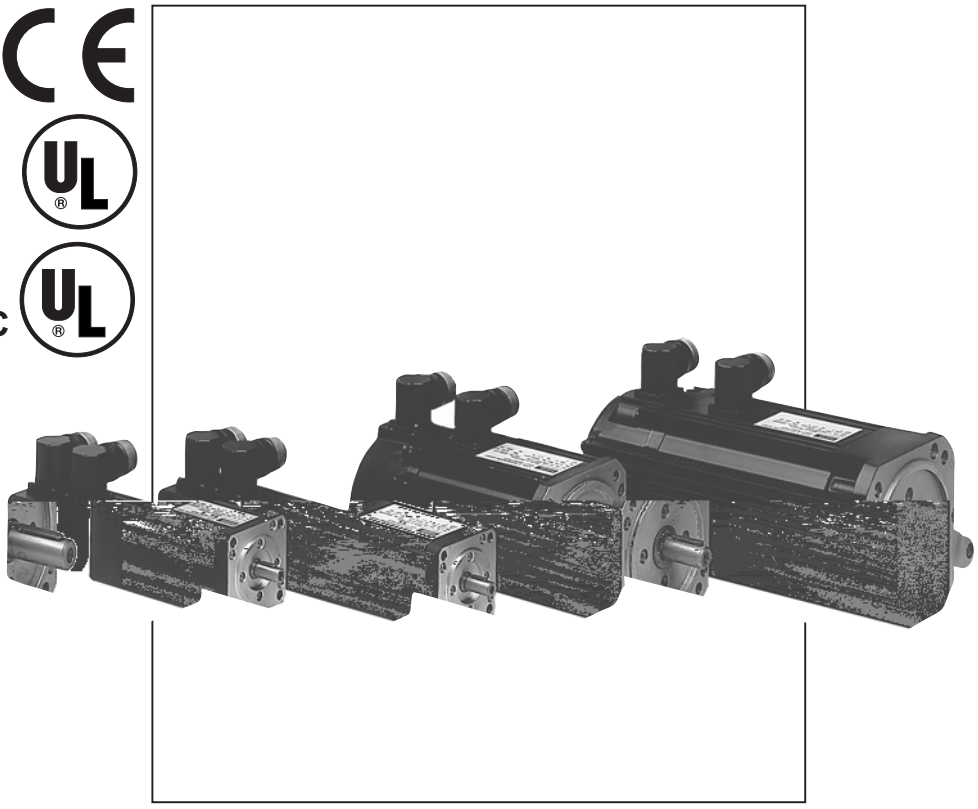
BETRIEBSANLEITUNG

INSTRUCTION MANUAL



KEB Servomotore
KEB Servo Motors

Größe A1 . . . F3
Size A1 ... F3

00.SM.01B-K011

KEB

06/2004

Diese Betriebsanleitung beschreibt die Servomotoren A1...F3 und muß jedem Anwender zugänglich gemacht werden. Vor jeglichen Arbeiten muß sich der Anwender mit dem Gerät vertraut machen. Den **Sicherheits- und Warnhinweisen** in dieser Anleitung und in der Beschreibung für den Servosteller sowie in weiterer Dokumentation ist für einen sicheren Betrieb unbedingt Folge zu leisten. Die in dieser Anleitung aufgeführten Sicherheits- und Warnhinweise erheben keinen Anspruch auf Vollständigkeit. Die KEB Antriebstechnik GmbH behält sich das Recht vor, Spezifikationen und technische Daten ohne vorherige Benachrichtigung zu ändern, bzw. anzupassen.
Die in dieser Betriebsanleitung verwendeten Pictogramme entsprechen folgender Bedeutung:

Gefahr / Warnung / Vorsicht
Wird verwendet, wenn Leben oder Gesundheit des Benutzers gefährdet sind oder erheblicher Sachschaden auftreten kann.

Achtung
Unbedingt beachten! Besondere Hinweise für den sicheren und störungsfreien Betrieb.

Information
Hilfestellung, Tip

Alle Arbeiten zum Transport, Anschluß, zur Inbetriebnahme und Instandhaltung sind von qualifizierten, verantwortlichen Fachpersonal auszuführen. Unsachgemäßes Verhalten kann schwere Personen- und Sachschäden verursachen. Ein sicherer und störungsfreier Betrieb ist nur bei Einhaltung der jeweils gültigen Vorschriften gemäß DIN VDE 0100, IEC1000, EN 60204-1, EN 55014, EN 50082-2 sowie einschlägiger örtlicher Bestimmungen gegeben.

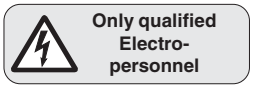
This Instruction Manual describes the Servo Motors A1 ... F3 and must be made available to every user. Prior to performing any work the user must familiarize himself with the unit.
The **safety and warning notes** listed in this instruction manual and in the description of the servo controller as well as in other documentation must be observed at any rate to ensure a safe operation.The safety and warning instructions specified in this manual do not lay claim on completeness. KEB reserves the right to change/adapt specifications and technical data without prior notice.

Below the meaning of the pictograms used in this manual:

Danger / Warning / Caution
Used when life or health of the user are exposed to danger or when the possibility of servere damage to the material exists.

Attention
Observe at all costs! Special instructions for a safe and trouble-free operation.

Information
Assistance, Tips



The KEB COMBIVERT is operated with voltages that can cause a severe electric shock dangerous to life. Therefore the installation of the unit as well as of the available accessories is only permissible by qualified electro-personnel. A safe and trouble-free operation is only possible when the valid regulations according to DIN VDE 0100, IEC1000, EN 60204-1, EN 55014, EN 50082-2 as well as the relevant regulations for your area are observed.

1. Introduction

1.1 Intended Use

The synchronous servo motors KEB COMBIVERT SM serve for the operation on digital servo controllers and are intended for industrial systems. They comply to the harmonized standards of the series VDE 0530/EN 60034. The use in hazardous areas is prohibited, unless it is explicitely permitted (observe additional instructions).

2. Safety Instructions

- All works on the installation are to be carried out in a **de-energized** state.
- In the case of synchronous motors with rotating rotor a high voltage is applied onto the motor connections.
- After mounting the motor check the faultless function of the brake (if available).
- Repairs may be carried out only by the manufacturer or repair places authorized by him. Unauthorized opening and improper tampering can lead to bodily injuries or damages to property.
- Before starting up motors with featherkey in the shaft end, the featherkey must be secured against flinging out, if this is not already prevented through output components like belt pulley, clutches or similar elements.
- The motors are not intended for direct connection to the three-phase system. They must be operated by a servo controller. A direct power connection can lead to the destruction of the motor.
- The motors can reach a surface temperature of more than 100°C. No temperature-sensitive parts may lay close to or be attached onto the motor. If necessary, protective measurements must be taken against touching.
- The optional built-in deadlock holding brake is only designed for a limited number of emergency stops. The use as a working brake is not permitted.
- For motors with plug connection and built-in brake you must install the varistor required for the brake wiring at commissioning.
- The thermistor fitted in the winding is to be connected and evaluated by a suitable wiring, for the protection of the motor against thermal overload in case of slow changes. **Attention**: The thermistor does not represent an all-around protection of the winding.

3. Transport and Storage

After final tests all motors leave the factory in perfect condition.
On delivery check the motor for outside damages. If you should determine transport damages, then a notice of damage is to be issued in the presence of the carrier. If necessary, **stop** the **commissioning** of these motors.
Screwed-in ring bolts are designed for the weight of the motors, i.e. the attachment of additional loads is prohibited.
The storage is only permitted in **closed, dry, dust-free, ventilated** and **non-vibrating** environments. Before commissioning measure the insulation resistance. In case of values $\leq$ 1 kΩ per volt of rated voltage dry the winding (voltage of insulation resistance meter: 1000 V). After a longer storage (> 3 months) operate the motor at slow speed ($\leq$ 100 min^{-1}) in both directions, so that the lubrication can spread evenly in the bearings.
Damages that occur as a result of improper handling are not subject to our warranty.

