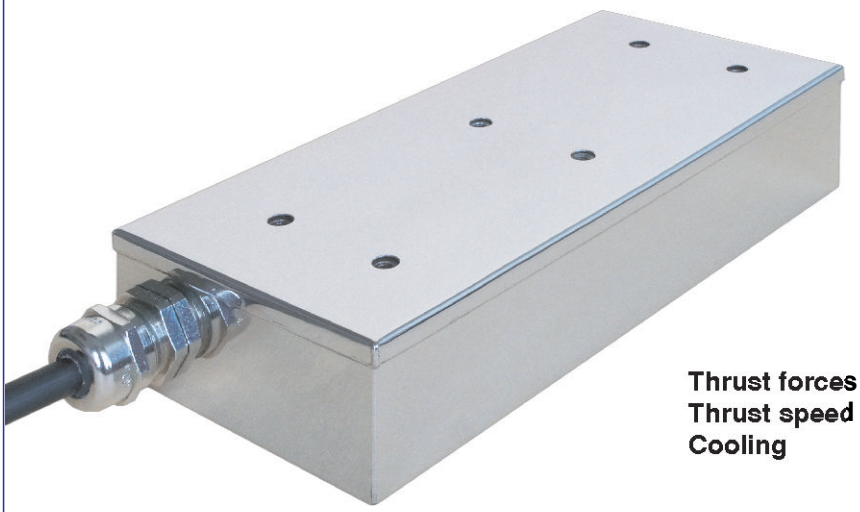
Synchronous linear motors of series L7S / L7SK

flat linear motors for dynamic drives



Thrust forces	**30 - 7 500 N**
Thrust speed	**0 - 20 ms^{-1}**
Cooling	**IC40**
	IC3W7

Technical data

The L7S/L7SK series of synchronous linear motors is characterized with an increased degree of protection IP67. The increased degree of protection is ensured by encapsulating the active part of the motor with winding (primary part) into a metal frame. The primary part of the linear motor with a vacuum poured winding is located in a stainless sheet metal housing. The advantage of this design is strengthening the motor against splashed liquids and long service life of the drive. The L7S series can be equipped alternatively with integrated water cooling which ensures more efficient removal of losses and guarantees a considerable improvement in the motor parameters.

In the case of the L7S series of linear motors, it is possible to choose a winding with a suitable force constant out of many variants. The winding can be chosen according to customer's wishes for the required rated speed of the motor or for the rated current from the frequency converter.

Cooling of primary parts

Series L7S : IC40 (i.e. air cooling by motor surface)
Series L7SK: ICW37 (i.e. water cooling by integrated cooler)

Operating conditions

Linear motors are designed for being used in the environment protected against weather influences defined in ČSN EN 60721-3-3:

ambient temperature +5 ^{0}C to +40 ^{0}C
relative humidity of air 5 % to 95 %;
altitude above sea level up to 1000 m;

