ULTRACT III
SERVO MOTORS

CONTENTS

COMPANY PROFILE

Physis New Energy Technology S.p.A. designs and assembles mechatronic systems, made by the CNC, servo-drive and servo-motor, in the Motion Control Industry. The Company was established as the European technology hub of Ningbo Physis Technology Co., Ltd. which is the headquarters of Physis Group founded in 2001 as a holding company of private enterprises. Physis Group is dedicated to the innovation and industrialization of mechatronic systems and provides servo products and solutions for the Motion Control and Power Conversion industries. Today Physis Group, with more than 1.250 people worldwide and total sales of more than 200MilE is an innovative high-tech enterprise, bringing together R&D, Production and Sales, and has a number of domestic and international subsidiaries.

3 R&D CENTERS

4 PRODUCTION SITES

300 + R&D TEAMS

350 + LICENSED PATENTS

R&D TEAM

Our enterprise excels in the research and development (R&D) of mechatronic systems, an integration of mechanical elements like servomotors and electronic components such as servo drives.

1. **Expertise and Initiative:** Our R&D personnel are not only technically proficient but also proactive in discerning our clients' requirements, enabling us to establish accurate prototype specifications and deliver a product that aligns with the client's expectations.
2. **Client-Focused:** We prioritize our clients and their needs, striving to deliver solutions that cater to market demands efficiently and effectively.
3. **Standardization and Industrialization:** We consider standardization and industrialization requirements during the prototype design phase, ensuring that the transition from prototype to product adheres to market quality and cost standards.
4. **Adaptability and Promptness:** We exhibit flexibility in managing diverse projects and speed in devising technical solutions that provide our clients with tangible results.
5. **Investment in Innovation:** A significant portion of our resources is dedicated to discovering novel solutions in energy control, aiming for increased efficiency and sustainability.
6. **Material Innovation:** We are on a constant quest for new materials that can minimize the environmental footprint of our products.
7. **Sustainable Practices:** We are exploring more sustainable processes, such as the potential recycling of rare earth elements used in the magnets of our servomotors, contributing to global sustainability.

Our enterprise is committed to delivering innovative and eco-friendly solutions that cater to our clients' needs and contribute to the well-being of our planet.
We appreciate the opportunity to share our mission and values.

SPECIFICATION OF STANDARD MODELS

Type	Brushless PM AC servomotors, low inertia, high angular stiffness
Rotor	Syntered, high temperature rare earth, mech anically fastened magnets (without bonding)
Insulation	Motor: Class F according to D1N 0530 Winding: Class H according to D1N 0530, special high frequency winding suitable for long wiring with high frequency PWM waveforms
Thermal protection	PTC+KTY 84 linear probe
Bearings	Heavy duty, life lubricated
Balancing	Grade R(reduced tolerance)
Concentricity and perpendicularity of mounting flange	Grade R (reduced tolerance) according to 1EC 72- D1N 0530
Shaft	cylindrical shaft without keyway, or shaft with key
Cooling options	Natural convection IC0041 Size 7/10/13/18 option Fan cooling and water cooling
Working position	Any
Mounting	Flanged B5 option B3,Size U310&U313&U318 only
Stray capacitance to ground	Minimized EMC impact
Protection	IP 65 IP 54(motor with fan cooling)
Position sensor	S: Sincos Encoder, heidenhain M/N: Absolute encoder, heidenhain Endat/ Sick Hiperface Incremental D: Incremental encoder, Tamagawa/Danaher R: Resolver, Tamagawa
Safety brake	According to the motor can choose different torque by safety brake
Connector	Industrial circular type, signal or signal + power

MOTOR CODING

U3 10 07 F 20 3 R4 0 Y0 K bl

03, 05, 07, 10, 13, 18

Size, (approx. shaft height in cm)
03 (Motor □75) ,05(Motor □100)
07(Motor □145) ,10(Motor □200)
13(Motor □264) ,18(Motor □360)

03, 05, 07 Nm
10, 13, 16, 18, 20 *10 Nm

Locked rotor motor torque:
Nm for size:03,05,07
Nm*10 for size:10,13,18,20

cooling :
A: natural convection,
no field
F: servo fan cooling
C: water cooling

Nominal speed identifier:
rpm*100

Nominal voltage at nominal speed identifier:
2:220/240 Vac
3:380/440 Vac
4:480/516 Vac

Sensor identifier:
N7: EnDat inductive absolute multi tur n(4096 rev +19 bit/rev
S1: Sincos 2048 cy/rev + single turn absolute track (for motor size 5...20)
R4: Resolver Tamagawa TS2640N321E64
Z: no sensor
......

Safety brake:
B:with brake
0:without brake

connection:
YZ:Power and signal circular
connector
Y0:Signal circular connector
and power box
00:No circular connector

shaft:
K: shaft with key
E: cylindrical shaft
without key

Mounting feet:
bl:standard feet
00:without feet

ORDER CODE EXAMPLE:

U3 10 07 F 30 3 R4 B Y0 K bl

Motor type U31007F30(70Nm,3000rpm), 380Vac, servo fan cooling, resolverTS2640N321E64, safety brake, signal circular connector only, with Key on shaft, standard feet.

U303__A MOTOR

Motor Code			U30301A		U30302A			U30304A		
Rated Speed	nM	[rpm]	2000	3000	1000	2000	3000	1000	2000	3000
Stall Torque 2)	Md0	[Nm]	1.08		2.1			3.7		
Current @ Stall Torque 2)	Id0	[A]	0.51	0.70	0.51	1.00	2.19	1.04	1.84	2.20
Number of Poles	2p		8							
Nominal Rating										
Rated Torque 2)	MdN	[Nm]	1	0.94	1.98	1.87	1.7	3.5	3.2	2.7
Rated Current 2)	IdN	[A]	0.47	0.61	0.48	0.89	1.77	0.99	1.59	1.61
Rated Power	PdN	[kW]	0.21	0.3	0.21	0.39	0.53	0.37	0.67	0.85
Voltage Constant 3)	Ke	[V/1000rpm]	145	105.8	281	143.9	65.9	243.5	138.4	115.4
Torque Constant 3)	Kt	[Nm/A]	2.40	1.75	4.65	2.38	1.09	4.03	2.29	1.91
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	2.11	1.54	4.09	2.09	0.96	3.54	2.01	1.68
Winding Resistance 3)	Ru-v	[Ω]	119	60	150	43.16	8.5	53	15.84	10.1
Winding Inductance 3)	Lu-v	[mH]	147	81	294	76.56	14.55	113.4	36.7	24
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12							
Nominal Voltage	Vn	[V]	343	353	348	325	213	292	302	363
Losses	Loss	[KW]	0.084	0.082	0.112	0.108	0.106	0.129	0.129	0.129
Efficiency	Eff	[%]	71	78	65	78	83	74	84	87
Knee Speed @ 380Vac	nknee1	[rpm]	2252	3249	1111	2377	5515	1358	2560	3149
Knee Speed @ 480Vac	nknee2	[rpm]	2932	4181	1462	3062	7017	1763	3275	4009
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	893	1654	309	1177	3552	516	1378	1840
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	1398	2327	564	1666	4669	800	1876	2456
Maximum Values										
Max. Torque	Mmax	[Nm]	5		10			20		
Max. Current (peak value)	Imax	[A]	2.6	3.6	2.7	5.3	11.5	6.2	10.9	13.1
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	2621	3592	1352	2641	5766	1561	2746	3293
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	3310	4537	1708	3336	7284	1971	3468	4159
Max. Mechanical Speed	nmax	[rpm]	6000							
Mechanical Data										
Inertia	Jm	[Kgcm²]	0.48		0.92			1.72		
Mass	M	[Kg]	3		3.2			5		
Technical Data of the Holding Brake										
Holding Torque	MBr	[Nm]	4							
Rated Voltage (±10%)	UBr	[Vdc]	24							
Rated Current	IBr	[A]	0.58							
Mass	MBr	[Kg]	0.5							
Inertia	JBr	[Kgcm²]	0.22							
Addditional Motor Length	Length	[mm]	30							

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

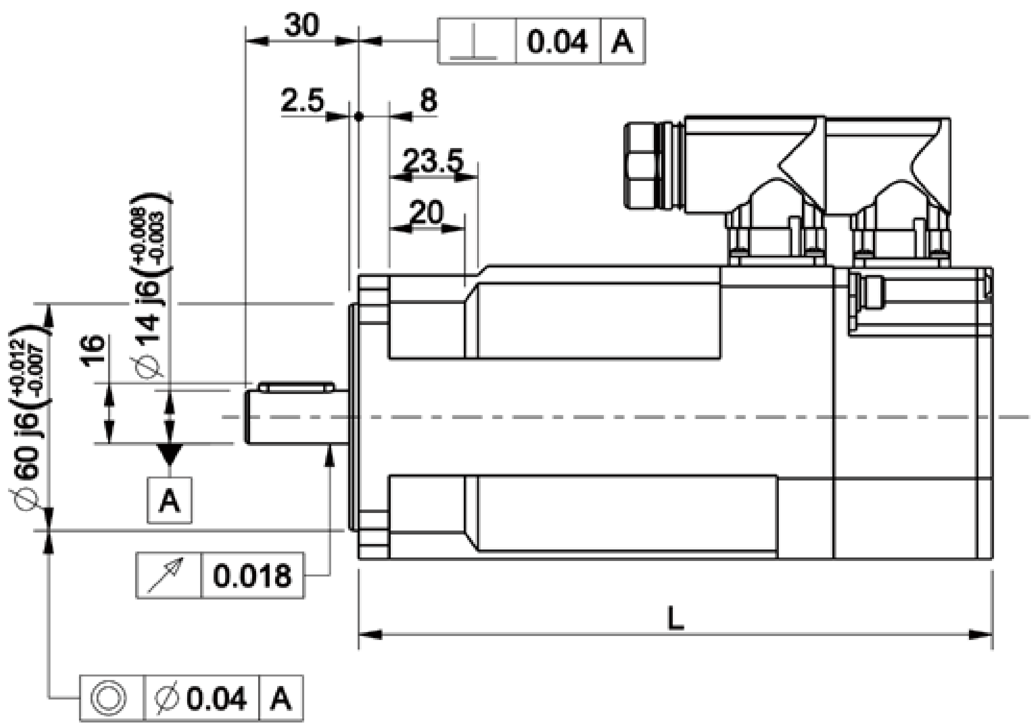
2) Motor flanged on heatsink 300x300x20

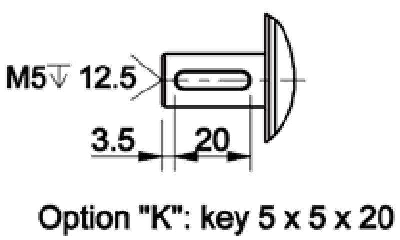
3) Typical data tolerance ±10%

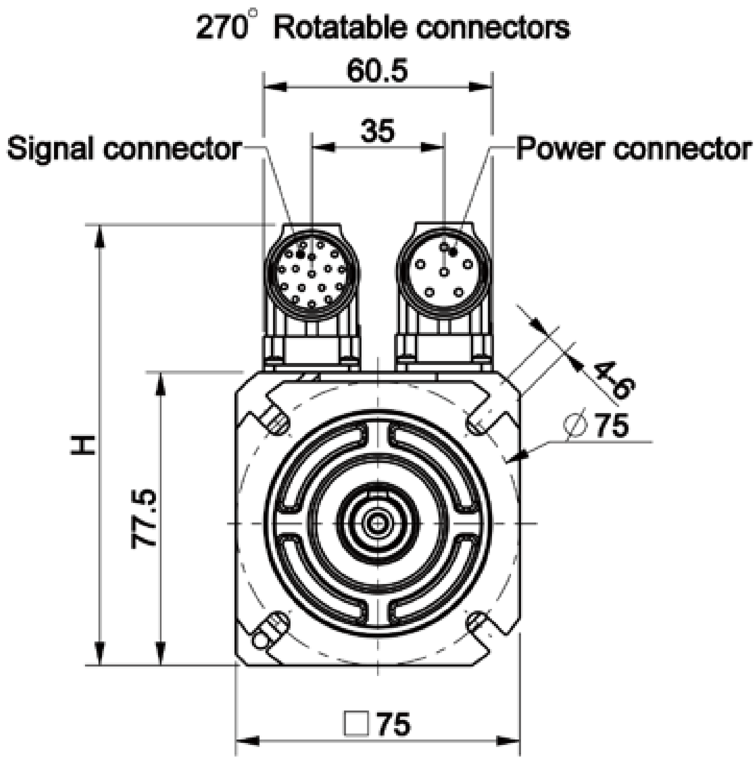
4) Treshold of built in PTC 130°C

5) Chopper frequency 8kHz

Type	L (mm)	H (mm)
U30301A	145	116.5
U30302A	167	117
U30304A	221	116.5







U305__A MOTOR

Motor Code			U30503A		U30506A		U30509A		U30512A	
Rated Speed	nM	[rpm]	1500	3000	1500	3000	1500	3000	1500	3000
Stall Torque 2)	Md0	[Nm]	3.6		7.2		10.5		14	
Current @ Stall Torque 2)	Id0	[A]	1.4	2.7	2.7	5.4	4.1	7.7	5.2	10
Number of Poles	2p		8							
Nominal Rating										
Rated Torque 2)	MdN	[Nm]	3.5	3.1	7	6	10	8.6	13.2	11.4
Rated Current 2)	IdN	[A]	1.4	2.4	2.7	4.5	3.9	6.3	4.9	8.2
Rated Power	PdN	[kW]	0.55	0.97	1.10	1.88	1.57	2.70	2.07	3.58
Voltage Constant 3)	Ke	[V/1000rpm]	177	90	180	92	177	94	184	96
Torque Constant 3)	Kt	[Nm/A]	2.93	1.49	2.98	1.52	2.93	1.55	3.04	1.59
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	2.58	1.31	2.62	1.34	2.58	1.37	2.68	1.40
Winding Resistance 3)	Ru-v	[Ω]	30.00	8.50	12.50	3.20	6.60	2.00	5.30	1.45
Winding Inductance 3)	Lu-v	[mH]	112	26.00	54.70	14.2	34.00	9.80	27.8	7.59
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12							
Nominal Voltage	Vn	[V]	312	295	309	297	297	300	308	306
Losses	Loss	[KW]	0.12	0.13	0.19	0.18	0.23	0.23	0.29	0.29
Efficiency	Eff	[%]	82	88	85	91	87	92	88	93
Knee Speed @ 380Vac	nknee1	[rpm]	1867	3916	1877	3879	1956	3823	1879	3753
Knee Speed @ 480Vac	nknee2	[rpm]	2407	4994	2410	4934	2501	4858	2404	4767
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	958	2279	1025	2273	1115	2256	1036	2182
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	1291	2979	1365	2939	1468	2912	1366	2815
Maximum Values										
Max. Torque	Mmax	[Nm]	14		28		42		58	
Max. Current (peak value)	Imax	[A]	6.0	11.8	11.8	23.0	17.9	33.8	23.8	45.7
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	2147	4222	2111	4130	2147	4043	2065	3958
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	2712	5333	2667	5217	2712	5106	2609	5000
Max. Mechanical Speed	nmax	[rpm]	6000							
Mechanical Data										
Inertia	Jm	[Kgcm²]	1.7		3.2		4.6		6	
Mass	M	[Kg]	5		7		9		11	
Technical Data of the Holding Brake										
Holding Torque	MBr	[Nm]	9							
Rated Voltage (±10%)	UBr	[Vdc]	24							
Rated Current	IBr	[A]	0.75							
Mass	MBr	[Kg]	0.7							
Inertia	JBr	[Kgcm²]	0.65							
Addditional Motor Length	Length	[mm]	33							

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

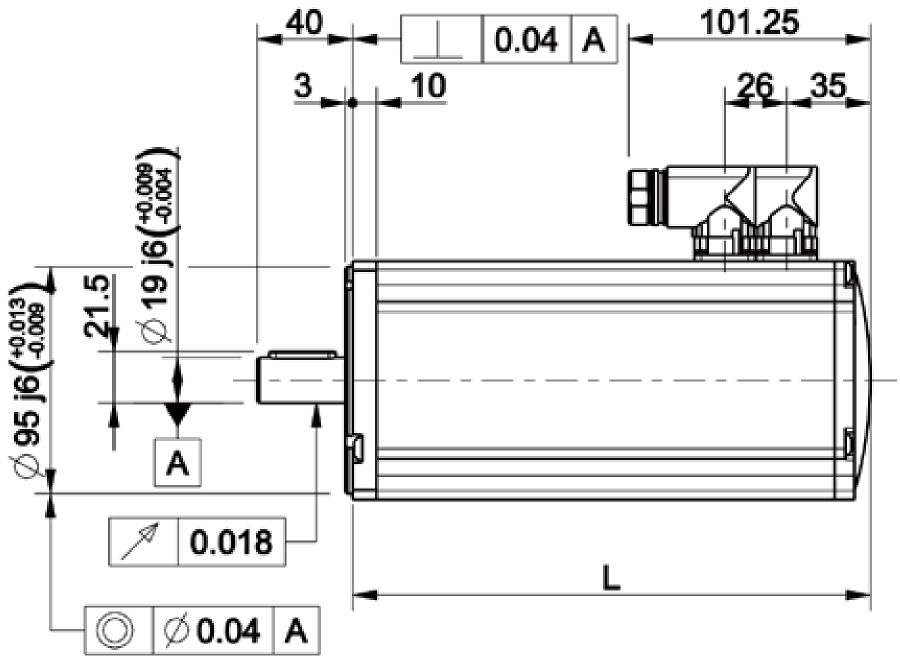
2) Motor flanged on heatsink 300x300x20

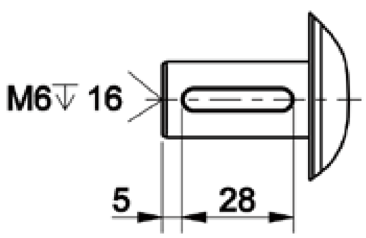
3) Typical data tolerance ±10%

4) Treshold of built in PTC 130°C

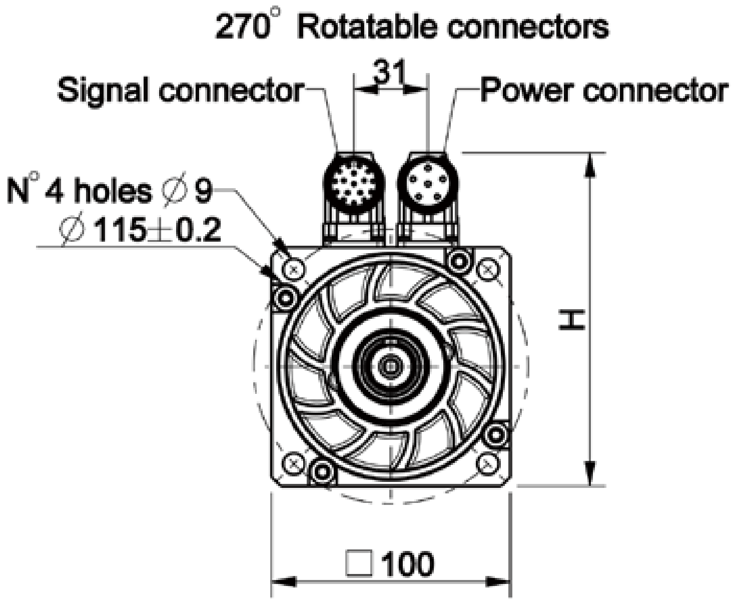
5) Chopper frequency 8kHz

Type	L (mm)	H (mm)
U30503A	195	139.5
U30506A	239	139.5
U30509A	283	139.5
U30512A	327	139.5