4. Installation

When installing the motor make sure of even supporting surface, solid foot or flange mounting and exact alignment in case of direct coupling. Turn the motor shaft by **hand** and listen for abnormal slipping noises.

4.1 Type of Protection

The motors of the series A1...F3 are designed in the type of protection IP65 (shaft gland IP64, optionally with shaft sealing ring IP65). The only exception is the built-on version "Shaft end upwards" (IM V3, IM V36), as here no liquid may remain in the D-side flange bearing end-shield.
In the case of terminal box designs observe the correct sealing of the outgoing cables.
By turning the flange sockets or the terminal box any outgoing cable direction can be adjusted (rotatable by 90° each). **Attention**: In the case of improper execution of the work the type of protection IP65 is no longer warranted.
If connector systems are used, then the type of protection IP65 is only achieved with correctly wired and firmly tightened mating connector.

4.2 Ambient Temperature / Cooling

Ambient temperature: -5°C. . . 40 °C (194 °F)
Site altitude: ≤ 1000 m above sea level
The motor must be mounted in such a manner that the ventilation is not obstructed, i.e. sufficient heat dissipation through convection and radiation must be ensured.
If the motor is equipped with a separate ventilator, it must be connected correctly. The exhaust air of neighbouring units may not be sucked in again directly. For three-phase separate ventilator connection the correct direction of rotation is to be checked (direction arrow towards ventilator housing).

4.3 Output Components

The rotor of the motor is dynamically balanced through a full featherkey in the shaft end according to DIN 6885 Sheet 1.
For motors with built-in radial sealing ring (option) only a reduced maximum speed is permissible according to the instruction manual.
For putting on or taking off output components (gear wheels, belt pulleys, clutches and similar parts) suitable devices are to be used. The bracing must be carried out on the D-side shaft end (Drive-End).
Attention: Servo motors are precision drive components, no shocks or impacts may arrive at the motor.

5. Electrical Connection

All work may be carried out only by qualified technical personnel on the motor at rest in de-energized status and secured against restarting. Verify the safe isolation from supply!
The connection must be carried out in such a way that a permanently safe, electrical connection is maintained. Pay attention to a safe protective conductor connection.

6. Operation and Maintenance

In case of changes as compared to the normal operation, e.g. increased temperature, noises, oscillations, find out the cause, if necessary, contact the manufacturer. In case of doubt switch off the motor!
The maintenance of the motor is limited to the cleaning of the motor surface.
The radial groove ball bearings of the motor are lubricated for life and are designed for nominal service life of 20.000 hours.

7. Part Code

The KEB servo motors of series A1...F3 have the following standard design:

- UL/CSA - Acceptance test (E 234 973)
- Rotatable angular flange socket for encoder and motor connection
- Flange quality "R" according to DIN 42955
- Vibration quality "R" according to DIN ISO 2373
- Shaft end with featherkey balanced according to ISO 8821
- Resolver 2 pole
- Type of protection IP65 (IP64 at shaft gland)
- Type of construction B5
- PTC-resistor

Further definitions can be taken from the following key.

A 1 . S M . 0 0 0 - 6 2 0 0

Encoder	0:	2-pole resolver
	A:	Stegmann Hiperface Singleturn SRS 50/60
	B:	Stegmann Hiperface Multiturn SRM 50/60
	C:	Heidenhain EnDat Singleturn ECN 1113/1313 512 Inc
	D:	Heidenhain EnDat Multiturn EQN 1125/1325 512 Inc
	F:	Heidenhain Sin/Cos Encoder ERN 1387 2048 Inc
	H:	Heidenhain Sin/Cos Encoder ERN 1188 512 Inc
	I:	Heidenhain EnDat Singleturn ECI 1317 32 Inc
	J:	Heidenhain EnDat Multiturn EQI 1329 32 Inc
Connection	0:	Connector/connector turnable angular flange connector
	9:	Connector Size1,5
Voltage	2:	190 V (200V class) 4: 330 V (400V class)
Speed	1:	1500 RPM 4: 4000 RPM
	2:	2000 RPM 6: 6000 RPM
	3:	3000 RPM
Version	0:	without brake; with feather key; IP65 (standard)
	1:	Standard with brake
	2:	Standard without feather key
	3:	Standard with brake, without feather key
	4:	Standard with oil-tight flange IP65 (Radial shaft seal ring)
	5:	Standard with brake and oil-tight flange
	8:	Standard with center hole M5
	9:	Standard with brake and center hole
	B:	Standard without feahter key and oilt-tight flange
	C:	Standard with brake, without feather key and oil-tight flange
Cooling	0:	Self-cooling with flange B5 IFT5 compatible
	1:	Separate cooling with flange B5 IFT5 compatible
	2:	Self-cooling;foot
	3:	Separate cooling; foot
Motor Type	0:	Three-phase synchronous motor
Unit Type	SM:	Servo motor
Size	A1...F3	

8. Project design

8.1 Selection of the Servo Motor

Calculate the following values before you selection the servo motor:

- Determine inertia (J_{App}) of the application without motor
- Calculate required peak torque (M_{Lmax}) of the application at the drive. The inertia of the motor (JMot) can be accepted here with 1/5 inertia (JApp) of the application.
- Determine the effective torque (M_{eff}) via the time.

Now the motor can be selected on the basis of the calculated values and the technical data of the following pages. The following selection features must be observed:

calculate		motor data
n_{max}	$\leq$	n_N
M_{Lmax}	$\leq$	M_{max}
M_{eff}	$\leq$	M_{dN}
$J_{App}/10$	$\leq$	J_{mot}

For examination or optimization it can be calculated again with the real motor data.

8.2 Selection of the Servo Controller

The selection of the servo controller occurs via the max. short time current limit and the output rated current.

$$\text{Max. short time current limit} = \frac{M_{Lmax} \bullet \text{Stall current (Id0)}}{\text{Stall torque (Md0)}}$$

$$\text{Output rated current} = \frac{\text{Effective torque} \bullet \text{Stall current (Id0)}}{\text{Stall torque (Md0)}}$$

9. Start-up

Before initial operation and after major inspections, check the complete plant both from a mechanical and electrical point of view.

9.1 Before Switching on

The procedure should include checks that:

- the installation and the operating conditions comply with the specified name-plate data,
- the motor is properly installed and aligned,
- the driving elements are properly adjusted (e.g. proper belt tension, coupling properly aligned and balanced),
- the motor is properly wired (power cables and leads of monitoring devices),
- The earthing and equipotential bonding have been made as specified in the applicable regulations,
- all fastening screws, connecting elements and electrical connections are properly tightened,
- the key is safed unless prevented otherwise by driving elements such as pulleys, couplings etc.
- the forced ventilation is correctly connected and in proper service condition,
- the direction of rotation of the fan motor corresponds with the direction arrow on the fan housing,
- the cooling air flow is not impaired (the hot outlet cooling air must not be drawn in by the fan!),
- the brakes, if provided, are inspected for proper functioning.