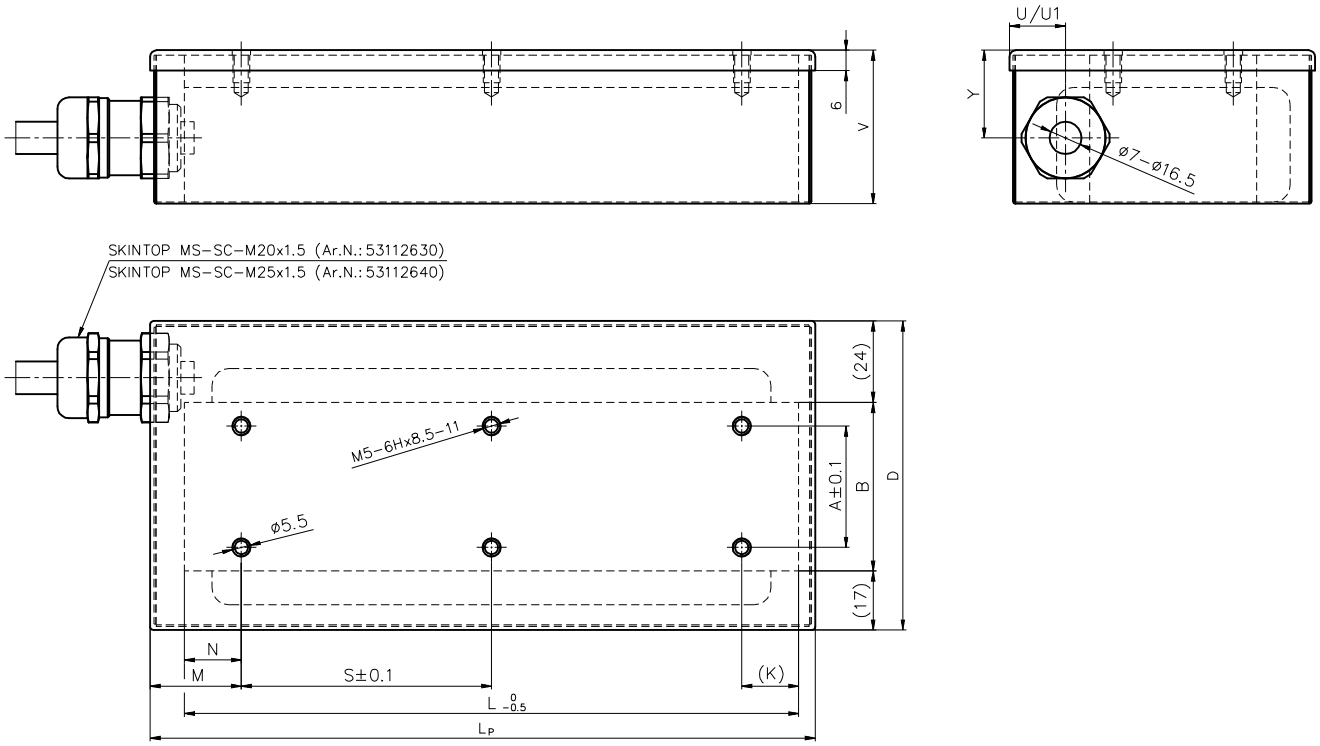
Cooling of the motors is described through thermal resistance

Air cooling IC40: in technical data declared values of thermal resistance $R_{TH(NC)}$ are corresponding to air cooling by the motor surface and additional cooling area by speed aprox. 0,5 m/s - 1 m/s. The additional cooling area is represented by an aluminium plate with the thickness of 10 mm and the cooling surface area three times as large as mechanical interface of the primary part. This addtional cooling plate serves for simulating heat removal into the surface of the driven equipment.
Water cooling ICW37: in technical data declared values of thermal resistance $R_{TH(WC)}$ are corresponding to water cooling through the water with inlet temperature from +5^{0}C to +25^{0}C with rated water flow.

Other technical l data

Degree of protection of the motor: A high degree of protection against contact with live parts is reached by embedding the whole winding and the primary motor circuit into protective sealing compound. As the motors are usually delivered as built-in ones, protection against contact with moving parts cannot be ensured.
Thermal insulation class F , maximum temperature rise of the winding is 105K.
The winding of the standard motor design is three-phase one, star-connected, without neutral point led out.

Connection of the motor to the converter: The winding outlet is made as a standard by flexible cable enabling also supply of the moving primary part. By request the motor winding can be led out to a connector determined by the customer.
Surface protection: Surface protection is made by black varnish paint. By request of the customer also a paint for food industry or another shade can be used.