Option "K": full key 6 x 6 x 28



U307__A MOTOR

Motor Code			U30710A			U30720A			U30730A			U30740A		
Rated Speed	nM	[rpm]	1500	2000	3000	1500	2000	3000	1500	2000	3000	1500	2000	3000
Stall Torque 2)	Md0	[Nm]	10			19			27			35		
Current @ Stall Torque 2)	Id0	[A]	3.4	4.2	6.1	6.0	7.8	11.7	8.3	11.1	19.9	10.7	12.1	24.0
Number of Poles	2p		8											
Nominal Rating														
Rated Torque 2)	MdN	[Nm]	9.1	9	8.5	17	16	11	24	23	18	33	32	26
Rated Current 2)	IdN	[A]	3.1	3.8	5.2	5.4	6.5	6.7	7.4	9.4	13.3	10.1	11.0	17.9
Rated Power	PdN	[kW]	1.4	1.9	2.7	2.7	3.3	3.5	3.8	4.8	5.7	5.2	6.7	8.2
Voltage Constant 3)	Ke	[V/1000rpm]	202	162	112	218	168	112	224	167.6	93	224	199	100
Torque Constant 3)	Kt	[Nm/A]	3.34	2.68	1.85	3.61	2.78	1.85	3.70	2.77	1.54	3.70	3.29	1.65
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	2.94	2.36	1.63	3.17	2.45	1.63	3.26	2.44	1.35	3.26	2.90	1.46
Winding Resistance 3)	Ru-v	[Ω]	10.30	6.62	3.05	4.26	2.54	1.11	2.348	1.49	0.41	1.85	1.43	0.33
Winding Inductance 3)	Lu-v	[mH]	61.30	39.20	18.80	32.50	19.30	8.40	22.20	12.50	3.65	16.40	12.90	3.20
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12											
Nominal Voltage	Vn	[V]	346	363	366	359	362	348	362	358	289	364	424	311
Losses	Loss	[KW]	0.23	0.23	0.23	0.30	0.30	0.30	0.35	0.35	0.35	0.41	0.41	0.41
Efficiency	Eff	[%]	86	89	92	90	92	92	92	93	94	93	94	95
Knee Speed @ 380Vac	nknee1	[rpm]	1658	2103	3122	1591	2102	3281	1578	2129	3966	1571	1784	3672
Knee Speed @ 480Vac	nknee2	[rpm]	2127	2688	3973	2031	2677	4159	2009	2707	5022	2002	2270	4651
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	923	1202	1829	952	1281	2024	955	1298	2539	972	1115	2383
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	1217	1570	2359	1243	1658	2597	1239	1676	3242	1263	1443	3042
Maximum Values														
Max. Torque	Mmax	[Nm]	33			65			100			130		
Max. Current (peak value)	Imax	[A]	12	15	22	23	29	44	34	45	81	44	49	98
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	1881	2346	3393	1743	2262	3393	1696	2267	4086	1696	1910	3800
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	2376	2963	4286	2202	2857	4286	2143	2864	5161	2143	2412	4800
Max. Mechanical Speed	nmax	[rpm]	6000											
Mechanical Data														
Inertia	Jm	[Kgcm²]	8			14			20			26		
Mass	M	[Kg]	12			16			20			24		
Technical Data of the Holding Brake														
Holding Torque	MBr	[Nm]	32											
Rated Voltage (±10%)	UBr	[Vdc]	24											
Rated Current	IBr	[A]	1.08											
Mass	MBr	[Kg]	2.4											
Inertia	JBr	[Kgcm²]	6											
Addditional Motor Length	Length	[mm]	50											

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

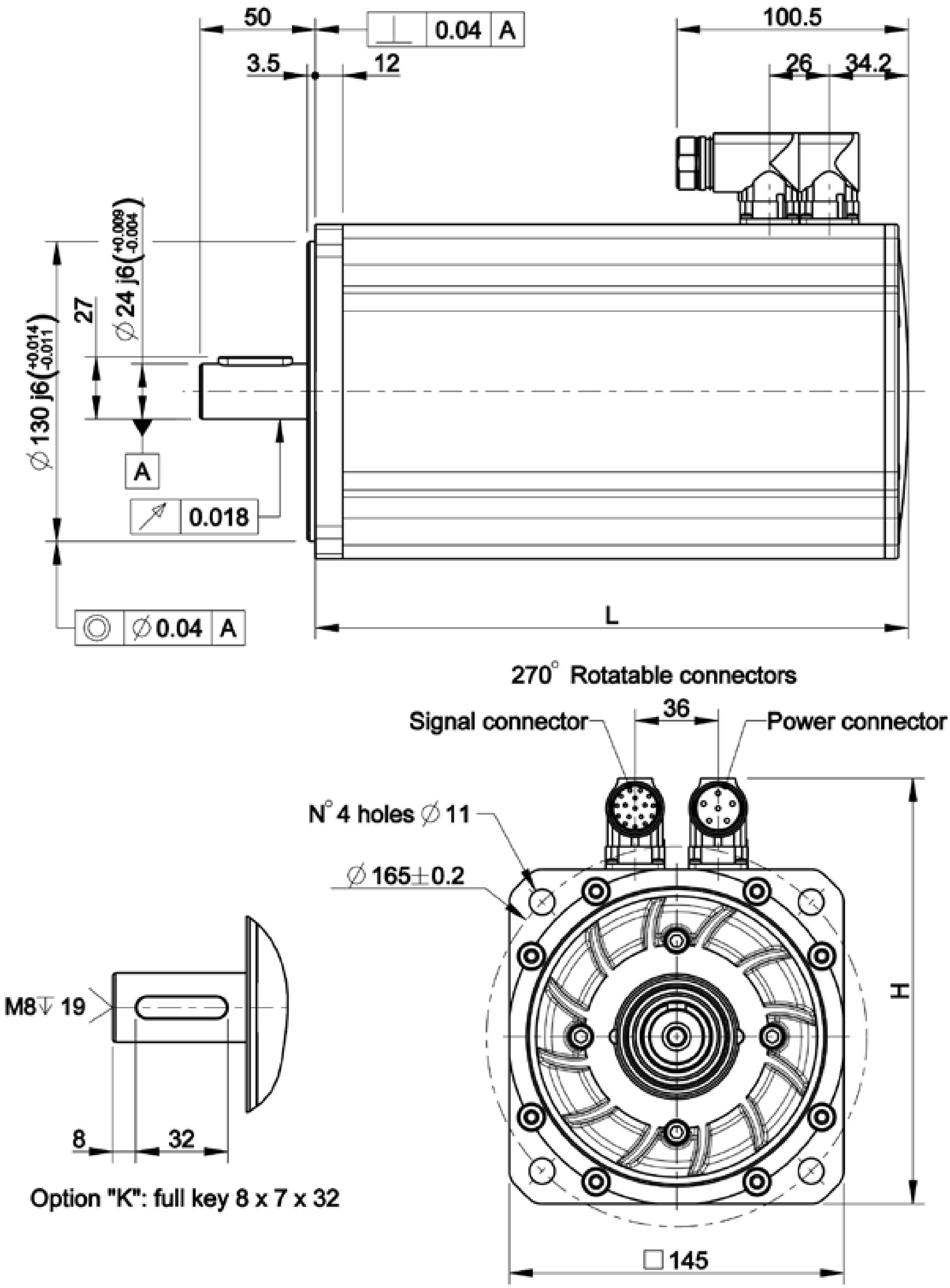
2) Motor flanged (Tflange = 30°C or heatsinker 500x500x20)

3) Typical data tolerance ±10%

4) Treshold of built in PTC 130°C

5) Chopper frequency 8kHz

Type	L (mm)	H (mm)
U30710A	208	184.5
U30720A	257	184.5
U30730A	307	184.5
U30740A	358	184.5



U307__F MOTOR

Motor Code			U30720F			U30730F			U30740F		
Rated Speed	nM	[rpm]	1500	2000	3000	1500	2000	3000	1500	2000	3000
Stall Torque 2)	Md0	[Nm]	24			41			54		
Current @ Stall Torque 2)	Id0	[A]	9.8	9.8	14.3	12.4	16.6	23.7	16.4	24.1	32.7
Number of Poles	2p		8								
Nominal Rating											
Rated Torque 2)	MdN	[Nm]	21.7	21.7	21.7	39	36.4	35.9	45.5	44.5	43.5
Rated Current 2)	IdN	[A]	8.9	8.9	13.5	12.0	15.4	22.5	14.0	21.0	28.0
Rated Power	PdN	[kW]	3.4	4.5	6.8	6.1	7.6	11.3	7.1	9.3	13.7
Voltage Constant 3)	Ke	[V/1000rpm]	161.3	161.3	108	227.3	164.7	114.5	226	154.1	113.6
Torque Constant 3)	Kt	[Nm/A]	2.67	2.67	1.79	3.76	2.72	1.89	3.74	2.55	1.88
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	2.35	2.35	1.57	3.31	2.40	1.67	3.29	2.24	1.65
Winding Resistance 3)	Ru-v	[Ω]	2	2	0.9741	2.092	1.337	0.607	1.934	0.7442	0.4114
Winding Inductance 3)	Lu-v	[mH]	16.4	16.4	7.74	20.8	12.8	5.88	17	7.84	4.38
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12								
Nominal Voltage	Vn	[V]	269	354	354	387	376	383	385	343	375
Losses	Loss	[KW]	0.39	0.39	0.46	0.74	0.77	0.76	0.89	0.83	1.30
Efficiency	Eff	[%]	90	92	94	89	91	94	89	92	91
Knee Speed @ 380Vac	nknee1	[rpm]	2152	2152	3226	1471	2025	2973	1480	2223	3039
Knee Speed @ 480Vac	nknee2	[rpm]	2741	2741	4100	1879	2582	3778	1894	2828	3858
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	1422	1422	2124	1003	1290	1973	950	1485	2021
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	1834	1834	2722	1298	1662	2524	1235	1905	2582
Maximum Values											
Max. Torque	Mmax	[Nm]	65			100			130		
Max. Current (peak value)	Imax	[A]	30	30	45	33	46	66	43	64	86
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	2356	2356	3519	1672	2307	3319	1681	2466	3345
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	2976	2976	4444	2112	2914	4192	2124	3115	4225
Max. Mechanical Speed	nmax	[rpm]	6000								
Mechanical Data											
Inertia	Jm	[Kgcm²]	14			20			26		
Mass	M	[Kg]	22			27			32		
Technical Data of the Holding Brake											
Holding Torque	MBr	[Nm]	32								
Rated Voltage (±10%)	UBr	[Vdc]	24								
Rated Current	IBr	[A]	1.08								
Mass	MBr	[Kg]	2.4								
Inertia	JBr	[Kgcm²]	6								
Addditional Motor Length	Length	[mm]	50								

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

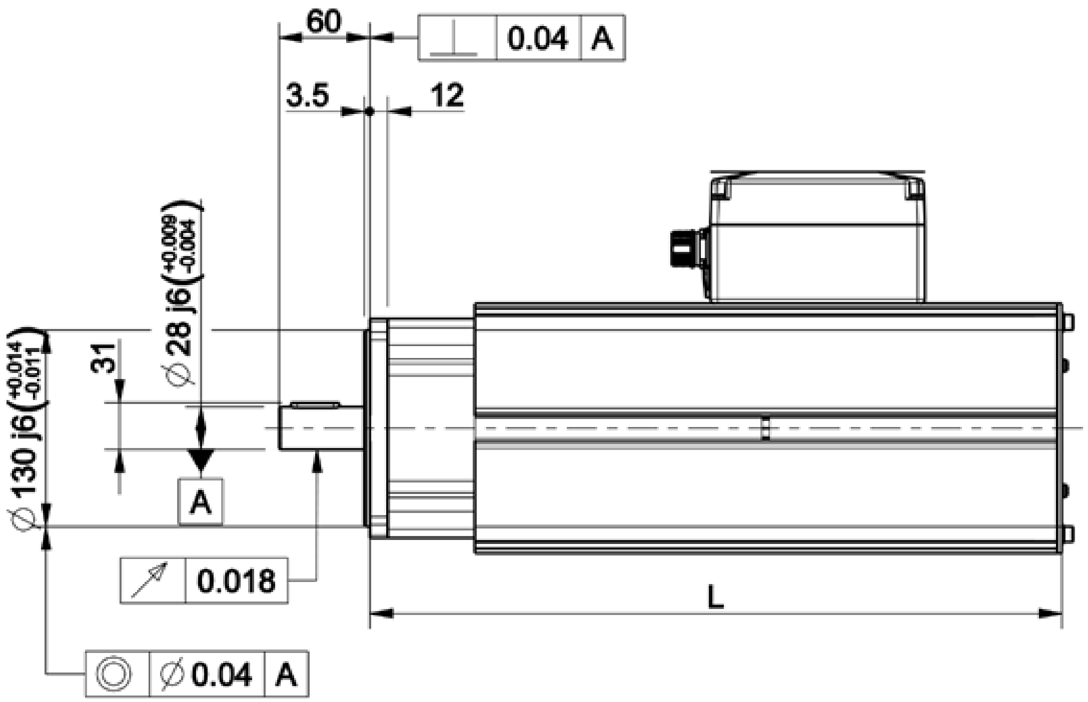
2) Water inlet temperature max 20°C

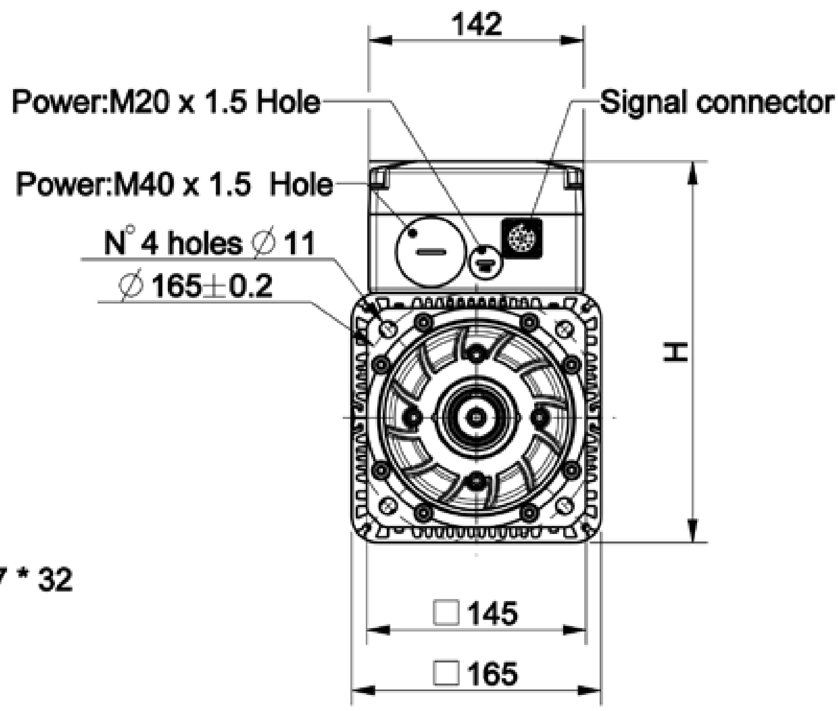
3) Typical data tolerance ±10%

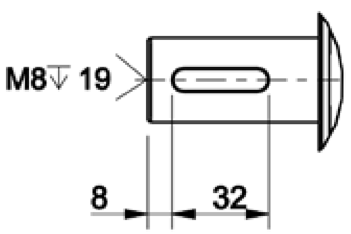
4) Treshold of built in PTC 130°C

5) Chopper frequency 8kHz

Type	L (mm)	H (mm)
U30720F	356.3	251.8
U30730F	406.3	251.8
U30740F	457.3	251.8







Option "K":full key 8 * 7 * 32

U307__C MOTOR

Motor Code			U30720C		U30730C		U30740C	
Rated Speed	nM	[rpm]	1500	3000	1500	3000	1500	3000
Stall Torque 2)	Md0	[Nm]	35		58		80	
Current @ Stall Torque 2)	Id0	[A]	11	24	19	36	28	55
Number of Poles	2p		8					
Nominal Rating								
Rated Torque 2)	MdN	[Nm]	33	30	53	50	78	70
Rated Current 2)	IdN	[A]	10	21	18	31	27	48
Rated Power	PdN	[kW]	5	9	8	16	12	22
Voltage Constant 3)	Ke	[V/1000rpm]	218	100	205	112	199	100
Torque Constant 3)	Kt	[Nm/A]	3.61	1.65	3.39	1.85	3.29	1.65
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	3.17	1.46	2.98	1.63	2.90	1.46
Winding Resistance 3)	Ru-v	[Ω]	4.18	0.82	2.2	0.67	1.25	0.38
Winding Inductance 3)	Lu-v	[mH]	32.5	6.8	18.6	5.5	12.9	3.2
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12					
Nominal Voltage	Vn	[V]	408	350	386	399	378	357
Minimum Flow Rate	Flow	[L/min]	2		3		5	
Losses	Loss	[KW]	1.36		2.20		2.87	
Efficiency	Eff	[%]	79	87	79	88	81	88
Knee Speed @ 380Vac	nknee1	[rpm]	1388	3271	1477	2855	1509	3197
Knee Speed @ 480Vac	nknee2	[rpm]	1788	4162	1898	3639	1933	4070
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	953	2277	1040	2027	1132	2365
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	1246	2914	1351	2598	1460	3024
Maximum Values								
Max. Torque	Mmax	[Nm]	65		100		130	
Max. Current (peak value)	Imax	[A]	23	49	37	67	49	98
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	1743	3800	1854	3393	1910	3800
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	2202	4800	2341	4286	2412	4800
Max. Mechanical Speed	nmax	[rpm]	6000					
Mechanical Data								
Inertia	Jm	[Kgcm²]	14		20		26	
Mass	M	[Kg]	17		21		25	
Technical Data of the Holding Brake								
Holding Torque	MBr	[Nm]	32					
Rated Voltage (±10%)	UBr	[Vdc]	24					
Rated Current	IBr	[A]	1.08					
Mass	MBr	[Kg]	3					
Inertia	JBr	[Kgcm²]	6					
Addditional Motor Length	Length	[mm]	50					