9.2 Switch on the Motor

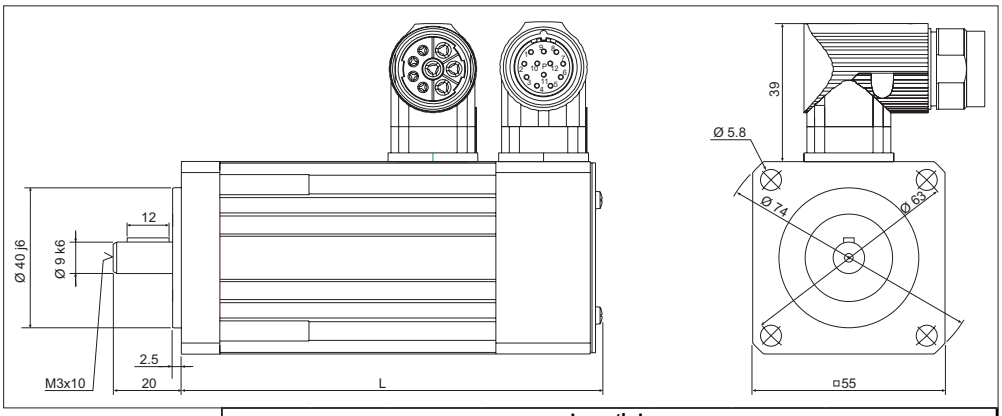
The following measures are recommended to be taken after installing or inspecting the motors:

- Start the motor with no load.
- Check the mechanical running for any noise or vibrations on the bearings or end shields.
- If there is any abnormal noise or the motor runs unevenly, switch it off immediately and find out the cause.
- If the mechanical running improves immediately after the motor has been switched off, there is an electrical or magnetic cause. If this is not the case, there is a mechanical cause.
- If the mechanical running is smooth at no load, load the motor. Check the running smoothness, measure the voltage, current and power and record them. Measure and record these values also for the driven equipment, if possible.
- Monitor the temperatures of the bearings, windings etc. until they have stabilised and record the values (as far as this is possible with the available measuring equipment).

10. Technical Data

Servo motor		Ax.SM.000-yyyy							
Size (x)		A1		A2		A3		A4	
Voltage and speed variant (y)		6200	6400	6200	6400	6200	6400	6200	6400
Stall torque M_{d0}	Nm	0,34		0,50		0,65		1,0	
Current at stall torque I_{d0}	A	1,2	0,84	1,50	1	2	1,2	3,2	1,6
Nominal Rating									
Rated voltage U_N	V	230	400	230	400	230	400	230	400
Rated torque M_{dN}	Nm	0,32		0,48		0,6		0,8	
Rated current I_{dN}	A	1,0	0,8	1,5	0,9	2,0	1,1	2,9	1,4
Rated speed n_N	min^{-1}	6000		6000		6000		6000	
Rated power P_N	W	200		300		375		500	
Voltage constant k_E [1]	$V/1000min^{-1}$	20,0	27,6	20,0	32,8	20,0	35,2	20,0	40,0
Winding resistance R_{u-v}	Ohm	21	40,5	8,7	25,8	6,1	18,9	3,3	13,1
Winding inductance L_{u-v}	mH	9,9	18,7	5,4	14,5	3,9	12,2	2,7	10,7
Max. values									
max. torque M_{max}	Nm	1,7		2,5		3,2		5,0	
max. current (peak value) Imax	A	10,0	7,1	12,8	8,5	15,3	9,2	24,0	12,0
mechanical data [2]									
Inertia J_L	$kgcm^2$	0,17		0,24		0,31		0,45	
Weight m	kg	1,0		1,2		1,4		1,8	

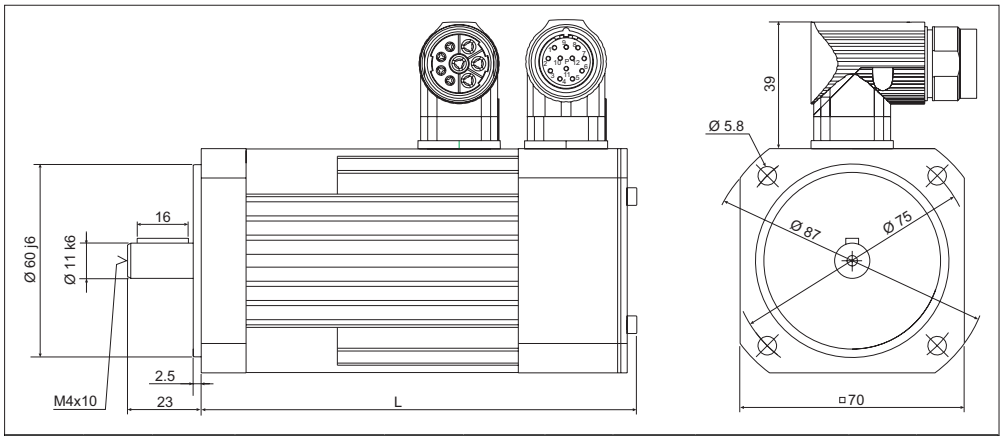
[1] Specify the peak value of motor EMK at 1000 rpm as line-to-line voltage.
[2] With resolver; without holding brake



Length L						
Type	without brake			with brake		
Encoder	Resolver	SIN/COS	EnDat	Resolver	SIN/COS	EnDat
Size	-	ERN 1185	ECN1113/EQN1125	-	ERN 1185	ECN1113/EQN1125
A1	121	156	159	145	180	183
A2	133	168	168	157	192	195
A3	145	180	183	169	204	207
A4	170	205	208	194	229	232

Servo motor		Bx.SM.000-yyyy											
Size (x)		B1				B2				B3			
Voltage and speed variant (y)		4200	4400	6200	6400	4200	4400	6200	6400	4200	4400	6200	6400
Stall torque M_{d0}	Nm	0,65				1,5				2,3			
Current at stall torque I_{d0}	A	1,9	0,9	2,6	1,3	3,2	1,6	5,0	2,4	5,5	2,4	7,7	3,5
Nominal Rating													
Rated voltage U_N	V	230	400	230	400	230	400	230	400	230	400	230	400
Rated torque M_{dN}	Nm	0,6		0,5		1,3		1,0		2,0		1,5	
Rated current I_{dN}	A	2,0	0,9	2,5	1,2	2,9	1,4	4,4	2,1	4,7	2,0	6,6	3,0
Rated speed n_N	min^{-1}	4000		6000		4000		6000		4000		6000	
Rated power P_N	W	250		310		540		620		830		940	
Voltage constant k_E [1]	$V/1000min^{-1}$	20,8	47,9	15,4	32,1	27,7	57,2	17,8	37,5	26,3	60,4	18,6	41,8
Winding resistance R_{u-v}	Ohm	6,8	39,5	3,8	17	4	17,3	1,6	7	1,7	9,2	0,83	4,2
Winding inductance L_{u-v}	mH	11,5	61,1	6,3	27,4	11,5	48,8	4,8	21,0	5,6	29,4	2,8	14,1
Max. values													
max. torque M_{max}	Nm	3,1				7,2				11,0			
max. current (peak value) Imax	A	16,1	7,6	22,1	11,1	27,2	13,6	42,4	20,4	46,7	20,4	65,3	29,7
mechanical data [2]													
Inertia J_L	$kgcm^2$	0,22				0,36				0,57			
Weight m	kg	1,5				2,1				2,9			

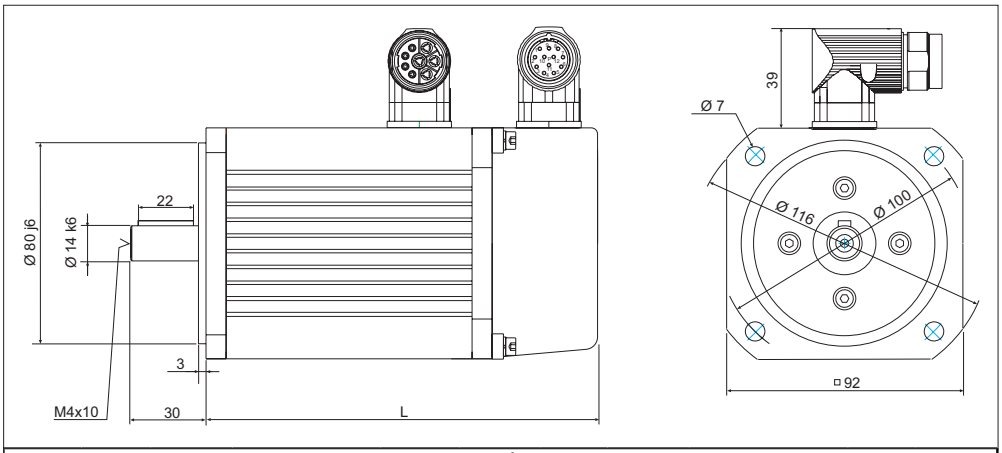
[1] Specify the peak value of motor EMK at 1000 rpm as line-to-line voltage.
[2] With resolver; without holding brake