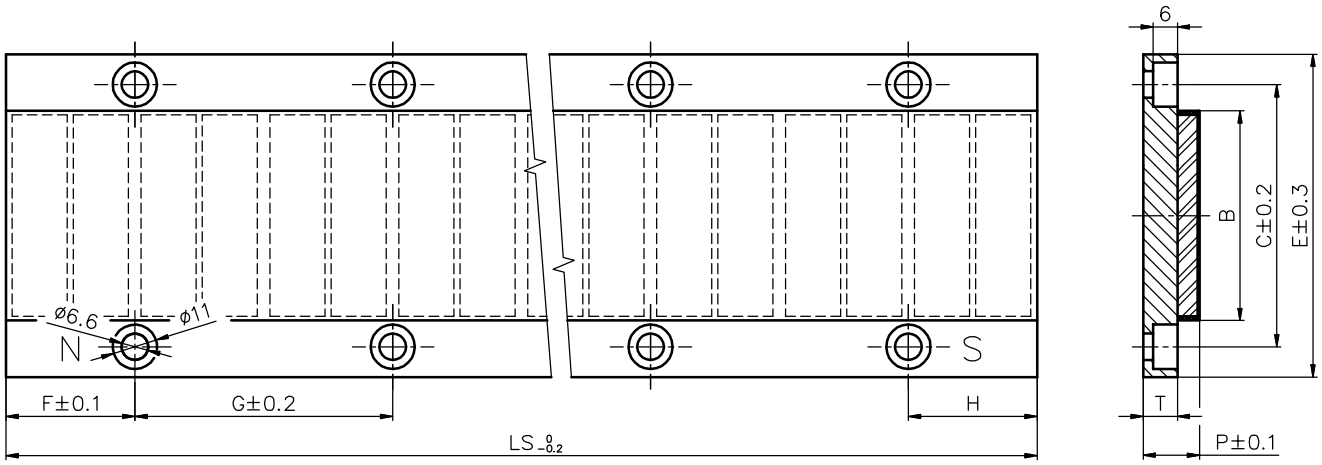


L7S - Primary parts

Type	A [mm]	B [mm]	D [mm]	L [mm]	L_p [mm]	K [mm]	M [mm]	N [mm]	S [mm]	V [mm]	U/U1 [mm]	Y [mm]	m [kg]
L7S030P-1215	1x16	30	71	184,2	199	17,1	27	17,1	75	44,9	16/19	26	3
L7S030P-2415				360	375	30	40	30					5,8
L7S030P-3615				535,8	551	42,9	53	42,9					8,76
L7S030P-4815				711,6	727	18,3	28,5	18,3					12
L7S050P-1215	1x36	50	91	184,2	199	17,1	27	17,1	75	44,9	16/19	26	4,3
L7S050P-2415				360	375	30	40	30					8,3
L7S050P-3615				535,8	551	42,9	53	42,9					12,5
L7S050P-4815				711,6	727	18,3	28,5	18,3					16,7
L7S075P-1215	2x32	75	116	184,2	199	17,1	27	17,1	75	44,9	16/19	26	6
L7S075P-2415				360	375	30	40	30					11,5
L7S075P-3615				535,8	551	42,9	53	42,9					17,3
L7S075P-4815				711,6	727	18,3	28,5	18,3					23
L7S100P-1215	2x36	100	141	184,2	199	17,1	27	17,1	75	44,9	16/19	26	7,8
L7S100P-2415				360	375	30	40	30					15
L7S100P-3615				535,8	551	42,9	53	42,9					22,7
L7S100P-4815				711,6	727	18,3	28,5	18,3					30
L7S150P-1215	4x32	150	191	184,2	199	17,1	27	17,1	75	46,9	16/19	26	11,4
L7S150P-2415				360	375	30	40	30					21,6
L7S150P-3615				535,8	551	42,9	53	42,9					32,4
L7S150P-4815				711,6	727	18,3	28,5	18,3					43,2

Thermal protection

The winding of the standard motor design is protected by a thermal sensor (break contact) being located in end windings and reacting at the temperature of 125 ^{0}C.
By request of the customer also PTC, KTY 83-110, KTY 84-130 or Pt100 thermal protection.



L7S(K) - Secondary parts

Type	B [mm]	C [mm]	E [mm]	F [mm]	G [mm]	H [mm]	Ls [mm]	P [mm]	T [mm]	2p	m [kg]
L7S030S-0416	30	45	60	32	-	32	64	14	8,5	4	0,34
L7S030S-0816					64		128			8	0,68
L7S030S-1616					3x64		256			16	1,36
L7S030S-3216					7x64		512			32	2,72
L7S030S-6416					15x64		1024			64	5,43
L7S050S-0416	50	65	80	32	-	32	64	14	8,5	4	0,47
L7S050S-0816					64		128			8	0,95
L7S050S-1616					3x64		256			16	1,89
L7S050S-3216					7x64		512			32	3,8
L7S050S-6416					15x64		1024			64	7,58
L7S075S-0416	75	90	105	32	-	32	64	14	8,5	4	0,64
L7S075S-0816					64		128			8	1,28
L7S075S-1616					3x64		256			16	2,56
L7S075S-3216					7x64		512			32	5,12
L7S075S-6416					15x64		1024			64	10,24
L7S100S-0416	100	115	130	32	-	32	64	14	8,5	4	0,8
L7S100S-0816					64		128			8	1,6
L7S100S-1616					3x64		256			16	3,2
L7S100S-3216					7x64		512			32	6,4
L7S100S-6416					15x64		1024			64	12,8
L7S150S-0416	150	165	180	32	-	32	64	14	8,5	4	1,31
L7S150S-0816					64		128			8	2,62
L7S150S-1616					3x64		256			16	5,25
L7S150S-3216					7x64		512			32	10,5
L7S150S-6416					15x64		1024			64	21

Rules for transport and storage

Products in store rooms must be designated with a warning plate (ATTENTION! STRONG MAGNETS!).