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

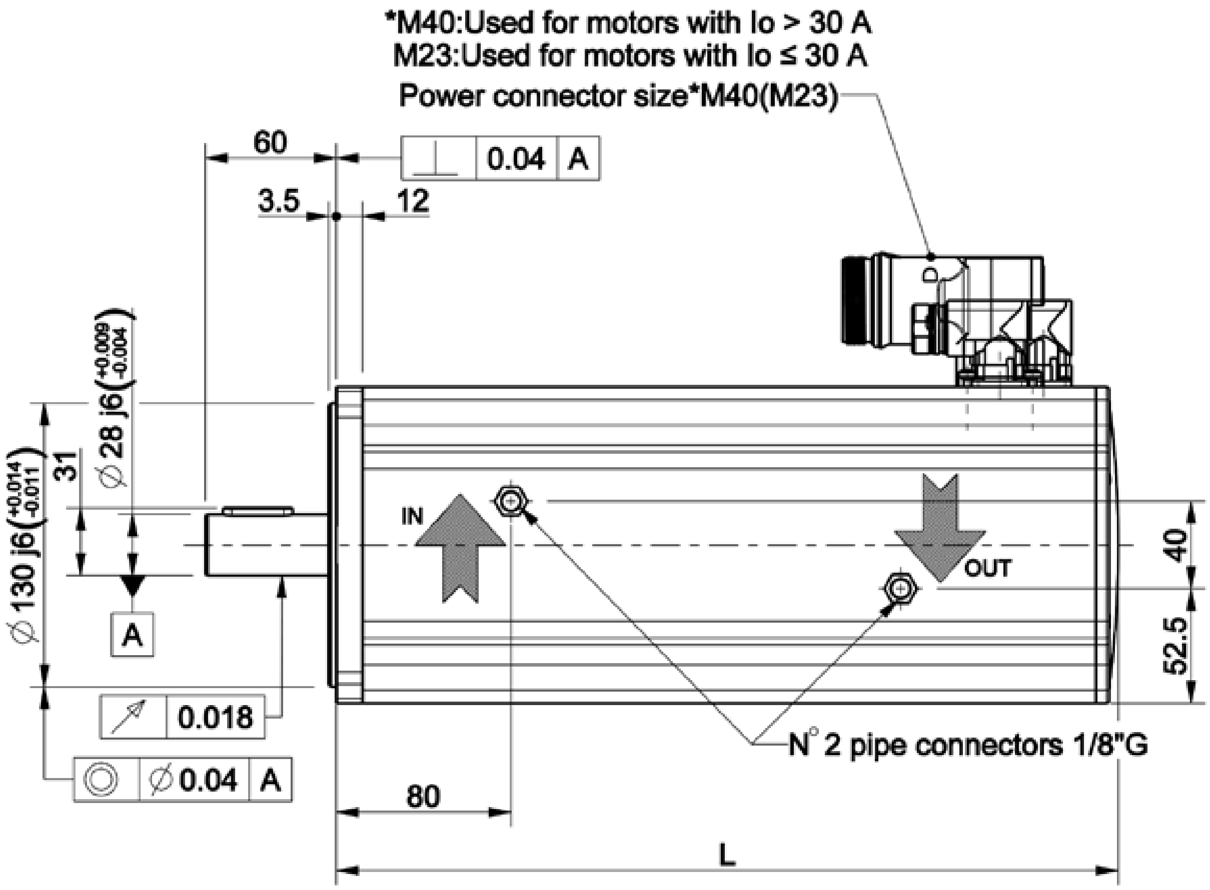
2) Water inlet temperature max 20°C

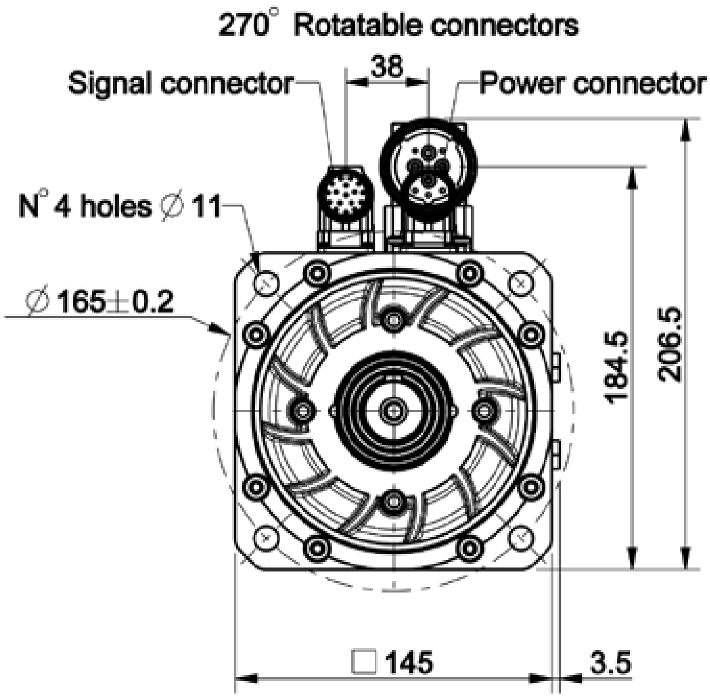
3) Typical data tolerance ±10%

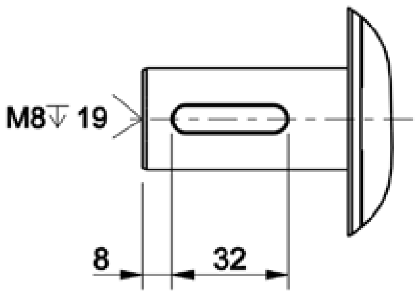
4) Treshold of built in PTC 130°C

5) Chopper frequency 8kHz

Type	L (mm)
U30720C	257
U30730C	307
U30740C	358







Option "K":full key 8 * 7 * 32

U310__A MOTOR

Motor Code			U31004A				U31007A				U31010A				U31013A			
Rated Speed	nM	[rpm]	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	3000
Stall Torque 2)	Md0	[Nm]	35				60				88				105			
Current @ Stall Torque 2)	Id0	[A]	9	11	14	24	15	19	28	45	20	31	36	55	25	33	49	64
Number of Poles	2p		8															
Nominal Rating																		
Rated Torque 2)	MdN	[Nm]	32	32	31	27	57	52	50	30	84	78	73	32	95	90	80	45
Rated Current 2)	IdN	[A]	8	10	13	18	14	16	23	22	19	28	30	20	22	28	38	28
Rated Power	PdN	[kW]	3.3	5	6	8	6	8	10	9	9	12	15	10	10	14	17	14
Voltage Constant 3)	Ke	[V/1000rpm]	277	213	166	102	274	221	148	93	304	193	166	110	293	221	146	112
Torque Constant 3)	Kt	[Nm/A]	4.58	3.52	2.75	1.68	4.54	3.65	2.44	1.53	5.02	3.19	2.74	1.82	4.85	3.65	2.42	1.85
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	4.03	3.10	2.42	1.48	4.00	3.21	2.15	1.35	4.42	2.81	2.41	1.60	4.27	3.21	2.13	1.63
Winding Resistance 3)	Ru-v	[Ω]	3.400	2.000	1.220	0.458	1.290	0.820	0.370	0.145	0.908	0.370	0.270	0.120	0.620	0.350	0.154	0.090
Winding Inductance 3)	Lu-v	[mH]	34.00	18.80	8.00	4.30	16.00	10.20	4.55	1.80	13.90	5.60	4.10	1.84	9.10	5.12	2.30	1.28
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12															
Nominal Voltage	Vn	[V]	316	353	354	323	302	354	312	284	333	310	350	335	314	348	304	340
Losses	Loss	[KW]	0.55	0.55	0.55	0.55	0.63	0.62	0.62	0.62	0.78	0.79	0.78	0.78	0.81	0.81	0.81	0.81
Efficiency	Eff	[%]	86	90	92	94	90	94	94	94	92	94	95	93	92	95	95	95
Knee Speed @ 380Vac	nknee1	[rpm]	1219	1619	2153	3536	1272	1613	2445	4029	1149	1848	2174	3410	1219	1640	2507	3356
Knee Speed @ 480Vac	nknee2	[rpm]	1559	2065	2740	4484	1621	2051	3101	5096	1463	2346	2756	4312	1549	2081	3175	4244
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	730	1021	1577	2270	782	1005	1551	2521	694	1137	1343	2039	754	1032	1578	2146
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	953	1323	2039	2901	1013	1294	1984	3209	897	1456	1716	2595	973	1325	2014	2733
Maximum Values																		
Max. Torque	Mmax	[Nm]	105				210				310				410			
Max. Current (peak value)	Imax	[A]	29	37	48	78	58	72	108	172	77	121	141	213	106	140	212	277
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	1372	1786	2286	3741	1384	1722	2578	4108	1252	1970	2294	3453	1296	1722	2597	3397
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	1733	2255	2887	4726	1749	2175	3254	5189	1582	2488	2897	4362	1637	2175	3281	4291
Max. Mechanical Speed	nmax	[rpm]	6000															
Mechanical Data																		
Inertia	Jm	[Kgcm²]	50				90				130				170			
Mass	M	[Kg]	28				40				55				70			
Technical Data of the Holding Brake																		
Holding Torque	MBr	[Nm]	140															
Rated Voltage (±10%)	UBr	[Vdc]	24															
Rated Current	IBr	[A]	2.3															
Mass	MBr	[Kg]	11															
Inertia	JBr	[Kgcm²]	56															
Addditional Motor Length	Length	[mm]	65															

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

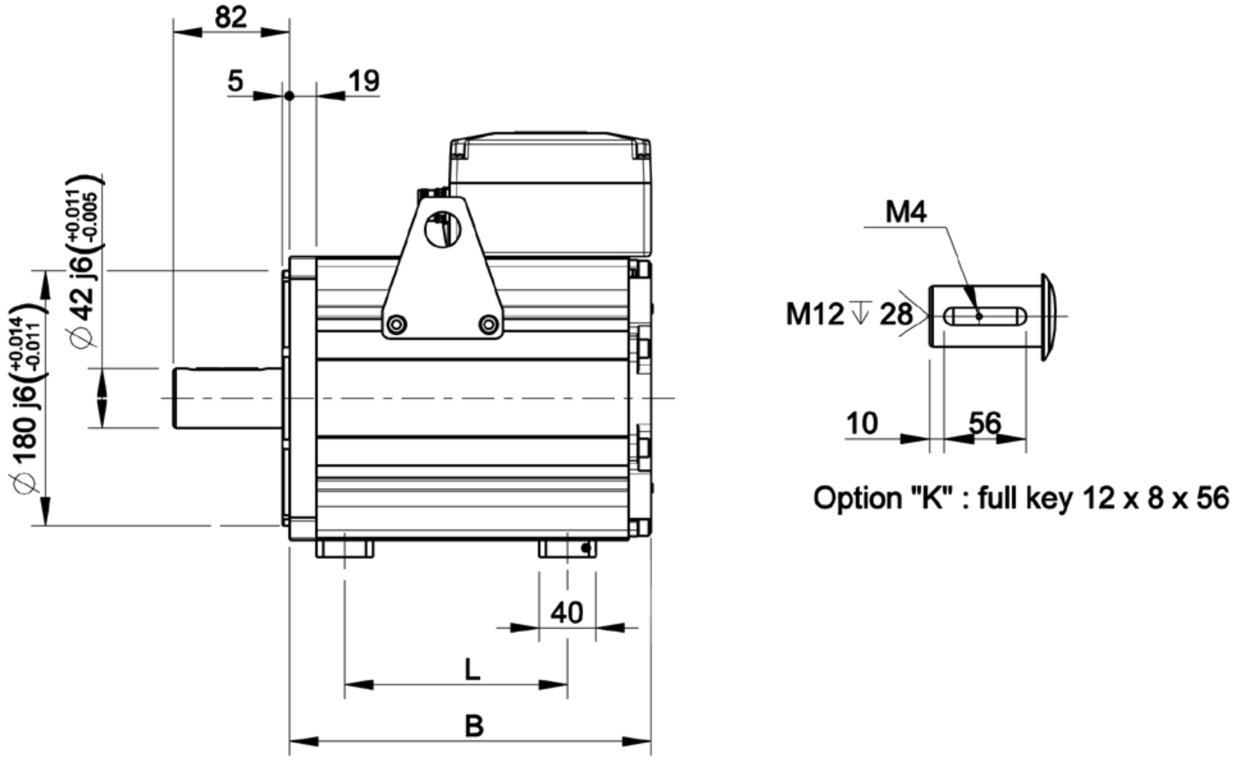
2) Motor flanged (Tflange = 30°C)

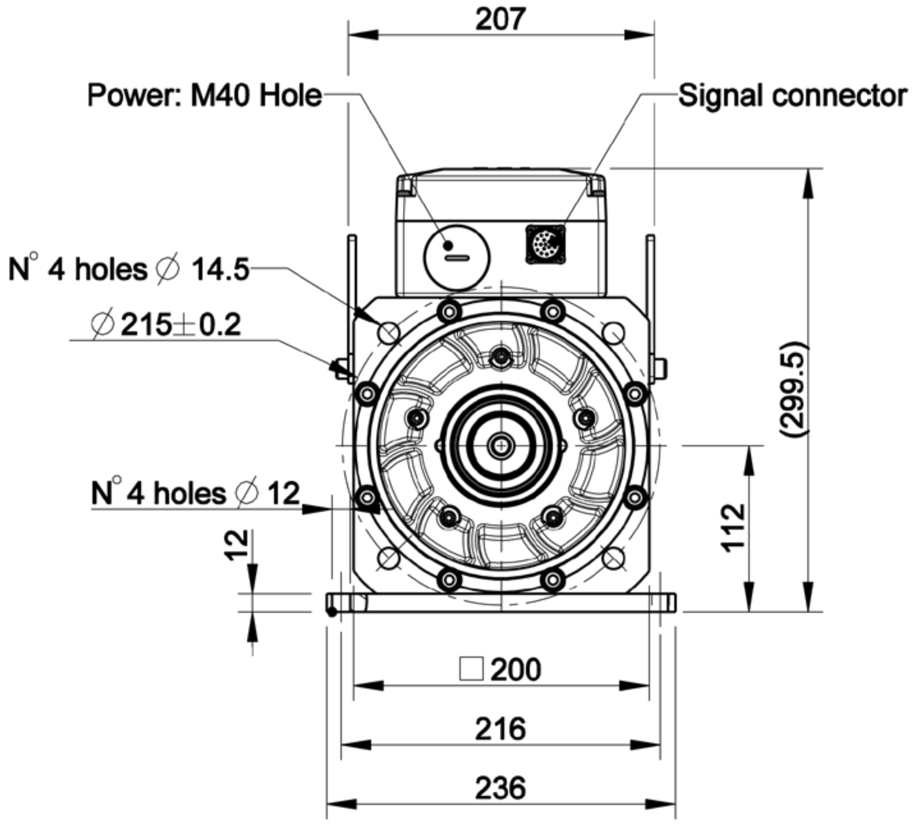
3) Typical data tolerance ±10%

4) Treshold of built in PTC 130°C

5) Chopper frequency 8kHz

Type	B (mm)		L (mm)
	Encoder: R,S,N1,etc...	Encoder: N3,S5,D6,M2,etc...	
U31004A	255	263.5	157
U31007A	327	335.5	232
U31010A	399	407.5	306
U31013A	471	479.5	381





U310__F MOTOR

Motor Code			U31004F				U31007F				U31010F				U31013F			
Rated Speed	nM	[rpm]	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	3000
Stall Torque 2)	Md0	[Nm]	45				90				130				170			
Current @ Stall Torque 2)	Id0	[A]	11	16	22	30	23	30	42	67	30	46	65	81	40	53	80	104
Number of Poles	2p		8															
Nominal Rating																		
Rated Torque 2)	MdN	[Nm]	42	42	40	38	74	73	72	70	100	99	97	95	149	146	142	135
Rated Current 2)	IdN	[A]	10	15	20	26	19	24	34	52	23	35	48	59	35	45	67	83
Rated Power	PdN	[kW]	4	7	8	12	8	11	15	22	10	16	20	30	16	23	30	42
Voltage Constant 3)	Ke	[V/1000rpm]	277	193	139	102	274	206	148	93	302	193	138	110	293	221	146	112
Torque Constant 3)	Kt	[Nm/A]	4.58	3.20	2.30	1.68	4.54	3.40	2.44	1.53	5.00	3.19	2.28	1.82	4.85	3.65	2.42	1.85
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	4.03	2.82	2.02	1.48	4.00	2.99	2.15	1.35	4.40	2.81	2.01	1.60	4.27	3.21	2.13	1.63
Winding Resistance 3)	Ru-v	[Ω]	3.400	1.650	0.860	0.458	1.290	0.720	0.370	0.145	0.910	0.370	0.190	0.120	0.620	0.350	0.154	0.090
Winding Inductance 3)	Lu-v	[mH]	34.00	16.00	8.60	4.30	16.00	11.00	4.55	1.80	13.90	5.60	2.84	1.84	9.10	5.12	2.30	1.28
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12															
Nominal Voltage	Vn	[V]	333	338	318	337	314	355	325	302	340	319	301	357	333	367	321	361
Losses	Loss	[KW]	0.90	0.89	0.90	0.90	1.38	1.38	1.37	1.37	1.68	1.68	1.68	1.67	2.08	2.07	2.07	2.07
Efficiency	Eff	[%]	83	88	90	93	85	89	92	94	86	90	92	95	88	92	93	95
Knee Speed @ 380Vac	nknee1	[rpm]	1154	1701	2410	3393	1224	1610	2348	3794	1124	1795	2542	3200	1151	1554	2374	3161
Knee Speed @ 480Vac	nknee2	[rpm]	1481	2173	3067	4309	1563	2050	2983	4809	1433	2282	3224	4055	1468	1977	3013	4006
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	730	1118	1566	2270	782	954	1551	2521	693	1137	1628	2039	754	1032	1578	2146
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	953	1444	2009	2901	1013	1224	1984	3209	896	1456	2076	2595	973	1325	2014	2733
Maximum Values																		
Max. Torque	Mmax	[Nm]	105				210				310				410			
Max. Current (peak value)	Imax	[A]	29	41	57	78	58	77	108	172	78	121	170	213	106	140	212	277
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	1372	1964	2733	3741	1384	1849	2576	4108	1257	1970	2757	3453	1296	1722	2597	3397
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	1733	2481	3452	4726	1749	2335	3254	5189	1588	2489	3482	4362	1637	2175	3281	4291
Max. Mechanical Speed	nmax	[rpm]	6000															
Mechanical Data																		
Inertia	Jm	[Kgcm²]	50				90				130				170			
Mass	M	[Kg]	35				50				65				80			
Technical Data of the Holding Brake																		
Holding Torque	MBr	[Nm]	140															
Rated Voltage (±10%)	UBr	[Vdc]	24															
Rated Current	IBr	[A]	2.3															
Mass	MBr	[Kg]	11															
Inertia	JBr	[Kgcm²]	56															
Addditional Motor Length	Length	[mm]	65															

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

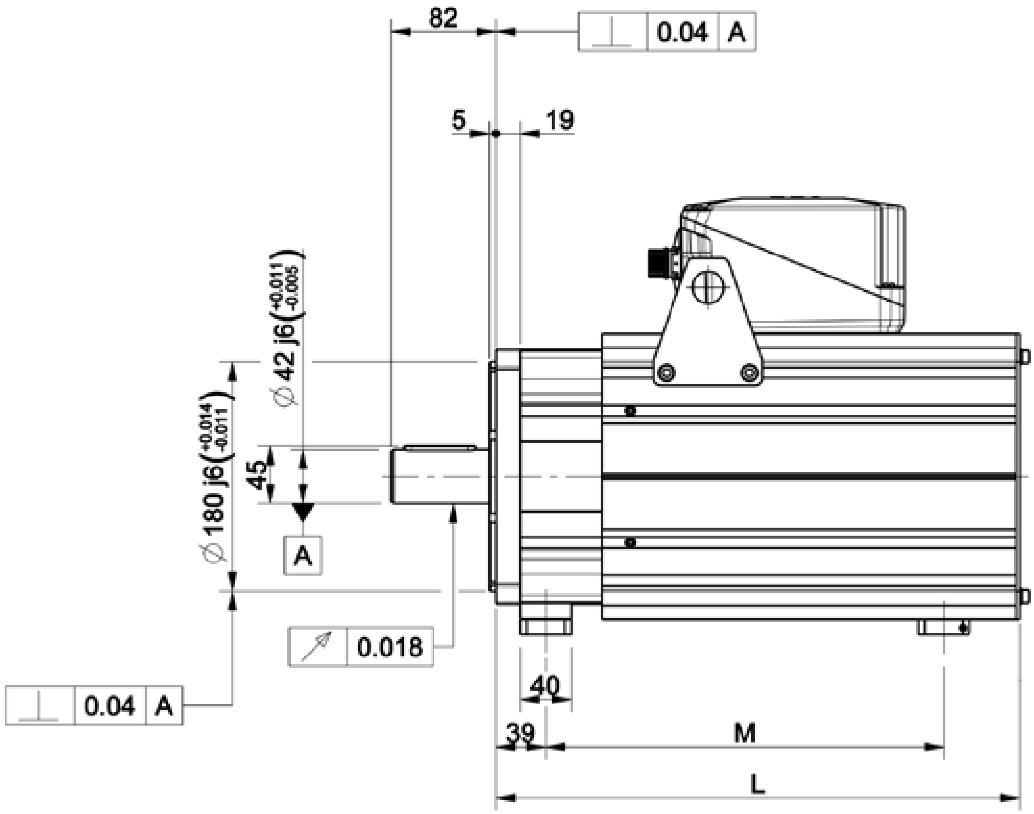
2) Motor flanged (Tflange = 30°C)