Length L										
Type	without brake					with brake				
Encoder	Resolver	SIN/COS	EnDat		Hiperface	Resolver	SIN/COS	EnDat		Hiperface
Size	-	ERN 1185	ECN1113/EQN1125	EQI / ECI	SRS/M 50	-	ERN 1185	ECN1113/EQN1125	EQI/ECI	SRS/M 50
B1	136	167	170	162	177	162	164	167	190	205
B2	160	191	194	186	201	186	188	191	214	229
B3	196	227	230	222	237	222	224	227	250	265

Servo motor		Cx.SM.000-yyyy									
Size (x)		C1						C2			
Voltage and speed variant (y)		3200	3400	4200	4400	6200	6400	3200	3400	4200	4400
Stall torque M_{d0}	Nm	0,95						2,7			
Current at stall torque I_{d0}	A	1,5	0,8	2,0	1,1	3,0	1,6	3,2	1,9	4,3	2,5
Nominal Rating											
Rated voltage U_N	V	230	400	230	400	230	400	230	400	230	400
Rated torque M_{dN}	Nm	0,8		0,75		0,7		2,4		2,2	
Rated current I_{dN}	A	1,4	0,75	1,8	0,9	2,4	1,3	3,0	1,8	3,6	2,1
Rated speed n_N	min^{-1}	3000		4000		6000		3000		4000	
Rated power P_N	W	0,25		0,31		0,44		0,75		0,92	
Voltage constant k_E [1]	$V/1000min^{-1}$	36,5	66,5	27,5	50,2	18,3	33,6	45,5	78,8	34,3	59,0
Winding resistance R_{u-v}	Ohm	20,5	74,9	12,1	39,4	5,1	18,9	4,2	13,1	2,3	6,9
Winding inductance L_{u-v}	mH	30,5	101	17,1	57,6	7,6	25,9	11,4	34,4	6,5	19,3
Max. values											
max. torque M_{max}	Nm	4,3						12,2			
max. current (peak value) Imax	A	10,6	5,6	14,1	7,7	21,2	11,3	22,6	13,3	30,4	17,6
mechanical data [2]											
Inertia J_L	$kgcm^2$	1,2						2,7			
Weight m	kg	2,7						3,9			

[1] Specify the peak value of motor EMK at 1000 rpm as line-to-line voltage.
[2] With resolver; without holding brake

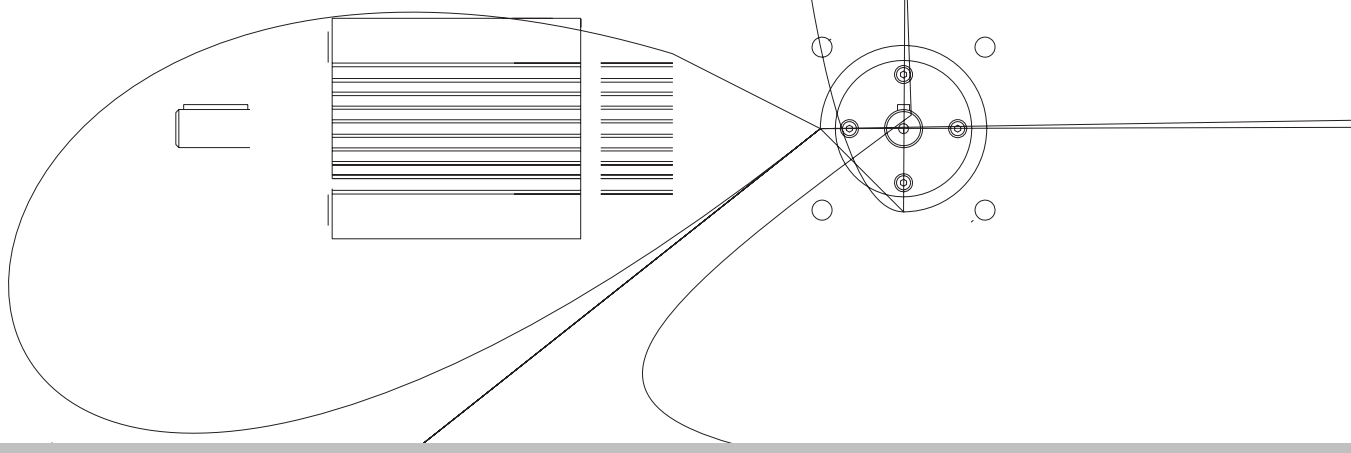


Length L											
Type	without brake					with brake					
Encoder	Resolver	SIN/COS	EnDat		Hiperface	Resolver	SIN/COS	EnDat		Hiperface	
Size	-	ERN 1387	ECN1313/EQN1325	EQI / ECI	SRS/M 50	-	ERN 1387	ECN1313/EQN1325	EQI/ECI	SRS/M 50	
C1	156	193	201	193	163	192	229	237	229	199	
C2	180	217	225	217	187	226	263	271	263	233	
C3	214	251	259	251	221	260	297	305	297	267	
C4	248	285	293	285	255	294	331	339	331	301	

Cx.SM.000-yyyy													
C2		**C3**						**C4**					
6200	6400	3200	3400	4200	4400	6200	6400	3200	3400	4200	4400	6200	6400
2,7		4,5						6					
6,5	3,7	5,1	2,9	6,7	3,8	9,9	5,6	7,1	4,2	9,1	5,5	13,7	7,8
230	400	230	400	230	400	230	400	230	400	230	400	230	400
2,0		3,9		3,5		2,8		5,0		4,5		3,0	
5,3	3,0	4,6	2,7	5,5	3,1	6,7	3,8	6,3	3,7	7,3	4,4	7,9	4,5
6000		3000		4000		6000		3000		4000		6000	
1,25		1,22		1,47		1,76		1,57		1,88		1,88	
23,3	39,4	49,1	83,5	37,2	64,2	25,0	43,4	47,9	79,9	37,5	61,3	24,7	42,5
0,95	3,3	2	5,9	1,1	3,7	0,54	1,7	1,2	3,4	0,74	2,1	0,32	1,03
2,7	8,6	6,9	20,6	4	12,2	1,8	5,7	4,5	13,1	2,8	7,8	1,2	3,8
12,2		20,3						27,0					
45,9	26,1	36,0	20,5	47,3	26,8	70,0	39,5	50,2	29,7	64,3	38,9	96,8	55,1
2,7		4,2						5,4					
3,9		5,2						6,6					