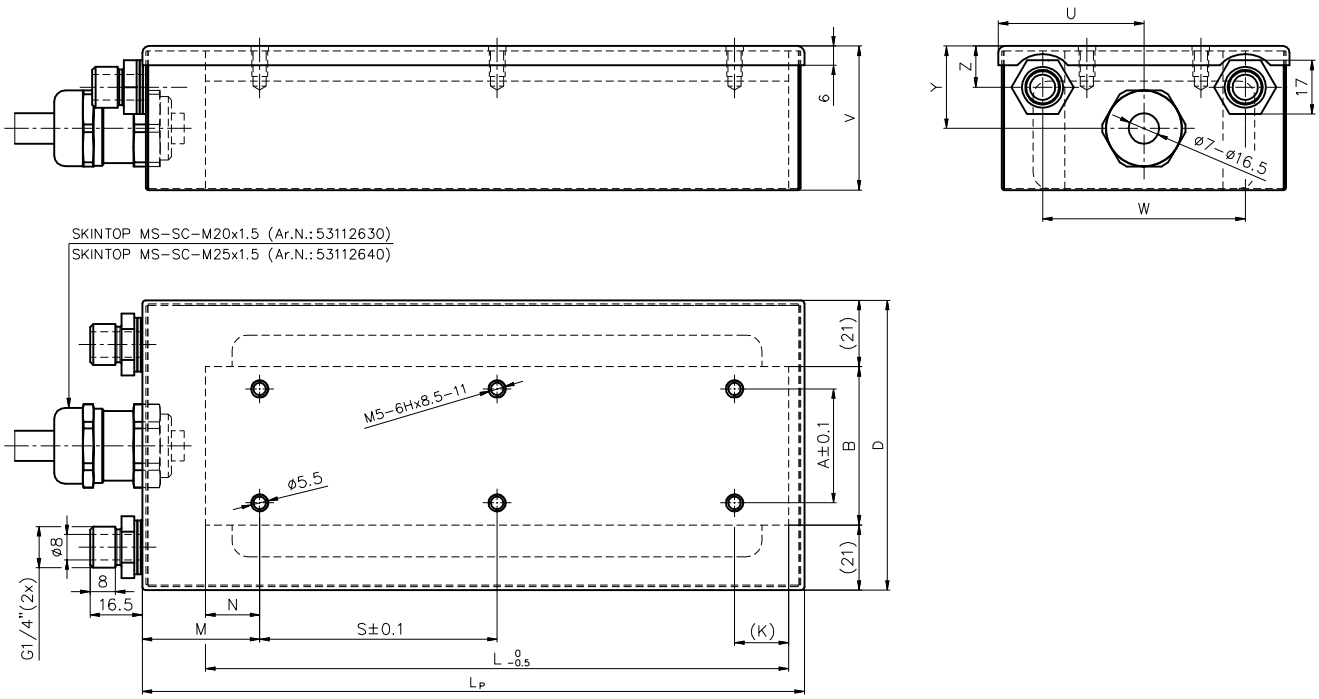
Products must never be stored without a cover, always a special non-magnetic packing with the electromagnetic gap of 25 mm must be used.

Warning plates must be read and complied with.

Store rooms must be kept dry.

Products must not be stored at high temperatures.

In the course of transporting the machines or their parts with built-in primary and secondary parts their mutual moving must be prevented.



L7SK - Primary parts

Type	A [mm]	B [mm]	D [mm]	L [mm]	L_p [mm]	K [mm]	M [mm]	N [mm]	S [mm]	U [mm]	V [mm]	W [mm]	Z [mm]	m [kg]
L7SK050P-1215	1x36	50	92	184,2	209	37	37	17,1	75	46	44,9	64	13	4,2
L7SK050P-2415				360	385	50	50	30						8
L7SK050P-3615				535,8	561	63	63	42,9						12,1
L7SK050P-4815				711,6	737	38,3	38,3	18,3						16,2
L7SK075P-1215	2x32	75	117	184,2	209	37	37	17,1	75	58,5	44,9	89	13	5,8
L7SK075P-2415				360	385	50	50	30						11,2
L7SK075P-3615				535,8	561	63	63	42,9						16,8
L7SK075P-4815				711,6	737	38,3	38,3	18,3						22,4
L7SK100P-1215	2x36	100	142	184,2	209	37	37	17,1	75	60	44,9	114	13	7,6
L7SK100P-2415				360	385	50	50	30						14,6
L7SK100P-3615				535,8	561	63	63	42,9						22,1
L7SK100P-4815				711,6	737	38,3	38,3	18,3						29,3
L7SK150P-1215	4x32	150	192	184,2	209	37	37	17,1	75	60	46,9	164	15	11,1
L7SK150P-2415				360	385	50	50	30						21
L7SK150P-3615				535,8	561	63	63	42,9						31,8
L7SK150P-4815				711,6	737	38,3	38,3	18,3						42

