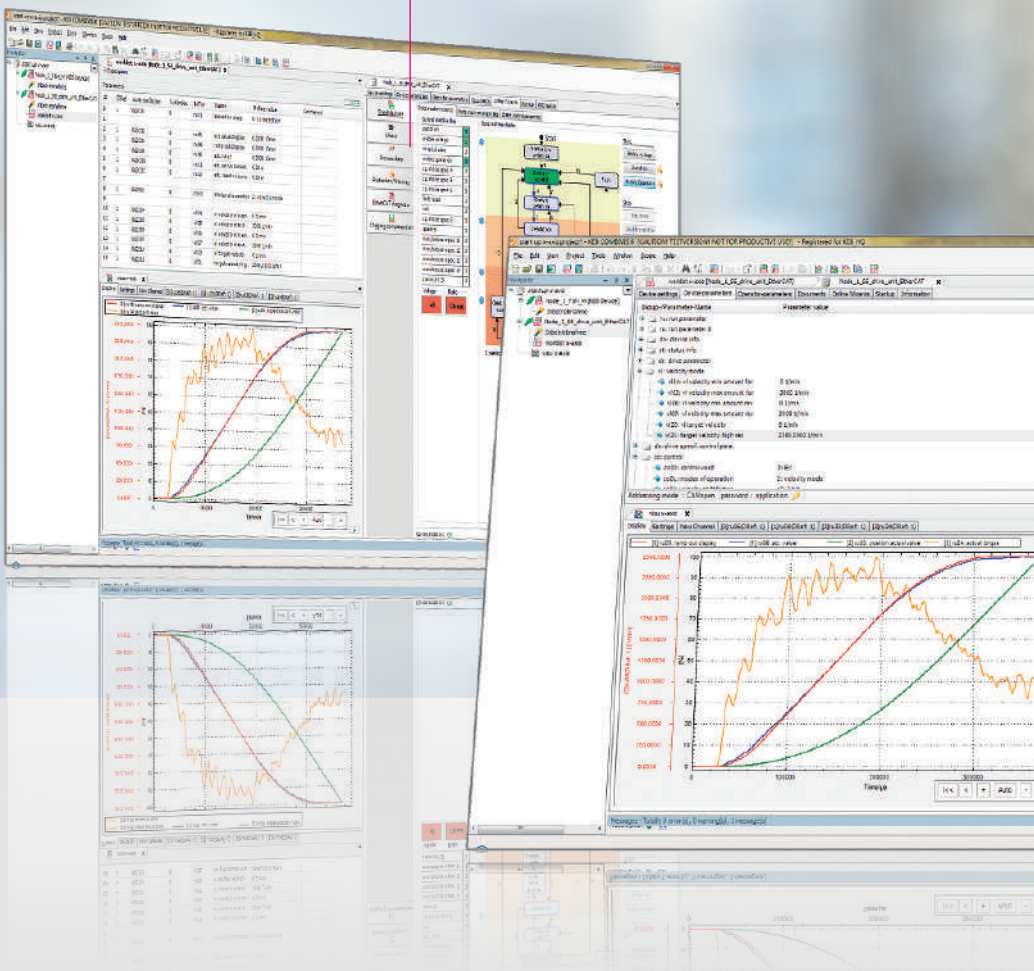
- drive side open end with 0.3 m open shielding
- motor side conncetor - M23 - Spedtecfor motor size TA2. . .TA5

00S4519-00__

cable length	1. . .30 m	in 1m step
	35. . .50 m	in 5 m step

COMBIVIS 6

- Free and easy-to-use software for startup, administration and analysis
- Integrated start-up assistants (Wizards) for quick and easy configuration
- Direct access to device documentation
- 16 channel oscilloscope for extensive analysis
- Online parameter list comparison
- Parameterisation of key safety indicators and functions