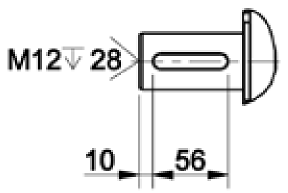
3) Typical data tolerance ±10%

4) Treshold of built in PTC 130°C

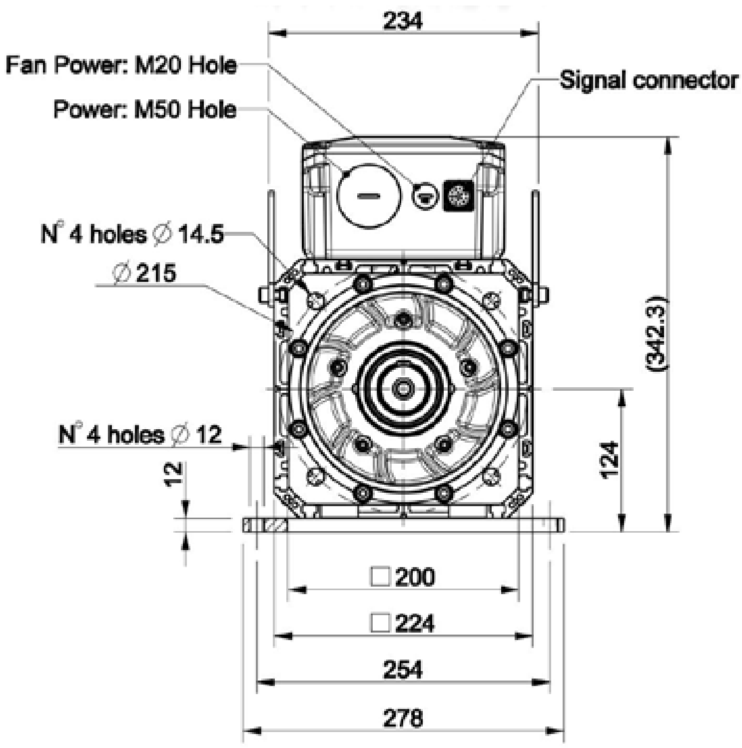
5) Chopper frequency 8kHz

Type	L (mm)		M (mm)
	Encoder: R,S1,N7,etc...	Encoder: N3,D,S5,M2,etc...	
U31004F	342	350	267
U31007F	414	425	312
U31010F	486	497	396
U31013F	558	564	471





Option "K" : full key 12 x 8 x 56



U310__C MOTOR

Motor Code			U31004C				U31007C				U31010C				U31013C			
Rated Speed	nM	[rpm]	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	3000
Stall Torque 2)	Md0	[Nm]	55				110				165				220			
Current @ Stall Torque 2)	Id0	[A]	14	21	27	37	29	41	59	82	41	59	82	118	52	83	103	166
Number of Poles	2p		8															
Nominal Rating																		
Rated Torque 2)	MdN	[Nm]	54	53	53	53	109	108	108	108	164	164	163	160	219	219	218	217
Rated Current 2)	IdN	[A]	13	20	26	36	29	40	58	80	41	58	81	114	51	82	102	163
Rated Power	PdN	[kW]	6	8	11	17	11	17	23	34	17	26	34	50	23	34	46	68
Voltage Constant 3)	Ke	[V/1000rpm]	276	183	139	102	258	184	128	93	276	193	138	96	293	183	146	91
Torque Constant 3)	Kt	[Nm/A]	4.56	3.03	2.30	1.68	4.26	3.05	2.12	1.53	4.56	3.19	2.28	1.59	4.85	3.02	2.42	1.51
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	4.01	2.67	2.02	1.48	3.75	2.68	1.87	1.35	4.01	2.81	2.01	1.40	4.27	2.66	2.13	1.33
Winding Resistance 3)	Ru-v	[Ω]	3.400	1.520	0.860	0.458	1.136	0.580	0.280	0.145	0.758	0.370	0.190	0.092	0.620	0.240	0.154	0.060
Winding Inductance 3)	Lu-v	[mH]	34.00	14.50	8.60	4.30	15.00	7.65	3.75	1.80	11.50	5.60	2.87	1.40	9.10	3.80	2.30	0.90
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12															
Nominal Voltage	Vn	[V]	356	339	340	360	327	341	313	328	347	356	335	345	363	337	351	325
Minimum Flow Rate	Flow	[L/min]	2.5				4				5				7			
Losses	Loss	[KW]	1.25	1.27	1.25	1.24	1.92	1.91	1.91	1.90	2.52	2.51	2.52	2.51	3.23	3.23	3.23	3.23
Efficiency	Eff	[%]	86	87	90	93	86	90	92	95	87	91	93	95	88	91	93	95
Knee Speed @ 380Vac	nknee1	[rpm]	1075	1694	2252	3170	1177	1683	2447	3492	1102	1608	2279	3314	1052	1699	2173	3525
Knee Speed @ 480Vac	nknee2	[rpm]	1386	2168	2872	4032	1507	2146	3111	4433	1410	2049	2897	4204	1347	2165	2764	4471
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	730	1178	1566	2270	811	1172	1709	2521	770	1137	1618	2349	754	1207	1578	2569
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	952	1520	2009	2901	1048	1503	2182	3209	993	1456	2063	2987	973	1544	2014	3265
Maximum Values																		
Max. Torque	Mmax	[Nm]	105				210				310				410			
Max. Current (peak value)	Imax	[A]	29	43	57	78	62	86	124	172	85	121	170	244	106	170	212	339
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	1378	2074	2733	3741	1475	2061	2965	4108	1378	1970	2757	3953	1296	2081	2597	4162
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	1741	2620	3452	4726	1864	2603	3745	5189	1741	2489	3482	4993	1637	2629	3281	5258
Max. Mechanical Speed	nmax	[rpm]	6000															
Mechanical Data																		
Inertia	Jm	[Kgcm²]	50				90				130				170			
Mass	M	[Kg]	35				43				57				70			
Technical Data of the Holding Brake																		
Holding Torque	MBr	[Nm]	140															
Rated Voltage (±10%)	UBr	[Vdc]	24															
Rated Current	IBr	[A]	2.3															
Mass	MBr	[Kg]	11															
Inertia	JBr	[Kgcm²]	56															
Addditional Motor Length	Length	[mm]	65															

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

2) Water inlet temperature max 20°C

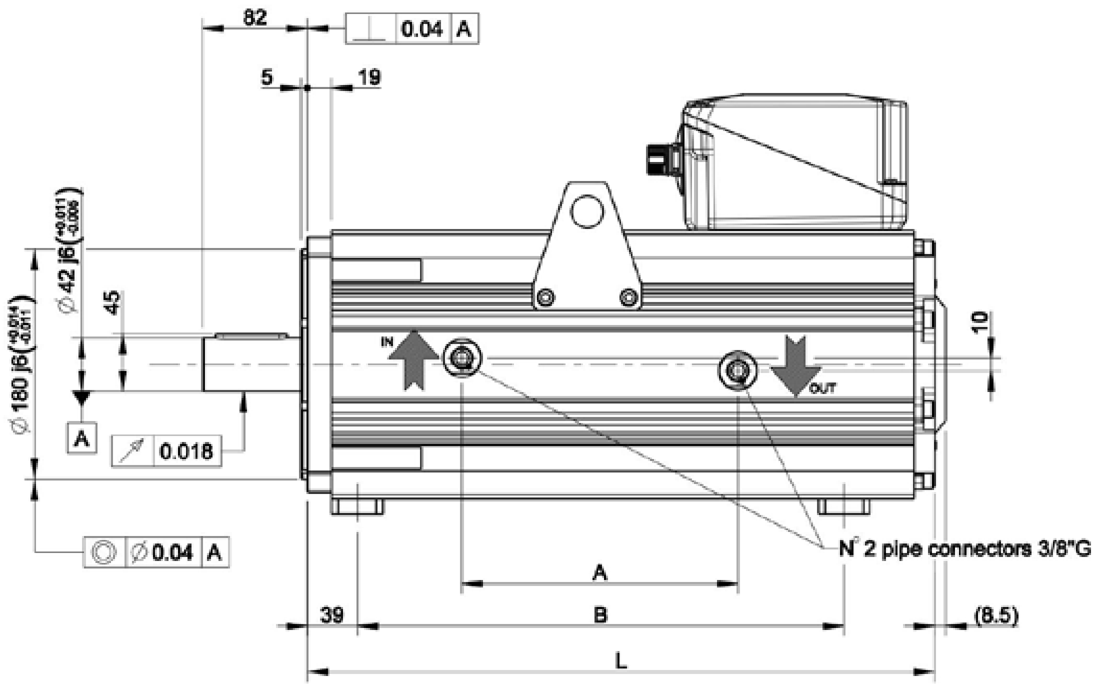
3) Typical data tolerance ±10%

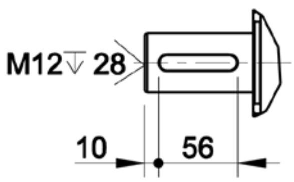
4) Treshold of built in PTC 130°C

5) Chopper frequency 8kHz

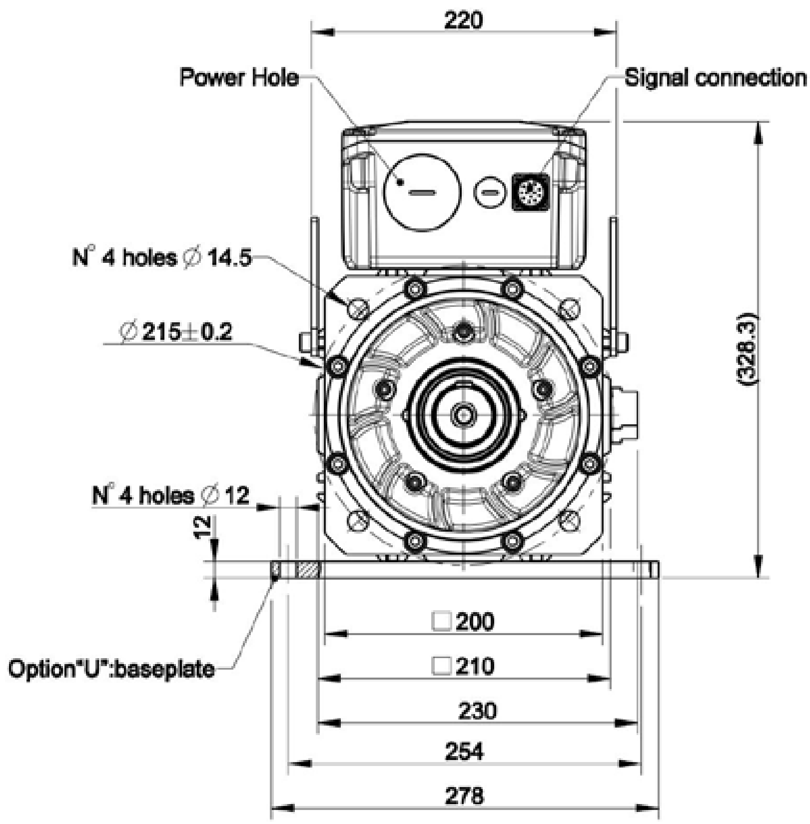
6) If Id0 >= 130A: + 20mm of addtional length

Type	L (mm)		A (mm)	B (mm)
	Encoder: R,S1,N1,etc...	Encoder: N3,M2,S5,etc...		
U31004C	275	283.5	39	157
U31007C	347	355.5	100	232
U31010C	419	427.5	150	306
U31013C	491	499.5	218	381





Option"K":full key 12 x 8 x 56



U313__A MOTOR

Motor Code			U31310A				U31320A				U31330A			U31340A		
Rated Speed	nM	[rpm]	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	1000	1500	2000
Stall Torque 2)	Md0	[Nm]	100				190				260			350		
Current @ Stall Torque 2)	Id0	[A]	20	30	40	60	39	58	88	117	54	81	107	65	108	163
Number of Poles	2p		8													
Nominal Rating																
Rated Torque 2)	MdN	[Nm]	95	93	87	70	170	160	100	50	240	230	180	270	230	130
Rated Current 2)	IdN	[A]	19	28	35	42	35	49	47	31	50	71	74	50	71	61
Rated Power	PdN	[kW]	10	15	18	22	18	25	21	16	25	36	38	28	36	27
Voltage Constant 3)	Ke	[V/1000rpm]	343	229	172	114	333	224	148	111	333	222	166	369	222	148
Torque Constant 3)	Kt	[Nm/A]	5.68	3.79	2.84	1.89	5.50	3.70	2.44	1.84	5.50	3.67	2.75	6.10	3.67	2.44
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	5.00	3.34	2.50	1.66	4.84	3.26	2.15	1.62	4.84	3.23	2.42	5.37	3.23	2.15
Winding Resistance 3)	Ru-v	[Ω]	0.800	0.360	0.200	0.090	0.300	0.136	0.058	0.033	0.196	0.087	0.049	0.160	0.059	0.026
Winding Inductance 3)	Lu-v	[mH]	18.00	8.26	4.50	2.00	9.10	4.00	1.94	1.03	6.00	2.70	1.50	5.50	2.20	0.97
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12													
Nominal Voltage	Vn	[V]	378	374	367	358	361	358	305	336	358	354	345	389	347	299
Losses	Loss	[KW]	0.69	0.70	0.69	0.70	1.00	1.00	0.98	0.98	1.22	1.22	1.22	1.47	1.50	1.49
Efficiency	Eff	[%]	93	96	96	97	95	96	96	97	96	97	97	96	97	97
Knee Speed @ 380Vac	nknee1	[rpm]	1007	1525	2069	3186	1055	1595	2499	3390	1064	1612	2203	977	1644	2540
Knee Speed @ 480Vac	nknee2	[rpm]	1281	1935	2622	4031	1339	2021	3161	4284	1350	2042	2787	1238	2080	3211
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	666	1007	1384	2101	679	1045	1503	2091	681	1033	1400	619	990	1507
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	855	1285	1762	2668	867	1330	1908	2652	870	1315	1779	791	1258	1912
Maximum Values																
Max. Torque	Mmax	[Nm]	280				550				830			1100		
Max. Current (peak value)	Imax	[A]	62	92	123	185	125	186	282	374	189	283	377	225	375	564
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	1107	1658	2213	3325	1143	1699	2576	3416	1143	1713	2286	1030	1713	2576
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	1398	2095	2795	4201	1443	2146	3254	4315	1443	2163	2887	1301	2163	3254
Max. Mechanical Speed	nmax	[rpm]	6000													
Mechanical Data																
Inertia	Jm	[Kgcm²]	225				410				593			777		
Mass	M	[Kg]	85				115				150			185		
Technical Data of the Holding Brake																
Holding Torque	MBr	[Nm]	300													
Rated Voltage (±10%)	UBr	[Vdc]	24													
Rated Current	IBr	[A]	1.74													
Mass	MBr	[Kg]	18													
Inertia	JBr	[Kgcm²]	200													
Addditional Motor Length	Length	[mm]	80													

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

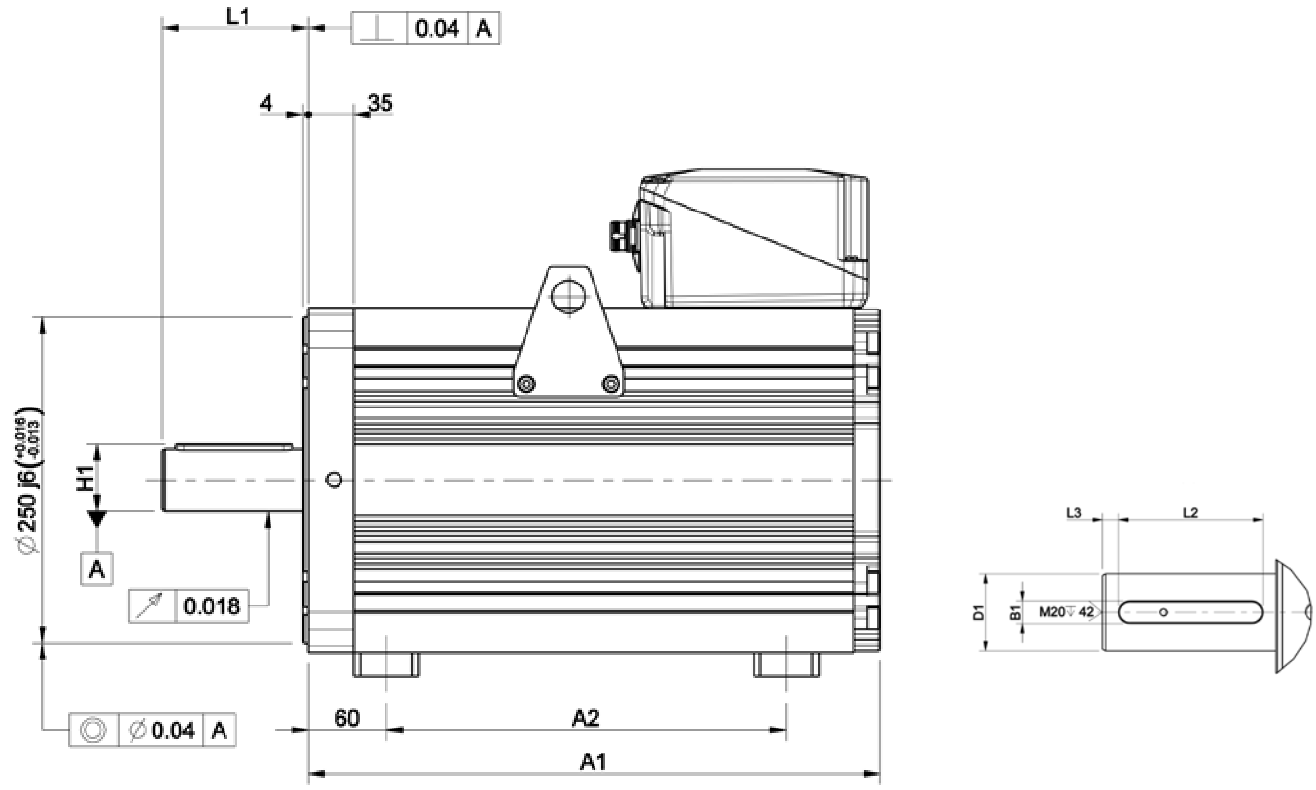
2) Motor flanged (Tflange = 30°C)