Technical Data

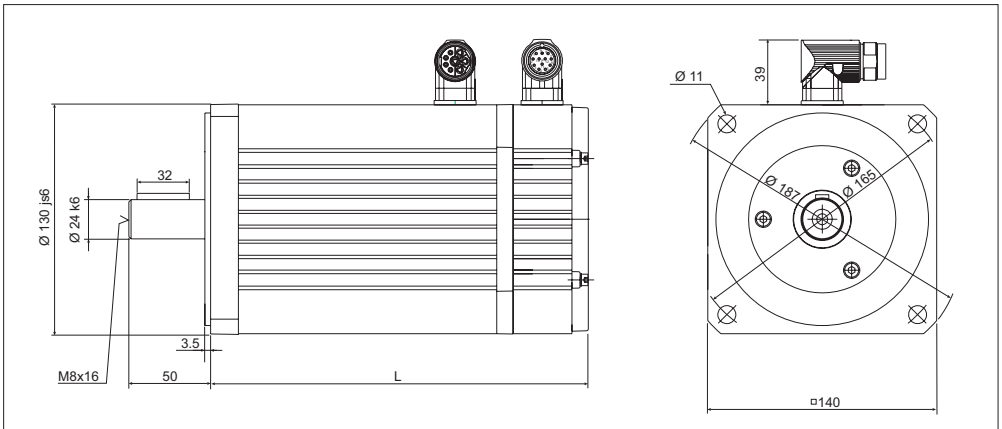
[1] Specify the peak value of motor EMK at 1000 rpm as line-to-line voltage.
[2] With resolver; without holding brake



Dx.SM.000-yyyy											
D2		**D3**						**D4**			
6200	6400	3200	3400	4200	4400	6200	6400	3200	3400	4200	4400
7		10						12			
16,0	9,9	12,4	7,2	17,0	9,7	22,6	13,6	14,2	8,5	18,2	11,6
230	400	230	400	230	400	230	400	230	400	230	400
3,8		8,4		7,6		5,0		9,9		8,6	
9,6	5,9	10,9	6,3	13,5	7,7	12,7	7,6	12,2	7,3	13,5	8,6
6000		3000		4000		6000		3000		4000	
2,4		2,6		3,2		3,1		3,1		3,6	
25,1	40,9	49,0	84,7	35,7	62,4	26,8	44,6	51,7	85,9	40,1	63,1
0,27	0,7	0,6	1,9	0,33	1,04	0,18	0,57	0,5	1,4	0,3	0,76
1,1	3,0	2,8	8,3	1,5	4,5	0,83	2,3	2,4	6,7	1,5	3,6
31,5		45,0						54,0			
108,6	67,2	84,1	48,8	115,4	65,8	152,7	92,3	96,3	57,7	123,5	78,8
7,4		9,8						12,7			
7,9		9,6						11,2			

Servo motor		Ex.SM.000-yyyy									
Size (x)		E1						E2			
Voltage and speed variant (y)		2200	2400	3200	3400	4200	4400	2200	2400	3200	3400
Stall torque M_{d0}	Nm	8,5						14			
Current at stall torque I_{d0}	A	5,3	3,1	8,0	4,7	10,7	6,2	8,6	4,7	13,3	7,5
Nominal Rating											
Rated voltage U_N	V	230	400	230	400	230	400	230	400	230	400
Rated torque M_{dN}	Nm	7,0		6,5		5,2		12,2		11,0	
Rated current I_{dN}	A	4,4	2,6	6,4	3,8	6,9	4,0	7,5	4,1	10,4	5,8
Rated speed n_N	min^{-1}	2000		3000		4000		2000		3000	
Rated power P_N	W	1,5		2		2,2		2,6		3,5	
Voltage constant k_E [1]	$V/1000min^{-1}$	102,9	176,5	68,2	116,6	51,2	88,0	107,9	180,3	71,9	119,4
Winding resistance R_{u-v}	Ohm	3,5	10,2	1,5	4,4	0,85	2,6	1,37	4,3	0,6	2
Winding inductance L_{u-v}	mH	9,9	29,3	4,4	12,7	2,5	6,8	6,1	17,9	2,7	8,2
Max. values											
max. torque M_{max}	Nm	42,0						70,0			
max. current (peak value) Imax	A	40	23	60	35	81	47	65	35	101	57
mechanical data [2]											
Inertia J_L	$kgcm^2$	12,3						19,5			
Weight m	kg	10,2						12,3			

[1] Specify the peak value of motor EMK at 1000 rpm as line-to-line voltage.
[2] With resolver; without holding brake



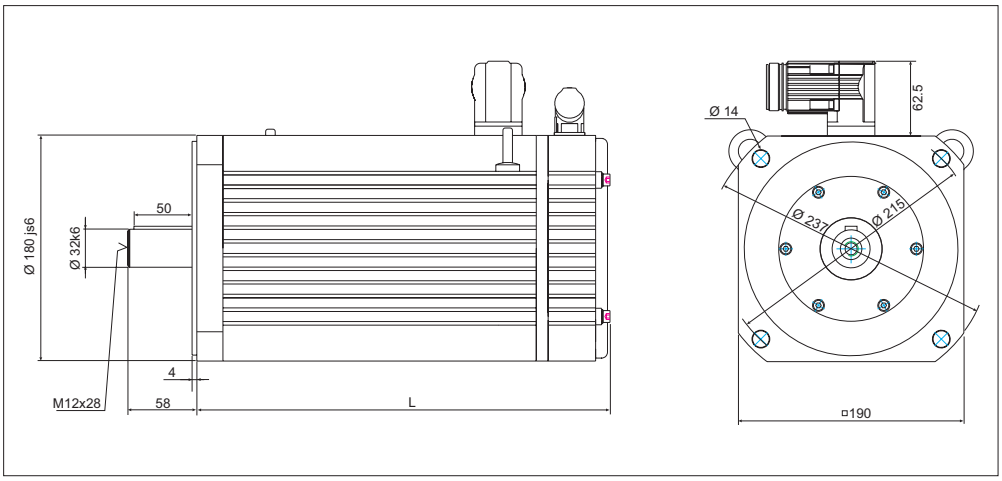
Length L											
Type	without brake					with brake					
Encoder	Resolver	SIN/COS	EnDat		Hiperface	Resolver	SIN/COS	EnDat		Hiperface	
Size	-	ERN 1387	ECN1313/EQN1325	EQI / ECI	SRS/M 50	-	ERN 1387	ECN1313/EQN1325	EQI/ECI	SRS/M 50	
E1	231	263	271	263	238	276	308	316	308	283	
E2	261	293	301	293	268	306	338	346	338	313	
E3	291	232	240	232	298	336	368	376	368	343	
E4	336	368	376	368	343	381	413	421	413	388	

Ex.SM.000-yyyy											
E2		**E3**						**E4**			
4200	4400	2200	2400	3200	3400	4200	4400	2200	2400	3200	3400
14		19						27			
17,8	10,0	11,7	6,8	17,6	10,3	21,9	13,5	16,5	9,9	23,2	14,4
230	400	230	400	230	400	230	400	230	400	230	400
7,6		16,5		14,6		8,7		21,4		15,5	
9,7	5,4	10,6	6,1	14,0	8,3	10,4	6,4	13,0	7,8	13,3	8,3
4000		2000		3000		4000		2000		3000	
3,2		3,5		4,6		3,6		4,5		4,9	
56,4	90,6	101,2	175,3	67,5	114,7	53,9	87,7	107,9	183,5	78,1	125,2
0,38	1,14	0,85	2,6	0,38	1,11	0,24	0,64	0,57	1,7	0,29	0,81
1,7	4,7	4,2	9,9	1,9	5,1	1,3	3,0	2,5	7,2	1,3	3,4
70,0		85,0						121,0			
133	75	79	46	119	70	148	92	112	67	157	98
19,5		26,7						36			
12,3		15,5						20,4			