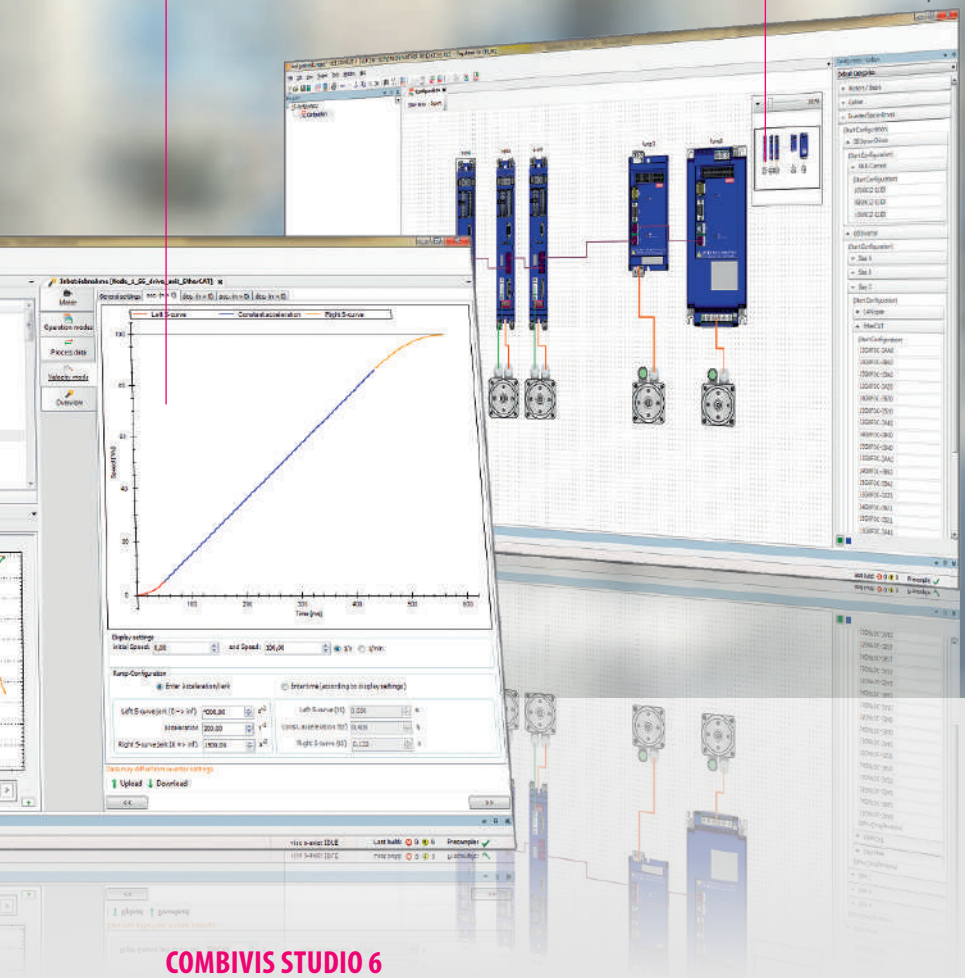


COMMISSIONING ASSISTANT

- Complete user guidance through the commissioning process
- KEB Motor database, free for extensions
- Anti cogging
- Fieldbus diagnostic and optimisation

SYSTEM CONFIGURATION AS A NEW COMPONENT OF COMBIVIS

- Access to complete KEB product database
- Intuitive gear component selection and system configuration using drag and drop
- Selection assistant with display of compatible components
- Display of all interfaces and connection components
- Material number generator
- Extensive export function for quote list, Combivis Project, Excel …



COMBIVIS STUDIO 6

The intelligent automation suite from KEB combines an assistant-guided component selection, fieldbus configuration, drive parameterisation, IEC 61131-3 project generation and motion control. Throughout the planning and layout phase, implementation of control sequences and multi-axis movement profiles, to start-up and fine tuning, the user is supported by a tool developed by experienced application engineers.

With a foundation built on libraries, devices and template databases, rapid and simple solutions can be generated for a wide range of applications.

HIGHLIGHTS

- IEC 61131-3 Applications development
- Device and library database
- Product configuration
- Start-up and diagnosis assistant
- COMBIVIS studio HMI integration
- Document database

KEB SERVICE

PERFORMANCE AND COMPETENCE

AFTER-SALES CUSTOMER SUPPORT

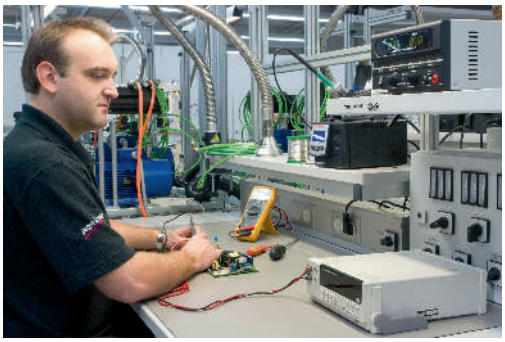
- start-up support
- EMC service
- mains analysis
- Insulation, heat or vibration measurements
- conversion of old product series

MAINTENANCE AND REPAIRS

- rush or standard service

COMPONENT AND SPACE PART SUPPLY

- used and new parts for the exchange



PREVENTIVE MAINTENANCE

- forming and cleaning, inspection, functional analysis

CUSTOMER SPECIFIC SERVICE

- individual service support
- system optimisation

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