For water cooling, there is necessary to use treated water without mechanical impurities. The recommended water hardness is max. 0,7 mmol/l. If necessary, water softeners are to be used. In order to prevent corrosion of aluminium, we recommend to use inhibitors. The ratio of the inhibitor to water should not exceed 25% to 75%. Otherwise, cooling performance may be reduced. The recommended cooling water acidity is 6,5 pH to 7,5 pH. The inlet water temperature is +5 °C to +25 °C. The maximum quantity of cooling water is 5 l/min at the pressure drop of 0,1 MPa. The cooling system is tested at the maximum pressure of 1 MPa. Minimal water flow or minimal pressure difference is given in data sheet of appropriate motor. Furthermore we recommend the usage of a detector for the water for the water-pressure and the rate of water flow in order to prevent the unlike event of an emergency shut down of the machine due to an overheated motor. The whole water cooling circuit should be examined whether there are materials which are in touch with the cooling liquid and 1) have a certain voltage drop according to the electro-chemical voltage order and 2) and electrically connected so that an electro galvanizing process can take place. In this case the worser metal will be destroyed and enriched at the better metal.

Technical data
U_{DC}=560V

TYPE	F peak	I peak	v 0	F 1	I 1	v 1	f 1	dP 1	F nc1	I nc1	v nc1	dP nc1	F A	I ULT	k F	k E
	N	A	m/s	N	A	m/s	Hz	W	N	A	m/s	W	N	A	N/A	Vsm-1
L7S030P-1215-HH	380	8,0	8,6	285	5,8	7,1	200	370	128	2,4	7,8	65	900	10	60	35
L7S030P-2415-HH	760	16,0	8,6	570	11,5	7,1	200	737	255	4,7	7,8	127	1750	20	60	35
L7S030P-3615-HH	1140	25,0	8,6	855	17,3	7,1	200	1100	383	7,1	7,8	191	2580	30	60	35
L7S050P-1215-JH	618	7,8	5,1	475	5,7	4,2	118	498	238	2,6	4,6	108	1480	10	100	58
L7S050P-2415-JH	1235	15,6	5,1	950	11,4	4,2	118	990	476	5,3	4,6	216	2880	20	100	58
L7S050P-3615-JH	1853	23,5	5,1	1425	17,2	4,2	118	1493	714	8,0	4,6	324	4300	30	100	58
L7S050P-4815-JH	2470	31,2	5,1	1900	22,9	4,2	118	1998	952	10,5	4,6	432	5700	40	100	58
L7S075P-1215-NH	950	8,0	3,7	713	5,7	2,8	79	660	374	2,8	3,1	157	2200	10	150	87
L7S075P-2415-NH	1900	16,0	3,7	1425	11,5	2,8	79	1320	748	5,6	3,1	315	4320	20	150	87
L7S075P-3615-NH	2850	24,0	3,7	2138	17,2	2,8	79	1980	1122	8,5	3,1	473	6430	30	150	87
L7S075P-4815-NH	3800	32,0	3,7	2850	23,0	2,8	79	2638	1496	11,2	3,1	627	8540	40	150	87
L7S100P-1215-PH	1259	7,1	2,2	950	5,1	1,9	53	820	510	2,5	2,0	203	2950	9	200	116
L7S100P-2415-PH	2518	14,2	2,2	1900	10,3	1,9	53	1640	1020	5,1	2,0	408	5760	18	200	116
L7S100P-3615-PH	3772	21,3	2,2	2850	15,4	1,9	53	2456	1530	7,6	2,0	610	8570	27	200	116
L7S100P-4815-PH	5035	28,4	2,2	3800	20,5	1,9	53	3277	2040	10,2	2,0	814	11380	35	200	116
L7S150P-1215-SH	1900	7,7	1,7	1425	5,7	1,4	39	1144	765	2,8	1,5	285	4420	10	300	173
L7S150P-2415-SH	3705	15,4	1,7	2850	11,5	1,4	39	2288	1530	5,7	1,5	569	8640	19	300	173
L7S150P-3615-SH	5510	23,1	1,7	4275	17,2	1,4	39	3432	2295	8,5	1,5	854	12860	29	300	173
L7S150P-4815-SH	7315	30,8	1,7	5700	22,9	1,4	39	4576	3060	11,4	1,5	1139	17000	39	300	173