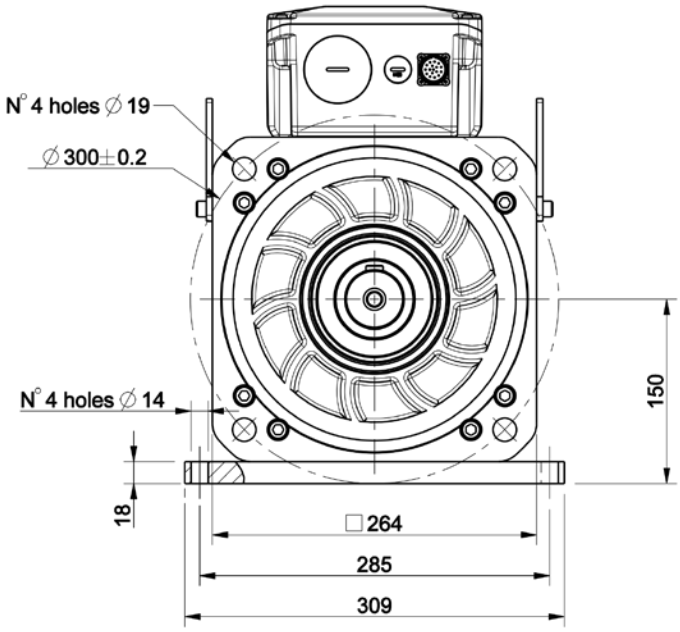
3) Typical data tolerance ±10%

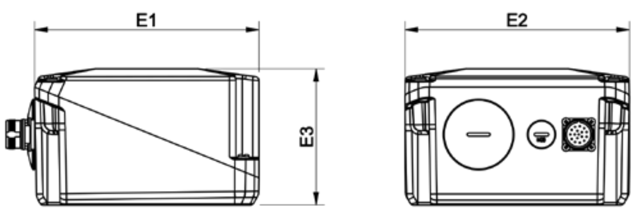
4) Treshold of built in PTC 130°C

5) Chopper frequency 8kHz

Type	A1 (mm) In ≤ 150A	A2 (mm)	L1 (mm)	L2 (mm)	L3 (mm)	B1 (mm)	D1	H1 (mm)
U31310A	332	200	112	90	10	14	48j6	51.5
U31320A	439	307	112	90	10	14	48j6	51.5
U31330A	546	414	112	90	10	14	48j6	51.5
U31340A	653	521	112	90	10	14	48j6	51.5







Box option

E1	E2	E3	Current
175	175	106.3	30A≤In<125A
240	195	122	125A≤In<200A
353	264	157.5	200A≤In<340A
353	264	157.5	340A≤In<600A

U313__F MOTOR

Motor Code			U31310F				U31320F				U31330F				U31340F			
Rated Speed	nM	[rpm]	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	3000
Stall Torque 2)	Md0	[Nm]	150				280				410				540			
Current @ Stall Torque 2)	Id0	[A]	30	49	60	90	58	86	130	173	85	127	469	253	125	167	251	333
Number of Poles	2p		8															
Nominal Rating																		
Rated Torque 2)	MdN	[Nm]	145	140	135	130	270	265	260	240	400	390	380	350	510	500	480	460
Rated Current 2)	IdN	[A]	29	46	54	78	56	81	121	148	83	121	157	216	118	155	224	284
Rated Power	PdN	[kW]	15	22	28	41	28	42	54	75	42	61	80	110	53	79	100	144
Voltage Constant 3)	Ke	[V/1000rpm]	343	210	172	114	333	224	148	111	333	222	166	111	296	222	148	111
Torque Constant 3)	Kt	[Nm/A]	5.68	3.47	2.84	1.89	5.50	3.70	2.44	1.84	5.50	3.67	2.75	1.84	4.90	3.67	2.44	1.84
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	5.00	3.05	2.50	1.66	4.84	3.26	2.15	1.62	4.84	3.23	2.42	1.62	4.31	3.23	2.15	1.62
Winding Resistance 3)	Ru-v	[Ω]	0.800	0.300	0.200	0.090	0.300	0.136	0.058	0.033	0.196	0.087	0.049	0.022	0.105	0.059	0.026	0.015
Winding Inductance 3)	Lu-v	[mH]	18.00	6.70	4.90	2.00	9.10	4.00	1.94	1.09	6.00	2.70	1.50	0.73	3.87	2.20	0.97	0.52
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12															
Nominal Voltage	Vn	[V]	410	367	402	388	393	388	346	381	390	385	380	379	349	388	339	374
Losses	Loss	[KW]	1.72	1.73	1.72	1.75	2.40	2.41	2.36	2.36	3.37	3.36	3.37	3.38	3.94	3.95	3.94	3.86
Efficiency	Eff	[%]	91	93	95	95	92	94	95	96	93	95	95	96	93	95	96	97
Knee Speed @ 380Vac	nknee1	[rpm]	924	1555	1890	2936	966	1469	2200	2992	972	1479	2001	3008	1091	1469	2246	3051
Knee Speed @ 480Vac	nknee2	[rpm]	1179	1976	2398	3720	1229	1864	2787	3788	1237	1877	2536	3807	1386	1863	2845	3861
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	666	1125	1318	2101	679	1045	1503	2020	681	1033	1400	2006	740	990	1507	2084
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	855	1435	1677	2668	867	1330	1908	2561	870	1315	1779	2543	943	1258	1912	2641
Maximum Values																		
Max. Torque	Mmax	[Nm]	280				550				830				1100			
Max. Current (peak value)	Imax	[A]	62	101	123	185	125	186	282	374	189	283	377	564	281	375	564	747
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	1107	1811	2213	3325	1143	1699	2576	3416	1143	1713	2286	3416	1283	1713	2576	3416
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	1398	2288	2795	4201	1443	2146	3254	4315	1443	2163	2887	4315	1620	2163	3254	4315
Max. Mechanical Speed	nmax	[rpm]	6000															
Mechanical Data																		
Inertia	Jm	[Kgcm²]	225				410				593				780			
Mass	M	[Kg]	90				130				170				210			
Technical Data of the Holding Brake																		
Holding Torque	MBr	[Nm]	300															
Rated Voltage (±10%)	UBr	[Vdc]	24															
Rated Current	IBr	[A]	1.74															
Mass	MBr	[Kg]	18															
Inertia	JBr	[Kgcm²]	200															
Addditional Motor Length	Length	[mm]	80															

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

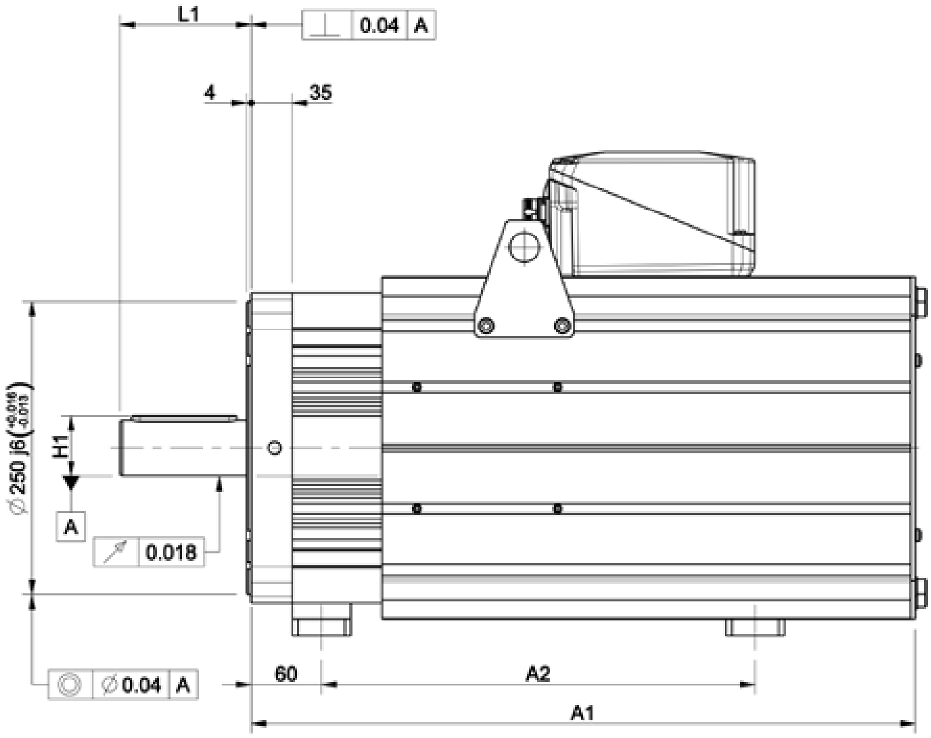
2) If Id0 >= 150A: + 40mm of addtional length

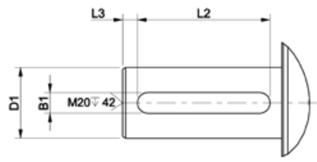
3) Typical data tolerance ±10%

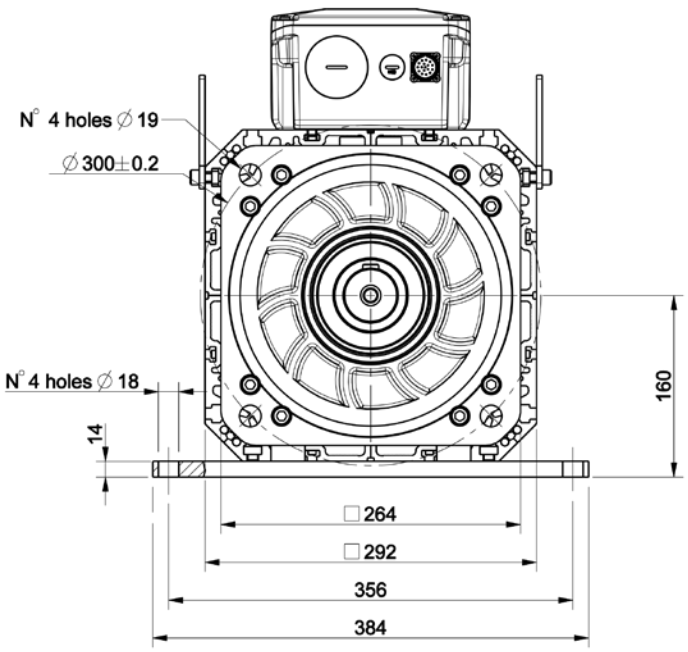
4) Treshold of built in PTC 130°C

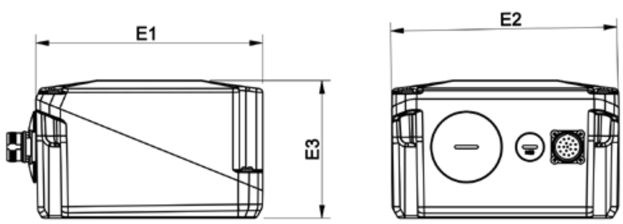
5) Chopper frequency 8kHz

Type	A1 (mm)		A2 (mm)	L1 (mm)	L2 (mm)	L3 (mm)	B1 (mm)	D1	H1 (mm)
	In ⩽ 150A	In > 150A							
U31310F	459.5	499.5	262	112	90	10	14	48j6	51.5
U31320F	566.5	606.5	370	112	90	10	14	48j6	51.5
U31330F	673.5	713.5	476	112	90	10	14	48j6	51.5
U31340F	780.5	820.5	583	112	90	10	18	60m6	64









Box option			
E1	E2	E3	Current
175	175	106.3	30A≤In<125A
240	195	122	125A≤In<200A
353	264	157.5	200A≤In<340A
353	264	157.5	340A≤In<600A

U313__C MOTOR

Motor Code			U31310C				U31320C				U31330C				U31340C			
Rated Speed	nM	[rpm]	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	3000	1000	1500	2000	3000
Stall Torque 2)	Md0	[Nm]	180				360				540				720			
Current @ Stall Torque 2)	Id0	[A]	43	65	72	108	84	149	168	222	134	223	267	333	149	268	335	445
Number of Poles	2p		8															
Nominal Rating																		
Rated Torque 2)	MdN	[Nm]	179	178	178	175	357	354	353	348	539	534	530	520	715	713	710	700
Rated Current 2)	IdN	[A]	43	64	71	105	83	146	164	215	134	221	262	321	148	266	331	432
Rated Power	PdN	[kW]	19	28	37	55	37	56	74	109	56	84	111	163	75	115	149	220
Voltage Constant 3)	Ke	[V/1000rpm]	287	191	172	114	296	166	148	111	277	166	139	111	333	184	148	111
Torque Constant 3)	Kt	[Nm/A]	4.74	3.16	2.84	1.89	4.89	2.75	2.44	1.84	4.58	2.75	2.30	1.84	5.50	3.05	2.44	1.84
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	4.17	2.78	2.50	1.66	4.30	2.42	2.15	1.62	4.03	2.42	2.02	1.62	4.84	2.68	2.15	1.62
Winding Resistance 3)	Ru-v	[Ω]	0.560	0.247	0.200	0.090	0.243	0.080	0.060	0.034	0.135	0.049	0.034	0.022	0.127	0.039	0.026	0.015
Winding Inductance 3)	Lu-v	[mH]	12.50	5.53	4.90	2.00	7.10	2.24	1.80	1.00	4.20	1.50	1.05	0.73	4.50	1.38	0.97	0.52
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12															
Nominal Voltage	Vn	[V]	364	357	437	419	379	315	372	413	357	315	349	425	424	348	382	418
Losses	Loss	[KW]	2.05	2.03	2.04	2.07	3.34	3.48	3.31	3.30	4.76	4.79	4.75	4.80	5.52	5.51	5.63	5.63
Minimum Flow Rate	Flow	[L/min]	5				8				11				14			
Efficiency	Eff	[%]	86	93	95	96	92	94	96	97	92	95	96	97	93	95	96	98
Knee Speed @ 380Vac	nknee1	[rpm]	1047	1601	1735	2716	1003	1819	2045	2759	1069	1816	2184	2679	893	1639	1992	2723
Knee Speed @ 480Vac	nknee2	[rpm]	1336	2036	2203	3443	1277	2308	2593	3495	1360	2303	2768	3393	1137	2079	2524	3448
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	809	1244	1318	2101	773	1406	1573	2127	821	1400	1681	2006	689	1271	1507	2084
Knee Speed @ 480Vac and Mmax	nknee4	[rpm]	1036	1585	1677	2668	987	1787	1997	2698	1047	1779	2134	2543	879	1614	1912	2641
Maximum Values																		
Max. Torque	Mmax	[Nm]	280				550				830				1100			
Max. Current (peak value)	Imax	[A]	74	111	123	185	141	250	282	374	227	377	451	564	250	451	564	747
Max. Saturation Speed @ 380Vac	nmax1	[rpm]	1326	1989	2213	3325	1285	2286	2576	3416	1372	2286	2733	3416	1143	2061	2576	3416
Max. Saturation Speed @ 480Vac	nmax2	[rpm]	1675	2512	2795	4201	1624	2887	3254	4315	1733	2887	3452	4315	1443	2603	3254	4315
Max. Mechanical Speed	nmax	[rpm]	6000															
Mechanical Data																		
Inertia	Jm	[Kgcm²]	225				410				593				777			
Mass	M	[Kg]	95				120				150				190			
Technical Data of the Holding Brake																		
Holding Torque	MBr	[Nm]	300															
Rated Voltage (±10%)	UBr	[Vdc]	24															
Rated Current	IBr	[A]	1.74															
Mass	MBr	[Kg]	18															
Inertia	JBr	[Kgcm²]	200															
Addditional Motor Length	Length	[mm]	80															

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

2) Water inlet temperature max 20°C

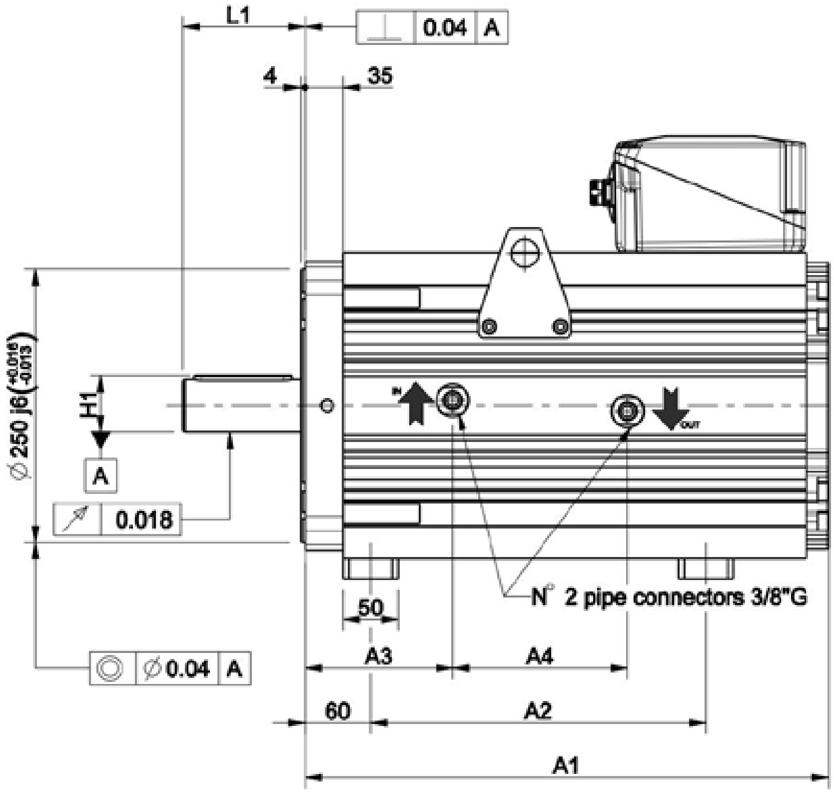
3) Typical data tolerance ±10%

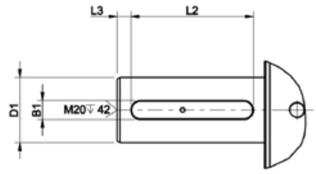
4) Treshold of built in PTC 130°C

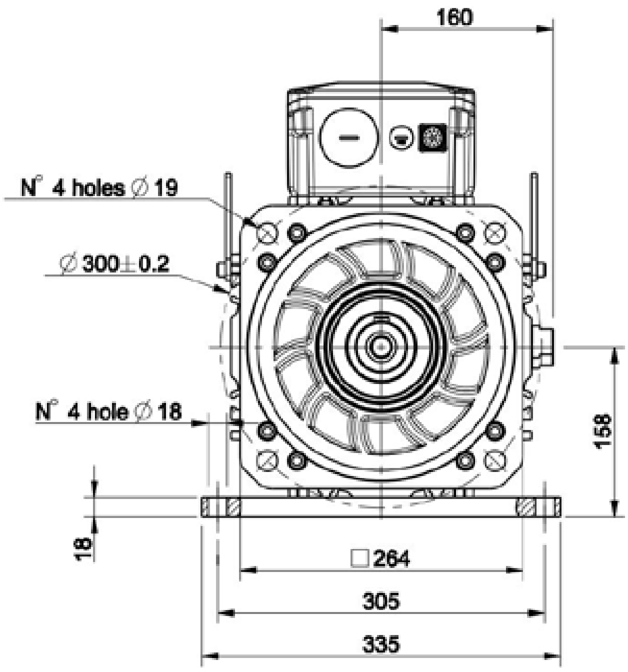
5) Chopper frequency 8kHz

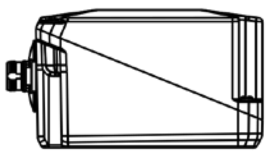
6) If Id0 >= 150A: + 40mm of addtional length

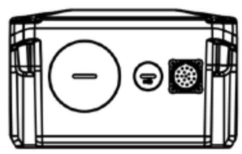
Type	A1 (mm)		A2 (mm)	A3 (mm)	A4 (mm)	L1 (mm)	L2 (mm)	L3 (mm)	B1 (mm)	D1	H1 (mm)
	In ≤ 150A	In > 150A									
U31310C	332		200	121.4	63.7	112	90	10	14	48j6	51.5
U31320C		479	307	135	160	112	90	10	14	48j6	51.5
U31330C		586	414	141	253	112	90	10	18	60m6	64
U31340C		693	521	141	360	112	90	10	18	60m6	64











Box option			
E1	E2	E3	Current
175	175	106.3	30A≤In<125A
240	195	122	125A≤In<200A
353	264	157.5	200A≤In<340A
353	264	157.5	340A≤In<600A