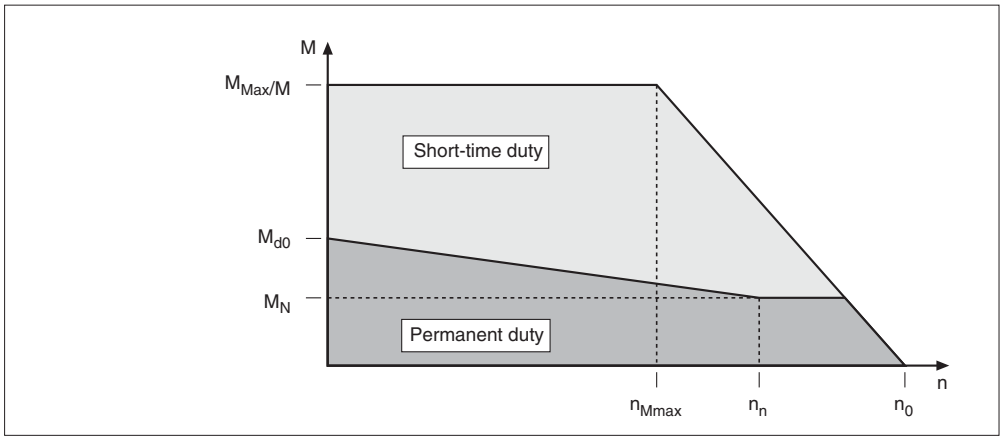
Technical Data

Servo motor		Fx.SM.000-yyyy									
Size (x)		F1				F2			F3		
Voltage and speed variant (y)		1400	2400	3400	4400	1400	2400	3400	1400	2400	3400
Stall torque M_{d0}	Nm	25				50			70		
Current at stall torque I_{d0}	A	8,2	11,1	17,0	22,2	17,0	22,3	32,2	23,1	30,8	46,2
Nominal Rating											
Rated voltage U_N	V	400				400			400		
Rated torque M_{dN}	Nm	22,5	21,5	20,0	16,0	42,0	38,0	31,0	61,0	52,0	33,0
Rated current I_{dN}	A	7,5	9,7	13,8	14,8	14,5	17,2	20,6	20,9	23,7	22,9
Rated speed n_N	min^{-1}	1500	2000	3000	4000	1500	2000	3000	1500	2000	3000
Rated power P_N	W	3,5	4,5	6,3	6,7	6,6	7,9	9,7	9,6	10,9	10,4
Voltage constant k_E [1]	$V/1000min^{-1}$	189,2	140,6	91,9	70,3	179,6	137,3	95,1	184,6	138,4	92,3
Winding resistance R_{u-v}	Ohm	2,36	1,36	0,58	0,34	0,81	0,48	0,23	0,51	0,3	0,13
Winding inductance L_{u-v}	mH	29,7	16,4	7	4,1	12,8	7,5	3,6	6,8	3,8	1,7
Max. values											
max. torque M_{max}	Nm	88,0				175,0			245,0		
max. current (peak value) Imax	A	41	55	85	110	85	111	160	115	153	229
mechanical data [2]											
Inertia J_L	$kgcm^2$	84				147			210		
Weight m	kg	30,5				44,0			57,5		

[1] Specify the peak value of motor EMK at 1000 rpm as line-to-line voltage.
[2] With resolver; without holding brake



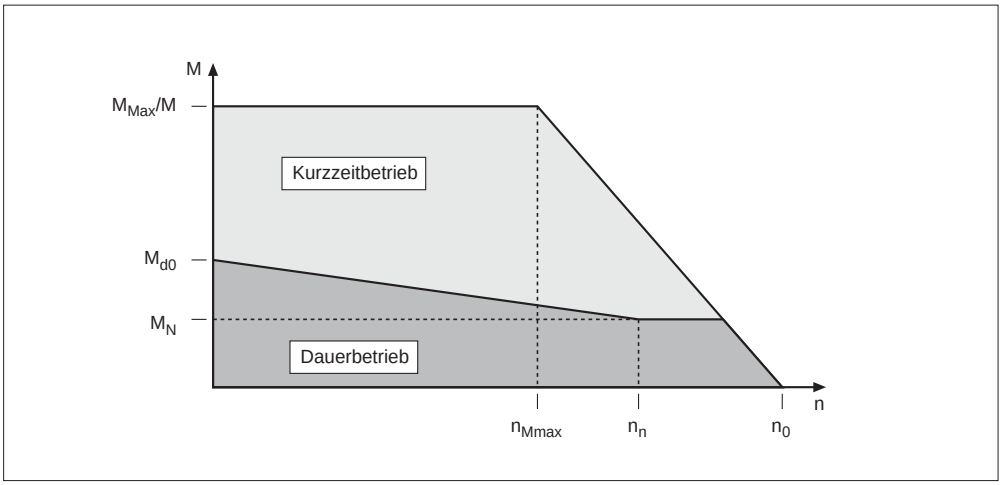
11. Torque-Speed Characteristic



11.1 Motors of the 230 V Class

KEB Part No.	M_{max}/M_N	M_{d0} [Nm]	M_N [Nm]	n_{Mmax} [1rpm]	n_0 [1rpm]
A1.SM.000-6200	5,0	0,34	0,32	4900	11500
A2.SM.000-6200	5,0	0,50	0,48	6650	11500
A3.SM.000-6200	5,0	0,65	0,60	6750	11500
A4.SM.000-6200	3,7	1,00	0,80	7550	11500
B1.SM.000-4200	5,0	0,65	0,60	5250	11050
B1.SM.000-6200	5,0	0,65	0,50	7250	14900
B2.SM.000-4200	4,3	1,50	1,30	3450	8300
B2.SM.000-6200	4,1	1,50	1,00	6000	12900
B3.SM.000-4200	3,8	2,30	2,00	4700	8700
B3.SM.000-6200	4,5	2,30	1,50	5950	12350
C1.SM.000-3200	5,0	0,95	0,80	1800	6300
C1.SM.000-4200	5,0	0,95	0,75	2850	8350
C1.SM.000-6200	5,0	0,95	0,70	5350	12550
C2.SM.000-3200	4,2	2,70	2,40	2550	5050
C2.SM.000-4200	3,5	2,70	2,20	3950	6700
C2.SM.000-6200	3,4	2,70	2,00	6150	9850
C3.SM.000-3200	3,9	4,50	3,90	2600	4650
C3.SM.000-4200	3,3	4,50	3,50	3850	6150
C3.SM.000-6200	4,4	4,50	2,80	5550	9200
C4.SM.000-3200	4,7	6,00	5,00	2600	4800
C4.SM.000-4200	4,1	6,00	4,50	3600	6100
C4.SM.000-6200	3,8	6,00	3,00	6300	9300

KEB Part No.	M_{max}/M_N	M_{d0} [Nm]	M_N [Nm]	n_{Mmax} [1rpm]	n_0 [1rpm]
D1.SM.000-3200	3,7	4,20	3,70	2550	4850
D1.SM.000-4200	3,0	4,20	3,50	3850	6400
D1.SM.000-6200	3,6	4,20	3,00	5350	9400
D2.SM.000-3200	3,7	7,00	6,10	2750	4850
D2.SM.000-4200	3,4	7,00	5,80	4000	6600
D2.SM.000-6200	3,1	7,00	3,80	6300	9150
D3.SM.000-3200	3,3	10,00	8,40	2850	4650
D3.SM.000-4200	3,7	10,00	7,60	3950	6400
D3.SM.000-6200	3,9	10,00	5,00	5600	8550
D4.SM.000-3200	3,0	12,00	9,90	2850	4400
D4.SM.000-4200	3,7	12,00	8,60	3550	5700
E1.SM.000-2200	4,1	8,50	7,00	1200	2200
E1.SM.000-3200	4,6	8,50	6,50	1800	3350
E1.SM.000-4200	4,3	8,50	5,20	2750	4450
E2.SM.000-2200	4,0	14,00	12,20	1200	2100
E2.SM.000-3200	3,5	14,00	11,00	1950	3150
E2.SM.000-4200	3,7	14,00	7,60	2650	4050
E3.SM.000-2200	3,4	19,00	16,50	1350	2250
E3.SM.000-3200	3,5	19,00	14,60	2100	3400
E3.SM.000-4200	3,5	19,00	8,70	2950	4250
E4.SM.000-2200	3,8	27,00	21,40	1350	2100
E4.SM.000-3200	3,7	27,00	15,50	2000	2900