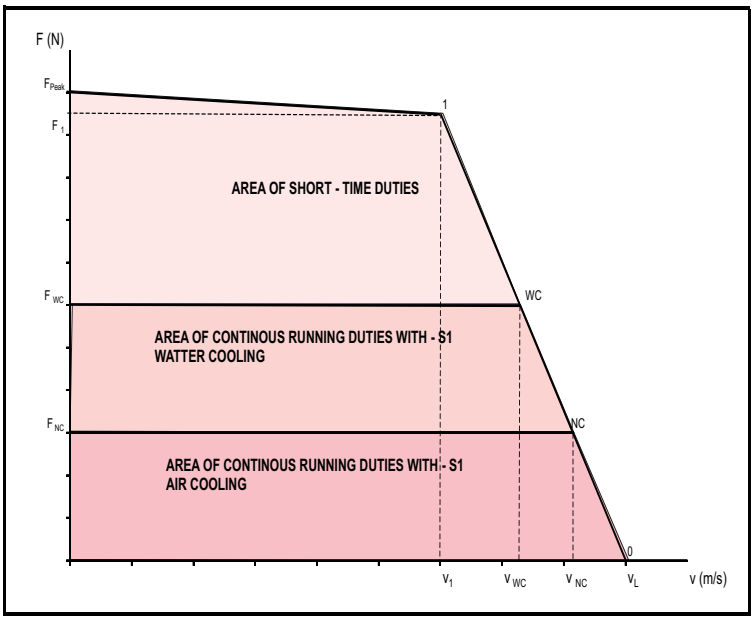
Note: Possibility choice of winding with other types of force constant kF according to type key (technical data on demande).
Insulation systém of winding for voltage of intermediate circuit 330VDC or 560VDC

Technical data
U_{DC}=560V

TYPE	F peak	I peak	v 0	F 1	I 1	v 1	f 1	dP 1	F wc1	I wc1	v wc1	dP wc1	F A	I ULT	k F	k E
	N	A	m/s	N	A	m/s	Hz	W	N	A	m/s	W	N	A	N/A	Vsm-1
L7SK050P-1215-IH	618	8,6	5,7	475	6,4	4,7	132	552	475	6,4	4,7	552	1480	11	90	52
L7SK050P-2415-IH	1235	17,2	5,7	950	12,8	4,7	132	1104	950	12,8	4,7	1104	2880	22	90	52
L7SK050P-3615-IH	1853	25,8	5,7	1425	19,2	4,7	132	1656	1425	19,2	4,7	1656	4300	33	90	52
L7SK050P-4815-IH	2470	34,4	5,7	1900	25,6	4,7	132	2208	1900	25,6	4,7	2208	5700	44	90	52
L7SK075P-1215-LH	950	8,9	4,2	713	6,4	3,1	87	730	713	6,4	3,1	730	2200	11	120	69
L7SK075P-2415-LH	1900	17,7	4,2	1425	12,7	3,1	87	1460	1425	12,8	3,1	1460	4320	22	120	69
L7SK075P-3615-LH	2850	26,6	4,2	2138	19,1	3,1	87	2190	2138	19,2	3,1	2190	6430	33	120	69
L7SK075P-4815-LH	3800	35,4	4,2	2850	25,4	3,1	87	2920	2850	25,6	3,1	2920	8540	44	120	69
L7SK100P-1215-NH	1259	8,8	2,8	950	6,4	1,9	53	911	950	6,4	1,9	911	2950	11	150	87
L7SK100P-2415-NH	2518	17,6	2,8	1900	12,8	1,9	53	1822	1900	12,8	1,9	1822	5760	22	150	87
L7SK100P-3615-NH	3772	26,4	2,8	2850	19,2	1,9	53	2733	2850	19,2	1,9	2733	8570	33	150	87
L7SK100P-4815-NH	5035	35,2	2,8	3800	25,6	1,9	53	3644	3800	25,6	1,9	3644	11380	44	150	87
L7SK150P-1215-RH	1900	8,7	1,8	1425	6,4	1,5	42	1270	1425	6,4	1,5	1270	4420	11	250	144
L7SK150P-2415-RH	3705	17,3	1,8	2850	12,8	1,5	42	2540	2850	12,8	1,5	2540	8640	22	250	144
L7SK150P-3615-RH	5510	26,0	1,8	4275	19,2	1,5	42	3810	4275	19,2	1,5	3810	12860	33	250	144
L7SK150P-4815-RH	7315	34,6	1,8	5700	25,6	1,5	42	5080	5700	25,6	1,5	5080	17000	44	250	144