U318__F MOTOR

Motor Code			U318035F	U318050F	U318060F	U318070F	U318100F
Rated Speed	nM	[rpm]	1500	1500	1500	1500	1500
Stall Torque 2)	Md0	[Nm]	579	761	932	1095	1398
Current @ Stall Torque 2)	Id0	[A]	169	209	273	321	384
Number of Poles	2p		12				
Nominal Rating							
Rated Torque 2)	MdN	[Nm]	478	623	748	869	1103
Rated Current 2)	IdN	[A]	151	185	237	275	328
Rated Power	PdN	[kW]	75	98	118	137	173
Voltage Constant 3)	Ke	[V/1000rpm]	216	231	216	216	231
Torque Constant 3)	Kt	[Nm/A]	3.58	3.82	3.58	3.58	3.82
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	3.32	3.54	3.32	3.32	3.54
Winding Resistance 3)	Ru-v	[Ω]	0.045	0.035	0.023	0.018	0.015
Winding Inductance 3)	Lu-v	[mH]	0.616	0.526	0.37	0.308	0.263
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12				
Nominal Voltage	Vn	[V]	317	337	314	313	333
Losses	Loss	[KW]	3.01	3.54	4.06	4.52	5.3
Efficiency	Eff	[%]	96	97	97	97	97
Knee Speed @ 380Vac	nknee1	[rpm]	1796	1687	1811	1816	1707
Knee Speed @ 380Vac and Mmax	nknee3	[rpm]	1521	1429	1533	1536	1440
Maximum Values							
Max. Torque	Mmax	[Nm]	1346	1795	2244	2692	3590
Max. Current (peak value)	Imax	[A]	380	475	633	759	949
Max. Speed Deflux	nmax1	[rpm]	2000				
Max. Mechanical Speed	nknee	[rpm]	4000				
Mechanical Data							
Inertia	Jm	[Kgcm²]	2820	3660	4500	5340	7010
Mass	M	[Kg]	285	350	395	435	520

Test Condition

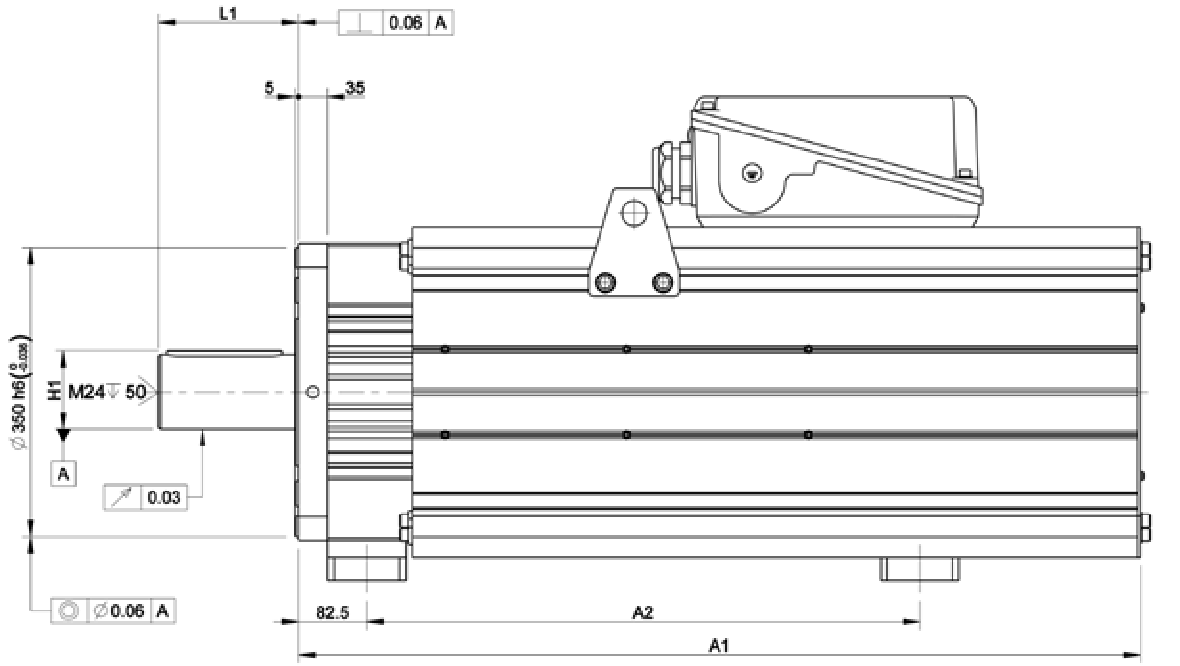
1) Motor tested in horizontal position in free still air, ambient temperature 30°C

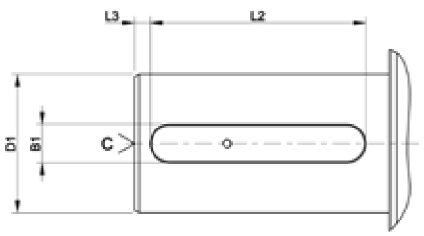
2) Typical data tolerance ±10%

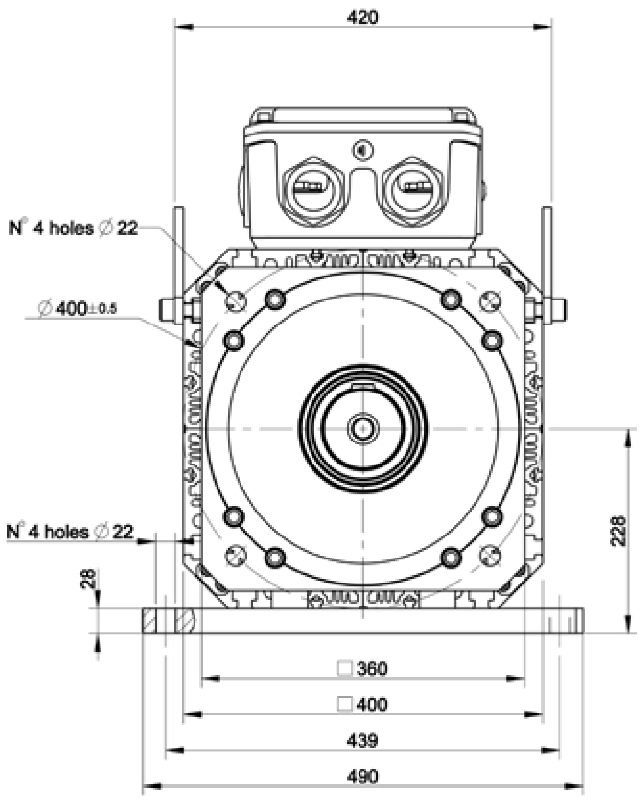
3) Treshold of built in PTC 130°C

4) Chopper frequency 8kHz

Type	A1 (mm)	A2 (mm)	L1 (mm)	L2 (mm)	L3 (mm)	B1 (mm)	D1	H1 (mm)
U318035F	700	348	140	125	6	18	60m6	64
U318050F	764	412	170	140	10	22	80m6	85
U318060F	828	476	170	140	10	22	80m6	85
U318070F	892	540	170	140	10	22	80m6	85
U318100F	1020	670	170	140	10	25	90m6	95







U318__C MOTOR

Motor Code			U318035C		U318070C		U318100C	
Rated Speed	nM	[rpm]	1000	2000	1000	2000	1000	2000
Stall Torque 2)	Md0	[Nm]	550		1100		1600	
Current @ Stall Torque 2)	Id0	[A]	97	194	194	388	317	635
Number of Poles	2p		12					
Nominal Rating								
Rated Torque 2)	MdN	[Nm]	500	497	1000	980	1540	1480
Rated Current 2)	IdN	[A]	88	175	176	345	305	588
Rated Power	PdN	[kW]	52	104	105	205	161	310
Voltage Constant 3)	Ke	[V/1000rpm]	390	195	390	195	347	173
Torque Constant 3)	Kt	[Nm/A]	6.45	3.23	6.45	3.23	5.74	2.86
Torque Constant @ 130°C 3)	Kt100	[Nm/A]	5.68	2.84	5.68	2.84	5.05	2.52
Winding Resistance 3)	Ru-v	[Ω]	0.16	0.042	0.059	0.015	0.032	0.009
Winding Inductance 3)	Lu-v	[mH]	2.2	0.55	1.1	0.45	1.04	0.27
Derating Temp. Coeff. Of Back EMF	Dke/Dt	[%/°C]	-0.12					
Nominal Voltage	Vn	[V]	416	410	413	429	395	391
Minimum Flow Rate	Flow	[L/min]	8		11		14	
Losses	Loss	[KW]	3.24	3.41	4.79	4.87	6.94	7.85
Efficiency	Eff	[%]	95	95	94	94	95	95
Knee Speed @ 380Vac	nknee1	[rpm]	911	1852	919	1769	961	1944
Knee Speed @ 380Vac	nmax2	[rpm]	1159	2347	1167	2239	1219	2461
Knee Speed @ 380Vac and Mmax	nmax3	[rpm]	714	1482	741	1211	662	1314
Knee Speed @ 380Vac and Mmax	nmax4	[rpm]	917	1888	946	1537	843	1667
Maximum Values								
Max. Torque	Mmax	[Nm]	1300		2500		3500	
Max. Current (peak value)	Imax	[A]	252	504	484	969	762	1529
Max. Speed Deflux	nmax1	[rpm]	974	1949	974	1949	1095	2197
Max. Speed Deflux	nmax2	[rpm]	1231	2462	1231	2462	1383	2775
Max. Mechanical Speed	nmax	[rpm]	4000					
Mechanical Data								
Inertia	Jm	[Kgcm²]	2820		5340		7010	
Mass	M	[Kg]	265		380		455	

Test Condition

1) Motor tested in horizontal position in free still air, ambient temperature 30°C

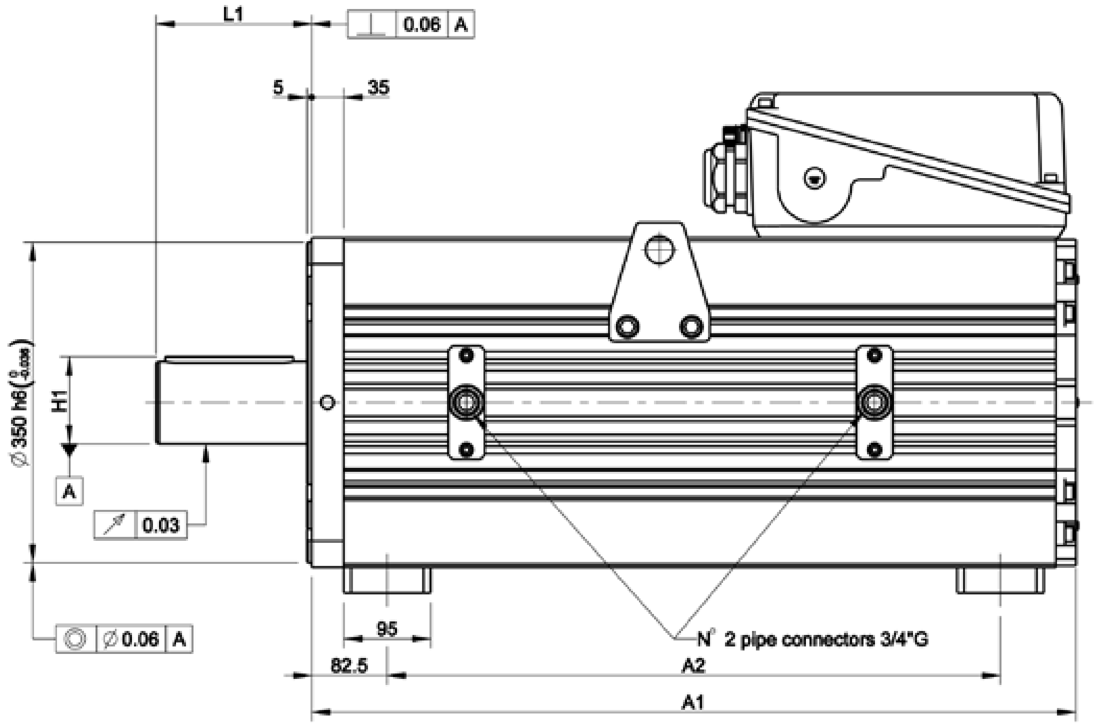
2) Motor flanged (Tflange = 30°C)

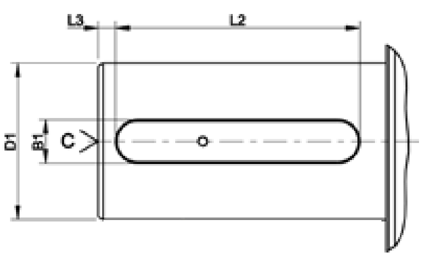
3) Typical data tolerance ±10%

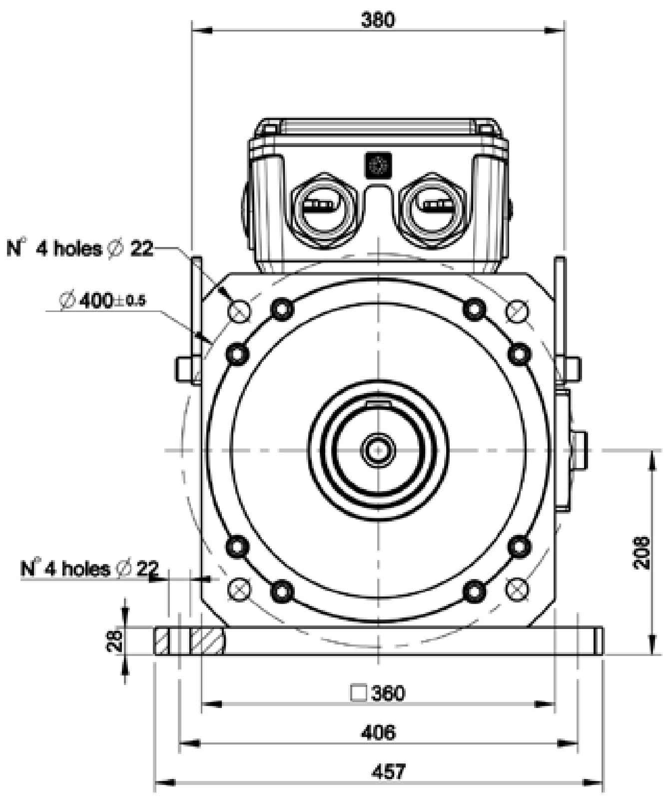
4) Treshold of built in PTC 130°C

5) Chopper frequency 8kHz

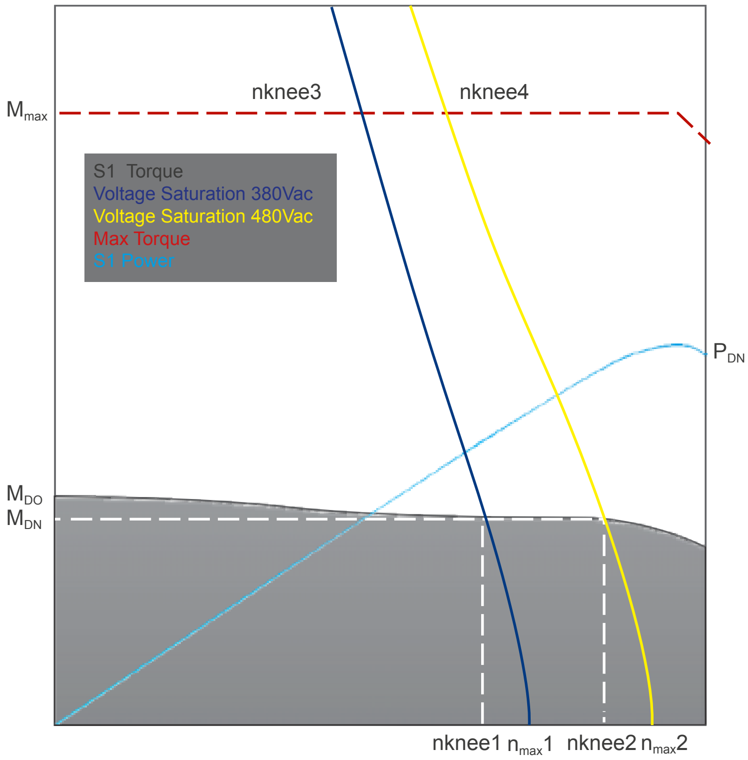
Type	A1 (mm)	A2 (mm)	L1 (mm)	L2 (mm)	L3 (mm)	B1 (mm)	D1	H1 (mm)
U318035C	515	348	140	125	6	18	60m6	64
U318070C	707	540	170	140	10	22	80m6	85
U318100C	835	670	170	140	10	25	90m6	95



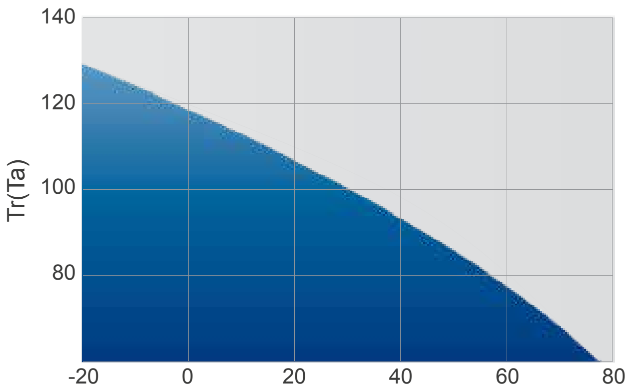




MOTOR PERFORMANCE CURVES

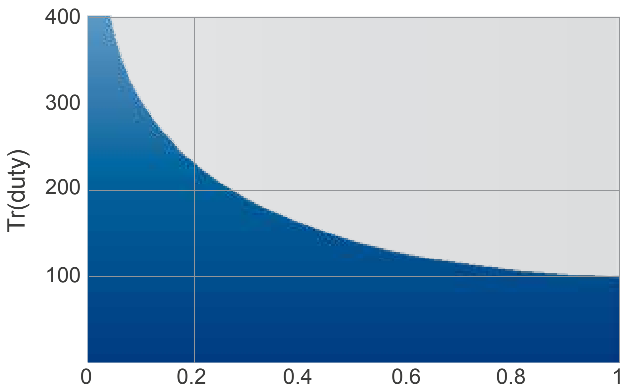


Thermal Derating



Permissible torque vs. ambient temperature, % of Md0

Overload Rating



Permissible torque overload vs. duty cycle, all motors.