11.2 Motors of the 400 V Class

KEB Part No.	M_{max}/M_N	M_{d0} [Nm]	M_N [Nm]	n_{Mmax} [1rpm]	n_0 [1rpm]
A1.SM.000-6400	5,0	0,34	0,32	7550	14450
A2.SM.000-6400	5,0	0,50	0,48	6900	12150
A3.SM.000-6400	5,0	0,65	0,60	6600	11350
A4.SM.000-6400	4,4	1,00	0,80	6000	10000
B1.SM.000-4400	5,0	0,65	0,60	2800	8350
B1.SM.000-6400	5,0	0,65	0,50	5200	12450
B2.SM.000-4400	5,0	1,50	1,30	1850	6950
B2.SM.000-6400	3,5	1,50	1,00	4800	10650
B3.SM.000-4400	3,7	2,30	2,00	3100	6600
B3.SM.000-6400	3,5	2,30	1,50	4500	9550
C1.SM.000-3400	5,0	0,95	0,80	1500	6000
C1.SM.000-4400	5,0	0,95	0,75	2850	7950
C1.SM.000-6400	5,0	0,95	0,70	4750	11900
C2.SM.000-3400	4,1	2,70	2,40	2500	5050
C2.SM.000-4400	3,5	2,70	2,20	4000	6750
C2.SM.000-6400	3,5	2,70	2,00	6150	10150
C3.SM.000-3400	3,9	4,50	3,90	2650	4750
C3.SM.000-4400	3,4	4,50	3,50	3850	6200
C3.SM.000-6400	4,5	4,50	2,80	5450	9200
C4.SM.000-3400	4,6	6,00	5,00	2750	5000
C4.SM.000-4400	3,9	6,00	4,50	3950	6500
C4.SM.000-6400	3,8	6,00	3,00	6300	9400
D1.SM.000-3400	3,7	4,20	3,70	2500	4800
D1.SM.000-4400	3,0	4,20	3,50	3850	6450
D1.SM.000-6400	3,5	4,20	3,00	5600	9650
D2.SM.000-3400	3,8	7,00	6,10	2650	4700
D2.SM.000-4400	3,7	7,00	5,80	3650	6350

KEB Part No.	M_{max}/M_N	M_{d0} [Nm]	M_N [Nm]	n_{Mmax} [1rpm]	n_0 [1rpm]
D2.SM.000-6400	3,7	7,00	3,80	6550	9750
D3.SM.000-3400	3,4	10,00	8,40	2850	4700
D3.SM.000-4400	3,9	10,00	7,60	3900	6400
D3.SM.000-6400	3,9	10,00	5,00	5900	8950
D4.SM.000-3400	3,0	12,00	9,90	3000	4650
D4.SM.000-4400	3,5	12,00	8,60	4150	6300
E1.SM.000-2400	4,0	8,50	7,00	1200	2250
E1.SM.000-3400	4,5	8,50	6,50	1900	3400
E1.SM.000-4400	4,3	8,50	5,20	2850	4500
E2.SM.000-2400	4,1	14,00	12,20	1250	2200
E2.SM.000-3400	3,7	14,00	11,00	2000	3350
E2.SM.000-4400	4,0	14,00	7,60	2900	4400
E3.SM.000-2400	3,5	19,00	16,50	1450	2250
E3.SM.000-3400	3,6	19,00	14,60	2200	3450
E3.SM.000-4400	4,6	19,00	8,70	3100	4550
E4.SM.000-2400	3,8	27,00	21,40	1400	2150
E4.SM.000-3400	3,6	27,00	15,50	2200	3150
F1.SM.000-1400	4,0	25,00	22,50	600	2100
F1.SM.000-2400	3,1	25,00	21,50	1200	2800
F1.SM.000-3400	3,6	25,00	20,00	1800	4350
F1.SM.000-4400	3,3	25,00	16,00	2850	5650
F2.SM.000-1400	3,4	50,00	42,00	950	2200
F2.SM.000-2400	3,7	50,00	38,00	1300	2900
F2.SM.000-3400	3,1	50,00	31,00	2300	4200
F3.SM.000-1400	3,0	70,00	61,00	1200	2150
F3.SM.000-2400	3,2	70,00	52,00	1700	2850
F3.SM.000-3400	3,3	70,00	33,00	2900	4300

12. Axial and Lateral Force

The table specifies:

– the largest permissible lateral force F_{Rm} at $x=l_1/2$
– the largest permissible axial force F_{Am} for a service life of 20000 hours.

Motor	Lateral force F_{Rm} [N] at speed n [rpm]				Axial force F_{Am} [N] at speed n [rpm]				d_1 l_1	F_G [N]	P [mm]	C [mm]	F_{Rmax} [N]
	2000	3000	4000	6000	2000	3000	4000	6000					
A1	310	260	240	210	250	200	170	140	9 k6 20	1	10	96	600
A2										2		108	
A3										3		121	
A4										4		145	
B1	400	340	300	270	310	260	220	180	11 j6 23	2	11	81	800
B2										4		105	
B3										6		141	
C1	470	400	350	320	380	310	260	220	14 k6 30	3	17	131	1000
C2										9		155	
C3										14		189	
C4	460	370	330	260	350	280	240	200		20		223	
D1	720	640	550	490	590	500	420	350	19 k6 40	10	24	138	2000
D2										17		168	
D3										23		198	
D4										30		228	
E1	1100	1000	850	-	900	770	650	560	24 k6 50	17	24	188	2300
E2										30		218	
E3										40		248	
E4										60		293	
F1	2300	1900	1800	-	1800	1500	1400	-	32 k6 58	85	31	280	6000
F2										140		360	
F3										200		440	

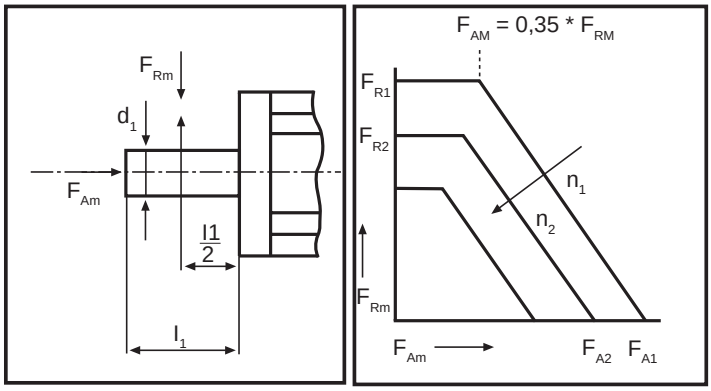
Legend
F_{Rm}: Permissible lateral force
F_{Rmax}: max. permissible dynamic lateral force
F_{Am}: Permissible Axial force
d_1: Shaft end diameter
l_1: Length of the shaft end
F_G: Mass force of the rotor
P: Linear size P (see page 23)
C: Linear size C (see page 23)

Axial and Lateral Force

12.1 Shaft Load

The permissible axial and lateral forces are listed in the table on page 21.

The endurance strength of the shaft and the service life on the bearings determine the permissible lateral force F_{Rm} on the D(rive-End)-side shaft end.



12.2 Output Component

The smallest possible effective circular diameter of the output component can be computed as follows:

$$D_W = \frac{k * 2 * M_b}{F_{Rm}}$$

D_W: effective circular diameter of the output components
K: pretension factor
F_{Rm}: permissible lateral force
M_b: acceleration torque of the drive

12.3 Pretension Factor

Empirical values for the pretension factor k:

ca. k = 1,5	for pinion
ca. k = 1,2 to 2,0	for toothed belt
ca. k = 2,2 to 3,0	for flat belt

For dynamic processes like braking and accelerating, the permissible lateral force F_R is not to be exceeded in order to avoid a mechanical destruction of the motor.