Note: Possibility choice of winding with other types of force constant kF according to type key (technical data on demande).
Insulation systém of winding for voltage of intermediate circuit 330VDC or 560VDC

DEFINITION PARAMETERS



Power characteristic of the linear motor

Linear motors are generally designed in the same way as servomotors rather for dynamic processes with a wide range of speed and with a variable load than for the continuous running duty S1 with constant load and constant speed. That is why these motors can be loaded with substantially higher forces (currents) than the rated ones, provided that their average r.m.s. value does not exceed the rated values for the continuous running duty S1.The utilizable working area from the point of view of the linear motor can be seen from the power characteristic.

F_{peak} (N)	highest force developed by the motor
I_{peak} (A)	current corresponding to the force F_{peak}
F_1 (N)	maximal force corresponding to current I_1 and speed v_1
v_1 (m/s)	speed of motor corrsponding to current I_1 and speed F_1
I_1 (A)	max. short-time allowable current (RMS value) cor. to force F_1
F_{NC} (N)	force being developed by the motor continuously at the air cooling corresponding to $R_{TH\ (NC)}$
F_{WC} (N)	force being developed by the motor continuously at the watter cooling corresponding to $R_{TH\ (WC)}$
F_A (N)	max. attractive force between the primary and secondary parts
I_{NC}	current corresponding to force F_{NC}
I_{WC}	current corresponding to force F_{WC}
v_L (m/s)	max. short-time allowable current
R_{TH} (K/W)	thermal resistance (according to norm IEN60034-20)
R_{TH1} (K/W)	thermal resistance corresponding to designed point 1
I_{ULT} (A)	supply current the exceeding of which brings about demagnetization of magnets
R_{UV} ( )	resistance of winding at 20^0C
L_{UV} (mH)	inductance of the winding
t_{el} (ms)	electromagnetic time constant of the motor
U_{BUS} (V)	voltage of intermediate circuit of converter
k_F (N/A)	force constant of the motor
k_E (Vs/m)	voltage constant of the motor
P_1 (W)	motor losses corresponding to force F_1 by temperature of winding of 130^0C
P_{WC} (W)	motor losses corresponding to force F_{WC} by temperature of winding of 130^0C
P_{NC} (W)	motor losses corresponding to force F^{NC} by temperature of winding of 130^0C
m (kg)	mass of the primary part
m_{SEC} (kg)	mass of the secondary part
f_1 (Hz)	supply current frequency cor. to speed v_1
v_0 (m/s)	theoretic no-load speed

Type key for linear motors

L | 7 | S | K | 050 | P | - | 32 | 11 | - | F | L | - | X | 0 | - | 000

Linear (L)

Number of the series (7)
(1 , 2 , 3 , 7)

Type of the motor (S)

Synchronous	S
Induction	A
Reluctance	R

Integrated cooler (K)

Active width (050)

Part of the motor (P)

Primary	P
Secondary	S
Additional cooler	K

Number of slots in primary part (32)
Number of poles in secondary part

Slot pitch of primary part (11)
Pole pitch of secondary part

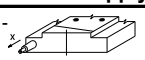
Force constant (F)

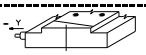
B - 8,5	H - 60	O - 180	0 - For secondary
C - 15	K - 70	P - 200	part and cooler
D - 25	I - 90	R - 250	
E - 30	J - 100	S - 300	
F - 45	L - 120	U - 350	
G - 50	N - 150	Q - 400	

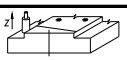
Type of the winding (L)

N	- Winding for U_{DC}=140 V $_{DC}$
L	- Winding for U_{DC}=330 V $_{DC}$
H	- Winding for U_{DC} = 560 V $_{DC}$
0	- For secondary part and cooler