MOTOR CONNECTIONS

Signal

Signal Connector M23-17 Pin
EnDat Type Mx, Nx

PIN	Function	AxM Port E1
1	A +	n.c.
2	A -	n.c.
3	DATA +	14
4	PTC +	8
5	CLOCK +	3
6	n.c.	n.c.
7	0 V	1
8	KTY84 +	n.c.
9	KTY84 –	n.c.
10	+ Vac	
11	B +	n.c.
12	B –	n.c.
13	DATA –	9
14	CLOCK –	4
15	0V sense	n.c.
16	Vac sense	n.c.
17	PTC –	1

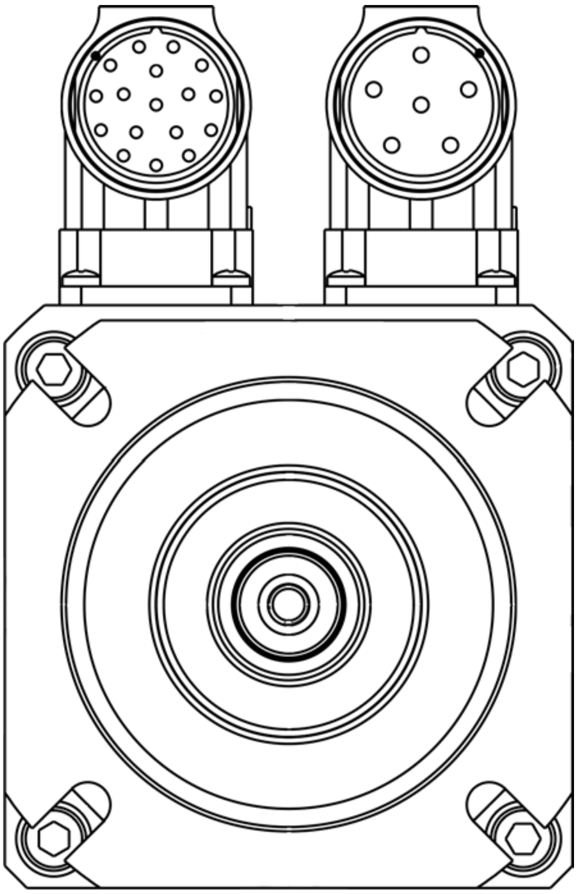
Signal Connector M23-17 Pin
Resolver Type R

PIN	Function	AxM Port E1 PIN
1	n.c.	n.c.
2	n.c.	n.c.
3	n.c.	n.c.
4	Sin -,1 c/r	5
5	Cos +,1 c/r	3
6	Cos -,1 c/r	4
7	Resex-	10
8	KTY84 +	n.c.
9	KTY84 -	n.c.
10	Resex -	11
11	n.c.	n.c.
12	n.c.	n.c.
13	n.c.	n.c.
14	Sin +,1 c/r	2
15	n.c.	n.c.
16	PTC +	8
17	PTC -	1

Signal Connector M23-17 Pin
SinCos Encoder Type S1

PIN	Function	AxV Port S2 PIN	AxM Port E1 PIN
1	A +	1	7
2	A -	14	12
3	I + (index)	3	14
4	Sin –, 1 c/r	6	5
5	Cos +, 1 c/r	17	3
6	Cos -, 1 c/r	5	4
7	0 V	10	1
8	PTC +	11	8
9	PTC – / KTY –	13	1
10	+ Vcc (5Vdc)	25	6
11	B +	2	15
12	B -	15	13
13	I – (index –)	16	9
14	Sin +, 1 c/r	18	2
15	0V sense	n.c.	n.c.
16	+ Vcc sense	n.c.	n.c.
17	KTY +	n.c.	n.c.

Power (Size 303,305,307)



Wiring

Use shielded cable only, with shield cover- age > 85%
Power cables longer than 20 meters may Insert series induc-tance > 1mH.

Encoder

Phasing performed at factory, no further phasing is necessary if the motor is coupled to the drives of Physis.

Power Connector
M23 Size 1- 5+ PE

PIN	Description
1	Phase A
2	Phase B
3	GND
4	BR + (Option)
5	BR - (Option)
6	Phase C

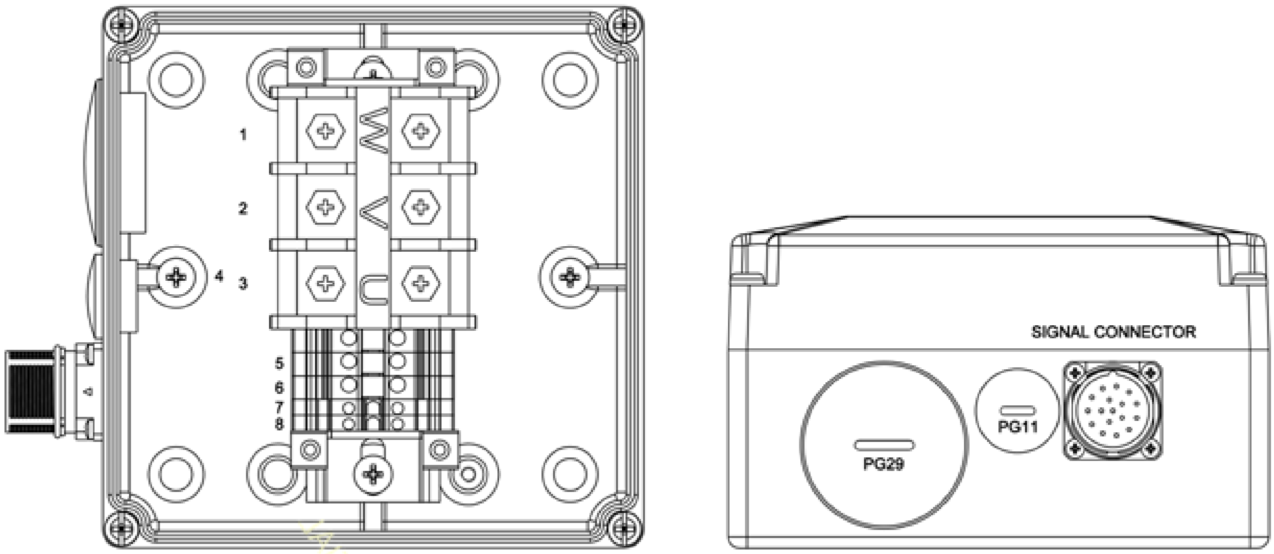
For motors with Inom <= 30 Arms

Power Connector
M40 Size 1,5-2+3+PE

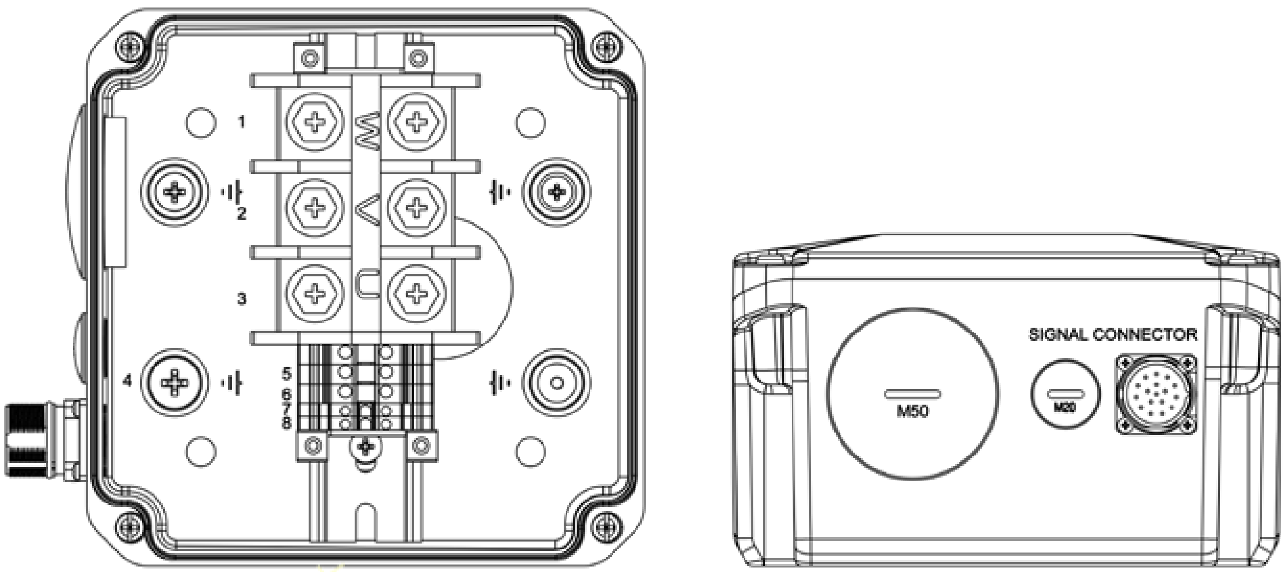
PIN	Description
U	Phase A
V	Phase B
W	Phase C
⏚	GND
+	BR + (Option)
–	BR - (Option)

For motors with Inom > 30 Arms

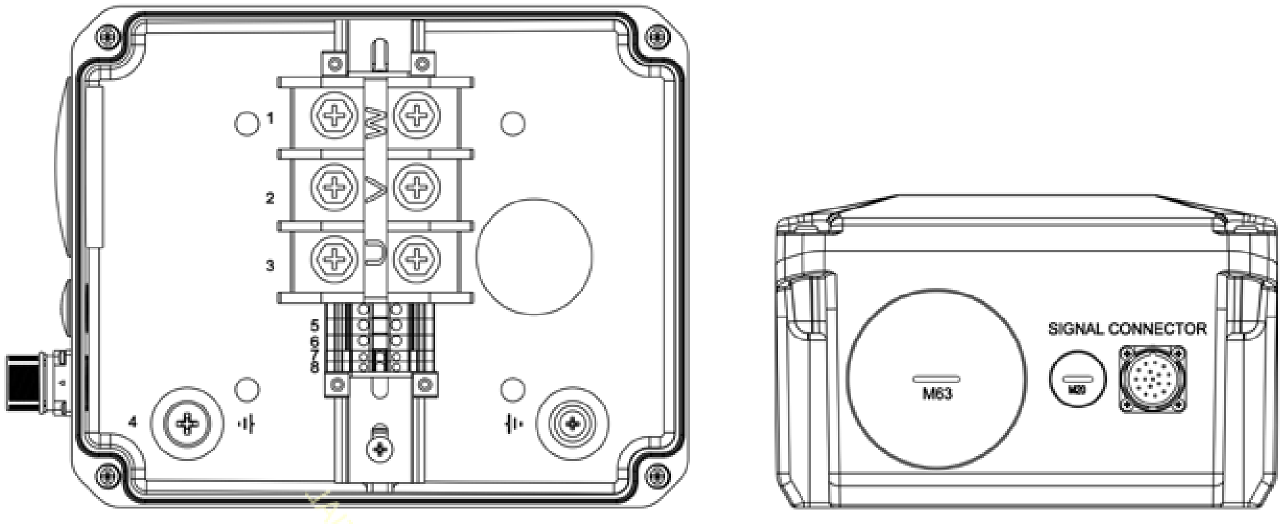
Power (Size 310,313,318)



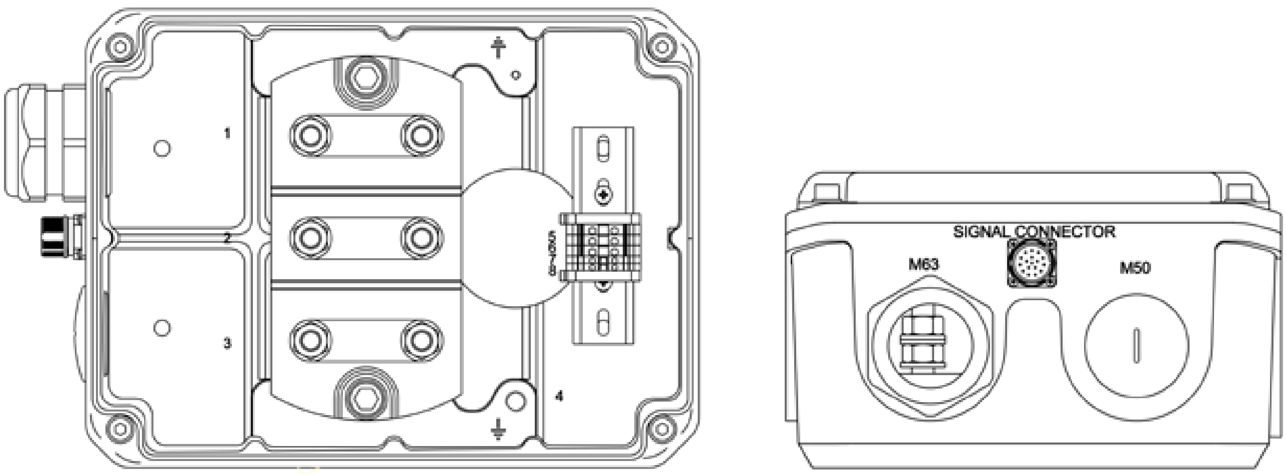
142×142
CONNECTION BOX 142×142



175×175
CONNECTION BOX 175×175



240×195
CONNECTION BOX 240×195



353×264
CONNECTION BOX 353×264

	Connection box configuration
1	Phase W
2	Phase V
3	Phase U
4	GND
5	Fan *
6	Fan *

	Connection box configuration
7	Brake (+ 24V) *
8	Brake (0V) *
9	Reserved for internal use*
10	Reserved for internal use*
11	Reserved for internal use*

(*) If present!

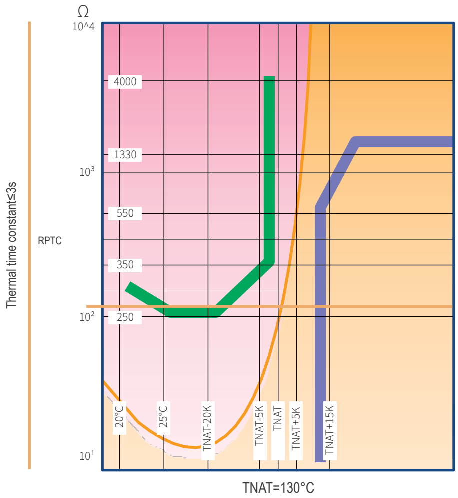
SAFETY BRAKE SPECIFICATION

Motor size		U303	U305	U307	U310	U313
Min. static torque（120°C）	Nm	4	9	32	140	300
Operate time	ms	15	25	40	100	300
Release time	ms	40	40	100	180	350
Release voltage	Vdc+/-10%	24				
Release voltage	Adc	0.58	0.75	1.08	2.3	1.7
Additional mass	kg	0.65	1	3	11	18
Inertia	mkgm^2	0.022	0.065	0.6	5.6	20
Torque derating of motor	%	9.5	8	8.6	6.5	4.8
Additional motor length	mm	30	33	50	65	80

Derating of nominal torque at 65□ΔT, for the shortest motor in the size, without voltage reduction after operate. For voltage reduction at 12V after operate, or forced cooling, derating < 2%.

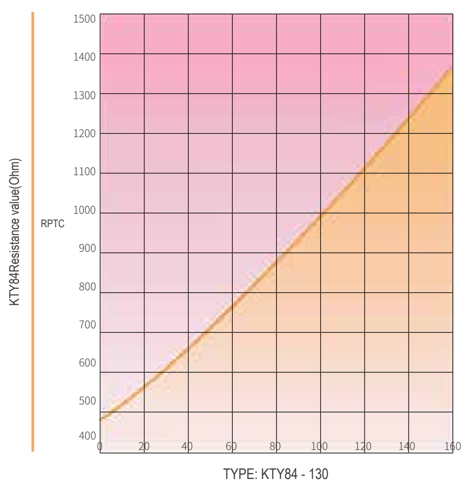
MOTOR & MACHINE PROTECTION

PTC Characteristics



Protection device (PTC) resistance vs. temperature Green and blue bands: limits of PTC tolerance values

KTY Thermal Sensor, option W



Temperature (C)

APPLICATION GUIDELINES

FORREWORD

AC brushless servo drive systems, based on rare earth PM magnets, provide the highest level of dynamic performance and torque density available today. The trend to replace conventional hydraulic, DC, stepper or inverter driven AC drives with brushless drives yields to a new level of system performance, in terms of shorter cycle times, higher productivity, improved accuracy coupled with shorter settling times, increased reliability and longer life. In order to achieve the steep performance improvement which is feasible with the new motors, however, a good understanding of the characteristics of this technology is a prerequisite. In fact, just replacing a conventional motor with a new technology drive on a machine not designed for high speed control could result in unexpected problems and at times even in a deterioration of the machine operability.

These application guidelines were designed to provide a basic tool for the optimization of new applications without prior knowledge of these new drives. For applications where the performance or the motor stress is perceived to be critical, or where a full optimization could be beneficial, contact the Factory.

DRIVE AND MECHANICAL LINKAGE SELECTION

The success of all drive applications dictate a careful selection of the complete system parameters. This in turn is based on a good understanding of the capabilities, which are very high but often not fully understood, of modern brushless drive systems. In fact, brushless drives are not motors, but complete, and complex, control systems; this results in more degrees of design freedom, and more parameters to select, than a conventional drive.

From a conceptual viewpoint, a high performance brushless motor is more similar to the membrane of a loudspeaker than to a standard induction motor. Just as a loudspeaker, the motor has a very short response time, limited inertia, and therefore it faithfully copies the control signal, whatever it may be.Just like a loudspeaker, the quality of the result depends more on the system parameters and drive conditions than on the motor itself.

The design choices facing the system designer are thus at the same time mechanical, electric and electronic, and such choices are interwoven, requiring an interdisciplinary approach.

In particular, all systems require two fundamental selections:

● Mechanical level: choice of the mechanical linkage, of the transmission ratio, of the motion type conversion, of the couplings and clutches;

● Electronic level: Feedback strategy, sensor type and number selection, sensor placement, amplifier type, synchronization and control bus.

The next chapters outline a few guidelines to help with the selection as a function of the application characteristics.

THE BRUSHLESS DRIVE: OPERATIONAL PRINCIPLES, CHARACTERISTICS AND LIMITATIONS

All brushless servo systems consist of an electronic drive, a servo motor, and at least one feedback sensor. All these component operate in a control loop: the drive accepts a reference from the outside world, and feeds current to the motor. The motor is a torquetransducer and applies torque to the load. The load reacts, or accelerates, according to its own characteristics. The sensor measures the load position, enabling the drive to compare the motion with the reference and to change the motor current to force the motion to copy the reference.

As an example, if constant speed is required, the drive would increase the current to the motor until the motor speed equals the reference. If the load is suddenly stepped up, the speed diminishes; the sensor detects the speed change and consequently the drive increases the motor torque to match the increased load and to return to the set speed. From this example, a few deductions are possible:

● The speed accuracy is virtually independent of load and motor, but depends on the quality of the sensor signal and the speed and control algorithm of the drive;

● The time lag between load perturbation and speed correction depends critically on the speed and resolution of the sensor and on the parameters of the electronic drive.

Modern brushless servo drives react to sensor signals with time lags in the order of a millisecond or less, providing for very high loop performance.

At this level, however, the propagation time through the mechanical linkages often becomes the prime limit to the system dynamics.

As an example, consider a system in which a servo motor drives a constant speed, large inertia load through a timing belt. The timing belt has a finite, and significant, elasticity. Analyzing a speed correction at the millisecond timescale, the following sequence is obtained:

1 The drive sets a current level through the motor which applies a torque almost instantly;

2 Initially, while the belt is being stretched, the load does not accelerate as fast as the motor;

3 Consequently, the motor reaches the set speed before the load; the sensor, on the motor, cuts the current and consequently the torque;

4 The increased tension of the belt slows the motor down forcing the drive to increase the current again, and a new cycle is initiated.

In this example, the system is oscillating; the motor torque pulsates and so does the load speed. The end result is noise, overheat and wear, none of which are clearly due to thewould likely disappear, increasing the feeling that the new drives are not adequate.

This simplistic understanding is erroneous. In fact, analyzing the above example:

1 The instability is due to the mismatch betwe- en the system reaction speed (high) and the mechanical propagation or reaction time (long); the motor reacts quicker than the time required by the system to settle through the new torque configuration;

2 The possible solutions are:

either to reduce the mechanical system reaction time, by stiffening the linkage and lowering the inertias, e.g. going direct drive or replacing the belt with a gearbox; or to lower the speed of the control system, giving up some control ban- dwidth which would have been achievable with the new technology.

The second solution, of course, sells away some quality, as it impairs the capability to react quickly to sudden load variations. In fact, older drives, which were anyway slower, compensated the lack of speed with a large motor inertia; on the other side, brushless motors, where inertia is minimized, need a good bandwidth to guarantee good rotation accuracy.

All this explains why brushless drives are rela- tively unforgiving of mechanical inaccuracies, backlash, keyways etc.;

For this reason, the best motors are manufactured with round shaft without keyway, for interference coupling with conical fittings (e.g. Ring-feder) and their shafts and flanges are machined to a reduced toleran- ce to remove the need for flexible couplings. If a coupling is needed, it needs to be torsionally stiff, such as the metallic bellows type.

In conclusion:

While traditional drive systems (DC of PM DC, inverter driven AC) would limit themselves, with their own inertia and response time, the performance of the application, the high level of the new brushless drives move the performance threshold above the mechanical limits of most traditional applications. As a result, the design verification of the mechanical system, and its upgrade to the new requirements, is more important than it used to be up until now. The success of a new application hinges critically on a good dynamical design of the whole system.