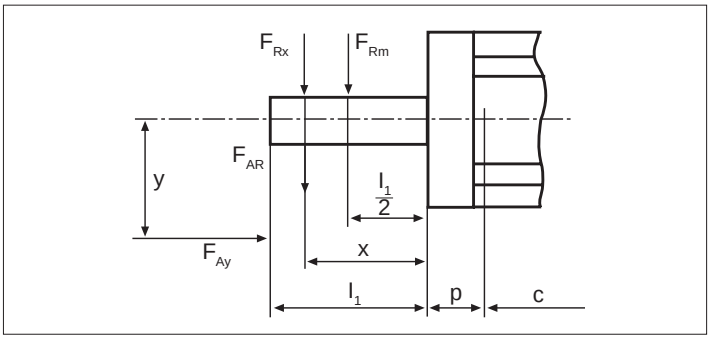
12.4 Horizontal Position of Use

If the lateral force F_R does not take effect at $x = l_1/2$, changed radial forces occur.

$$F_{Rx} = F_{Rm} * \frac{c + p + 0{,}5 * l1}{c + p + x}$$

If the axial force F_{AR} is not working on the centre of the shaft then the radial parts of this force take effect.

$$F_{AR} = F_{AY} * \frac{y}{p + x}$$



12.5 Vertical Position of Use

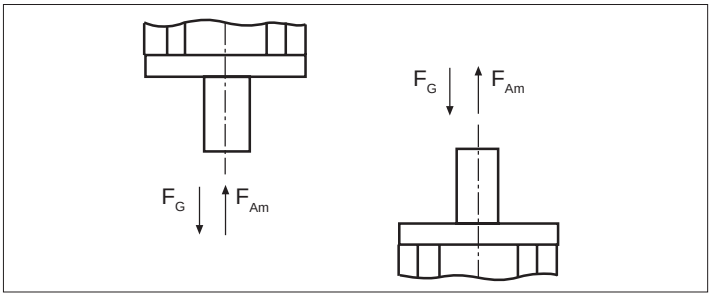
If the motor is installed vertically, the permissible axial forces F_{Am} (see table page 21) for the force direction upward apply.

For the force direction downward the permissible axial force F_{Am} is becoming smaller by the mass force F_G of the rotor.

$F_{Am/ne}w = F_{Am} - F_G$
$F_G = m_L * g$
m_L: mass of rotor
G: gravitational acceleration

If the axial force F_{Am} is working away from the motor then the force F_W must be taken into account for safety reasons.

$F_{Am/ne}w = F_{Am} - F_G - F_W$
F_W [N] = 10 x d_1 [mm]



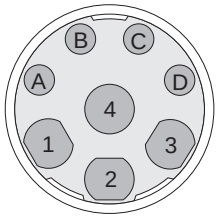
The motors of the series A1...F3 with built-in holding brake are not to be loaded with axial forces, as this causes a change of the working airgap of the holding brake thereby making the brake inoperative.

13. Connection

13.1 Connector Assignments

Connection power connector

Servo motor Power connector
(top view)

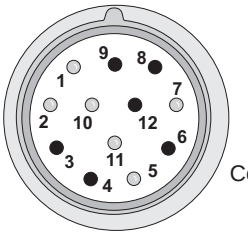


Connector PIN	*Designation*	*Cable Core*
1	U	1
4	V	2
3	W	3
2	PE	green-yellow
A	Brake +	5
B	Brake –	6
C	PTC-Contact (T1)	7
D	PTC-Contact (T2)	8

PTC-connection (230 V / 400 V - Class)		*1...3 PTC-detectors (series connection)*
max. cold resistance of PTC-detector chain	[Ω]	400
Error tripping range	[Ω]	≥ 1650
Error reset range	[Ω]	≤ 500

Connection resolver

Servo motor Resolver connector
(top view)

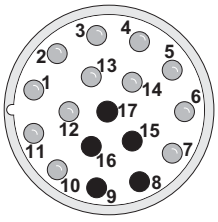


Connector PIN	*Designation*	*Cable Color*
1	SIN_LO	red
2	COS_LO	pink
5	SIN_REF_LO	yellow
7	SIN_REF	green
10	SIN	blue
11	COS	gray

Contacts 3, 4, 6, 8, 9 and 12 are not assigned.

Connection SIN/COS Encoder

Servo motor SIN/COS-encoder connector
(top view)

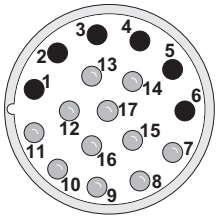


Connector PIN	**Designation**	**Cable Color**
1	A (+)	green
2	A (-)	yellow
3	R (+)	gray
4	D (-)	purple
5	C (+)	white
6	C (-)	brown
7	GND	white/green
10	+ 5 V	gray / pink
11	B (+)	blue
12	B (-)	red
13	R (-)	pink
14	D (+)	black

Contacts 8, 9, 15, 16 and 17 are not assigned.

Connection EnDat Encoder

Servo motor EnDat-encoder connector
(top view)

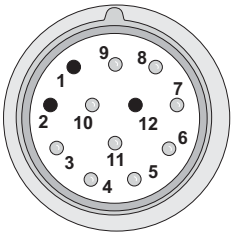


Connector PIN	Designation	Cable Color
7	+5V	white
8	Clock (+)	black
9	Clock (-)	purple
10	COM	brown
12	B (+)	blue
13	B (-)	red
14	Data (+)	gray
15	A (+)	green
16	A (-)	yellow
17	Data (-)	pink

Contacts 1...6 are not assigned.

Connection Hiperface Encoder

Servo motor Hiperface-encoder connector
(top view)



Connector PIN	Designation	Cable Color
4	REF_SIN (-)	red
5	REF_COS (-)	yellow
6	Data (+)	gray
7	Data (-)	pink
8	SIN (+)	blue
9	COS (+)	green
10	+7,5V	brown
11	COM	white

Contacts 1, 2 and 12 are not assigned.

Motor cable and encoder cable

The UL tested motor and encoder cables can be acquired ready-made in different lengths by KEB. The cables are dragable and appropriated for a continuous bending radius of 120 mm.

14. Options

14.1 Holding Brake

Motor typ		Ax.SM.001-xx00	Bx.SM.001-xx00	Cx.SM.001-xx00
Holding torque	[Nm]	2,0	4,5	9
Moment of inertia	[kgcm^2]	0,067	0,183	0,6
max. Speed	[min^{-1}]	10.000	10.000	10.000
Mass	[kg]	0,18	0,30	0,50
Rated voltage	[V]	24 (+6%, -10%)		
Rated current	[A]	0,46	0,50	0,75
Release time t2	[ms]	25	35	40
Engaging delay t11	[ms]	2	2	2
Engaging time t1	[ms]	8	7	7
Power	[W]	11	12	18
Typ		03.P1.330-0567	05.P1.320-0487	06.P1.320-0087

Motortyp		Dx.SM.001-xx00	Ex.SM.001-xx00	Fx.SM.001-xx00
Holding torque	[Nm]	11	36	72
Moment of inertia	[kgcm^2]	2,3	5,9	17,6
max. Speed	[min^{-1}]	6.000	10.000	4.000
Mass	[kg]	0,78	1,95	3,8
Rated voltage	[V]	24 (+6%, -10%)		
Rated current	[A]	0,83	1,1	1,67
Release time t2	[ms]	25	90	140
Engaging delay t11	[ms]	3	3	5
Engaging time t1	[ms]	25	22	25
Power	[W]	20	26	40
Typ		08.P1.320-0357	08.P1.320-0057	09.P1.320-0017

The indicated switching times are reached with adjusted nominal air gap (Xmin). There are average values, whose leakage is dependent on the power supply and the coil temperature. The marking of the switching times corresponds to DIN VDE 580.

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 00.SM.01B-K011 06/2004