Electrical supply (X)

X - 

Y - 

Z - 

0	- For secondary part and cooler
S	- Connector

Version (0)

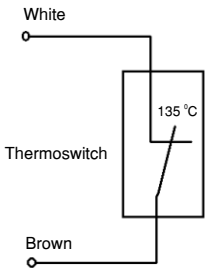
0	- Standard
1	- Dimensional deviations
2	- Electrical deviations
3	- Dimensional and electrical deviations

Serial number of the variant (000)

Standard cables

Cable	30°C*	40°C*	60°C*
4 x 0,75 + 1x (2 x 0,25)	12 A	10,4 A	7,8 A
4 x 1,5 + 1x (2 x 0,5)	18 A	15,5 A	11,7 A
4 x 2,5 + 1x (2 x 0,5)	26 A	24 A	16,8 A
4 x 4 + 1x (2 x 0,5)	42 A	38,5 A	27,5 A

*) Ambient temperature



Connection

Converter	Cable
U	1
V	2
W	3
PE	YG*
TS	White
TS	Brown

TS Thermoswitch
YG* Yelow-green

Assembly rules

The secondary part package must be removed just before it is mounted into the equipment.

The assembly must be always done by two workers.

For the case of an accident at least two solid wedges made of non-magnetic material, e.g. of stainless steel (with the angle of 10^0 to 15^0) and a hammer (approx. 3 kg) must be always at hand. It is necessary for the separation of ferromagnetic parts attracted by magnetic field to the secondary part, and possibly also for subsequent releasing of fingers, hands or feet.

The secondary part of the linear motor must never be placed with its magnetically active surface directed at the ferromagnetic parts of the equipment.

The primary part of the linear motor must never be placed directly against the secondary part.

Before starting the assembly work on the equipment where the secondary part have been already installed this part must be provided with a non-magnetic cover with the electromagnetic gap of the width approx. 25 mm (e.g. a wooden plate of the thickness 25 mm).

Any spontaneous movement (due to magnetic forces) of the primary and secondary parts of the linear motor that have not yet be built in must be prevented.

Any spontaneous movement of the secondary part or primary part of the linear motor along its assembled track must be prevented.

Special assembly facilities can be used, if necessary.

Labour protection

Because of permanent magnets (Br 1,2 T) on the secondary part, both parts of the linear motor must be handled very carefully. High-energy magnetic fields and associated high magnetic attraction forces can result both in direct life endangering (e.g. people with pacemakers) and indirect one (high speed of moving parts of the machine).
As to the influence of magnetic field to human body, the latest medical reports confirmed that magnetic field with induction lower than 5 mT does not influence it in any way. In the distance of about 100 mm magnetic field induction is already lower than 5mT. Intensity of magnetic field induced by the poles of the secondary part of the linear motors is constant and independent of the operating conditions of the machine.

Because of a high attraction force, there is necessary to pay an increased attention in the vicinity of the secondary part. That is why heavy (> 1 kg) or big (>1 dm^3) parts made of steel or iron must not be handled by naked hands close to secondary parts. As magnetic forces are invisible, they are often underestimated. Attraction forces act suddenly and can reach values higher than 500 N (50 kg) very quickly because of ferromagnetic objects being in the vicinity. Injuries caused by attracting of individual parts due to magnetic forces are very painful and unpleasant, treatment and healing of the wounds is very difficult. It is necessary to comply with particular rules in handling them. The most important ones are given below.

Main precautions

Warning plates must be located on visible places (ATTENTION: STRONG MAGNETS IN LINEAR DRIVES OF THIS MACHINE!, STRONG MAGNETIC FIELD!, HIGH MAGNETIC ATTRACTION FORCES!).

Watches and electronic data media being sensitive to magnetic field must not be put near secondary parts.

Assembly or maintenance must be carried out always in gloves.

Persons with pacemakers should not handle secondary parts.

Heavy metal objects must not be placed near secondary parts of the linear motor.

Assembly and maintenance must be carried out by trained operators.

For the case of an accident that could occur when working with linear motor at least two solid wedges made of non-magnetic material, e.g. of stainless steel (with the angle of 10^0 to 15^0) and a hammer (approx. 3 kg) must be always at hand. It is necessary for the separation of ferromagnetic parts attracted by magnetic field to the secondary part, and possibly also for subsequent releasing of fingers, hands or feet.