The success of a new application hinges criti- cally on a good dynamical design of the whole system.

A few rules can also be derived from the sim- ple examples above:

● The speed accuracy does not depend on the motor but on the sensor;

● The following speed, and therefore the ability to compensate for sudden load variations, depends critically on the stiffness and quality of the mechanical linkage.

The motor noise, which is often observed in poor or retrofit applications, is not due either to the motor or the drive but often enough to a “primeval” mechanical linkage. In fact,noise in due to the motor “hunting” for the correct tor- que; in this situation, the motor is likely to over- heat irrespectively of loading.

The same system might have worked well with an older drive, where the large motor inertia Lrolls overLall imperfections

The dynamic study of the application is funda- mental to the motor selection.

To this aim, this broad concept can be divided in two elements:

● Large signal bandwidth: this is the raw ability to deliver enough torque and speed, in sufficien- tly short time, to force the load on the desired trajectory. This depends exclusively on motor and load torque and inertia, and can be studied considering all components as infinitely stiff;

● Small signal bandwidth or control bandwidth, which relates to the inverse of the settling time. This is necessarily lower than any mechanical resonance frequency in the system; its inverse expresses the settling time of the control loop,i.e. the time required at the end of a motion command to settle in the target position within a required accuracy. Typically, it will be impossible to achieve a settling time better than 2-3 times the damping time of all the oscillations or reso- nances in the load and linkage.

As an example, consider the indexing axis of a high speed notching machine. The rate target is set at 10 strokes per second, i.e. the drive starts and stops the workpiece in a new position ten times per second. If the whole linkage (shaft, reducer, belts, ball screw etc) has a first reso- nance frequency of 50 Hz, the system will settle in about 50-60 msec, leaving only 40 msec for the move and the punch! This application is near impossible, as very high torque and accelera- tions would be needed. However, if the linkage is stiffened, by removing the belt, adopting a lar- ger screw, etc. so that the resonance frequency of the linkage is increased to 100 Hz, the settling time is reduced to 25-30 msec, the time availa- ble for the move is doubled, the required torque is halved, and the application is feasible.

OPTIMAL DRIVE DESIGN: THE TRANSMISSION RATIO, THE TYPE OF CONVERSION, THE COUPLINGS.

The size of brushless motor is determined by its output torque. In all applications, therefore, low motor speed yields to a low specific power and relatively low efficiency. On the other hand, brushless motors have no minimum speed (the speed depends only on the sensor used; there are applications whose axis speed is 1 revolution/ year); as a consequence, a high gearing is advisable only to minimize the motor mass (e.g. with electric traction) or to maximize the efficiency; it is often not advisable from the viewpoint of cost or dynamic performance. Wherever the motor is applied directly on the load, the control bandwidth is maximized because maximum transmission stiffness is achieved; consequently, these applications provide the best position or following accuracy with the shortest settling time.

Before starting with the selection of the right drive for a specific system, it is necessary to know the type of mechanical transmission which can be used. The most common transmissions are the following:

ROTATION-ROTATION CONVERSION

● Timing belt;

● Reducer with helical wheels and parallel axes;

● Cycloid and epicyclic reducer;

● Harmonic Drive™;

● Tangent screw reducer or Gleason gears.

ROTATIONAL-LINEAR MOTION CONVER-SION:

● Timing belts;

● Pinion-rack;

● Metallic band;

● Ball screw.

For any transmission system, the load parameters can be transferred to the motor axis as follows.

If n = transmission ratio (ratio between the motor and the load speed, rad/m in the case of a conversion from linear motion):

● Motor torque = Torque (thrust) to the load/n

● Motor speed = Load speed x n

● Load inertia reduced to the motor axis = iner- tia (or mass) of load/n2

Among all the listed transmissions, the first ones, which are the least expensive, are also the slowest; they result in low control bandwidth (lower than 10 Hz, using a high stiffness belt); for the same reason, it is important to avoid the ratios which make the load inertia transferred to the motor axis too much higher than the motor one. The belt transmission should not be applied for positioning applications with cycle times a lot shorter than one second.

Gear reducers are a good solution, provided that their angular backlash is considerably lower than the accuracy required by the system; the best type of reducer (the most expensive too) is the epicyclic; there are special series of cycloid and epicycloid reducers purpose designed for servo controls, where the angular backlash at the output shaft is limited to 1-3 arc minutes. Such reducers are the only ones that can be specified for applications with control bandwidth higher than 10 Hz. The “servo series” reducers are designed to be coupled directly to the motor with a stiff coupling device, without keyway.

The Harmonic Drive™ gearbox was specifically designed for positioning. It has limited size, high ratio and low backlash. The angular stiffness is not very good and the achievable control bandwidth is in the 10-30 Hz range. Because of its limited efficiency, it should be used for positioning only.

Tangent screw reducers fit in a class apart. These gears, although common and inexpensive, are not suitable for position control. The tangent screw, whose efficiency is based on an effective lubrication, display a low efficiency which drops dramatically at low speed, because below a critical speed the oil film collapses, efficiency drops and a quick wear ensues.

Wherever a rotary to linear conversion is required, ball screws provide a quality solution up to about 4 m/s, especially if they are driven directly by the motor. Direct drive with a low inertia motor generally avoids the need of a torque limiting clutch. For very long movements it is necessary to check the flexure and torsional stiffness of the screw, which may limit the system bandwidth. Longer movements are carried out with rack and pinion, which have always a significant backlash which generally results in limit cycling and motor noise. The traditional backlash elimination methods add stick-slip non linearity instead, and so do friction wheels, typically with similar limit cycling results.

Fast and accurate movements can be obtained with metallic tapes replacing the timing belts with superior stiffness. This technique, while not well known and therefore not standardized, is able to reach excellent performances in the control of small loads (a few kilos).

In general, however, linear motors rest as the best solution for high accuracy control of a linear motion.

In order to select the most suitable reduction method and transmission ratio for a specific application, it is useful to classify first the applications into two broad families:

1 Power services : the motor supplies power to a process (spindles, traction, winding, conve- ying etc.), where the dynamic performance is of marginal importance, the power controlled is significant, the motor cost is an important frac- tion of the system cost;

2 Position control :or high rate cycling (electro- nic camshaft), in which most of the energy is used to accelerate, to brake and to position objects in a short time and with a more or less high accuracy.

Traditionally, the two above mentioned categories are referred to respectively as spindle drives and axis drive.

In the first case, the dynamic properties are often not important, therefore simple speed reducers are acceptable and, as the power is often relevant, a mechanical transmission with a reduction stage is normally useful. In order to choose the best transmission ratio, consider that up to ~ 4000 RPM, the cost and size of the motor decrease in a quasi linear way with the increase of the transmission ratio. On the contrary, the cost of the transmission increases step by step according to the number of gear stages or pulleys; from an application cost viewpoint, the minimum overall cost can only be found in a few points, precisely:

- Either with a direct drive;
- Or at the speed corresponding to the maxi- mum ratio which is possible with just one reduc- tion stage;
- Or at the speed corresponding to the maxi- mum ratio which is possible with two reduction stages and so on.

The economic optimization, in this case, is carried out checking these points and adding the costs of the motor to that of the reducer. For all dynamic applications (axes) the situation is completely different. If the torque required in the drive cycle is dominated by theinertial torques both of the motor and of the load, for an increase in the reduction ratio there is a decrease in the impact of the load inertia and an increase of the impact of the motor inertia. Consequently, for an application where the required torque is exclusively inertial, the reduction ratio at which the load inertia, translated to the motor axis, equals the motor inertia (inertial match) is characterized by the minimum motor torque and therefore by the smallest motor.

For this reason, inertial matching was long considered the best gear ratio selection tool. Such rule, on the contrary, is just a useful indication. In fact, the minimum size motor, considering that the cost of a quality reducer can double the cost of the motor, does not correspond to the lowest cost application sizing. Furthermore, the level of quality and performance is determined a lot more by gear backlash and shaft elasticity than by the motor itself. Consequently, a ratio selection which accounts for the motor only is clearly flawed. A better set of rules is the following;

- Any transmission ratio higher than the inertial ratio is wrong;
- The best ratio is always lower or equal to the inertial one, and it is obtained considering the motor and reducer costs;
- High ratios always yield a narrower control bandwidth and a lower degree of accuracy (with a higher energetic consumption) than what can be obtained with lower ratios.

These considerations explain the current attempt to replace step down gears with direct drives.

Wherever the load inertia transferred to the motor shaft is more than a few times the motor inertia, however, care must be taken, because the motor inertia is not there to carry out a stabilizing action on the possible mechanical resonances or load disturbance on the system. As a consequence, a high control bandwidth needs to be achieved, to compensate electronically what is not obtained by inertia alone; to do this, the mechanical linkage in these applications needs to be of high quality, stiff and without backlash (no keyways!).

From an analytical viewpoint, extreme direct drives mandate a check on the torsional stiffness of the system. The torsional stiffness of the motor shaft needs to be considered as well; this, although minimized in the ULTRACT II design by means of large shafts, is significant for the long and thin motors. In fact, the ULTRACT II range was purposefully overlapped, so that the same torque can be obtained either with a long and narrow motor or with a short and stocky one. For this reason:

- Long motors have a minimum moment of iner- tia; they are intended for high acceleration with low inertia loads;
- Stocky motors have a maximum torsional stiffness; they are intended for high inertia loads, where the motor inertia is small compared to the load.

As a reference, the torsional stiffness of a shaft whose diameter is D and whose length is L, made of steel, is:

$$S_m = \frac{\pi}{32} \cdot \frac{D^4}{L} \cdot 78.5 \cdot 10^9 \cdot \frac{N}{m^2}$$

While the frequency of torsional resonance of a load with inertia Jl connected to an axis with torsional stiffness Sm is:

$$F_1 = \frac{1}{(2 \cdot \pi)} \cdot \sqrt{\frac{S_m}{Jl}}$$

In all applications with large inertia and short settling time, a check on the first torsiona resonance frequency is highly advisable.

CONTROL STRATEGY SELECTION

All drive system can be configured according to three main control strategies:

- Torque control (the speed depends on the load);
- Speed control (the torque depends on the load);
- Position control (the torque depends on the load)

The first strategy is the easiest to implement and can be used when it is necessary to control a force or a pull (winders/unwinders, textile, tape/paper processing, etc.). Torque control is native, or intrinsic to the brushless motors, which are always current controlled. For this reason, torque control has minimum sensor requirement (just commutation or Hall sensor), is very fast (control bandwidth >300 Hz) and intrinsically stable and robust irrespective of load. Torque controlled drives are simple amplifiers which require no calibration or adjustment whatsoever and are therefore the simplest controllers. Accuracy is not too high due to motor friction, cogging, ripple, sensor drift; typically it can range in the 5-10% area.

In the multi-axes applications with very fast and modern NCs or controller boards, where multiple axes must be linked (multiple electric gears and cams), or with adaptive control or with variable parameters, a simple and effective strategy is to set the drives in torque control mode and to assign the other loops to the NC. In this way the encoders are fed to the NC, all drives are equal, intrinsically stable and need no programming; all the system and control parameters (offsets, PID values, etc) are lumped in the NC or control PC. The drives can be replaced without programming and no download of parameters is necessary. The control signal to the drives is a simple differential torque reference, offset insensitive. The encoders are fed directly to the NC; the drive only reads the commutation system. This simple and elegant approach provides very good performance in multiple systems without incurring the cost and complexity of high speed field buses, which are anyway rather limited in the number of axes and in the achievable speed. On the down side, it downloads on the NC or PC the processing of the encoders, which could be cumbersome where very high resolution is needed.

Speed control is the most traditional strategy. It usually embodies an integration term so that the speed error is limited to the system offsets. In the digital drives, the speed loop is derived from the space loop (see next).

Position or space control in servo amplifiers is carried out only by digital drives (AX-V). In this way, the steady state position and speed following error is limited to a few points of the sensor, that is in the case of an encoder with 4096 pulse/revolutions, 1/16,000 of a revolution. Position loop capability, inside or outside the drive, is necessary to synchronize several axes (electrical axis or electronic cam).

CHECK OF THE DRIVE AND MOTOR SIZING

After selecting the motor and the transmission, a check of the correct sizing of motor and drive is required. Such check is easy for applications where speed and load are quite steady or which vary on a timescale which is long with respect to the time constant of the motor (or of the electronics). In this case, it is only necessary to check for the maximum load to be within the specified limits of the motor and the electronics.

1 Trace the speed/time diagram of the cycle, considering that the acquisition of a precise position or speed requires, apart from the time determined by the limits on the speed and acceleration of the system, also a settling time equal to 2-3 times the inverse of the system control bandwidth;

2 Transfer the inertia and the loads of the system to the motor shaft;

3 Calculate the cycle of the accelerations and the inertial torques [acceleration x (motor inertia + load inertia transferred to the motor shaft)], checking also the inertia of couplings, clutches, transmission devices;

4 Add the load on the motor axis to the inertial torque and derive a torque/time diagram in the cycle;

5 By inspection of the torque vs. time diagram obtain the root mean square value of the torque: e.g. divide the cycle into time segments t1,t2....tn inside of which the torque is constant; if the torque values in each segment of the cycle are respectively C1,C2...Cn, the root mean square torque in the cycle is:

$$\text{Ceff} = \sqrt{\frac{C_1^2 \cdot t_1 + C_2^2 \cdot t_2 + \cdots + C_n^2 \cdot t_n}{(t_1 + t_2 + \cdots + t_n)}}$$

6 Calculate the root mean square or effective speed in the cycle ωeff with the same formula;

7 Calculate the mean torque in the cycle Cave;

8 Calculate the maximum duration time of the maximum torque in the cycle tcmax;

9 Calculate the required torque at the maxi-mum speed Cwmax;

10 Calculate the maximum torque Cpk.

The data thus obtained needs to be compared with the motor and electronic limits to validate the application.

MOTOR SIZE VERIFICATION

Brushless motors are excellent torque transducers, linear to a peak torque several times the nominal. As a consequence, the obtainable peak torque is usually determined only by the choice of the electronic drive. The correct sizing of the motor is thermal and electric; the optimally sized motor is the one which, on the worst load, settles at the correct temperature rise, usually 40-50°C above the room temperature.

The complete check of the selection of the proper motor is carried out in three steps:

- Control of the peak or demagnetizing torque;
- Thermal dimensioning;
- Electric, or winding, dimensioning.

1 Demagnetization current check

Compare the peak current , expressed by:

$$I_{pk} = \frac{C_{pk}}{Kt} \cdot \sqrt{2}$$

With the motor demagnetization current, considering that the motor demagnetization current increases as the temperature decreases. This check is usually meaningful for small motors only.

2 Temperature rise check

Preliminarily, check that the point Ceff, ωeff is within in the continuous operation area (S1) of the chosen motor. More accurately, the temperature rise of the motor can be predicted by:

$$\Delta_{mot} = \frac{65}{L_n} \cdot \left[\left(\frac{C_{eff}}{T_n} \right)^2 \cdot L_n + \left(\frac{w_{eff}}{w_n} \right)^2 \cdot L_o \right]$$

Where Ln represents the nominal losses of the motor with temperature rise of 65°C.

If the predicted temperature rise is higher than the motor maximum or acceptable temperature rise, it is necessary to select a larger motor.

NOTE: the excessive temperature rise is generally the only good reason for the use of a larger motor.

3 Electric sizing check

At the maximum speed, the voltage required by the motor to supply the required torque must be lower or equal to what is available from the drive, for the minimum mains supply voltage which is specified for full specification operation (usually 90% of the nominal voltage).

If Emin is the voltage value which can be supplied by the electronic power supply at the minimum supply voltage, it is necessary to check that:

$$V_{max} = \sqrt{3} \cdot \sqrt{\left(Ke \cdot \frac{w_{pk}}{\sqrt{3}} + \frac{R_w}{2} \cdot \frac{C_{wmax}}{Kt} \right)^2 + \left(\frac{C_{wmax}}{Kt} \cdot \frac{PN}{4} \cdot W_{pk} \cdot L_w \right)^2} \leq E_{min}$$

If this condition is not verified, it is necessary to choose a motor with a higher speed winding; this will of course also require a higher drive current.

CONFORMITY DECLARATION

DECLARATION OF CONFORMITY TO THE LOW VOLTAGE DIRECTIVE

Operating instructions in compliance with EC directives
Declaration of conformity to the Low Voltage Directive
Recycling: all packages and packing tapes used in the ULTRACT III packing are recyclable

GENERAL: THE EC DIRECTIVES

The EC Directives are issued by the European Council and are intended for the determination of common technical requirements and certification procedures within the European Community. The Directives establish guidelines that are or will be converted in national laws in the member states. The certification issued in any state member guarantees free access in all the European Community without further testing.
The conformity of a product or component is certified by the CE marking on the product. In the case of variable speed drives, or PDS, motors are considered components; the only directive which applies to components is the Low Voltage Directive 73/23/CEE amended by 93/68/CEE. The CE mark on the Ultract motors is referred to compliance to the LVD.
As for the EMCD, compliance is required at system level and not at compo-nent level, as EMI emission depends critically on system composition and wiring. In order to help the user to comply with the EMD directive, the Ultract motors have been tested and compliance was verified in a ìCE verified typical system, driven by a AX4 series drive. The system is described in the AX4 product documentation,

THE LOW VOLTAGE DIRECTIVE

The LVD applies to all electrical components operating between 50 and 1000 Vac or 75 to 1500 V DC in under normal ambient conditions. Explosive atmospheres or passenger lifts are excepted.
The objective of the low voltage directive is to ensure that only that electrical equipment that does not endanger the safety of humans or the preservation of material assets is marketed.

SAFETY INFORMATION

Only qualified personnel are permitted to transport, install or operate the units (IEC 60364).
A defective installation or operation of the units with safety covers open may lead to personal or material danger;The motors may have live, hot and rotating parts inside during operation, even after the mains voltage has been disconnected
The motors use strong permanent magnets; the rotor should never be remo-ved without proper safety precautions.

APPLICATION AS DIRECTED

The Ultract III ervomotors are intended for the powering of industrial equip- ment.
The entire drive systems may only be commissioned after compliance with the EMC directive 89/336/CEE and the machinery directive 98/37/CEE has been verified.
The motors are conformal to LVD 73/23/CEE. The technical data stated in the nameplate and in the product documenta- tion must be observed.

INSTALLATION

The units must be installed and cooled according to the product documen- tation.Ensure that the motors were not damaged during transport so as to impair user safety.When the unit is operated, the valid national regulations for the prevention of accidents must be observed.The electrical installation must comply with the applicable regulations (cable sections, fuses, protections).When using current operated protective devices, please note that most drive are equipped with an internal mains rectifier, which can lead to a potential DC leakage current, which may impair the correct operation of some current operated protective device. Protective devices which are insensitive to DC fault currents must be specified. Additionally, EMC filters inside most drive create a leakage current to ground which must be considered while selecting the protective devices.
The opportune value inductances * 1 mH have to be applied when welding cables between driving and motor have length superior than 20 meters. Please note that, irrespective of the CE marking on the motors, the confor- mity of the drive system to the EMC directive is the responsibility of the manufacturer of the system or machine. Useful recommendations on wiring and filtering, along with a CE compliance typical system, are described in the product documentation or can be obtained by the manufacturer.
EC EX “conformità EC” Declaration of Conformityfor the purpose of the EC Low Voltage Directive 73/23/CEE.
The ULTRACT brushless servo motor series were designed, manufactured and tested in conformity to the EC Low Voltage Directive 73/23/CEE under the sole responsibility of:Ningbo Physis Technology Co., Ltd.

The considered standards are:
IEC 72/1, 34/1, 34/5, 34/11
EN 60034-1 + VAR A1 + VAR A2 EN 60529
EN 50262 CEE 73/23

Notes